S.D.V.S. Sangh's

S.S.Arts College & T.P. Science Institute, Sankeshwar.

Chintakar Chawadi Report

Date of the activity	09/12/2023
Organizing Department	Department of Political science
Outcomes	women's Empowerment and Women's Reservation
No. of teachers participated	07
No. of students participated	95
Collaborating Agency	IQAC
Impact of the activity	Inspired by learning about Women's Reservation and women's Empowerment

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Chintakar Chawadi		Date : 09/12/2023
Sl. No	Name of the Teacher	Sign
01	Prof. P. B. Purji	
02	Prof. M. R Patil	
03.	Prof B. G Patil	
04	Prof. K. B. Marathe	Marathe
05	Dr. V. D. Nagneri	
06	Dr. P. V. Gadavi	
07	Dr. G. L. Rajput	

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Sl. No	Reg. No	Name	Sign
1	U15CH22A0023	Akshata. Kerimani	
2	U15CH22S0037	Amal Ramadi	
3	U15CH23S0029	Chetan. S. Khanapuri	
4	U15CH23S0023	Sahil Mujawar	
5	U15CH23S0018	Shreenath. B. Sanadi	S.B.Sanadi
6	U15CH23S0049	Abhishek. P. Kamble	
7	U15CH23S0017	Tejashree Bandekar	
8	U15CH23S0020	Vaibhavi. S. Suryavanshi	
9	U15CH23S0003	Shivaprasad. Gunachari	
10	U15CH23S0015	Vivek Kori	
11	U15CH23S0051	Vijay. Ramugoudti	
12	U15CH23S0035	Balakrishna. Tandalekar	
13	U15CH23S0009	Naveen Uppar	
14	U15CH22A0078	Mushabbarin Kadalji	
15	U15CH22A0080	Mahek Kalawant	
16	U15CH23A0009	Chandana. B. Khanapur	
17	U15CH23A0001	priyanka Patil	
18	U15CH23A0080	Laxmi Hegade	
19	U15CH23A0085	Keerti patrot	
20	U15CH22A0065	Soumya. S Gudimani	
21	U15CH22A0071	Jyoti Pokale	
22	U15CH22A0092	Poornima. Shettennavar	
23	U15CH22A0084	Prachi Kulkarni	
24	U15CH23A0077	Bharati Jayakar	
25	U15CH22A0116	pranali k Gundakolli	
26	U15CH22A0117	Sonali M pandhari	
27	U15CH23S0011	soujanya R Matiwaddar	
28	U15CH23S0027	Priya. S. Mavadi	
29	U15CH23S0029	Rahul. K. Halaj	
30	U15CH23S0034	Rakshita. B. Zirli	
31	U15CH23S0043	Laxmi. S. Aragundi	
32	U15CH23S0001	Rida. S. Patel	
33	U15CH23S0002	Farzeha. M. Patel	
34	U15CH23S0031	Bhargavi Balkutagi	
35	U15CH23S0026	Vijayalaxmi. S. Koli	

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Sl. No	Reg. No	Name	Sign
36	U15CH22A0037	SHANKAR. PUJERI.	
37	U15CH22A0111	Kaushik Bidampuri	Kaushik
38	U15CH22A0110	Abhishek. Raju. Managuli	
39	U15CH22A0129	Vinod. MUKENNAVAR	
40	U15CH22A0143	Prajwal. Talawar	Ptalawar
41	U15CH22A0108	PRAJWAL VYAPARI	
42	U15CH22A0096	Balesh. Moodki	
43	U15CH22H0249	Sanjana Hebbal	
44	U15CH22A0051	Balesh. I. Shidlihal	
45	U15CH22A0141	Darshan. Kabadar	
46	U15CH22A0112	Alagouda. D. Desai	
47	U15CH23S0008	Samruddhi. A. Ravaloji	
48	U15CH22A0056	Kajal R Habib	Kahabib
49	U15CH22A0057	Rukuja A Khanai	
50	U15CH22A0024	Rekha A. Koli	
51	U15CH22A0048	ARCHANA. D. KALAL	A.D.Kalal
52	U15CH22A0006	Deepali. S. Patil	
53	U15CH22A0066	Sampada. S. Vasadannavar	
54	U15CH23A0025	Laxmi L Palchapure	
55	U15CH23A0004	Shilpa. Patil	
56	U15CH23A0005	Shruti. Magadum	S.M.M
57	U15CH23A0002	Divya. A. Malagi.	DAMalagi
58	U15CH23A0137	Jyoti Talawar	
59	U15CH23A0136	Sumati. Pujeri	
60	U15CH23A0033	Padmaja. Patil	P.K.Patil
61	U15CH23A0038	Srushti. Girimallnavar	
62	U15CH23A0011	Reshma. V. Babalkavi	
63	U15CH23A0029.	Haveri, A. Madihalli	
64	U15CH23A0113	Ashwini A. Waghamare	A.A.W
65	U15CH23A0055	Sneha M. Chorabagi	
66	U15CH23A0026	Bheemappa B. Akkisagar	
67	U15CH22A0018	Sachin. A. Khanai	S.A.Khanai
68	U15CH22A0147	Omkar Y. Mahajan.	
69	U15CH23A0120	Kadambari Pradanji	
70	U15CH23A0114	Mahesh Nau	

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Sl. No	Reg. No	Name	Sign
71	U15CH22S0018	Priyanka. V. Gavari	
72	U15CH22S0030	Atufa. Attar	
73	U15CH22A0005	Asha B Naganuri	
74	U15CH22A0157	Zuja . M. Bagalkoti	
75	U15CH22A0047	Saniya. S Nadaf	
76	U15CH22A0009	Kedari. R. Kalagate.	
77	U15CH22A0002	Basavaraj. B. Patil	
78	U15CH22A0125	Prerana. V. Rampure	P. V. R
79	U15CH22A0060	Swati. S. Ajarekar	
80	U15CH22A0068	Laxmi. R. Chougala	L. R. C
81	U15CH22A0070	Lakshi. N. Patil	
82	U15CH22A0058	Vidya. R. Sankeshwari	
83	U15CH22A0014	Tungabhadra. R. Hasure	
84	U15CH23S0024	Sanjana. N. Kamatagi	
85	U15CH23S0038	Pooja - Talawar	
86	U15CH23S0025	Swati . Patil	
87	U15CH23S0044	Muskan. Ladakhan	
88	U15CH23A0093	Akash Talawar	
89	U15CH23A0143	Anjana. Managanvi.	
90	U15CH23A0098	Deepa. H. Hugar	
91	U15CH23A0076	Pavitra. M. Belageri	P. M. Belagri
92	U15CH23A0008	Triveni R. Khatedar	
93	U15CH23A0015	Keerti. B. Naik	
94	U15CH22A0073	Manjunath Kariyagi	
95	U15CH23A0020	Shiva. pathi	
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: ಮಹಿಳಾ ಮೀಸಲಾತಿ :

ಲೋಕಸಭೆಯಲ್ಲಿ ಮಹಿಳಾ ಮೀಸಲಾತಿ ಮಸೂದೆ ೨೦೨೩ ರ ಮುಖ್ಯವಾಗಿದೆ. 19 ಸೆಪ್ಟೆಂಬರ್ ೨೦೨೩ ರಂದು ಸಂವಿಧಾನ 128 ತಿದ್ದುಪಡಿ ಮಸೂದೆ ೨೦೨೩ ಅನ್ನು ಲೋಕಸಭೆಯಲ್ಲಿ ಪರಿಚಯಿಸಲಾಯಿತು. ಸಂಸತ್ತು ಮತ್ತು ರಾಜ್ಯ ಶಾಸಕಾಂಗಗಳಲ್ಲಿ 1/3 ಸ್ಥಾನಗಳ ಮೀಸಲಾತಿಗೆ ಕಾರಣ ಮಾಡಿಕೊಡುವ ಮೂಲಕ. ಬಹುಶಃ ೨೦೦೨ ರ ಸಾರ್ವತ್ರಿಕ ಚುನಾವಣೆಯಿಂದ ೨೦ ಸೆಪ್ಟೆಂಬರ್ ನಲ್ಲಿ ಸದಸ್ಯರಲ್ಲಿ ಸುಮಾರು 100% ಬಹುಮತದೊಂದಿಗೆ ಮಸೂದೆಯನ್ನು ಅಂಗೀಕರಿಸಿತು.

ರಾಜಕೀಯದಲ್ಲಿ ಮಹಿಳೆ ಮೀಸಲಾತಿ :

ಮಹಿಳಾ ಮೀಸಲಾತಿ ವಿಚಾರ ಸ್ವಾತಂತ್ರ್ಯ ಹೋರಾಟದ ಕಾಲದಿಂದಲು ಇದೆ. ಸಂವಿಧಾನ ರಚನಾ ಸಭೆಯ ಚರ್ಚೆಯ ಸಮಯದಲ್ಲಿಯು ಸಹ, ಈ ವಿಷಯವು ಪ್ರಸ್ತಾಪವಾಯಿತ್ತು. ಆನಂತರ ಪ್ರಾತಿನಿಧ್ಯವು ಎಲ್ಲಾ ಗುಂಪುಗಳ ಜನರಿಗೆ ಸಮಾನ ಪ್ರಾತಿನಿಧ್ಯವನ್ನು ನೀಡುತ್ತದೆ. ಬಂಲು ಕಾರಣದಿಂದ ಅದನ್ನು ತಿರಸ್ಕರಿಸಲಾಯಿತು.

ರಾಜಕೀಯದಲ್ಲಿ ಮಹಿಳಾ ಪ್ರಾತಿನಿಧ್ಯದಲ್ಲಿ ಯಾವುದೇ ಸುಧಾರಣೆ ಕಂಡು ಬಂದಿಲ್ಲ & ಸಂಖ್ಯೆಗಳು ಕಳಪೆಯಾಗಿ ಮುಂದುವರೆಯಿತು.

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ಮಹಿಳಾ ಮೀಸಲಾತಿಯ ಲಾಭಗಳು:

① ಮಸೂದೆಯು 454-ಕ್ಕಿಂತ ಹೆಚ್ಚು ಮತದಾರರನ್ನು ಪಡೆದಿತು. ಇದೇ ಮೊದಲ ಬಾರಿಗೆ ಮಂಡಲ ಮೀಸಲಾತಿ ಮಸೂದೆಯನ್ನು ಕೆಳಮನೆಯಲ್ಲಿ ಮತಕ್ಕೆ ಹಾಕಲಾಯಿತು.

② ಮುಂದಿನ ದಿನಗಳಲ್ಲಿ ರಾಷ್ಟ್ರಪತಿಯ ಆಡಳಿತವನ್ನು ತೆರವು ಗೊಳಿಸಲು ಮಸೂದೆ ಸಿದ್ಧವಾಗಿದೆ.

③ 33% ಕೋಟಾದೊಳಗೆ, SC, ST ಮತ್ತು ಆಂಗ್ಲೋ ಇಂಡಿಯನ ಸಮುದಾಯಗಳಿಗೆ ಉಪ-ಮೀಸಲಾತಿ ಇರುತ್ತದೆ.

④ ಪ್ರಸ್ತುತ ಮೀಸಲಿಟ್ಟ ಸ್ಥಾನಗಳ ಸಂಖ್ಯೆ-ಅಂದರೆ 543, 1971 ರಲ್ಲಿ ನಡೆದ ಕೊನೆಯ ಜನಗಣತಿಯನ್ನು ಆಧರಿಸಿದೆ.

⑤ ಜನಗಣತಿಯನ್ನು 2021 ರಲ್ಲಿ ನಡೆಸಲೇಬೇಕಿತ್ತು. ಆದರೆ ಕೊರೋನ-19 ಸಾಂಕ್ರಾಮಿಕ ರೋಗವು ಅದನ್ನು ಅನಿರ್ದಿಷ್ಟವಾಗಿ ಮುಂದೂಡಲ್ಪಟ್ಟಿದೆ.

⑥ ಮುಂದಿನ ಡಿಲಿಮಿಟೇಶನ ಜನಗಣತಿಯ ನಂತರ ಮೀಸಲು ಶಕ್ತಿಯ ಸ್ಥಾನಗಳ ಸಂಖ್ಯೆ ಶಿಫಾರಸ್ಸಿಗೆ ಒಳಪಡುವುದು.

⑦ ಡಿಲಿಮಿಟೇಶನ ಕಸರತ್ತು ನಡೆದ ನಂತರವೇ ಮಸೂದೆ ಜಾರಿಗೆ ಬರಲಿದೆ. ಹಾಗಾಗಿ 2029 ರ ಚುನಾವಣೆಯಲ್ಲಿ ಇದು ಜಾರಿಯಾಗುವ ಸಾಧ್ಯತೆ ಇದೆ.

⑧ ಮಂಡ್ಯೆಯವರಿಗೆ ಮಾತ್ರವೇ ಒಂದು ಸ್ಥಾನವನ್ನು ಮೀಸಲಿಟ್ಟ ಸಂವಿಧಾನ ತಿದ್ದುಪಡಿಯಲ್ಲಿ ನೀಡಲಾಗಿದೆ.

ಮೊಘಲ್ ಚಿತ್ರಕಲೆಯ ಲಕ್ಷಣಗಳು:

ಮೊಘಲ್ ಚಿತ್ರಕಲೆ ಮಸ್ಲಾದೆಯನ್ನು ಕೆಲವರು ತೀವ್ರವಾಗಿ ವಿರೋಧಿಸುತ್ತಿದ್ದಾರೆ. ಅವರ ವಾದಗಳನ್ನು ಕೆಳಗೆ ಉಲ್ಲೇಖಿಸಲಾಗಿದೆ.

(1) ಮೊಘಲರಿಗೆ ಚಿತ್ರಕಲೆ ನೀಡುವುದು ಸಂವಿಧಾನದಲ್ಲಿ ಪ್ರತಿಪಾದಿಸಿರುವ ಸಮಾನತೆಯ ತತ್ವಕ್ಕೆ ವಿರುದ್ಧವಾಗಿದೆ.

(2) ಮೊಘಲರು ಪಾತಿ ಗುಂಪುಗಳಂತೆ ಬಹಳಷ್ಟು ಗುಂಪನ್ನು ರಚಿಸುವುದಿಲ್ಲ. ಇದ್ದರಿಂದ ಮೊಘಲ್ ಚಿತ್ರಕಲೆಯು ಪಾತಿ ಧರ್ಮದಂತೆ ಚಿತ್ರಕಲೆಗೆ ಹೊಲುವಂತಿಲ್ಲ ಮತ್ತು ಬರಡಕ್ಕು ಇಂದೇ ಮಾನವನ್ನು ಮಾಡಲಾಗುವುದಿಲ್ಲ

(3) ಸಂಸತ್ತಿನ ಸ್ಥಾನಗಳ ಚಿತ್ರಕಲೆಯು ಮೊಘಲ್-ಅಲ್ಪಸಂಖ್ಯಾತರಿಗೆ ಮತದಾರರ ಭಿನ್ನಿಮನ್ನು ನಿರ್ಧರಿಸುತ್ತದೆ. ಏಂದು ಕೆಲವರು ವಾದಿಸುತ್ತಾರೆ.

(4) ಸಂಸತ್ತಿನ ಸ್ಥಾನಗಳ ಚಿತ್ರಕಲೆಯು ಮೊಘಲ್ ಅಲ್ಪಸಂಖ್ಯಾತರಿಗೆ ಮತದಾರರ ಭಿನ್ನಿಮನ್ನು ನಿರ್ಧರಿಸುತ್ತದೆ. ಏಂದು ಕೆಲವರು ವಾದಿಸುತ್ತಾರೆ.

(5) ರಾಜಕೀಯ ಪಕ್ಷಗಳು ಮೊಘಲರನ್ನು ಗೆಲ್ಲಲಾಗದ ಸ್ಥಾನಗಳಿಂದ ಸ್ಪರ್ಧಿಸಲುವುದು ಅಥವಾ ಅವರು ಸ್ಪರ್ಧಿಸುವ ಸ್ಥಾನಗಳಿಂದ ಅವರು ಗೆಲ್ಲದಿರಲುವುದು ಏಂದು ಇದು ಖಚ್ಚಿತವಾಗಲುವುದು.

⑥ ಈ ಪ್ರತಿಪಾದನೆಯು "ಆದರ್ಶ ಕುಟುಂಬ ಎಂದು ಪರಿಗಣಿ-
ಸಲ್ಪಡುವ ನಾಶಕ್ಕೆ ಕಾರಣವಾಗಬಹುದು. ಎಂದು ಕೆಲವು
ವಿಭಾಗಗಳು ವಾದಿಸುತ್ತವೆ.

⑦ ಪ್ರಸ್ತುತ ಮಸೂದೆಯು ರಾಜ್ಯಸಭೆ & ರಾಜ್ಯ ವಿಧಾನ ಪರಿಷತ್ತು-
ಗಳಲ್ಲಿ ಮಹಿಳಾ ಮೀಸಲಾತಿಯನ್ನು ಒದಗಿಸುವುದಿಲ್ಲ

⑧ ಮಹಿಳೆಯರ ಅಸಮಾನ ಸ್ಥಿತಿ ಇದು ಮಹಿಳೆಯರ ಅಸಮಾನ
ಸ್ಥಿತಿಯನ್ನು ಶಾಶ್ವತಗೊಳಿಸುತ್ತದೆ. ಎಂದು ವಾದಿಸಲಾಗಿದೆ.

⑨ ಮತದಾರರ ಆಯ್ಕೆಯನ್ನು ನಿರ್ಬಂಧಿಸುತ್ತದೆ. ಸಂಸತ್ತಿನಲ್ಲಿ
ಮಹಿಳೆಯರಿಗೆ ಸ್ಥಾನಗಳ ಮೀಸಲಾತಿಯು ಮತದಾರರ ಆಯ್ಕೆ-
ಯನ್ನು ಅವರು ಆದ್ಯತೆ ನೀಡಬಹುದಾದ ಅಥವಾ ಇಲ್ಲದಿರುವ
ಮಹಿಳಾ ಅಭ್ಯರ್ಥಿಗಳಿಗೆ ನಿರ್ಬಂಧಿಸುತ್ತದೆ.

Name : Saniya. S. Nadaf
Reg : U15CH22A0047

ಮಹಿಳಾ ಮೀಸಲಾತಿ

ಮಹಿಳಾ ಮೀಸಲಾತಿ ಎಂಬುದು ಮಹಿಳೆಯರಿಗೆ ವಿವಿಧ ಕ್ಷೇತ್ರಗಳಲ್ಲಿ (ರಾಜಕೀಯ, ಶಿಕ್ಷಣ, ಉದ್ಯೋಗ, & ಇತರ) ಸಮಾನ ಅವಕಾಶಗಳನ್ನು ನೀಡಲಾಗಿರುವ ಯಾವುದೇ ನೀತಿಗಳು ಮತ್ತು ಕ್ರಮಗಳನ್ನು ಸೂಚಿಸುತ್ತದೆ.

ಜಗತ್ತಿನ ಶ್ರೇಷ್ಠ ಚಿಂತಕರಲ್ಲಿ ಒಬ್ಬರಾದ ಮೈಕ್ಹೆಲ್ಏಂಜಲೋ ಅವರು ಹೇಳುತ್ತಾರೆ "ಯಾವುದು ಉತ್ತಮ ಪ್ರಜಾಪ್ರಭುತ್ವವೆಂದರೆ? ಮಹಿಳೆಯರಿಗೆ ಕೇವಲ ಮತದಾನ ಮಾಡುವ ಹಕ್ಕು ಮಾತ್ರವಲ್ಲದೆ ಅವರಿಗೆ ಪುರುಷರಿಗಿಂತ ಹೆಚ್ಚು ಇದ್ದಾಗ ಮಾತ್ರ ಒಂದು ಶ್ರೇಷ್ಠವಾದ ಪ್ರಜಾಪ್ರಭುತ್ವ ಸ್ಥಾಪನೆ ಸಾಧ್ಯ". ಶತಶತಮಾನಗಳಿಂದಲು ಸಮಾಜದ ಒಂದು ಮೂಲೆಗೆ ಮೀಸಲಾಗಿದ್ದ ಮಹಿಳೆಗೆ ಅದೇ ಸಮಾಜದಲ್ಲಿ ಉನ್ನತ ಸ್ಥಾನವನ್ನು ಅಲಂಕರಿಸಲು, ಸಮಾಜವನ್ನು ಸುಧಾರಣೆಮಾಡಲು, ಮಹಿಳಾ ಸಬಲೀಕರಣಕ್ಕೆ ಹೆಗಲು ಕೊಡಲು ಮಹಿಳಾ ಮೀಸಲಾತಿ ಮಸೂದೆ 2023 ರಾಷ್ಟ್ರಪತಿಗಳಿಂದ ಅಂಗೀಕಾರಗೊಂಡಿದೆ. ಭಾರತದಲ್ಲಿ ಅಂಗ ಅಸಮಾನತೆಯು ಲಿಂಗಾಧಾರಿತವು ಸಮುದ್ರದಲ್ಲಿ ಮಹಿಳಾ ಮೀಸಲಾತಿ ಮಸೂದೆ ಒಂದು ಭರವಸೆಯು ದೀಪಸ್ತಂಭವಾಗಿದೆ.

1996 ರಲ್ಲಿ ಮಹಿಳಾ ಮೀಸಲಾತಿ ಮಸೂದೆಯನ್ನು ಪರಿಚಯಿಸಲಾಯಿತು. ಈ ಮಸೂದೆ ಸಂಸತ್ತು ರಾಜ್ಯ ವಿಧಾನಸಭೆ ಮತ್ತು ದೆಹಲಿ ಅಸೆಂಬ್ಲಿಗಳಲ್ಲಿ ಮಹಿಳೆಯರಿಗೆ 33% ಸ್ಥಾನಗಳನ್ನು ಮೀಸಲಿಡಲು ಪ್ರಯತ್ನಿಸುತ್ತದೆ. ಲಿಂಗಸಮಾನತೆಯು ಕುರಿತ ಸಂವಿಧಾನಕರವಾಗಿ ಭರವಸೆ ಇದ್ದರೂ ಸಹ ರಾಜಕೀಯ ಮೇಲಿನವರಲ್ಲಿ ಮಹಿಳಾ ಪ್ರಾತಿನಿಧ್ಯ ಬಹಳಷ್ಟು ನಿರಾಶಾದಾಯಕವಾಗಿದೆ. ಈ ಮಸೂದೆ ಭಾರತದ ಜನಸಂಖ್ಯೆಯ ಸುಮಾರು ಅರ್ಧದಷ್ಟು ಭಾಗವನ್ನು ಹೊಂದಿರುವ ಮಹಿಳೆಯರ ವಿರುದ್ಧದ ಐತಿಹಾಸಿಕ ಪಕ್ಷಪಾತ ಮತ್ತು ತಾರತಮ್ಯವನ್ನು ಸರಿಪಡಿಸುವತ್ತ ಇದು ಒಂದು ಹೆಜ್ಜೆಯಾಗಿದೆ. ಕೇವಲ ಭಾರತ ಮಾತ್ರವಲ್ಲದೇ ಪ್ರಪಂಚದಾದ್ಯಂತ ಮಹಿಳಾ ರಾಜಕೀಯ ಪ್ರಾತಿನಿಧ್ಯ ಕಳಪೆಯಾಗಿದೆ.

ವಿಶ್ವಸಂಸ್ಥೆ ಸಹ ತನ್ನ ಸಂಸ್ಥೆಯ ಅಭಿವೃದ್ಧಿ ಗುರಿಗಳ ಮಹಿಳಾ ಸಾಮರ್ಥ್ಯದಲ್ಲಿ ಮಹಿಳೆಯರ ಸಬಲೀಕರಣ ಭಾಗವಹಿಸುವಿಕೆಯು ಅಗತ್ಯವನ್ನು ಒತ್ತಿಹೇಳುತ್ತದೆ. ಉದಾಹರಣೆಗೆ ರುವಾಂಡಾ ಸಾಮೂಹಿಕ ಸ್ವೀಡನ್ ನಂತಹ ದೇಶಗಳ ಸಂಸತ್ತಿನಲ್ಲಿ ಈ 50 ಕ್ಕಿಂತ ಹೆಚ್ಚು ಮಹಿಳೆಯರಿದ್ದಾರೆ.

ಇಷ್ಟೆಲ್ಲಾ ಮಹತ್ವಗಳಿಂದ ಮಹಿಳಾ ಮೀಸಲಾತಿ ಮಸೂದೆ ಭಾರತದ ಸಂಸತ್ತಿನಲ್ಲಿ ಚರ್ಚೆಯಾಗುತ್ತಿದೆ. ಆದಾಗ್ಯೂ, ಸೆಪ್ಟೆಂಬರ್ 20, 2023 ರಂದು ಲೋಕಸಭೆಯಲ್ಲಿ ಕಾಯ್ದೆಯಾಗುವಲ್ಲಿ ಲಂಗ ಸಮಾನತೆಯತ್ತ ಮಹತ್ವದ ಹೆಜ್ಜೆ ಇಟ್ಟಾಗ ಮಹತ್ವದ ಬೆಳವಣಿಗೆ ಕಂಡುಬಂದಿದೆ. ಮಹಿಳಾ ಮೀಸಲಾತಿ ಮಸೂದೆಯನ್ನು ಲೋಕಸಭೆಯಲ್ಲಿ ಮತಕ್ಕೆ ಹಾಕಲಾಯಿತು & ಪರವಾಗಿ 454 ಮತಗಳನ್ನಾಂದಿಗೆ ಬಹುಮತದೊಂದಿಗೆ ಅಂಗೀಕರಿಸಲಾಯಿತು.

ಮಹಿಳಾ ಮೀಸಲಾತಿ ಮಸೂದೆ ಇದು ಭಾರತದ ಸಂಸತ್ತು & ರಾಜ್ಯ ವಿಧಾನ ಸಭೆಗಳಲ್ಲಿ ಮಹಿಳೆಯರ ಪ್ರಾತಿನಿಧ್ಯವನ್ನು ಹೆಚ್ಚಿಸುವ ಗುರಿಯನ್ನು ಹೊಂದಿರುವ ಭಾರತದಲ್ಲಿ ಪ್ರಸ್ತಾವಿತ ಶಾಸನವಾಗಿದೆ. ಈ ಮಸೂದೆಯು ಈ ಶಾಸಕಾಂಗ ಸಂಸ್ಥೆಗಳಲ್ಲಿ ಮಹಿಳೆಯರಿಗೆ ಪ್ರತ್ಯೇಕವಾಗಿ ನಿರ್ದಿಷ್ಟ ಕೋಟಾವನ್ನು ಸ್ಥಾಪಿಸುವ ಮೀಸಲಾತಿ ಪ್ರಯತ್ನಿಸುತ್ತದೆ.

ಮಹಿಳಾ ಮೀಸಲಾತಿ ಮಸೂದೆಯು ಮೊದಲ ಪುನರಾವರ್ತನೆಯನ್ನು ಸೆಪ್ಟೆಂಬರ್ 1996 ರಲ್ಲಿ 81 ನೇ ಸಾಂವಿಧಾನಿಕ ತಿದ್ದುಪಡಿ ಮಸೂದೆಯಾಗಿ ಲೋಕಸಭೆಗೆ ಮಂಡಿಸಲಾಯಿತು. ಸದನವು ಅದನ್ನು ತಿರಸ್ಕರಿಸಿದ ನಂತರ ಮಸೂದೆಯನ್ನು ಗೀತಾ ಮುಖರ್ಜಿ ನೇತೃತ್ವದ ಜಂಟಿ ಸಂಸದೀಯ ಸಮಿತಿಗೆ ಉಲ್ಲೇಖಿಸಲಾಯಿತು & ಸಮಿತಿಯು ವರದಿಯನ್ನು ಡಿಸೆಂಬರ್ 1996 ರಲ್ಲಿ ಲೋಕಸಭೆಗೆ ಮಂಡಿಸಲಾಯಿತು. ಇತ್ತೀಚೆಗೆ ಮಹಿಳಾ ಮೀಸಲಾತಿ ಮಸೂದೆಯನ್ನು ಲೋಕಸಭೆಯಲ್ಲಿ ಸಂವಿಧಾನ (128 ನೇ ತಿದ್ದುಪಡಿ) ಮಸೂದೆಯಾಗಿ ಮಂಡಿಸಲಾಗಿದೆ. ಲೋಕಸಭೆ & ರಾಜ್ಯ ವಿಧಾನಸಭೆಗಳಲ್ಲಿ, ಪರಿಚಯಿಸಿದ ಶಾಸನದ ಅಡಿಯಲ್ಲಿ ಮಹಿಳೆಯರು 33% ಸ್ಥಾನಗಳನ್ನು ಪಡೆಯುತ್ತಾರೆ.

⇒ ಮುಖ್ಯ ಮೀಸಲಾತಿಯ ಉದ್ದೇಶಗಳು :—

1) ಸಮಾನ ಅವಕಾಶಗಳ ನಿವಾರಣೆ.

ಮುಖ್ಯಲೆಂಯಂತೆ ಶೈಕ್ಷಣಿಕ, ಆರ್ಥಿಕ, ರಾಜಕೀಯ ಮತ್ತು ಸಾಮಾಜಿಕ ಕ್ಷೇತ್ರಗಳಲ್ಲಿ ಸಮಾನ ಅವಕಾಶಗಳನ್ನು ಕಲ್ಪಿಸುವುದು.

2) ಸಾಮಾಜಿಕ & ಆರ್ಥಿಕ ಅಭಿವೃದ್ಧಿ.

ಮುಖ್ಯಲೆಂಯರು ಉದ್ಯೋಗ, ವ್ಯವಹಾರ ಹಾಗೂ ಸಾಂಸ್ಥಿಕರಾಗುವ ಅವಕಾಶಗಳನ್ನು ಪಡೆದು ಸಮಾಜದಲ್ಲಿ ತಮ್ಮ ಸ್ಥಾನವನ್ನು ಬಲಪಡಿಸಲು ನೆರವಾಗುವುದು.

3) ಅಂತಿನ ವೃದ್ಧಿ.

ಮುಖ್ಯಲೆಂಯರಲ್ಲಿ ಶೈಕ್ಷಣಿಕ & ವೃತ್ತಿಪರ ಅಂತು ಹೆಚ್ಚಿಸುವ ಮೂಲಕ ಅವರ ಆತ್ಮವಿಶ್ವಾಸವನ್ನು ಬೆಳೆಸುವುದು.

4) ಶ್ರಮಪ್ಕೀಕರ & ಪೌಜನ್ಯ ನಿವಾರಣೆ.

ಮುಖ್ಯಲೆಂಯರು ಪೌಜನ್ಯ, ಶೋಷಣೆ & ಹಿಂಸೆಯಿಂದ ವಿಮುಕ್ತರಾಗಲು ಬಲ ನೀಡುವುದು.

5) ರಾಜಕೀಯದಲ್ಲಿ ಭಾಗವಹಿಸುವಿಕೆ.

ಸ್ಥಳೀಯ ಸಂಸ್ಥೆಗಳು & ರಾಜ್ಯ / ರಾಷ್ಟ್ರೀಯ ಮಟ್ಟದಲ್ಲಿ ಮುಖ್ಯಲೆಂಯರು ಹೆಚ್ಚು ಸ್ಥಾನವನ್ನು ಪಡೆಯಲು ಅವಕಾಶ ಕಲ್ಪಿಸುವುದು.

6) ಸಮಾಜದ ಸಮತೋಲನ.

ಮುಖ್ಯಲಾ ಮೀಸಲಾತಿ ಮೂಲಕ ಸಮಾನ ಅವಕಾಶಗಳನ್ನು ನೀಡುವ ಮೂಲಕ ಸಮಾಜದಲ್ಲಿ ಅಂಗ ಸಮತೋಲನವನ್ನು ಕಾಪಾಡುವುದು.

7) ಅನ್ಯಾಯ ನಿವಾರಣೆ.

ಐತಿಹಾಸಿಕ ಕಾರಣಗಳಲ್ಲಿ ಮುಖ್ಯಲೆಂಯರಿಗೆ ತೊಂದರೆ ನೀಡಲಾಗಿದ್ದ ಪ್ರದೇಶಗಳಲ್ಲಿ ನ್ಯಾಯವನ್ನು ಒದಗಿಸುವುದು.

Name:- Doddavva. S. Shivapur
Reg. No:- U15CH22A00999.

S.S. Arts College & T.P. Science Institute SANKESHWAR 591313

PRINCIPAL
S.S. Arts College & T.P. Science Institute
SANKESHWAR

SDVS SANGH'S

S.S.ARTS AND T.P.SCIENCE INSTITUTE,SANKESHWAR

Affiliated to Rani-Chennamma University, Belagavi, Karnataka, India

A PROJECT REPORT

ON

"FOLIAR DUST DEPOSITION AND ITS IMPACT ON CHLOROPHYLL CONTENT OF THE PLANTS FROM POLLUTED AND UNPOLLUTED AREAS OF SANKESHWAR, KARNATAKA"

SUBMITTED TO

DEPARTMENT OF BOTANY

SDVS SANGH'S

S.S.ARTS AND T.P.SCIENCE INSTITUTE, SANKESHWAR

As the partial fulfillment for the award of Bachelor Degree in Science

(Bachelor of Science)

S.S. Arts College & T. P. Science Institute SANKESHWAR, 591313

SUBMITTED BY

Miss. Pankaja S Jain U15CH21S0081
Miss. Aruna M Nayak U15CH21S0064
Miss. Sartajbi J Inamdar U15CH21S0075
Miss. Saraswati R Kamble U15CH21S0055
Miss. Shrushti B Patil U15CH21S0078
Mr. Dastagir R Multani U15CH21S0001

2023-24

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SDVS SANGH'S

S.S.ARTS AND T.P.SCIENCE INSTITUTE, SANKESHWAR

Affiliated to Rani-Chennamma University, Belagavi, Karnataka, India

CERTIFICATE

This is to certify that the project report entitled "Foliar dust deposition and its impact on chlorophyll content of the plants from polluted and unpolluted areas of Sankeshwar, Karnataka" submitted to Department of Botany as a partial fulfillment for the award of Bachelor of Science is based on the results of the project work carried out by the students under my supervision.

Place: Sankeshwar

Date: 17-08-2024

S.S. Arts College & T. P. Science Institute SANKESHWAR 591313

17/8/2024

Dr. Irawwa B Gokak
Project Supervisor

Principal

PRINCIPAL
S. S. Arts College & T P Science Institute
SANKESHWAR.

External Examiner

(P.A-Sangappagol)

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DEDICATED TO

OUR BELOVED FAMILY MEMBERS,

FRIENDS AND TEACHERS

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INTRODUCTION

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INTRODUCTION

Air pollution arising from different sources represents a serious environmental threat to all living organisms, including vegetation. Monitoring air contamination levels is necessary to detect pollution levels, regulate atmospheric pollution, and ultimately improve ambient air quality. Studies suggest that one of major sources of urban air pollution is due to traffic emitting CO2, CO, NOx, other gaseous compounds as well as dust and soot particulate matter (PM). Furthermore, this pollution causes significant environmental damages on vegetation (Hosker and Lindbergh 1982). Dust deposits on leaf of urban trees may contain particulate matter (PM), non-gaseous components, carbon compounds, metals, pollen and soil particles. Atmospheric particulate matter causes respiratory and vascular diseases. Vehicles are major sources of Heavy Metals (Pb, Zn, Cu, Ni and Fe) particles (Christoforidis and Stamatis 2009). Heavy Metals pollution under urban conditions is strongly associated with Particulate Matter.

Leaf is the most sensitive part to be affected by air pollutants instead of all other plant parts such as stem and roots. The sensitivity rests on the fact that the major portions of the important physiological processes are concerned with leaf. Therefore, the leaf at its various stages of development serves as a good indicator of air pollution. Pollutants came from the auto emission can directly affect the plant by entering into the leaf, destroying individual cells, and reducing the plant ability to produce food. The response of the plant to dust accumulation may vary according to different species, as dust deposition fluctuates with plant species due to leaf orientation, leaf surface geometry, phyllotaxy, epidermal and cuticular features, leaf pubescence, height and canopy of roadside.

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Leaf surface is an important entrap for dust (Chen et al. 2014). Plant leaves have been used as indicators and monitors to trace metal pollution (Jensen et al. 1992; Jim and Chen 2008). Moreover, in some cases higher plants

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may give better quantifications for pollutant concentrations and atmospheric deposition than non-biological samples. Fine anthropogenic particles were often observed around and over the stomata which may affect the physiological characteristics of leaves (Saebo et al. 2012; Simon et al. 2014). These particles cause increased leaf temperature and decreased light absorption affecting the photosynthesis in plants. Trees can remove large numbers of airborne particles, hence improving the quality of air in polluted environments (Jensen et al. 1992; Beckett et al. 1998). Particulate Matter deposition depends on meteorological conditions mainly precipitation and wind speed, the particles size and shape, morphological characteristics of the plants, canopy structure and the planting configuration (Beckett et al. 2000a; Yuan et al. 2009; Saebo et al. 2012; Mori et al. 2015).

The leaf structure, roughness, presence of trichomes, stomata size and density may influence the dust and Particulate Matter deposit on rough leaf surfaces (Beckett et al. 2000b). The estimation of the air cleansing capacity of urban trees requires in situ measured data on various urban tree species concerning the dust and Heavy Metal deposition on their leaves. However, the situation is more complicated as trees in street canyons may reduce the air circulation and therefore may lead to higher local Particulate Matter concentrations. Therefore, Chen et al. (2016) suggest designing proper configuration of planting spaces to improve the purification function of urban trees. A review of the literature reveals that air pollutants adversely affect the physiological and biochemical processes in plants, causing leaf injuries, stomata closure, and premature leaf senescence. Air pollutants can also hamper the photosynthetic activities by reducing the total chlorophyll contents, which will lead to a decline in carbohydrates production. Furthermore, the generation of reactive oxygen species (ROS) will cause various effects on plants, from the oxidative damage of macromolecules to the variation of antioxidant synthesis rates (Prajapati 2012, Rai 2016, Kumar et al. 2018).

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Pollutants can cause leaf injury, stomata damage, premature senescence, decrease photosynthetic activity, disturb membrane permeability and reduce growth and yield in sensitive plant species (Tiwari et al 2006). Reductions in leaf area and leaf number may be due to decreased leaf production rate and enhanced senescence. The reduced leaf area results in reduced absorbed radiations and subsequently in reduced photosynthetic rate (Tiwari et al 2006).

These pollutants, when absorbed by the leaves, may cause a reduction in the concentration of photosynthetic pigments viz., chlorophyll and carotenoids, which directly affected to the plant productivity (Joshi and Swami 2009).A relationship between traffic density and photosynthetic activity, stomatal conductance, total chlorophyll content, and leaf senescence has been reported (Honnur et al 2009). One of the most common impacts of air pollution is the gradual disappearance of chlorophyll and concomitant yellowing of leaves, which may be associated with a consequent decrease in the capacity for photosynthesis (Joshi and Swami 2007). Chlorophyll is found in the chloroplasts of green plants and is called a photoreceptor. Chlorophyll is the principal photoreceptor in photosynthesis, the light-driven process in which carbon dioxide is "fixed" to yield carbohydrates and oxygen. When plants are exposed to the environmental pollution above the normal physiologically acceptable range, photosynthesis gets inactivated. Chlorophyll measurement is an important tool to evaluate the effects of air pollutants on plants as it plays an important role in plant metabolism. The evaluation of dust removal capacity of several common tree species requires investigations in interaction with urban conditions, but such measurements and data are very little known. In view of the above the present mini project work has been undertaken to study the potential impact of the pollution on the photosynthetic efficiency of the plants in terms of the chlorophyll content with following objectives.

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OBJECTIVES OF THE STUDY

- To estimate the dust deposition on the leaves of the plants growing in polluted and unpolluted areas of Sankeshwar city.
- To estimate the amount of chlorophyll in the test plant species to study the impact of pollution on photosynthetic pigments
- To correlate the dust deposition and chlorophyll pigment concentration with the possible impacts on the plant system.

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MATERIALS AND METHODS

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Mangifera indica L.

Ixora coccinia L.

Pongamia pinnata (L.) Pierre

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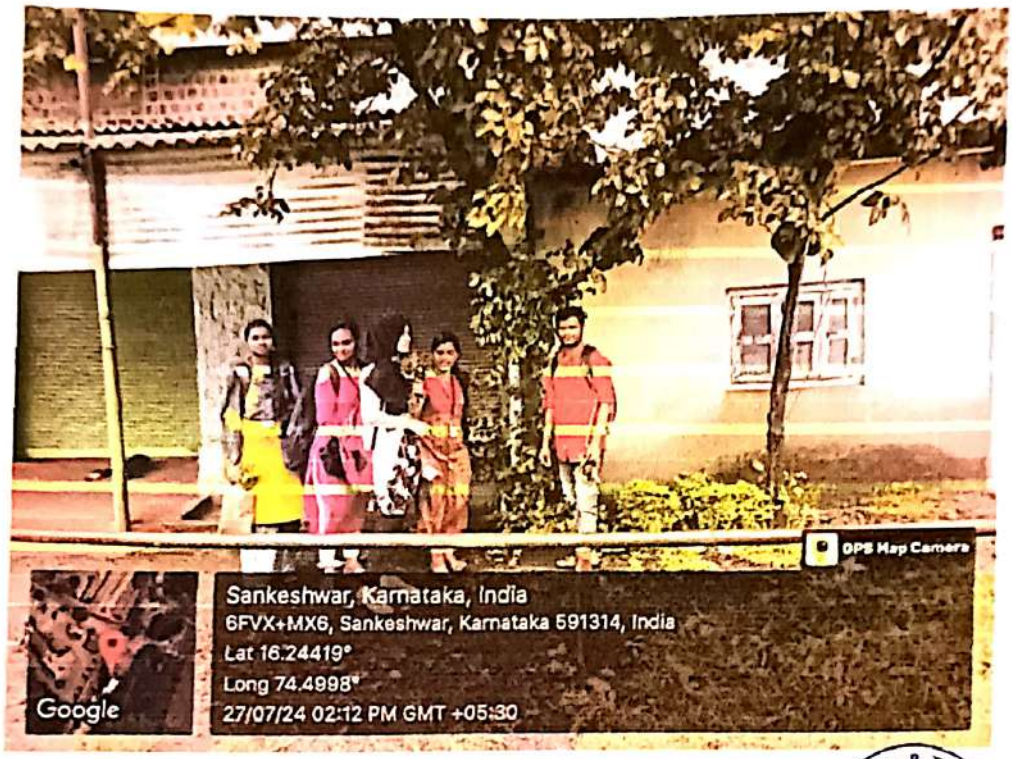
FIELD WORK



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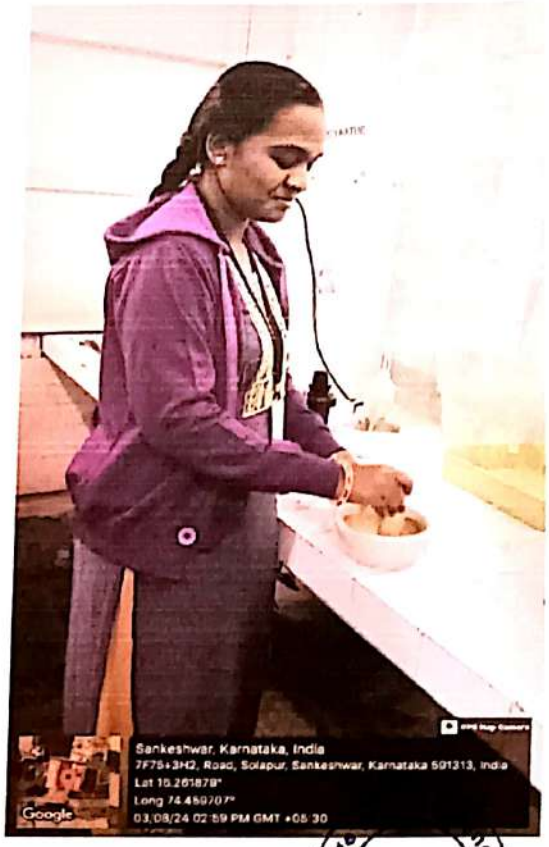
LAB WORK



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MATERIALS AND METHODS

STUDY AREA

The Sankeshwar city is selected as the study area for the said project. The two different localities Hiranyakeshi sugar factory premises, Sankeshwar which is a sugar factory premise and also the locality which is on the highway side which experiences more pollution due to the vehicular traffic and gases from the chimney of the factory and the other locality SDVS Sangh's SS Arts & TP Science Institute, Sankeshwar campus which is 2-3 km far from the highway and factory: unpolluted area.

TEST PLANT SPECIES

The following plant species have been selected for the study. The leaves of these plant species were collected from the polluted area (Hiranyakeshi sugar factory premises, Sankeshwar) and unpolluted area SDVS Sangh's SS Arts & TP Science Institute, Sankeshwar) for estimation of dust deposition and chlorophyll content.

1. *Mangifera indica* L.
2. *Pongamia pinnata* (L.) Pierre
3. *Ixora coccinia* L.

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***Mangifera indica* L.**

Classification (APG)

Kingdom: Plantae

Clade: Tracheophyta

Clade: Angiosperms

Clade: Eudicots

Clade: Rosids

Order: Sapindales

Family: Anacardiaceae

Genus: *Mangifera*

Species: *indica* L.

Description:

Mangifera indica is a large green tree, valued mainly for its fruits, both green and ripe. Approximately 500 varieties have been reported in India. It can grow up to 15–30 meters (50–100 feet) tall with a similar crown width and a trunk circumference of more than 3.7 m (12 ft). The leaves are simple, shiny and dark green. Yellow-white fragrant flowers appear at the end of winter, and also at the beginning of spring. Both male and female flowers are borne on same tree. Climatic conditions have a significant influence on the time of flowering. In South Asia, flowering starts in December in the south, in January in Bengal, in February in eastern Uttar Pradesh and Bihar, and in February–March in northern India. Panicle emergence occurs in early December and flower opening is completed by February.

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***Pongamia pinnata* (L.) Pierre**

Classification (APG)

Kingdom: Plantae

Clade: Tracheophyta

Clade: Angiosperms

Clade: Eudicots

Clade: Rosids

Order: Fabales

Family: Fabaceae

Genus: *Pongamia*

Species: *pinnata* (L.) Pierre

Description:

Pongamia pinnata is a legume tree that grows to about 15–25 m (50–80 ft) in height with a large canopy that spreads equally wide and creates dense shade. It has a straight or crooked trunk, 50–80 cm (20–30 in) in diameter, with grey-brown bark, which is smooth or vertically fissured. Its wood is white colored. Branches are glabrous with pale stipulate scars. The imparipinnate leaves of the tree alternate and are short-stalked, rounded, or cuneate at the base, ovate or oblong along the length, obtuse-acuminate at the apex, and not toothed on the edges.

Flowering generally starts after 3–4 years with small clusters of white, purple, and pink flowers blossoming throughout the year. The raceme-like inflorescences bear two to four flowers that are strongly fragrant and grow to be 15–18 mm (0.59–0.71 in) long. The calyx of the flowers is bell-shaped and truncated, while the corolla is a rounded ovate shape with basal auricles and often with a central blotch of green color. The brown seed pods appear immediately after flowering, and mature in 10 to 11 months. The seeds are about 1.5–2.5 cm (0.59–

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0.98 in) long with a brittle, oily coat, and are unpalatable in natural form to herbivores.

***Ixora coccinia* L.**

Classification (APG)

Kingdom: Plantae

Clade: Tracheophyta

Clade: Angiosperms

Clade: Eudicots

Clade: Asterids

Order: Gentianales

Family: Rubiaceae

Genus: *Pongamia*

Species: *pinnata* (L.) Pierre

Description:

***Ixora coccinia* L.** is a dense, multi-branched evergreen shrub, commonly 4–6 ft (1.2–1.8 m) in height, but capable of reaching up to 12 ft (3.7 m) high. It has a rounded form, with a spread that may exceed its height. The glossy, leathery, oblong leaves are about 4 in (10 cm) long, with entire margins, and are carried in opposite pairs or whorled on the stems. Small tubular, scarlet flowers in dense rounded clusters 2–5 in (5.1–12.7 cm) across are produced almost all year long. Although there are around 500 species in the genus *Ixora*, only a handful are commonly cultivated, and the common name, Ixora, is usually used for *I. coccinea*. *I. coccinea* is used in warm climates for hedges and screens, foundation plantings, massed in flowering beds, or grown as a specimen shrub or small tree. In cooler climate, it is grown in a greenhouse or as a potted house plant requiring bright light. *I. coccinea* is also grown in containers, looking very distinguished as a patio or poolside plant.

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ESTIMATION OF DUST DEPOSITION

Leaves were picked from the lower part of the canopy at an approximate height of 2–3 m. For each tree species, three trees of approximately the same size were selected on both localities for sampling, and five sample leaves were taken from each tree, randomly from all sides of the. Leaf samples were put carefully in paper bags and brought to the laboratory. The leaves were washed with the 20ml distilled water to collect the dust on surface. From each sample, the single leaf area of 5 leaves was measured, and then this was used to approximately calculate the average leaf area for each species from both locations. The individual leaf areas were measured by tracing them on the graph paper. The beaker containing 20ml of wash off was collected in a beaker. The beaker was kept in the oven for 24 hrs to evaporate the water. The amount of dust is calculated by subtracting the weight of the empty beaker from the beaker with dust.

ESTIMATION OF CHLOROPHYLL CONTENT

0.5 gm of finely cut and thoroughly washed representative sample of leaf was homogenized in 10 ml of 80% acetone. The homogenate was centrifuged at 5000 rpm for 5 minutes and the supernatant was transferred to volumetric flask. The volume of the supernatant was adjusted to 50 ml by adding 80% acetone and the optical density was measured at 645, 649 and 663 nm against 80% acetone (blank). The amount of chlorophyll per gm tissue was calculated using the following equations.

$$\text{mg chlorophyll a / gm tissue} = 12.7\,(A663) - 2.69\,(A645) \times \frac{V}{100 \times W}$$

$$\text{mg chlorophyll b / gm tissue} = 22.9\,(A645) - 4.68\,(A663) \times \frac{V}{100 \times W}$$

$$\text{mg total chlorophyll / gm tissue} = 20.2\,(A649) - 8.02\,(A663) \times \frac{V}{100 \times W}$$

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RESULTS & DISCUSSION

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RESULTS AND DISCUSSION

The results of the estimation of the dust deposition and the chlorophyll content in leaves of the plants growing in the polluted and unpolluted areas showed the significant difference. The results are tabulated in Table 1&2. The tabulations clearly depict that the dust deposition has a negative impact on the photosynthetic activity of the plants. The amount of dust deposited on the leaves of the plants growing in polluted area is approximately double than the plants growing in unpolluted area. Similarly the amount of chlorophyll also showed the same trend. The response of the plant to dust accumulation varied from species to species as dust deposition fluctuates with plant species due to leaf orientation, leaf surface geometry, phyllotaxy, epidermal and cuticular features, leaf pubescence, height and canopy of roadside plants (Wijayratne U C et al. 2009). With the accumulation of dust, the roadside plant may exhibit adaptive response by changing morphological and physiological attributes. Heavy metals released from automobiles are extremely toxic and reduces plant growth and morphological parameters. These vehicular exhaust and factory smoke introduce varieties of pollutants (oxides of nitrogen, sulphur, hydrocarbon, particulate matters, etc.) into the environment which put an adverse effect on growth and development of e trees and crops of such areas. Research studies revealed that plants growing in the urban areas are affected greatly by these pollutants (Uaboi-Egbenni P O et al 2009). Pollutants can cause leaf injury, stomatal damage, premature senescence, decrease photosynthetic activity, disturb membrane permeability and reduce growth and yield in sensitive plant species (Tiwari et al. 2006). Reductions in leaf area and leaf number may be due to decreased leaf production rate and enhanced senescence. The reduced leaf area results in reduced absorbed radiations and subsequently in reduced photosynthetic rate (Tiwari et al. 2006).

The interactions between plants and different types of pollutants were investigated by many authors: most of the studies on the influence of

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environmental pollution focusing on physiological and ultra structural aspects (Heumann H G, 2002). Studies concerning the anatomy of the vegetative organs under conditions of pollution have been also carried out Tiwari et al. recorded a reduction of leaf area and petiole length under pollution. Significant reduction in length and area of leaflets and length of petiole of *Guaiacum officinale* of polluted plants was recorded. Reduction in the dimension of a leaf blade of five tree species in the vicinity of heavy dust and SO_2 pollution was also observed (Jahan S and Iqbal M Z 1992). Significant effects of automobile exhaust on the phenology, periodicity and productivity of roadside tree species was also reported (Bhatti G H and Iqbal M Z 1988). All these studies clearly suggest that the dust deposition has a negative impact on the leaf such as decreased leaf area, petiole length, stomatal index and photosynthetic activity etc. all these observations can be correlated to the results of the present investigation.

The net photosynthetic rate is a commonly used indicator of the impact of increased air pollutants on tree growth. The photosynthetic rate is directly proportional to the chlorophyll content. The chlorophyll content in the test species growing in pollutes area is approximately half of the test species growing in the unpolluted area Plants that are constantly exposed to environmental pollutants absorb, accumulate and integrate these pollutants into their systems. It has been reported that depending on their sensitivity level, plants show visible changes which would include alteration in the biochemical processes or accumulation of certain metabolites (Agbaire P O and Esiefarienrhe E. 2009). Sulphur dioxide (SO_2), nitrogen oxides (NOx) and CO_2as well as suspended particulate matter. These pollutants, when absorbed by the leaves, may cause a reduction in the concentration of photosynthetic pigments viz., chlorophyll and carotenoids, which directly affected to the plant productivity (Joshi P C and Swami A.2009). One of the most common impacts of air pollution is the gradual disappearance of chlorophyll and concomitant yellowing of leaves, which may be associated with a consequent decrease in the capacity for photosynthesis (Joshi P C and Swami A. 2007). Chlorophyll is found in the

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chloroplasts of green plants and is called a photoreceptor. Chlorophyll is the principal photoreceptor in photosynthesis, the light-driven process in which carbon dioxide is "fixed" to yield carbohydrates and oxygen. When plants are exposed to the environmental pollution above the normal physiologically acceptable range, photosynthesis gets inactivated. The distribution of plant diversity is highly dependent on the presence of air pollutants in the ambient air and sensitivity of the plants. Chlorophyll measurement is an important tool to evaluate the effects of air pollutants on plants as it plays an important role in plant metabolism and any reduction in chlorophyll content corresponds directly to plant growth. Chlorophyll is an index of productivity of the plant. The shading effects due to deposition of suspended particulate matter on the leaf surface might be responsible for this decrease in the concentration of chlorophyll in a polluted area. It might clog the stomata thus interfering with the gaseous exchange, which leads to an increase in leaf temperature which may consequently retard chlorophyll synthesis.

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TABLES

Table 1. Chlorophyll content in the leaves of the plants collected from polluted area (Hiranyakeshi sugar factory premises, Sankeshwar)

Sl.No	Name of the plant	Chl a (mg/g)	Chl b (mg/g)	Total Chl (mg/g)
1	*Mangifera indica* L.	6.28	5.54	11.82
2	*Pongamia pinnata* (L.) Pierre	9.35	8.68	18.03
3	*Ixora coocinia L.*	4.12	9.42	13.54

Table 2. Chlorophyll content in the leaves of the plants collected from unpolluted area (SDVS Sangh's SS Arts & TP Science Institute, Sankeshwar)

Sl.No	Name of the plant	Chl a (mg/g)	Chl b (mg/g)	Total Chl (mg/g)
1	*Mangifera indica* L.	9.84	9.82	19.67
2	*Pongamia pinnata* (L.) Pierre	14.24	9.35	23.60
3	*Ixora coocinia L.*	9.80	10.25	20.04

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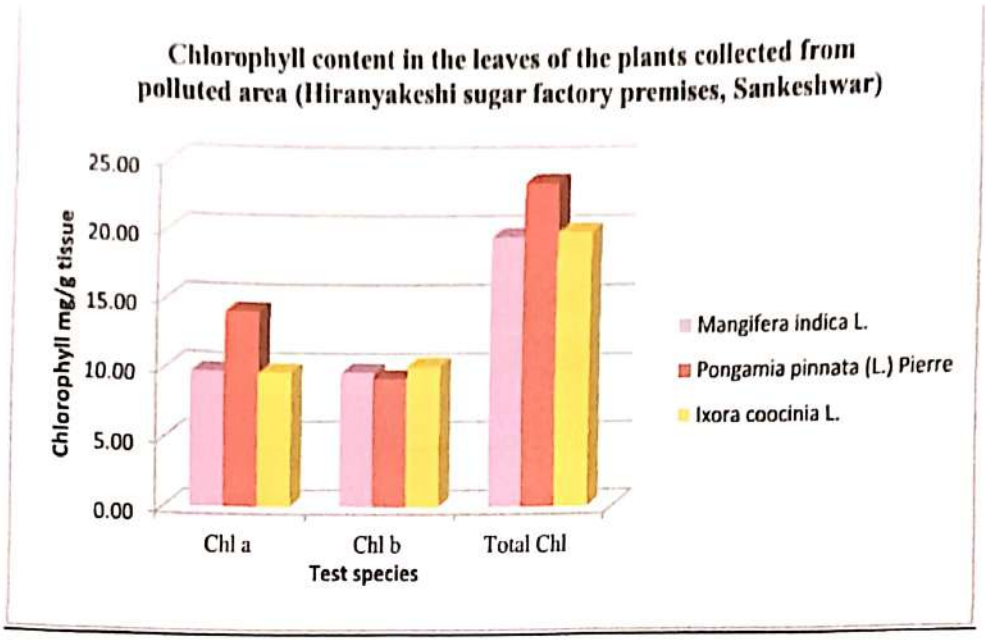
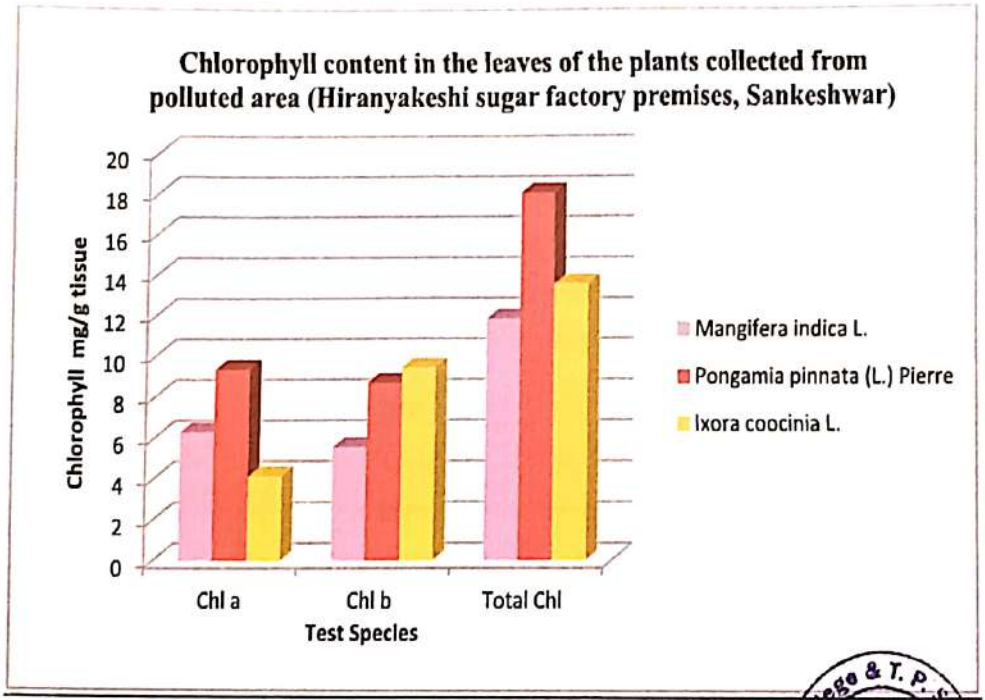
GRAPHS





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TABLES

Table 3. Dust deposition on the leaves of the plants collected from polluted area (Hiranyakeshi sugar factory premises, Sankeshwar)

Sl.No	Name of the plant	Dust (g)	Leaf Surface area (cm^2)	Dust deposition (g/cm^2)
1	*Mangifera indica* L.	62.51	405	0.15
2	*Pongamia pinnata* (L.) Pierre	38.12	278.5	0.14
3	*Ixora coocinia L.*	72.13	365.5	0.20

Table 4. Dust deposition on the leaves of the plants collected from unpolluted area (SDVS Sangh's SS Arts & TP Science Institute, Sankeshwar)

Sl.No	Name of the plant	Dust (g)	Leaf Surface area (cm^2)	Dust deposition (g/cm^2)
1	*Mangifera indica* L.	36.98	397.5	0.09
2	*Pongamia pinnata* (L.) Pierre	27.18	259.5	0.10
3	*Ixora coocinia L.*	50.91	382.5	0.13

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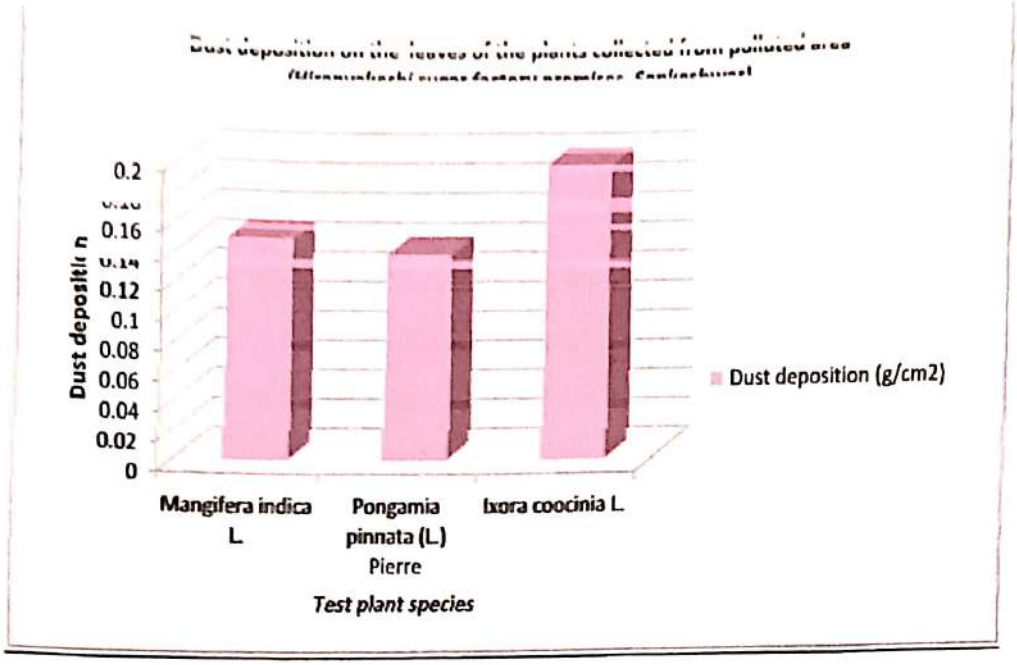
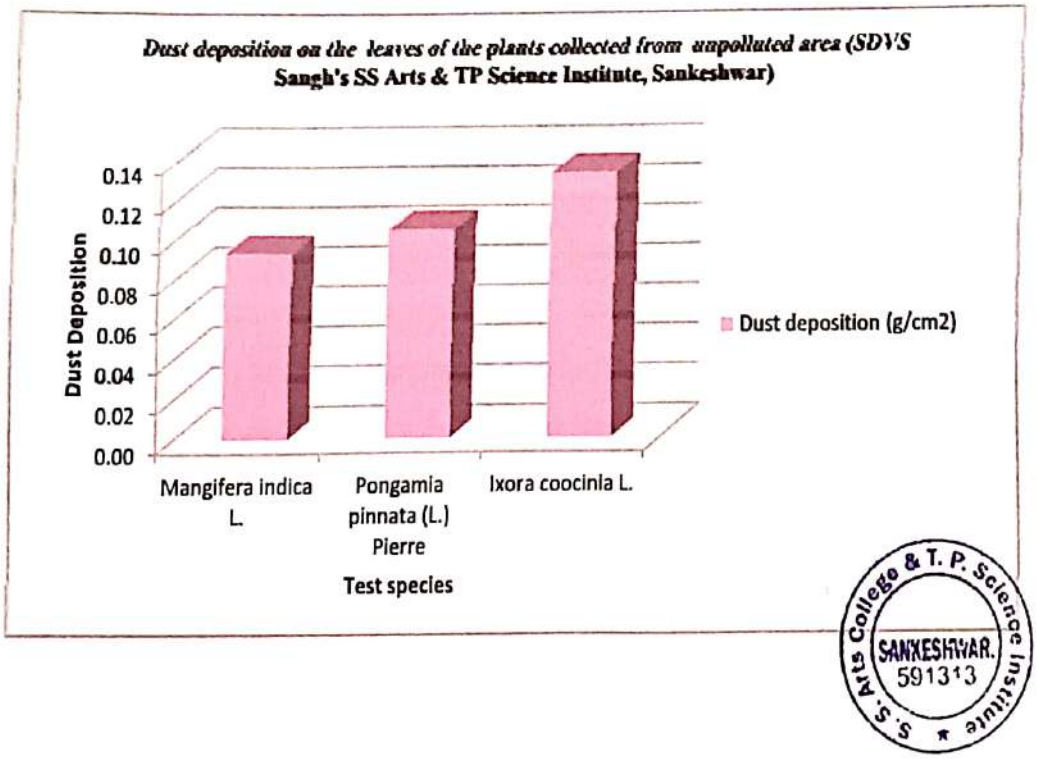
GRAPHS





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SUMMARY AND CONCLUSION

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SUMMARY AND CONCLUSION

The present project work is an attempt to investigate the impact of vehicular and factory smoke that contains the pollutants such as sulphur oxides, nitrous oxides, particulate matter and heavy metals etc. which gets deposited on the surface of the leaves as dust. The Sankeshwar city was selected as the study area for the said project. The two different localities Hiranyakeshi sugar factory premises, Sankeshwar which is a sugar factory premise and also the locality which is on the highway side and experiences more pollution due to the vehicular traffic and gases from the chimney of the factory and the other locality SDVS Sangh's S S Arts & T P Science Institute, Sankeshwar campus which is 2-3 km far from the highway and factory an unpolluted area. The three plants of almost same age and size were selected as test plant species for the project. The leaves of the test plant species from both the localities were collected to estimate the amount of dust deposition per cm2 and to estimate the chlorophyll content in order to study the impact of dust deposition on the photosynthetic activity as chlorophyll content can be directly correlated to carbon reduction capacity and carbohydrates production. The results of the work suggest that the dust deposition has the negative impact on the plant growth and productivity either by decreasing the leaf area, stomatal function or photosynthetic ability of the leaf as reported by many researchers discussed in the results section. The dust deposition on the leaves from polluted area is approximately double than the unpolluted area. The chlorophyll content in the leaves of the plants from polluted area is approximately half of the plants from unpolluted area which clearly suggest that the dust deposition is negatively impacted the photosynthetic ability of the plants thus by reducing the growth and development.

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FURTHER SCOPE OF THE STUDY

- The dust collected can be further subjected to the pollutant analysis like heavy metals and other pollutants to correlate the pollutant concentration and its possible hazardous effect
- The other biochemical parameters like carbohydrates, protein, proline etc can also be carried out to know the biochemical impacts of the dust deposition in the plant systems
- Enzymatic assays can also be carried out study the physiological response of the plants to pollutant stress in terms of deposition on the leaves

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AZOLLA CULTIVTION IN S.S. ARTS AND T.P. SCIENCE INSTITUTE SANKESHWER

A PROJECT REPORT SUBMITTED TO

RANI CHANNAMMA UNIVERSITY, BELAGAVI

S.S. ARTS AND T.P. SCIENCE INSTITUTE, SANKESHWAR.

FOR PARTIAL FULFILLMENT OF THE AWARD OF THE DEGREE OF

BACHELOR OF SCIENCE IN BOTANY

SUBMITTED BY

GANGA.R. PATIL	U15CH21S0005
BASAVARAJ. V.GHABE	U15CH21S0011
SHIVANI. M. RAIKAR	U15CH21S0024
SOUMYA. A . PATIL	U15CH21S0026
UMESH. K. MUNNOLI	U15CH21S0031
PRIYANKA.B. KAMBLE	U15CH21S0091
AKSHATA. R . HIREMATH	U15CH21S0101

S.S. Arts College & T.P. Science Institute SANKESHWAR. 591313

UNDER THE GUIDANCE OF

MISS: SNEHA M KAMBLE M.Sc. B.Ed

DEPARTMENT OF UNDER GRADUATE STUDIES IN BOTANY S.S. ARTS AND T.P. SCIENCE INSTITUTE, SANKESHWAR-591313

2023-2024

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RANI CHANNAMMA UNIVERSITY
BELAGAVI.

S. S. ARTS COLLEGE & T. P. SCIENCE INSTITUTE, SANKESHWAR.

CERTIFICATE

This is to certify that, this project entitled "**Azolla Cultivation**" in S.S Arts and T. P. Science Insitute Sankeshwar, is being submitted here with for the partial fulfillment of award of the Degree of Bachelor of Science in Botany project.

The work reported in this report is based upon the results of original work carried out by

1. Basavaraj . V . Ghabe
2. Umesh . K .Munnoli
3. Ganga . R .Patil
4. Soumya. A . Patil
5. Shivani . M .Raikar
6. Priyanka . B. Kamble
7. Akshata . R. Hiremath

S. S. Arts College & T. P. Science Institute SANKESHWAR 591313

Under our supervision

Guide/ Supervisor
Miss Sneha Kamble

Head of department

Principal

Examinars –

(P. A. Sangappagol)
BKC. Chikodi

PRINCIPAL
S. S. Arts College & T P Science Institute
SANKESHWAR

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DECLARATION

We hereby declare that this project work entitled **"Azolla Cultivation"** in S S Arts & T P Science Institute, Sankeshwar. Completed and written by us has not previously formed. This report is based on the results carried out by us.

Place : Sankeshwar

Date :

Basavaraj V. Ghabe
Umesh K.Munnoli
Ganga R. Patil
Soumya A. Patil
Shivani M.Raikar
Priyanka B.Kamble
Akshata R. Hiremath

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Umesh K.Munnoli
Ganga R. Patil
Soumya A. Patil
Shivani M.Raikar
Priyanka B.Kamble
Akshata R. Hiremath

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Dedicated To
Our Family
And
Friends

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CONTET

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INTRODUCTION

INTRODUCTION

In the recent past agriculture as a profession is losing its charm among the farmers. This has been attributed to several reasons; important among them are spiraling cost of inputs coupled with uncertainty in the price of the product. This has been aggravated by non-availability of assured irrigation due to depletion in ground water. This has in turn manifested as distress among the farmers in substantial are as in Andhra Pradesh, Maharashtra, Karnataka and Kerala, which are otherwise considered as agriculturally developed areas. A couple of committees have gone into the root cause of distress and suggested that alternate income generating opportunities can be a major remedy for such disappointment among the farming community. Animal husbandry is one such alternative available to such distressed farmers. Again, availability of quality fodder to the animals is the major impediment in scientific management of animals because India, having only 2.4% of the world's geographical area sustains 11% of the world's livestock population. It accounts for 55% of the world's buffalo population, 20% of the goat population and 16% of the cattle population. This has put unbearable burden on our natural vegetation.

Azolla, hitherto used mainly as a green manure in paddy has tremendous potential to meet the growing demand for fodder among the small farmers taking up animal husbandry.

About Azolla

Azolla is an aquatic floating fern, found in temperate climate suitable for paddy cultivation. The fern appears as a green mat over water. The Blue Green Algae cyanobacteria(Anabaena azollae) present as a symbiont with this fern in the lower cavities actually fixes atmospheric nitrogen. The rate of nitrogen fixed is around 25 kg/ha.

As green manure, Azolla is grown alone for two to three weeks in flooded fields. Afterwards, water is drained out and Azolla fern is in corporate in the field before transplanting of paddy. Otherwise, 4-5 q of fresh Azolla is applied in standing water one week after planting of paddy. Dry Azolla flakes can be used as poultry feed and green Azolla is also a good feed for fish. It can be used as a bio-fertilizer, a mosquito repellent, in the preparation of salads and above all as a bio-scavenger as it takes away all heavy metals.

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WHAT IS AZOLLA?

- Azolla species. are free-floating freshwater ferns.
- Live symbiotically with *Anabaena azollae*, a nitrogen fixing blue-green algae.
- A main stem growing at the surface of the water, with alternate leaves and adventitious roots at regular intervals along the stem.
- Azolla fronds are triangular or polygonal.
- Float on the water surface individually or in mats.
- Also known as duckweed ferns.
- Size(dia.)- ranges from 1/3 to 1 inch (1-2.5 cm) to 6 inches (15 cm) or more.

Species of Azolla found

Azollae filiculoides

Azollae caroliniana

Azollae mexicana.

Azollae microphylla (U.P.)

Azollae nilotica

Azollae pinnata (TN,AP)

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CHARACTERSTICS OF AZOLLA

- Rich in crude protein (19-30%)
- Rich in Essential amino acid
- High ash content (14-20%)
- Contain several vitamins (Vit. A,B-12 & B-carotene)
- Rich in minerals (Ca, Zn, Cu, Mg, K,P etc.)
- Nitrogen fixation
- Maintain soil health when applied in field
- Bioremediation
- Provide different nutrients
- Rapid multiplication rate
- Weed control

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CLASSIFICATION

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CLASSIFICATION

Kingdom	:	**Plantae**
Division	:	**Pteridophyta**
Class	:	**Pteridopsida**
Order	:	**Salvinales**
Family	:	**Salvinaceae**
Genus	:	***Azolla***
Sub Genus	:	***Eu- Azolla***

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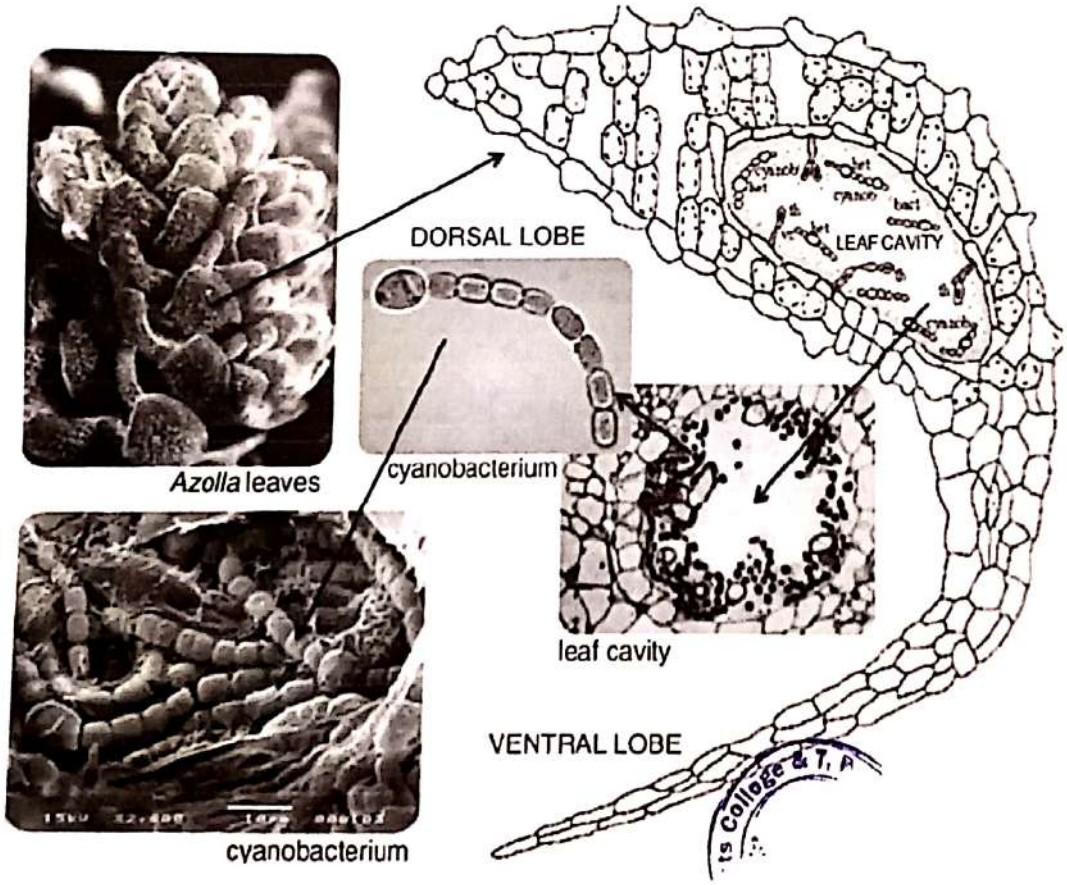
STRUCTURE OF AZOLLA

- Shape of Indian species is typically triangular measuring about 1.5 to 3.0 cm in length 1 to 2 cm in breadth.

- Roots emanating from growing branches remained suspended in water.

- The dorsal lobe which remains exposed to air is having a specific cavity containing its symbiotic partner, a Blue Green Algae (BGA), the *Anabaena azollae*.

- The fern is capable of fixing atmospheric nitrogen in the soil in the form of NH4+ and becomes available as a soluble nitrogen for the cultured species.



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MATERIALS
&
METHODS

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CULTIVATION OF AZOLLA

Growing of Azolla is done basically by two types

1. Azolla in situ

Grown with standing crop within the field

2. Azolla ex situ

Grown in an area by accumulating sufficient water

There is also another method of culturing Azolla in polythene.

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GROWING CONDITIONS FOR AZOLLA

Azolla prefers shade and requires light (30-50% light required for its growth) for photosynthesis. Azolla is a water based crop; one should ensure at least 5 inches of water in pond for proper growth. Azolla grows well where the ideal temperature range is 20-35°C. It requires a water pH value of 5 to 7 and relative humidity of 80-90%.

STEPS IN AZOLLA CULTIVATION

- Size of the tank depends quantity of feed to be harvested. For small holders a pond of about 2m length and In width is sufficient. The ground is leveled and bricks are laid in required dimension.
- Old plastic sacs or sheets are placed in the bottom of the pond
- Then the pond is covered with 150 gauge durable plastic sheets
- Secure sides of the plastic sheets by placing bricks over the sidewalls
- About 25 kg of clean and fertile soil is spread uniformly across the pond
- Then, a mixture of 5 kg cow dung and 30g rajphos /fertilizer is applied uniformly
- Water is maintained at a depth of 10 cm in the pond
- 500g of azolla culture is required per square meter of the pond
- Azolla will fully cover the pond by 1-2 weeks and can start harvesting it.

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REQUIREMENTS FOR AZOLLA GROWTH

Water: 10-15 cm fresh current water is necessary in multiplication pond. Maintenance of adequate water level (at least 4 inches in the pond) is essential.

Temperature: Day/night temperatures ranging between 32°C and 20°C have found to be most favorable. The optimum temperature for luxurious growth of Azolla is 25-30°C.

Light: It prefers to grow well under partial shade.

Relative Humidity: The optimum relative humidity requirement is 85to 90 per cent.

Soil pH: Azolla grows well in slightly acidic soil having 5.2 to 5.8 pH.

Nutrition: Being an Nitrogen fixing fern Azolla does not require nitrogenous fertilizer for its growth. Phosphorous 20 kg/ha is desirable for good bio- mass production.

Azolla is naturally found in ponds, ditches and wetlands of warm temperate and tropical regions throughout the world.

- It requires light for photosynthesis and grows well in partial shade.
- Generally, Azolla needs 25 to 50 per cent of full sunlight for its normal growth.
- Water is the basic requirement for the growth and multiplication of Azolla and is extremely sensitive to lack of water.
- Maintenance of adequate water level (at least 4 inches in the pond) is essential.
- The species vary in their requirement of ideal temperature. In general, the optimum is 20°C to 30° C. Temperatures above 37° C will seriously affect the multiplication of Azolla.
- The optimum relative humidity is 85 to 90 percent.
- The optimum pH is 5 to 7. too acidic or alkaline pH has an adverse effect on this fern.
- Azolla absorbs the nutrients from water. Though all elements are essential, phosphorus is the most common limiting element for its growth. About 20 ppm of phosphorus in the water is optimum.
- Micronutrient application improves the multiplication and growth.

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Chemical composition of Azolla

Sl. No.	Constituents	Dry matter (%)
1	Crude protein	24-30
2	Crude fat	3.3-3,6
3	Nitrogen	4-5
4	Phosphorus	0.5-0.9
5	Calcium	0.4-1.0
6	Potassium	2-4.5
7	Magnesium	0.5-0.65
8	Manganese	0.11-0.16
9	Iron	0.06-0.26
10	Soluble sugars	3.5
11	Crude fire	9.1
12	Starch	6.54

Source : Singh and subudhi (i978a)

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SELECTION OF LOCATION FOR THE POND

- Select an area near to the house to ensure regular up keep and monitoring of the pond.
- A suitable water source should be nearby for regular water supply.
- The site under partial shade
- The floor area of the pond should be free of pointed stones, roots and thorns
- Land should thoroughly prepared and levelled uniformly.

MATERIAL REQUIRED FOR PREPARATION OF ONE PIT: -

- Plastic sheet (21 x 3 m^2)
- Healthy Azolla culture (8-10 Kg.)
- Soil (80-100 Kg.)
- Fresh dung (10 Kg. In 20 Ltr. Water)
- Net(1 m^2)
- SSP (100 gm.)
- Carbofuran 3G (100 gm.

METHOD OF PRODUCTION OF AZOLLA

- ☐ For One Hectare of land, prepare 4 pits having size 20 m x 2 m x 0.25m and cover it with plastic sheet and press the edge by the soil.
- ☐ Lay 80-100 kg soil per pit uniformly on the floor.
- ☐ Make a solution of fresh cow dung and put it on the soil surface with the help of sieve.
- ☐ Fill the plot with 5-10 cm of water.
- ☐ Inoculated with Azolla (8-10 Kg).
- ☐ Sprinkle with 1-2 litres of water so that the roots get settled.
- ☐ Single super phosphate (100 g) in 2-3 split doses is applied at an interval of 4 days to each plot.

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MAINTENANCE OF AZOLLA

- Maintain 5-10 cm water level in the pit.Keep fertile soil at 30 days intervals.
- Put dung solution at a 15-day interval.
- When the problem of pest appears, add 100 grams of Carbofuran 3G per pit after 7-8 days.
- Any litter or aquatic weeds seen in the pond should be removed regularly.
- The pond needs to be emptied once in six months and cultivation has to be restarted with fresh Azolla culture and soil.

HARVESTING OF AZOLLA

- ❑ After15-20 days, the thick layer of Azolla will develop having weight about 100-150 Kg.
- ❑ Harvest the two-third of Azolla and use it in the rice field.
- ❑ Leave for one-third of Azolla's part for reproduction in the pit.
- ❑ After 15 days, one can harvest 3 Kg. of Azolla per day.

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RESULT AND DISCUSSION

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APPLICATION OF AZOLLA IN RICE FIELD

The most common mode of application of Azolla in the field is as green manure or as a dual crop along with rice.

As green manure: -

Azolla collected directly from ponds/ditches is applied in the field. A thickmat of Azolla will be formed after application in about 2-3 weeks time and can be incorporated in the soil. Rice can also be transplanted in the field subsequently. Single super phosphate (25-50 kg ha^{1}) is applied in split doses. Azolla application by this mode contributes around 20-40 kg /HA

IN DUAL CROPPING: -

- Azolla is grown along with rice and each crop of Azolla contributes on an average 30 kg/HA.
- After 7-10 days of transplantation fresh inoculums of Azolla is applied in the field at the rate of 0.50-1.0 ton / HA.
- Single super phosphate is applied at the rate of 20 kg ha- in split doses.
- In about 15-20 days time a thick mat of Azolla is formed weighing 10-20 tonnes.
- Azolla thus incorporated decomposes in about 8-10 days time and release the fixed nitrogen.

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Economic analysis of pit preparation

Sl. No	Materials	Quantity	Rate ($)	Value ($)
1	Plastic sheet (21*3)	4	$ 12/m^2	#3024
2	Labour	4	$ 290	$1160
3	SSP	400 gm.	$10/kg	$4
4	Azolla culture	1 kg	$250/kg	$250
5	Carbofuran 3G	400 gm.	$70/kg	$28
6	Nylon net	1 m^2	25/m^2	$25

Total expenditure $4691

Economic analysis

Sl. No	Materials	Traditional method	Dual cropping with azolla
1	Fertilization (150:60:60)		
	a) Urea ($5.5/kg.)	326 kg.	260 kg.
	b) Ssp ($7.2/kg)	333 kg.	278 kg.
	c) Mop($16.8/kg)	100 kg.	100 k.g.
2	Yield		
	a)Grain ($1470/Qtl)	48Qtl	60 Qtl
	b) Straw ($50/Qtl)	96 Qtl	120 Qtl
3	Total expenses	$5871	$5112+4691=$9803
4	Total income	$75360	$944200
5	Net profit	$69489	$84397

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- Again after 15-20 days we can harvest 3 Kg. Per day Azolla from each pond. So farmer can harvest 12 Kg. Per day Hence, Farmer can harvest ----
- 12x150 Kg. 1800 Kg. From one culture because after 6 months old one is discarded and new culture required.
- If we take an account loss due to weather condition is15% then farmer at least harvest 1530 Kg. Of azolla.
- Cost of Azolla for 1 Kg. = 250
- Cost of Azolla for 1530 Kg. = 250 x 1530382500
- There fore, total profit in six month is, 382500+₹14908₹397408
- Additional benefits of azolla such as improving soil health which is in valuable aspects.

USES OF AZOLLA

- ✓ Used as cattle feed
- ✓ Used as bio-fertilizer in Organic farming.
- ✓ Food for fishes.
- ✓ Food for pig, goat, poultry and other livestock.
- ✓ Note:- In case of livestock feed, azolla should be washed for 4-5 time with fresh water

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LIMITATIONS OF AZOLLA CULTIVATION

- Water is pre-requisite for it's multiplication, so it is not suitable for upland crop.

- Huge quantity of inoculums is required which is difficult for transplanting action during rainy days.

- Temperature more than 35°C is not suitable.

- Extreme low temperature is also not suitable.

- Non availability of technology to use Azolla as dry inoculum.

- Non availability of varieties suitable for higher temperature with low pH application.

- Initial cost of cultivation is high.

- Market for azolla is not so popular.

- Ignorance of people about benefit of Azolla.

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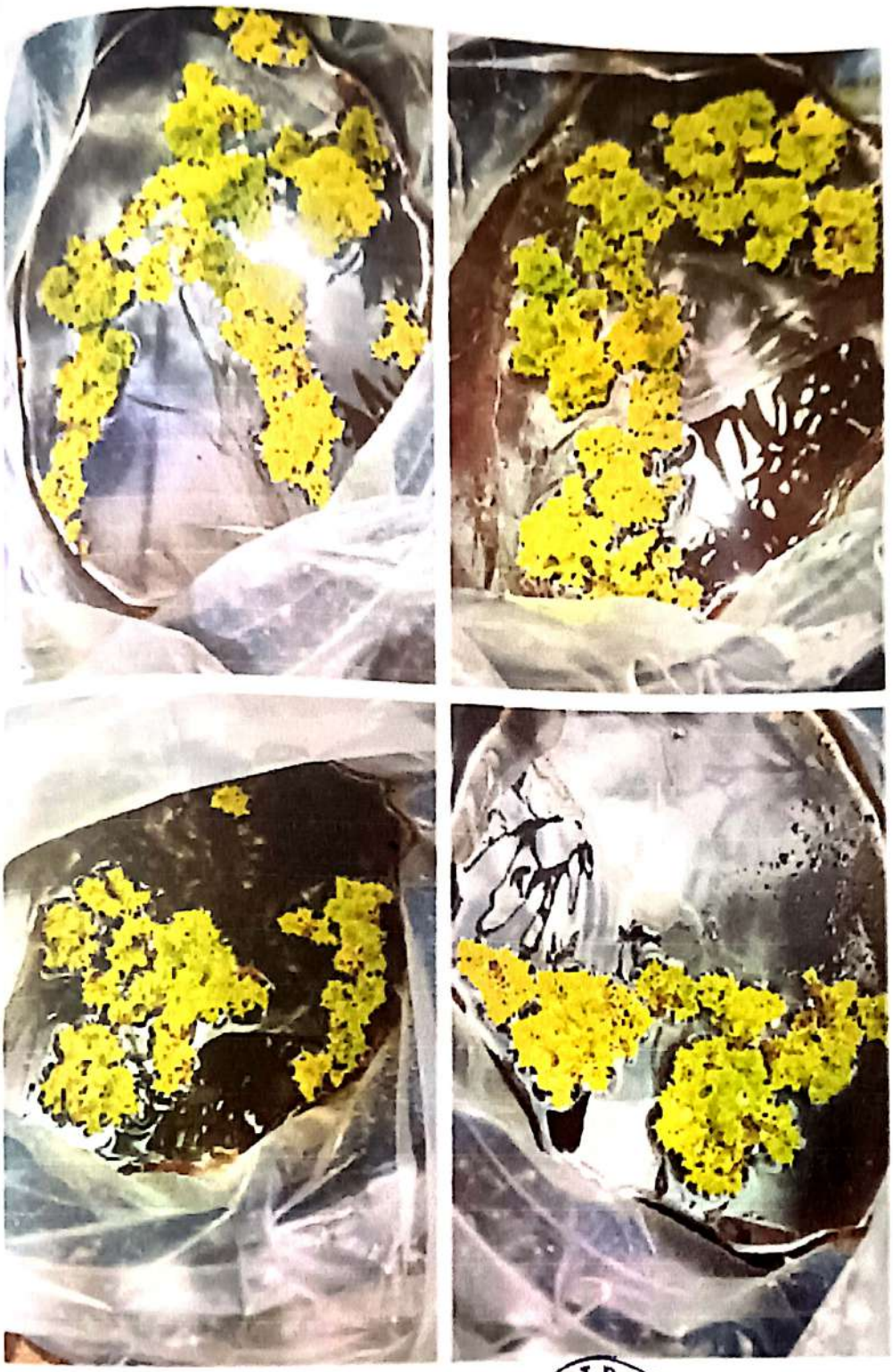

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SUMMARY

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SUMMARY

Azolla is an aquatic water fern which symbiotically associates with anabaena. Anabaena is a free living filamentous nitrogen fixing cyanobacterium. But it is also found in a symbiotic association with azolla to fix atmospheric nitrogen in usable form. Inturn, the bacterium gets a safe environment for survival. This little fern and its algal partner provide an important contribution as a biofertiliser in increasing the soil nitrogen content. Hence, azolla is majorily used in production of rice.

Rhizobium species is a symbiotic nitrogen fixing bacteria in association with the roots of leguminous plants.

Mycorrhiza is a symbiotic association of fungal species with the roots of plants.

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RANI CHANNNAMMA UNIVERSITY BELGAVI

S.S ARTS COLLEGE & T.P SCIENCE INSTITUTE,

SANKESHWAR

DEPARTMENT OF ZOOLOGY

Major Project Report Entitled

" A survey on the *Drosophila* fauna in the selected areas of college campus, Sankeshwar"

Submitted to

RANI CHANNAMMA UNIVERSITY ,BELAGAVI

BACHELOR OF SCIENCE IN ZOOLOGY

S.S. Arts College & T. P. Science Institute SANKESHWAR. 591313

By

Amruta .A. Patil	**(U15CH21S0097)**
Veena . V . Halasi	**(U15CH21S0053)**
Shilpa . M .Bisirotti	**(U15CH21S0056)**
Swastik . S . Kaggudi	**(U15CH21S0094)**
Sudarshan . R . Mankale	**(U15CH21S0087)**

Project guide

Miss. Rakshata. Kamate

2023-2024

RANI CHANNAMMA UNIVERSITY BELAGAVI

S.D.V.S. SANGH'S

S.S ARTS COLLEGE AND T.P SCIENCE INSTITUTE,

SANKESHWAR

DEPARTMENT OF ZOOLOGY

S.S. Arts College & T. P. Science Institute SANKESHWAR. 591313

CERTIFICATE

This is to certify that, the project on " A survey on the *Drosophila* fauna in the selected areas of college campus, Sankeshwar " submitted to Rani Channamma University Belagavi , embodies result of the word carried by Amruta . A . Patil Veena . V . Halasi Shilpa. M . Bisirotti Swastik . S . Kaggudi Sudarshan . R . Mankale . under the guidance at Department of studies in zoology S.S Arts College & T.P Science Institute ,Sankeshwar for academic year 2023-24

GUIDE

Miss . Rakshata kamate

Rukamate

Head of Department

Head
Department of Zoology
S.S. Arts College & T.P. Science Institute
SANKESHWAR

Principal

PRINCIPAL
S.S Arts College & T P Science Institute
SANKESHWAR

EXAMINARS

1.

2. 12/8/24

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ACKNOWLEDGEMENT

I would like to express my sincere gratitude to RANI CHANNAMMA UNIVERSITY , and S.S ARTS COLLEGE &T.P SCIENCE INSTITUTE SANKESHWAR for the opportunity given in completing this project work.

A special thanks to our teachers, Miss Rakshata Kamate and Miss Vachana Kolakar for their guidance, valuable time, suggestions and instructions served as the major contribution and promoted our efforts in all stages to complete my project work.

A sincere thanks to the Principal Shri P.B.Burji Sir S.D.V.S college for providing us with facilities required to carry out my project work.

At last, but not the least gratitude goes to all my friends who directly or indirectly helped us to complete this project work.

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1.SUDARSHAN MANKALE
2.SWASTIK KAGGUDI
3.VEENA HALASI
4.SHILPA BISIROTTI
5.AMRUTA PATIL

TABLE OF THE CONTECT

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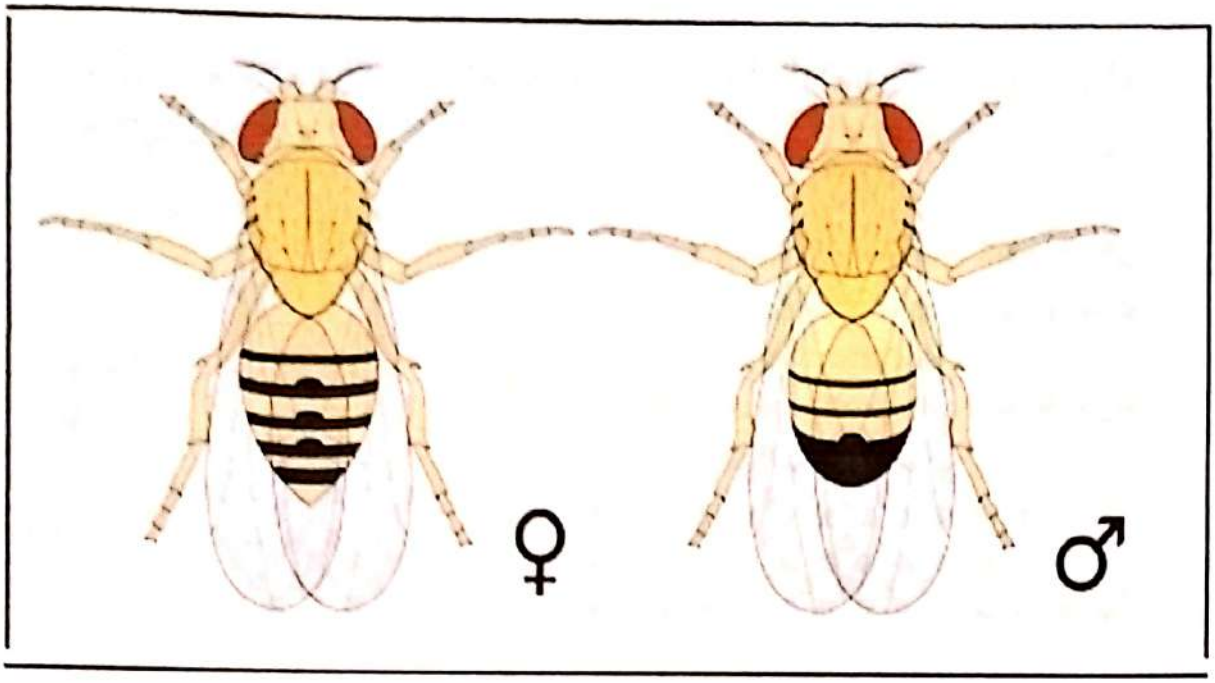
INTRODUTION

Drosophila melanogaster



- ***Drosophila melanogaster*** is a fruit fly. Well known as "Cinderella of genetic" is one amongst them
- *Drosophila* is used as model organism for addressing wide range of studies like basic genetics, population, behaviour, evolutionary biology and molecular biology
- *Drosophila* is most sought after experimental animal for its short life cycle, easy and inexpensive method of culturing , large, progeny, availability of number of mutant stock and genome of few species.
- Having only four chromosome in haploid set, giant chromosome in larva salivary gland is an added advantage for studies of these flies in the life science.
- The family *Drosophila* (Diptera) comprises more than 3,500 described species that occur in a number of ecosystem all over word
- **Thomas hunt Morgan** was the preeminent biology studying *Drosophila* early in the 1900s he was the first to discover sex-linked and genetic recombination . which placed the small fly in the forefront of genetic research
- Due to it's small size ease of culture and short generation time. Genetic been using *Drosophila* ever since
- *Drosophila* exhibit complete metamorphosis meaning the life cycle include on egg larva form pupa and finally emergence as a flying adult this is the some the well-known metamorphosis of butterflies .the larva stage has instars or moults

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ABOUT MALE AND FEMALE *DROSOPHILA*

❖ MALE *DROSOPHILA*

- The male *Drosophila* are smaller fruit flies with one X chromosome and one tiny Y chromosome
- Abdomen : Round at the bottom
- Do not have a spike
- Have fewer strips of which the last two strip are meld together becoming much darker towards the black of the abdomen
- Have sex comb, a short raw of thick, closely spaced bristles on the fourth segment of the front legs
- Closing mating partners: dance and brush against the female' body
- They smaller in size

❖ FEMALE *DROSOPHILA*

- The larger fruit flies with two X chromosome as sex chromosome
- 25% larger then the male counterpart
- Abdomen: pointed towards the bottom
- Have a spike at the dorsal surface at the rear
- Have more strips of which one thick band at the bottom of the abdomen with liger band on top of that
- No sex comb
- Choosing mating partners choose a mate within 15 minutes

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LITRATURE REVIEW

PRELIMINARY SURVEY OF *DROSOPHILA* FAUNA IN AND AROUND BALLARI DISTRICT KARNATAKA

" Department of studies in zoology . vijayanagara sri kirshanadevaraya university , ballari -583104 , India

- A survey on *Drosophila* was conducted from October 2018 to march 2019 (winter to early summer)
- *Drosophila* were collected from 15 different localities of ballari. Trapping method and net sweeping method were employed for the collection of fruit . the collected in culture bottles containing wheat cream agar medium
- A total of 733 *Drosophila* were collected amongst which 206 males and 473 females
- The current study revealed that a total of 08 species were identified
- Name : *Drosophila melanogaster* and *Drosophila* ananassae were found to be common in all fifteen regions suggesting their dominance in ballari. (north - east part of Karnataka)
- The study reveals that not only the number of *Drosophila* species varies among different places; but also the numbers of individuals belonging to same species differs among different places under study . in the present study
- Consideration of the common and abundant species shows that numerical variation exists in regard to these species at all fifteen altitude

I. Received: 05 November 2020
II. Accepted : January 2021
III. Published : 11 February 2021

Drosophila fauna of sahyadri hills (Western Ghats) with description of a new species

- *Drosophila* collection of sahyadei hill range revealed the occurrence of several know species of *Drosophila* in addition to a new species
- *Drosophila* sahyadri , a member of thesuzukii sub group of the melanogaster species group of the subgenus sophophora
- The distributional pattern of different species is closely related to the nature of the environmental condition of the localities
- The morphology and internal character of the new species are described
- The systematic position and the affinities are discussed

I. Published : February 1979

Population assemblage of the small fruit flies (*Diptera Drosophila*) in the north western Ghats of Karnataka (India) with special report on the dominant species

- The population assemblage of *Drosophila* in the four districts of north western Ghats was analysed .
- A total of 13,604 individuals comprising 17 species collection from 8 localities during the period of 2021 -22 across various seasons .
- The study highlights the dominance of three species *(Drosophila* bipectinata Duda , *Drosophila* malerkotliana parshad & paika and Drosophila eugracilis bock & wheeler)belonging to ananassae and eugracilis sub group.
- Overall collection data revealed the highest species richness and diversity for Dharwad and UK interior forests .
- Whereas the maximum abundance and the highest evenness were observed in UK coastal and Belagavi forests respectively .
- The species rank - abundance curve revealed Dharwad forest had higher species richness and comparatively stable species assemblage .
- *Drosophila* eugaracilis was the dominant species in both coastal and interior localities of UK forest rare faction curves plotted across the different seasons for all the forest localities revealed population assemblage and species richness of all forest across different seasons .
- Morisita index of similarities showed similarities for population across location and seasons nonparametric independent sample kruskal- wallis test was done to test distribution of abundance of individual species across spatial and temporal group .
- The study reveals variation of population assemblage across the forest of Dharwad belgavi and uttar kannada (coastal and interior) and dominance of *Drosophila* bipectinata , *Drosophila* malerkotlina and *Drosophila* eugracilis .

OBJECTIVES

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- The *Drosophila* produces a large number of offspring within short period and that allows us to collect the sufficient data about *Drosophila* fauna.

- There is a clear sexual dimorphism is present, male and female flies were identified with the help of taxonomic keys.

- Life cycle of *Drosophila* is short and is completed in two weeks it saves time to observe the results.

- The *Drosophila* genome is significantly homologous to that of the human genome which makes the study of genetics .

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MATERIALS AND METHODOLOGY

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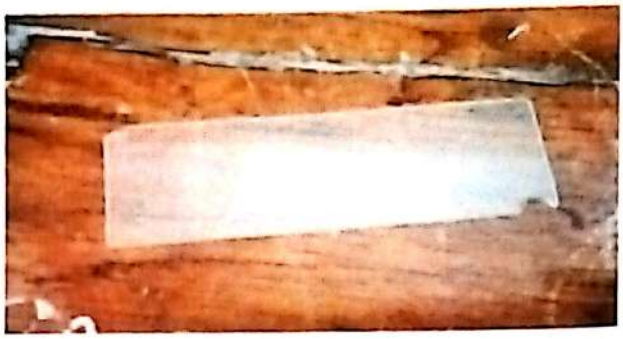
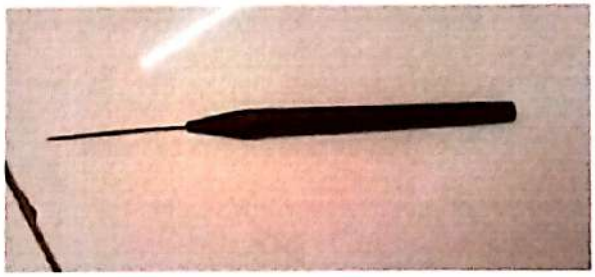
Materials

I. Glass slide : It is a thin flat piece of glass typically 75 by 26 mm and about 1 mm thick used to hold object for examination under a microscope.

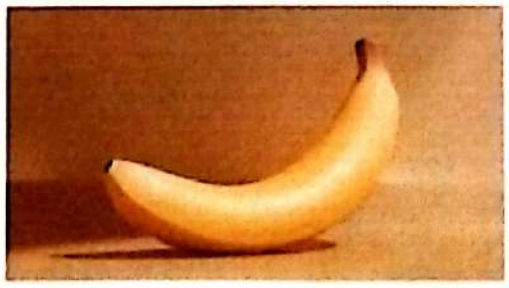


II. Watch glass : Watch glass is mainly to the compounds it is used as a lid to cover the beaker and flasks like container .

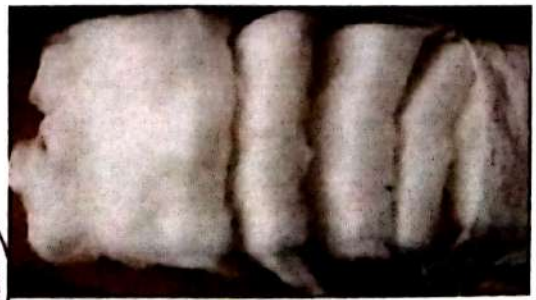
III. Needle : It is ideal for working with tiny *Drosophila* specimens needles can be sterilized and reused .



IV. Banana : Is used as food sours and it emits volatile compound that attract *Drosophila* encouraging them to feed and lay egg .



V. Cotton :It is every to handle and can be shaped to fit various experiment containers.



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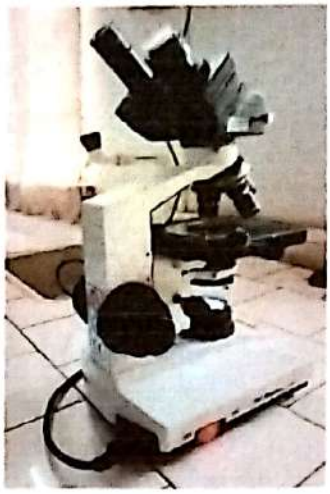

VI. Microscope : It is used to visualize tiny *Drosophila* structures such as eyes wings and embryo .

VII. Diethyl ether : It is the gentle anaesthetic that immobilizer *Drosophila* without causing harm allowing to handle and manipulate them easily .

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VIII. Glass bottles : Bottles are used to maintain a large population and culturing vials are used to maintain a small population and make absorb .

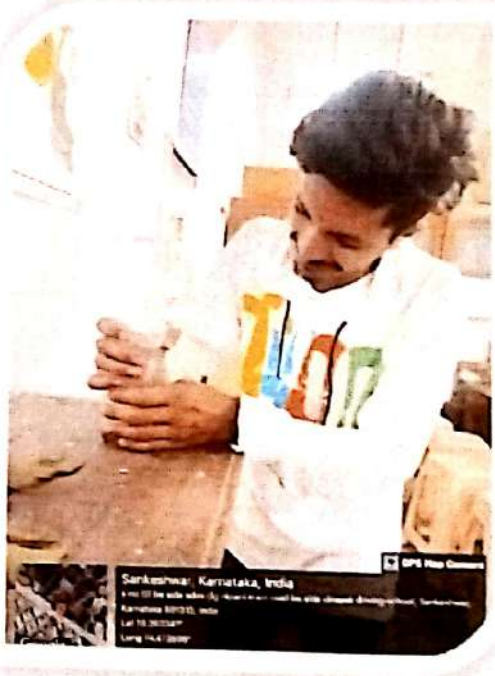
Methodology

- *Drosophila* thrives on fermenting soft fruit.
- There fore crushed banana is very suitable culture medium .
- Prepare bait bottles and kept in a different places to collect the *Drosophila* .
- For rearing and culturing the *Drosophila* .the collected samples need to be transferred from bait bottles to other empty bottle .
- While shifting flies from the bait bottle to other bottle the opening at the bottle must kept under bright light direction.
- The flies shift towards the light and thus making their transfer easy .
- **Anesthetization** :
- place the cotton ball soaked in Diethyl ether in a flies collected bottles.
- Wait for 2 to 3 minutes for the flies to be fully anesthetized.
- Take out the flies from the bottles , count the number of flies collected .
- **Microscopy** :
- Place the glass slide under microscope and focus on the desired characters .
- Observe and record the morphological characteristic such as ;
    1 Wing shape and venation
    2 Eye colour and shape
    3 Sex combs {in male }
    4 Abdominal marking

- **Identification :**
- Use the observed characteristics to identify the species .

- **Recording :** record the data and observation and the species name and date and any notable observation.


on the body,
an lead to fatigue
egs, raisins, leafy green
vegetables, beans and
enriched grains
or eyesight, g
of the immu
healthy skin
Sankeshwar, Karnataka, India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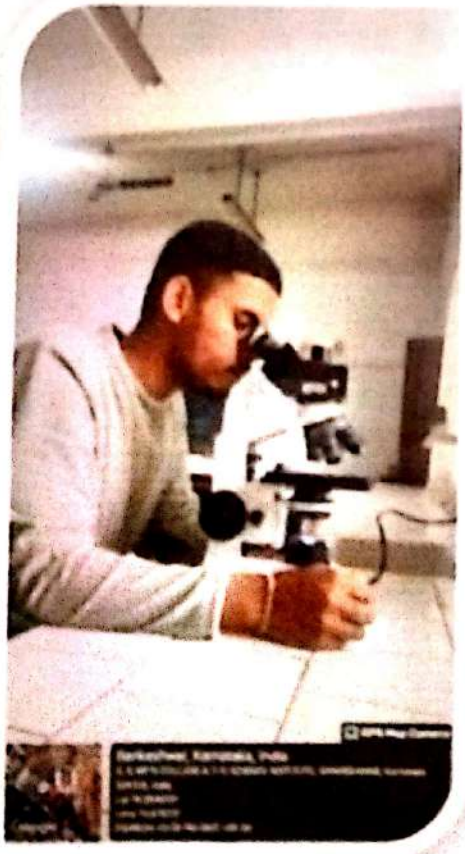
Sankeshwar, Karnataka, India



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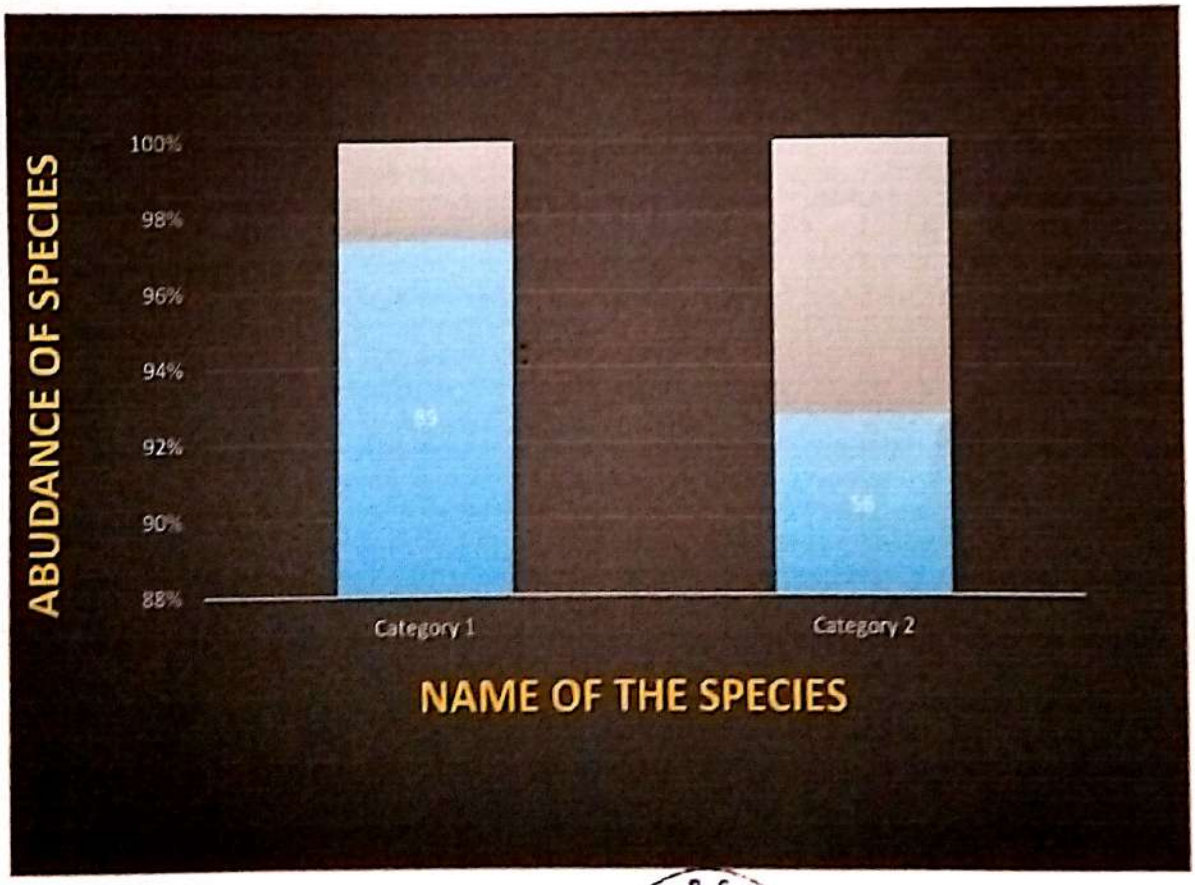
RESULT

Calculation period : July to August

SPOT : 1: in zooiogy ciass room		
Species	Name of the species	Total Abundance
1	*Drosophila melanogaster*	89
2	*Drosophila rajashekari*	56



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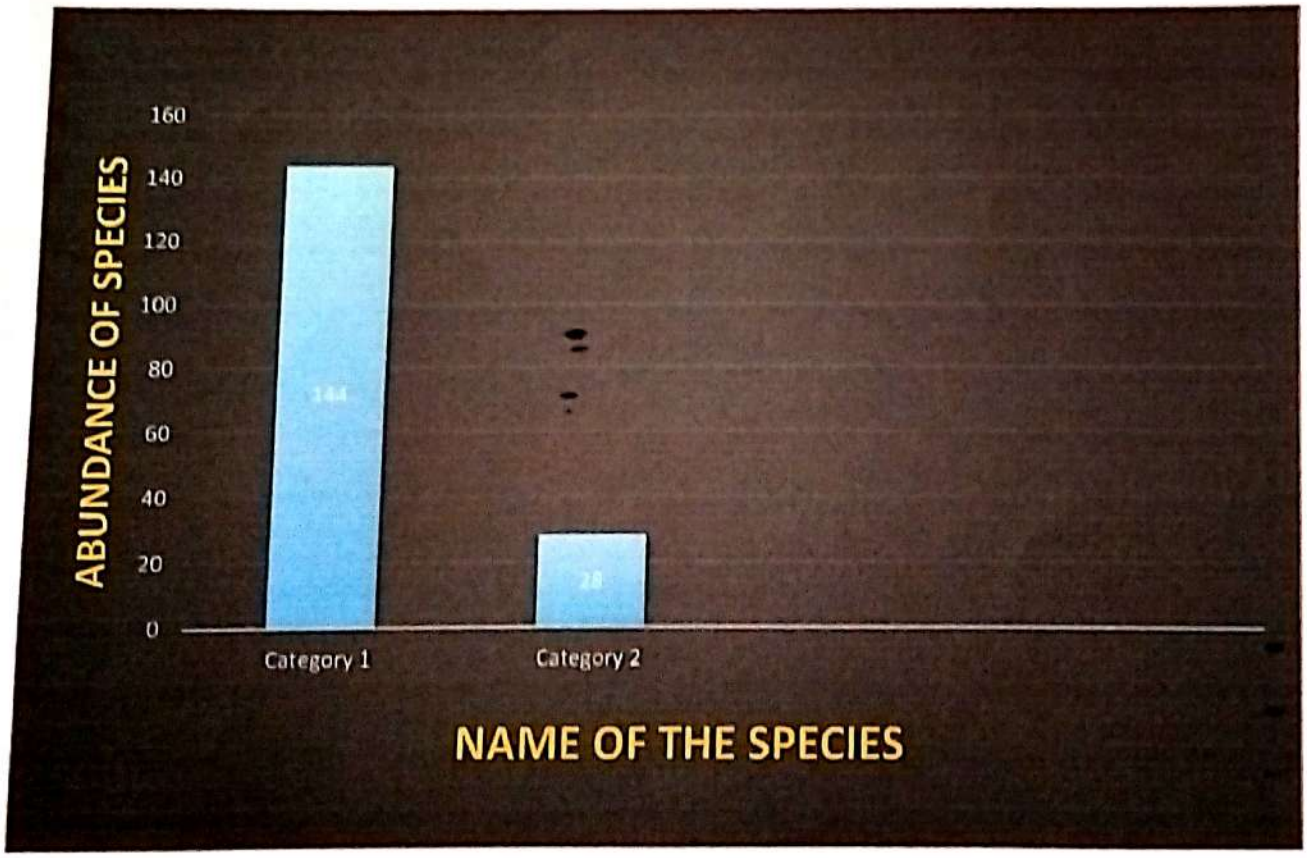
Calculation period : July to August

Spot : 2 : In college canteen		
Species	**Name of the species**	**Total Abundance**
1	*Drosophila melanogaster*	144
2	*Drosophila rajashekari*	28



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Drosophila rajashekari

- Body size : smaller than *Drosophila melanogaster.*
- Abdominal pigmentation : dark only on 5th segment
- Abdominal tip : pointed in female and blunt in male .
- Sex comb: 2 rows with 5 and 3 teeth respectively in fore leg of male fly genital pigmentation : darkly pigmented .
- Genital plate : first set with 2 teeth and second set with 6 teeth on primary clasper and no teeth on secondary clasper .
- Peculiar character : A small black spot is present on the wing of male fly.

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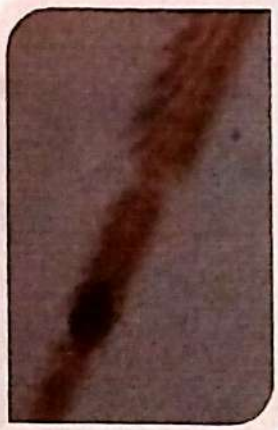
Drosophila melanogaster



- Body size male flies are smaller than female.
- Abdominal pigmentation : dark up to 4th and 5th segmented in male and light pigmentation in female .
- Abdominal tip : pointed in female and blunt in male .
- Sex comb : 1 row with 10 to 12 total sex comb teeth number .
- Genital pigmentation : dark .
- Genital plate : first set with 3 teeth on secondary claspers and second set with 4 teeth on primary claspers.

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DISCUSSION

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- The experiment uses different *Drosophila* species , each with unique features.
- *Drosophila melanogaster* is the most commonly used due to its well known genetics .
- Other species are used to study various aspects of biology , such as genetics , development , behaviour, and evolution.
- By comparing these species , researchers can gain a deeper understanding of how they evolved and how they adapt to their environments.
- This helps us learn more about the biology of *Drosophila* and how it relates to other living things .
- These species are used to study various aspects of biology, including ;
- Genetic variation and evolution .
- Developmental biology and morphology.
- Behavioural ecology and adaptation.
- Comparative genomic and transcriptomics .

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SUMMARY

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- *Drosophila melanogaster* or fruit flies inhabit wide range of habitats. Their native habitats is that seen in tropical areas of the old world however.

- The common fruit fly has been observed in almost all temperate region of the world .

- The factor of temperature highly influences the development of offspring of these species .

- The common fruit flies usually have a tan (yellow - brown)in colour.

- And are close to 3mm in length & 2mm wide.

- It has a rounded head with red ,large, compound eyes .

- Female is larger than males.

Materials and Methods

- *Drosophila* thrives on fermenting soft fruit , that's why prepared banana bait bottles for collection.
- *Drosophila* are collected in the bottles after sometime.
- Transfer the flies from collected bottles to empty bottles by covering carbon paper. For anesthetization place the cotton ball in empty bottle which is soaked in diethyl ether.
- Count the total number of flies which are collected, observe the flies and record the result.
- The two species are identified from collected *Drosophila* fauna those are *Drosophila melanogaste*r and *Drosophila rajashekari*
- *Drosophila rajashekari* smaller than *Drosophila melanogaster.*
- The abundance of *Drosophila* population varies from season to season.
- *Drosophila* population size was found to be maximum during Monsoon minimum during within ,the generation time is roughly 10 days form fertilized egg to enclosed adult.
- The maximum life span ranges from 60-80 days depending on the seasonal condition .

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CONCLUSION

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- The extensive knowledge of genetics of *Drosophila melanogaster* and the long-term experimental experience with this organism together with extensive genetics homology to mammals has made it of unique usefulness in mutation research and genetic toxicology .

- Many *Drosophila* genus are homologous to human genus and studied to gain a better understanding of what role these proteins have in human beings.

- Much research about the genetics of *Drosophila* over the last 50 years has resulted in a wealth of reference literature and knowledge about hundreds of its genes.

- Specific mutations can be targeted and analysed ease of handling ; short reproductive cycle allows scientists to analyse to test crosses .

- Also the offspring are produced in large numbers which provides statistically significant data phenotypic mutant changes are easily recognizable under the microscope .

- This review details on the life cycle of *Drosophila melanogaster* , its importance in genetic studies and also basic tool required for culturing flies in laboratory.

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DEPARTMENT OF ZOOLOGY

Major Project Report Entitled

STUDY OF LIFE CYCLE OF *"DROSOPHILA"* FAUNA AND BREEDING TECHNIQUES

Submitted to

RANI CHANNAMMA UNIVERSITY,BELAGAVI

For the partial fulfillment of the degree of

BACHELORS OF SCIENCE IN ZOOLOGY

By

Kartik Inamdar - U15CH21S0093

Rakshita Kumbar- U15CH21S0073

Laxmi Kurbet - U15CH21S0044

Tanzeela Nadaf - U15CH21S0068

Project Guide

Miss.V.R.Kolakar

S.S. Arts College & T. P. Science Institute SANKESHWAR. 591313

2023-2024

Rani Channamma University,Belagavi

S.D.V.S.SANGH'S

S.S.ARTS COLLEGE & T.P.SCIENCE INSTITUTE, SANKESHWAR

DEPARTMENT OF ZOOLOGY

Certificate

This is to certify that, the project work entitled "**Study of Life Cycle of "*Drosophila*" Fauna" and Breeding Techniques** submitted for partial fulfillment of Bachlors of Science in Zoology, to S.S ARTS COLLEGE & T.P. SCIENCE INSTITUTE, SANKESHWAR embodies result of the works carried by Kartik Inamdar . Rakshita Kumbar. Laxmi Kurbet . Tanzeela Nadaf . . Under the guidance at Department of Zoology S.S ARTS COLLEGE & T.P. SCIENCE INSTITUTE, SANKESHWAR for academic year 2023-24.

Guide:
Miss. Vachana R Kolakar

Head of Department
Miss. Rakshata V Kamate
Head
Department of Zoology
S.S Arts College & T.P. Science Institute
SANKESHWAR

Principal
Shri. P.B.Burji
PRINCIPAL
S.S.Arts College & T.P.Science Institute
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EXAMINERS:
1.
2. 12/8/24

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At last but not the least gratitude goes to all of our friends who directly or indirectly helped us to complete this project work.

Study of Life Cycle of *"Drosophila"* and Breeding techniques

CONTENTS

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INTRODUCTION

INTRODUCTION

Biodiversity is the sum total of all living organisms on the earth with particular reference to the profound variety in structure, function and genetic constitution. It includes both number and frequency of

species or genes in a given assemblage and the variety of resulting ecosystem in a region. These all organisms work together in the ecosystem to maintain balance and to support life to survive. Biodiversity can also be defined by the variety of organisms and species, their variety in function, structure and genetic constitution in an ecosystem. It is usually considered at three different levels: genetic, species and ecological diversities. Although some of the environmental factors including biotic and abiotic factors also affect the animal distribution.

Drosophila is a genus of small flies, belonging to the family Drosophilidae, whose members are often called "fruit flies". One species of Drosophila in particular*D.melanogaster*, has been heavily used in research in genetics and is a common model organism in developmentalbiology. The entire genus, however, contains about 1,500 species and is very diverse in appearance, behavior, and breeding habitat. Scientists who study Drosophila attribute the species'diversity to its ability to be competitive in almost every habitat, including deserts.

Drosophila derived from the Greek word Drosos means dew loving. They are minute organisms and most frequently known as fruit flies or often called as vinegar, wine or pomace flies, usually present on ripened fruits and vegetables. They are seen everywhere in the world, so are cosmopolitan in nature. Due to its cosmopolitan nature and complexities in species compositions, Drosophila forms a very good model for studying the eco-distributional patterns ofvarious species. Genus Drosophila belongs to the family Drosophilidae, characterized by rich species diversity at global level and also in India, which is a mega-diverse country. Fruit fly is anexcellent model organism because of low expense, can be easily maintained in the laboratory, have simplified short generation time which allows for quick experiments with high samples. As it has more importance in genetics, called as "Cinderella of genetics". Since the time of Morgan, Drosophila is being used as a model organism. It has answered many questions of the scientific community in the field of genetics, inheritance, variations, embryonic development, learning, behaviour, aging and evolution. About 75% of known human disease genes have a recognizable match in the genome of fruit flies. It has been reported that 548 genes of Drosophila are related tohuman disease-causing genes. Besides, global warming is one of the reasons to decrease the chromosomal diversity in Drosophila.

HABIT AND HABITAT:

Most species of Drosophila breed in various kinds of decaying plant and fungal material, including fruit, bark of trees, flowers and mushrooms, etc. Many species can be attracted to baits of ripened bananas or mushrooms, but some others are not attracted to any kind of baits. Several Drosophila species, like *D. melanogaster*, *D. immigrans* and *D simulans*, are closely associated with humans, and are often referred to as domestic species. These species with some wild species

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like *D. subobscura*, and some related to genus Zaprionus have been accidentally introducedaround the world by human activities such as fruit, flower and vegetable transports.

It can also be a pollution indicator since the fruits they feed on, which may be grown organically or inorganically, have impact on their fertility, longevity, activity and stress resistance. Thus, diversity among the species of Drosophila might indicate overall environmentalcondition of a region.

DISTRIBUTION AND CLASSIFICATION:

Native habitats of Drosophila species include those in the tropical regions of the old world, but the common fruit fly has been introduced to almost all temperate regions of the world. The genus Drosophila distributed in different geographical regions of the world will enable us to understand the hidden principles of adaptive radiation and certain mechanisms involved in speciation. Many works have been made in the field of taxonomy and systematics of family Drosophilidae in India. In India more knowledge of Drosophila was given by Dwivedi and Gupta.

CLASSIFICATION

Kingdom:Animalia

Subkingdom:Bilateria

Superphylum:Ecdysozoa

Phylum:Arthropoda

Subphylum:Hexapoda

Order:Diptera

Family:Drosophilidae

Genus:*Drosophila*

Many members of the family Drosophilidae are categorized into two subgenera, Drosophila and Sophophora. *D. melanogaster* of the sub-genus Sophophora is used as the model organism and was introduced in the field of genetic experiments by T. H. Morgan in 1909. and D.ananassae can be easily cultured in the laboratories and their genomes sequenced for a large comparative study in genetics. Even D. virilis of the genus Drosophila also used in comparative studies in the field of genetics and D. immigrans of same genus has been used in the evolutionarystudies to understand how viruses evolve with their hosts.

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MORPHOLOGY:

DROSOPHILA is a genus of small flies, belonging to the family *Drosophilidae*, whose members are often called "fruit flies". The entire genus, however, contains about 1,500 species and is very diverse in appearance, behavior, and breeding habitat. One species of *Drosophila* in particular D. melanogaster, has been heavily used in research in genetics and is acommon model organism in developmental biology. Basic genetic mechanisms are shared by most organisms. Therefore, it is only necessary to study the genetic mechanisms of a few organisms in order to understand how the mechanisms work in many organisms, including humans. *Drosophila melanogaster*, the fruit fly a little insect about 3mm long, is an excellent organism to study genetic mechanisms. The general principles of gene transmission, linkage, sex determination, genetic interactions; molecular, biochemical and developmental genetics, chromosomal aberrations, penetrance and expressivity, and evolutionary change may all be admirably demonstrated by using the fruit fly *Drosophila melanogaster*.

The life cycle of Drosophila is short and completes in about three weeks. Embryonic development, which follows fertilization and the formation of the zygote, occurs within the egg membrane. The egg produces larva, which eats and grows and at length becomes pupa. The pupa, in turn develops into an imago or adult. The duration of these stages varies with the temperature. Drosophila cultures ought to be kept in room temperature where the temperature does not range below 20oC or above 25oC. They are bred on fermenting medium which contains corn, dextrose, sugar and yeast extract. Their breeding ratio is 1:3 (male:female). The common culture contaminants include fungi, mites and bacteria. The male and the female are differentiated (under the microscope) based on their size, markings on their abdomen and presence of sex combs following anesthetization with ether.

Most Drosophila species are small, about 2-4 mm long, but some are larger than a housefly. The colour of the species varies from pale yellow to reddish brown or black and in some transverse black rings across the abdomen with brick red eyes. Many species have distinct black patterns on the wings with plumose, proboscis, the mouth part and arista, antennae, bristleson the head and thorax. The thorax has three segments. Prothorax is greatly reduced in Drosophila. Wings are attached to the mesothorax. The haltere, a pair of small balloons like organs used to maintain balance in the adult fly are attached to the metathorax. A pair of legs attached to each segment of thorax. The abdomen contains seven pairs of spiracles, one pair in each segment.

In Drosophila one such male-limited secondary sexual trait is the sex comb, a cluster of specialized bristle present on the forelegs. In Drosophila, female is generally larger than the male and have elongated tapering abdomen but male is with black spot at the tip of the blunt abdomen.

Flies consists of head with mouth,eye and antenna and 3 thoracic segment T1,T2,T3 or 9 abdominal segments [A1 to A8 or A9]

- T1 segment = Pairs of legs
- T2 segment =Pair of legs + Pair of wings
- T3 segment = Pair of legs + Pair of halters

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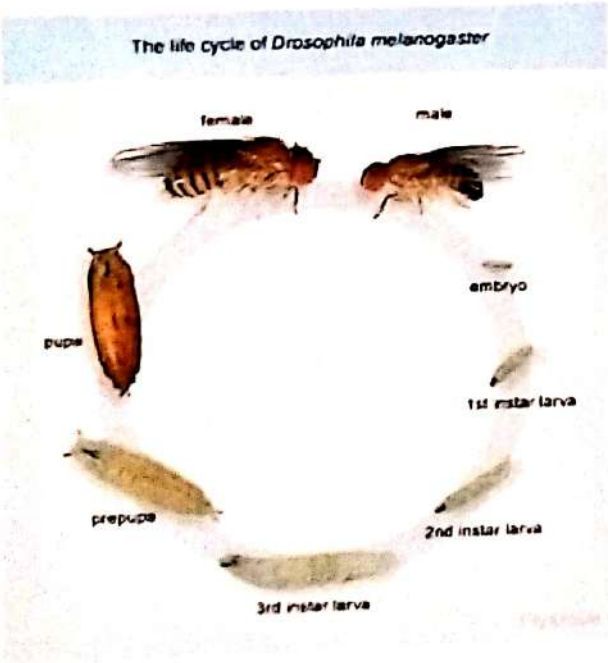
Halters : Helps to balance
[3 Pair leg +1 Pair wing+1 Pair Halters]

Life cycle of Drosophila

Drosophila are holometabolous insects and they undergo complete metamorphosis during their lifecycle. The lifecycle of Drosophila is short and completes in about three weeks, and is divided into four stages: egg, larva, pupa and adult. Embryonic development, which follows fertilization and formation of the zygote, occurs within the egg membrane and this stage lasts for 24 hours. The egg hatches out and forms larva which eats and grows to some length to become pupa and this stage lasts about 4 days. The pupa undergoes development to become imago or adult and this stage lasts about 4 days. The duration of these stages may vary with environmental conditions. The rate of development is more in higher temperatures. The lifecycle may complete in 14 or 15 days at 20°C, but at 25°C, cycle may last about 10 days. The average life span of Drosophila approximately ranges between 10 to 50 days under optimal ambient temperatures and sometimes may subject to vary.

Stages and duration:

Embryonic development, which follows fertilization and the formation of the zygote, occurs within the egg membrane. The egg produces larva, which eats and grows and at length becomes



Life cycle of *D. Melanogaster*

pupa. The pupa, in turn develops into an imago or adult. The duration of these stages varies with the temperature. At 20oC, the average length of the egg-larval period is 8days; at 25oC it is reduced to 5 days. The pupal life at 20oC is about 6.3 days, whereas at 25o C is about 4.2 days.

Thus at 25o c the life cycle may be completed in about 10 days, but at 20oC about 15 days are required. Drosophila cultures ought to be kept in room temperature where the temperature doesnot range below 20oC or above 25oC. Continued exposure to temperatures above 30° C may result in sterilization or death and at low temperatures the viability of flies is impaired and life cycle prolonged.

LITERATURE REVIEW

Literature Review

• (Srinath. BS and Shivanna. N, 2014) collected a total of 13853 flies in and around the Dharwad district during different seasons of 2011-2012, comprising of 20 different species where maximum 19 species recorded during Monsoon 2012, minimum 5 species recorded during winter 2012, statistical analysis revealed a positive correlation between abundance and average rainfall, not between the abundance and temperature.

• (Guruprasad and Padmaja C, 2016) revealed that the pattern of the distribution of different species of Drosophila, their population size varies in time and space, Chamundi Hill, Mysore. Similarlly (Megha et al., Hadya, Hassan, Western ghats, 2015; Bovito Achumi et al., Mount Japfu, Nagaland, 2013) concluded same result from population densities and relative abundance of the different species at different altitudinal variations, the diversity of Drosophila community was assessed by applying Simpson's diversity index.

• (Agarwal and Tamrakar, Raipur, 2017: M.S Krishna and V. Savinprakash, Biligiriranga hills,wildlife sanctuary, 2015, Neethu Raj and M.S Krishna, Waynad district, Kerala, Western ghats, 2015) used Simpson, berger-parker, Evenness and Shannon Wiener indices to assess the diversity of Drosophila community, low Simpson index showed highest diversity.

• (Vanitha B K et al., 2017) conducted study on diversity of fruit flies in different agroclimatic zones of Karnataka during April to June 2014, species of fruit flies in the mango orchard revealed four species of fruit flies that were attracted to methyl eugenol viz., Bactrocera dorsalis, Bactrocera correcta, Bactrocera zonata and Bactrocera affinis, among them, B. dorsalis was found to be dominant species, of the total species collected, 71.66% belonged to the B. dorsalis, 23.70 and 4.50% represented by B. correcta and B. conata respectively, B. affinis constituted only 0.14 % of the total catch of fruit flies, diversity indices showed that higher diversity of fruit flies recorded in Bidar and lower diversity recorded in Krishnarajpet.

• (Hegde et.al., 2021) did a survey on the Drosophila fauna in different localities of Ballari, where in fruit flies were identified up to species level by using taxonomic keys and collected 733 flies which includes 260 male flies and 473 female flies belonging to 8 different species

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OBJECTIVES

Objective

- The flies life cycle is short and ,only taking about 10 to 12 days at 25 degree celsius.
- The fruit fly,Drosophila melanogaster,has a life cycle that is often used as a model organism in biomedical research
- Easy to study genetics and behavior.28 degree Celsius is minimum temperature for development.It has 14000 coding gene.It ts referred as excellent for genetic study.
- It is easy to study, it has polethene chromosomes.

MATERIALS AND MATHEDOLOGY

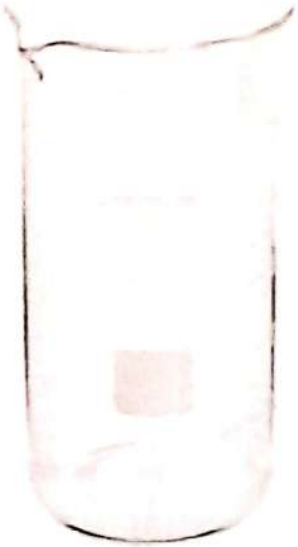
Materials and Methodology

Beaker , Ripened banana,Mobile phone,Place

Ripened banana

Mobile Phone

Place



Beaker

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RESULT

RESULT

The egg:

The egg of Drosophila melanogaster is about 0.5 of a millimeter long. An outer investing membrane, the chorion,is opaque and shows a pattern of hexagonal markings.A pair of filaments, extending from the anterodorsal surface,keeps the egg from sinking into soft food on which it may be laid. Penetration of spermatozoa into egg occurs through a small opening or micropyle, inthe conical protrusion at the anterior end, as the egg passes through the uterus. Many sperms mayenter an egg, through normally only one functions in fertilization. The spermatozoa have been stored by the female since the time of mating. Immediately after the entrance of the sperm, the reduction (meiotic) divisions are completed and the egg nucleus (female pronucleus) is formed.
The sperm nucleus and the egg nucleus then come into position side by side to produce the zygote nucleus, which divides to form the first two cleavage nuclei, the initial stage of development of the embryo. Eggs may be laid by the mother shortly after they are penetrated bythe sperm, or they may be retained in the uterus during the early stages of embryonic development.

The Larval Stages:

The larva , after hatching from the egg , undergoes two molts, so that the larval period consist of three stages (instars).The final stage , or third instar may attain a length of about 4.5millimeters. The larvae are such intensely active and voracious feeders that the culture medium in which they are crawling becomes heavily channeled and furrowed .

The larva has 12 segments: the 3 head segments, 3 thoracic segments, and 8 abdominal segments. The body wall is soft and flexible and consists of the outer noncellular cuticula and the inner cellular epidermis. A great number of sense organs are spread regularly over the whole body.

The larvae are quite transparent. Their fat bodies, in the form of long whitish sheets, the coiled intestine, and the yellowish malpighian tubules , as well as the gonads embedded in the fat body can easily be distinguished in the living larva when observed in transmitted light. The dorsal blood vessel is the circulatory organ of the larva. The larval muscles, segmentally arranged, are transparent but can be made visible when the larva is fixed in hot water. The larva contains a number of primitive cell complexes called imaginal discs, which are the primordia for later imaginal structures.

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The primary mechanism by which the larva grows is molting. At each molt the entire cuticle of the insect, including many specialized cuticular structures, as well as the mouth armature and the spiracles, is shed and has to be rebuilt again. During each molt, therefore many reconstruction processes occur, leading to the formation of structures characteristic of the ensuing instar. The growth of the internal organs proceeds gradually and seems to be rather independent of the molting process, which mainly affects the body wall. Organs such as Malpighian tubes, muscles, fat body, and intestine grow by an increase in cell size; the number of cells in the organ remains constant. The organ discs, on the other hand, grow chiefly by cell multiplication; the size of the individual cells remains about the same. In general, one might say that purely larval organs grow by an increase in cell size, whereas the presumptive imaginal organs grow by cell multiplication.

The Pupa:

A series of developmental steps by means of which the insect passes from the larval into the adult organism is called "metamorphosis". The most drastic changes in this transformation process take place during the pupal stage. Shortly before pupation the larva leaves the food and usually crawls onto the sides of the culture bottles, seeking a suitable place for pupation, and finally comes to rest. The larva is now very sluggish, everts its anterior spiracles, and becomes motionless. Soon the larva shortens and appears to be somewhat broader, thus gradually acquiring its pupal shape. The shortening of the larval cuticle, which forms the case of the puparium, is caused by muscular action. The puparium, which is the outer pupil case, is thus identical with the cuticle of the last larval instar. When the shaping of the puparium is completed,the larval segmentation is obliterated, but the cuticle is still white. This stage lasts only a few minutes and is thus an accurate time mark from which to date the age of the pupa. Immediately after the cuticle reaches the white prepupal stage, the hardening and the darkening of the cuticle

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begin and proceed very quickly. About three and a half hours later the puparium is fully coloured. Pigmentation apparently starts in the external surface of the cuticle and proceeds inward . Four hours after the formation of the puparium , the animal within it has separated its epidermis from the puparium and has become a headless individual having no external wings or legs and known as the "prepupa". A very fine prepupal cuticle has been secreted and surrounds the prepupa.

The Pupa

Pupation takes place about 12 hours after puparium formation. By muscular contraction the prepupa draws back from the anterior end of the puparim and everts its head structures. This movement also ejects the larval mouth armature, which until now was attached to the anterior end of the prepupa. The wings, halteres and legs are also everted. A typical pupa with head, thorax, and abdomen is thus shaped. In section it is seen that the pupa now lies within three membranes: an outer membrane, the puparium: an intermediate membrane, the prepupal cuticle; and an inner membrane, the newly secreted pupal cuticle.

Now metamorphosis involves the destruction of certain larval tissues and organs (histolysis) and the organization of adult structures from primitive cell complexes, the imaginal discs. It must, however, be realized that some larval organs are transformed into their imaginal state without any very drastic change in their structure.

The duration and extent of these transformation processes vary greatly for the different organs involved. Larval organs which are completely histolyzed during metamorphosis are the salivary glands, the fat bodies, the intestine and apparently the muscles. All these organs are formed anew, either from imaginal disc cells already present in the larva or from cells which

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come visibly into being in the course of pupal reorganization. The Malpighian tubules are relatively little altered during metamorphosis but nevertheless undergo some change in their structural composition. The same situation seems to prevail in the brain, which is not completely histolyzed. The extremities, eyes, mouthparts, antennae, and genital apparatus differentiate from their appropriate imaginal discs, which were already present in the larval stage and which undergo histogenesis during pupal development. The body wall of the imaginal head, thorax, andabdomen is also formed from imaginal disc cells. The body wall of head and thorax is formed by the combined effort of all the imaginal discs in this region, each of which contributes its part. The hypoderm of the abdomen is formed by segmentally arranged imaginal cells which first become visible in young prepupae.

Adult stage

When metamorphosis is complete, the adult flies emerge from the pupa case. They are fragile and light in color and their wings are not fully expanded. These flies darken in a few hours and take on the normal appearance of the adult fly. Upon emergence, flies are relatively light in color but they darken during the first few hours. It is possible by this criterion to distinguish recently emerged flies from older ones present in the same culture bottle.They live a month or more and then die. A female does not mate for about 10 to 12 hours after emerging from the pupa. Once she has mated, she stores a considerable quantity of sperm in receptacles and fertilizes her eggs as she lays them. Hence, to ensure a controlled mating, it is necessary to use females that have not mated before. These flies are referred to as virgin females.

Female and male adult *Drosophila*

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Methods of breeding drosophila:

Drosophila melanogaster is found in abundance on soft fruits like grapes, bananas, and plums, especially if they are overripe and have begun to ferment. Adult flies as well as larvae feed on fruit juices: and since yeast is present wherever fermentation is in progress, it is believedthat yeast constitutes an important part of their diet .Therefore Drosophila may be raised on any fermenting medium. The different types of medium routinely used for breeding Drosophila include cornmeal medium, banana jaggery medium, sucrose dextrose medium and maltose corn medium. The composition of the food predominantly includes sugar, yeast extract, dextrose and corn flour. They can be bred in glass bottles to obtain large numbers of the progeny. And most often crosses and experiments are set up in glass vials.

Scientists who study Drosophila attribute the species' diversity to its ability to be competitive in almost every habitat, including deserts. The extensive knowledge of the genetics of D. melanogaster and the long term experimental experience with this organism together with extensive genetic homology to mammals has made it of unique usefulness in mutation research and genetic toxicology. Many Drosophila genes are homologous to human genes and are studied to gain a better understanding of what role these proteins have in human beings. Much research about the genetics of Drosophila over the last 50 years has resulted in a wealth of reference literature and knowledge about hundreds of its genes. Specific mutations can be targeted and analyzed. Its ease of handling, short reproductive cycle allows scientists to analyze test crosses. Also, the offspring are produced in large numbers which provides statistically significant data and phenotypic mutant changes are easily recognizable under the microscope. This review details on the lifecycle of D. melanogaster, its importance in genetic studies and also basic tools required for culturing flies in laboratory

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SUMMARY

Summary

The life cycle of Drosophila,a fruit fly,consists of four stages: egg ,larva,pupa and adult.It begins with the female laying eggs in a suitable environment,which hatch into larvae within 24 hours.The larvae feed and grow,moulting three times,before transforming into pupae,a resting stage where they undergo a dramatic transformation.After 4-5 days,the adult emerges,ready to mate and reproduce.With a short lifespan of 10-30 days and high reproductive rate,Drosophila is an ideal model organism for specific research,particularly in genetics and developmental biology. *Drosoplila melanogaster* know colloquially as the fruit fly,remains one of the most commonly used model organisms for biomedical science.For more than one hundred years,the low cost,rapid generation time and excellent genetic tools have made the fly indispensable for basic research.

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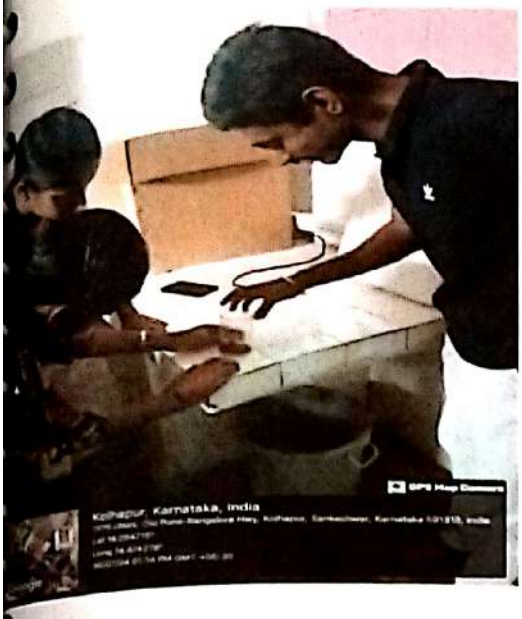

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CERTIFICATE

This is to certify that project work for the subject of "**calculus**" by

Name	Registration No.
1. Laxmi .R.Munnoli.	U15CH21S0059
2. Vidyarani .M.patil.	U15CH21S0104
3. Anusuya.B.Khanapuri.	U15CH21S0100
4. Shilpa.J.Karoshi	U15CH21S0017
5. Vidyashree.D.Chopade	U15CH21S0069

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A Subjected to the project of mathematics,satisfactorily completed their teamwork in course of B.Sc(Sem 5th -6th)during the year 2023-2024

Date: 10/08/2024

Project Guide: Miss .T. G. Karale.

Head Of The Department: Smt. S.I.Nadaf.

Principal: Prof. P.B.Burji

PRINCIPAL
S.S. Arts College & T.P. Science Institute
SANKESHWAR

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Examiner's signature **Head of the department**

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1 INTRODUCTION OF CALCULUS

0.1 History of calculus:

Calculus, originally called infinitesimal calculus, is a mathematical discipline focused on limits, continuity, derivatives, integrals, and infinite series. Many elements of calculus appeared in ancient Greece, then in China and the Middle East, and still later again in medieval Europe and in India.

Infinitesimal calculus was developed in the late 17th century by Isaac Newton and Gottfried Wilhelm Leibniz independently of each other. An argument over priority led to the Leibniz–Newton calculus controversy which continued until the death of Leibniz in 1716. The development of calculus and its uses within the sciences have continued to the present.

The formal study of calculus brought together Cavalieri's infinitesimals with the calculus of finite differences developed in Europe at around the same time, and Fermat's adequality.

The combination was achieved by John Wallis, Isaac Barrow, and James Gregory, the latter two proving predecessors to the second fundamental theorem of calculus around 1670.

In the 17th century, European mathematicians Isaac Barrow, René Descartes, Pierre de Fermat, Blaise Pascal, John Wallis and others discussed the idea of a derivative. In particular, in *Methodus ad disquirendam maximam et minima* and in *De tangentibus linearum curvarum* distributed in 1636, Fermat introduced the concept of adequality, which represented equality up to an infinitesimal error term.[21] This method could be used to determine the maxima, minima, and tangents to various curves and was closely related to differentiation.

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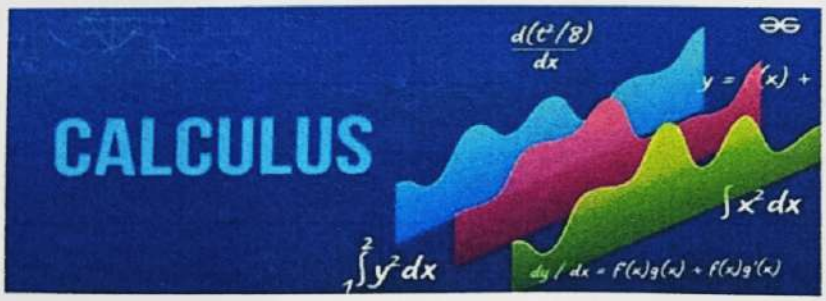
0.2 Father of calculus:

Gottfried Wilhelm Leibniz[a] (1 July 1646 [O.S. 21 June] – 14 November 1716) was a German polymath active as a mathematician, philosopher, scientist and diplomat.

who invented calculus in another branchesof mathematics, such asbinary arithmetic, and statistics Leibniz hasbeen called the "last universal genius" due tohis knowledge and skills in different fields andbecause such people became much less. commonafter his lifetime with the coming of the IndustrialRevolution and the spread of specialized labor.[15] He is a prominent figure in both the history of philosophyand the history of mathematics.

He wrotes work on philosophy ,theology,ethics,politices low,history,philology,games,music and other studies leibniz also made major contributions to physics and thechnology,and anticipated notions that surpaced much later in probabality theory.

0.3 Definition of calculus:



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Calculus, branch of mathematics concerned with the calculation of instantaneous rates of change (differential calculus) and the summation of infinitely many small factors to determine some whole (integral calculus).

1. Limits

1.0 INTRODUCTION OF LIMITS:

Lets study limits concept starting from its basics for that we need to understand limiting process in greater clarity. We study a few illustrative examples to gain some familiarity with the concept of limits

Consider the function $f(x) = x^2$. Observe that as x takes values very close to 0 the value of f(x) also moves towards 0 . We say $\lim_{x \to 0} f(x) = 0$

(to be read as limit of f (x) as x tends to zero equals zero). The limit of f (x) as x tends to zero is to be thought of as the value f (x) should assume at x = 0.

In general as $x \to a$, f (x) $\to$ l, then l is called limit of the function f (x) which is symbolically written as $\lim_{x \to a} f(x) = l$

Consider the following function g(x) = |x|, $x \neq 0$. Observe that g(0) is not defined. Computing the value of g(x) for values of x very near to 0, we see that the value of g(x) moves towards 0. So, $\lim_{x \to 0} g(x) = 0$. This is intuitively clear from the graph of y = |x| for $x \neq 0$.

Consider the following function. $h(x)=x^2-4/x-2, x \neq 0$

Compute the value of h(x) for values of x very near to 2 (but not at 2). Convince yourself that all these values are near to 4. This is somewhat strengthened by considering the graph of the function y = h(x) given here ,

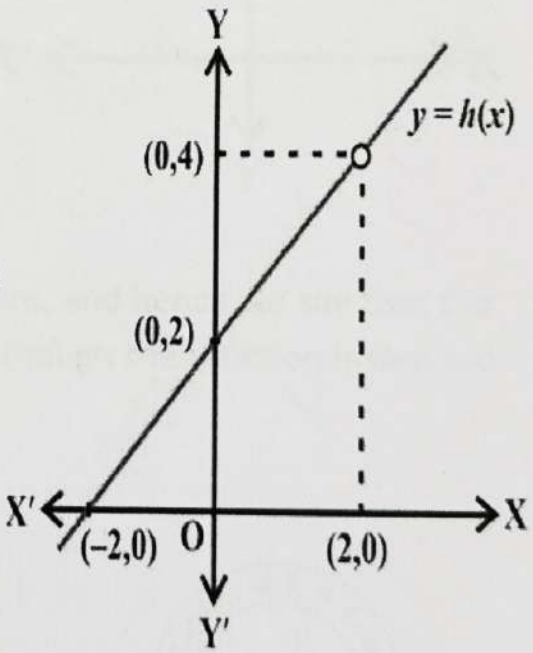

Fig 13.2

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In all these illustrations the value which the function should assume at a given point x = a did not really depend on how is x tending to a. Note that there are essentially two ways x could approach a number a either from left or from right, i.e., all the values of x near a could be less than a or could be greater than a. This naturally leads to two limits – the right hand limit and the left hand limit. Right hand limit of a function f(x) is that value of f(x) which is dictated by the values of f(x) when x tends to a from the right. Similarly, the left hand limit. To illustrate this, consider the function

$$F(x)=\begin{cases}1, x \leq 0\\ 2, x > 0\end{cases}$$

Graph of this function is shown in the Fig 1

clear that the value of f at 0 dictated by values of

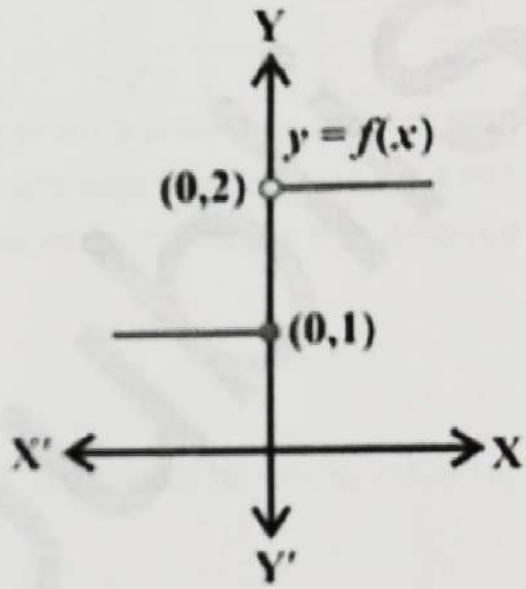
x ≤ 0 equals 1, i.e., the left hand limit of f (x) at 0

$\lim_{x \to 0} f(x) = 1$

Similarly, the value of f at 0 dictated by values of

f (x) with x > 0 equals 2, i.e., the right hand limit c

at 0 is $\lim_{x \to 0} f(x) = 2$



In this case the right and left hand limits are different, and hence we say that the limit of f (x) as x tends to zero does not exist (even though the function is defined at 0)

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Example :1

Illustration 1 Consider the function f(x) = x + 10. We want to find the limit of this function at x = 5. Let us compute the value of the function f(x) for x very near to 5. Some of the points near and to the left of 5 are 4.9, 4.95, 4.99, 4.995. . ., etc. Values of the function at these points are tabulated below. Similarly, the real number 5.001, Fig 13.3 © NCERT not to be republished 286 MATHEMATICS 5.01, 5.1 are also points near and to the right of 5. Values of the function at these points are also given in the Table

x	4.9	4.95	4.99	4.995	5.001	5.01	5.1
f(x)	14.9	14.95	14.99	14.995	15.001	15.01	15.1

From the Table 13.4, we deduce that value of f(x) at x = 5 should be greater than 14.995 and less than 15.001 assuming nothing dramatic happens between x = 4.995 and 5.001. It is reasonable to assume that the value of the f(x) at x = 5 as dictated by the numbers to the left of 5 is 15, i.e.

$$\lim_{x \to 5-} f(x) = 15$$

Similarly, when x approaches 5 from the right, f(x) should be taking value 15, i.e.

$$\lim_{x \to 5+} f(x) = 15$$

Hence, it is likely that the left hand limit of f(x) and the right hand limit of f(x) are both equal to 15. Thus,

$$\lim_{x \to 5-} f(x) = \lim_{x \to 5+} f(x) = \lim_{x \to 5} f(x) = 15$$

This conclusion about the limit being equal to 15 is somewhat strengthened by seeing the graph of this function which is given in Fig 2.16, Chapter 2. In this figure, we note that as x approaches 5 from either right or left, the graph of the function f(x) = x +10 approaches the point (5, 15).

We observe that the value of the function at x = 5 also happens to be equal to 15.

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Example :2

Consider the function f(x) = x3 . Let us try to find the limit of this function at x = 1. Proceeding as in the previous case, we tabulate the value of f(x) at x near 1. This is given in the Table 13.5.

x	0.9	0.99	0.999	1.001	1.01	1.1
F(x)	0.729	0.970299	0.997002999	1.003003001	1.030301	1.331

From this table, we deduce that value of f(x) at x = 1 should be greater than 0.997002999 and less than 1.003003001 assuming nothing dramatic happens between x = 0.999 and 1.001 it is reasonable to assume that the value of the f(x) at x=1 as dictated by the numbers to the left of 1 is 1,i.e., $\lim_{x\to 1-} f(x) = 1$

Similarly, when x approaches 1 from the right, f(x)should be taking value 1, i.e.,

$$\lim_{x\to 1+} f(x) = 1$$

Hence, it is likely that the left hand limit of f(x) and the right hand limit of f(x) are both equal to 1. Thus,

$$\lim_{x\to 1-} f(x) = \lim_{x\to 1=} f(x) = \lim_{x\to 1} f(x) = 1$$

This conclusion about the limit being equal to 1 is somewhat strengthened by seeing the graph of this function which is given in Fig 2.11, Chapter 2. In this figure, we note that as x approaches 1 from either right or left, the graph of the function f(x) = x3 approaches the point (1, 1).

We observe, again, that the value of the function at x = 1 also happens to be equal to 1.

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1.1 Algebra of limits:

In the above illustrations, we have observed that the limiting process respects addition, subtraction, multiplication and division as long as the limits and functions under consideration are well defined. This is not a coincidence. In fact, below we formalise these as a theorem without proof.

Theorem 1: Let f and g be two functions such that both $\lim_{x\to a} f(x)$ and $\lim_{x\to a} g(x)$ exist. then

(i) Limit of sum of two functions is sum of the limits of the functions, i.e.,

$$\lim_{x\to a}[f(x)+g(x)] = \lim_{x\to a} f(x) + \lim_{x\to a} g(x)$$

. (ii) Limit of difference of two functions is difference of the limits of the functions, i.e.,

$$\lim_{x\to a}[f(x)-g(x)] = \lim_{x\to a} f(x) - \lim_{x\to a} g(x)$$

(iii) Limit of product of two functions is product of the limits of the functions, i.e.,

$$\lim_{x\to a}[f(x).g(x)] = \lim_{x\to a} f(x) . \lim_{x\to a} g(x)$$

(iv) Limit of quotient of two functions is quotient of the limits of the functions (whenever the denominator is non zero), i.e.,

$$\lim_{x\to a} \frac{f(x)}{g(x)} = \frac{\lim_{x\to a} f(x)}{\lim_{x\to a} g(x)}$$

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1.2 Limits of polynomials and rational functions :

A function f is said to be a polynomial function if f(x) is zero function or if $f(x) = a_0 + a_1x + a_2x^2 + \ldots\ldots\ldots\ldots + a_nx^n$ where a_1s are real numbers such that $a_n \neq 0$ for sum natural number n.

We know that $\lim_{x \to a} x = a$ Hence

$$\lim_{x \to a} x^2 = \lim_{x \to a}(x.x) = \lim_{x \to a} x \lim_{x \to a} x = a.a = a^2$$

An easy exercise in induction on n tells us that

$$\lim_{x \to a} x^n = a^n$$

Now ,Let $f(x) = a_0 + a_1x + a_2x^2 + \ldots\ldots\ldots\ldots + a_nx^n$ be a polynomial function.Thinking of each of $a_0, a_1x, a_2x^2, \ldots\ldots\ldots, a_nx^n$ as a function, we have

$$\lim_{x \to a} f(x) = \lim_{x \to a}[a_0 + a_1x + a_2x^2 + \ldots\ldots\ldots\ldots + a_nx^n]$$

$$= \lim_{x \to a} a_0 + \lim_{x \to a} a_1x + \lim_{x \to a} a_2x^2 + \ldots\ldots\ldots\ldots + \lim_{x \to a} a_nx^n$$

$$= a_0 + a_1 \lim_{x \to a} x + a_2 \lim_{x \to a} x^2 + \ldots\ldots\ldots\ldots + a_n \lim_{x \to a} x^n$$

$$= a_0 + a_1a + a_2a^2 + \ldots\ldots\ldots\ldots + a_na$$

$$= f(a)$$

(make sure that you understand the justification for each step in the above)

A function f is said to be a rational function,if $f(x) = \frac{g(x)}{h(x)}$, where g(x) and h(x) are polynomials such that $h(x) \neq 0$. Then

$$\lim_{x \to a} f(x) = \lim_{x \to a} \frac{g(x)}{h(x)} = \frac{\lim_{x \to a} g(x)}{\lim_{x \to a} h(x)} = \frac{g(a)}{h(a)}$$

However, if h(a)=0, there are two scenarios – (i) when g(a) ≠ 0 and (ii) when g(a) = 0. In the former case we say that the limit does not exist. In the latter case we can write g(x) = (x – a) ^{k} g'(x), where k is the maximum of powers of (x – a) in g(x) Similarly, h(x) = (x – a) ' h· (x) as h (a) = 0. Now, if k > l, we have

$$\lim_{x\to a} f(x) = \frac{\lim_{x\to a} g(x)}{\lim_{x\to a} h(x)} = \frac{\lim_{x\to a}(x-a)^k g_r(x)}{\lim_{x\uparrow\to a}(x-a)^1 h_r(x)}$$

$$\frac{\lim_{x\to a}(x-a)^{k-1} g1(x)}{\lim_{x\uparrow\to a} h1(x)} = \frac{0.g_{1(a)}}{h_1(a)} = 0$$

If k<l,the limit is not defined

Example:1

1 Find the limits: $\lim_{x\to 1}[x^3-x^2+1]$

Solution The required limits are all limits of some polynomial functions. Hence the limits are the values of the function at the prescribed points. We have

$\lim_{x\to 1}[x^3-x^2+1] = 1^3-1^2+1=1$

2. Find the limits: $\lim_{x\to 3}[x(x+1)]$

Solution The required limits are all limits of some polynomial functions. Hence the limits are the values of the function at the prescribed points. We have

$\lim_{x\to 3}[x(x+1)]$=3(3+1)=3(4)=12

3.Find the limits: $\lim_{x\to -1}[1+x+x^2+\ldots\ldots\ldots+x^{10}]$

Solution The required limits are all limits of some polynomial functions. Hence the limits are the values of the function at the prescribed points. We have

$\lim_{x\to -1}[1+x+x^2+\ldots\ldots\ldots+x^{10}]=1+(-1)+(-1)^2+\ldots\ldots\ldots+(-1)^1$

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1.3 Hospital's Rule:

If the $\lim_{x\to c} \frac{f(x)}{g(x)}$ results in one of the following forms:

$$\frac{0}{0}, \pm\frac{\infty}{\infty}, 0*\pm\infty, \infty-\infty, 0^0, 1^\infty, \infty^0$$

And , $\lim_{x\to c} \frac{f(x)}{g(x)}$ exist and $g'(x)\neq 0$,then:

$$\lim_{x\to c} \frac{f(x)}{g(x)} = \lim_{x\to c} \frac{f'(x)}{g'(x)}$$

Example 1:Indeterminant form of $\frac{0}{0}$

Find the limit $\lim_{x\to 0} \frac{e^x-1}{x}$

Solution: $\lim_{x\to 0} \frac{e^x-1}{x} = \frac{0}{0} = \lim_{x\to 0} \frac{e^x}{1}$

Using L'Hospital's Rule: $\lim_{x\to 0} \frac{e^x-1}{x} = \lim_{x\to 0} \frac{e^x}{1} = \frac{1}{1} = 1$

Example 2:Indeterminant form of $\frac{\infty}{\infty}$

Find the limit $\lim_{x\to\infty} \frac{x^2}{2^x}$

Solution: $\lim_{x\to\infty} \frac{x^2}{2^x} = \frac{\infty}{\infty}$

Using L'Hospital's Rule: $\lim_{x\to\infty} \frac{x^2}{2^x} = \lim_{x\to\infty} \frac{2x}{2^x ln2} = \frac{2}{ln2} \lim_{x\to\infty} \frac{x}{2^x} = \frac{\infty}{\infty}$

Using L'Hospital's Rule Again:

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$$\frac{2}{ln2}\lim_{x\to\infty}\frac{x}{2^x}=\frac{2}{ln2}\lim_{x\to\infty}\frac{1}{2^x ln2}=\frac{2}{(ln2)^2}\lim_{x\to\infty}\frac{1}{2^x}=\frac{2}{(ln2)^2}*0=0$$

Example 3: Indeterminant form of $\infty-\infty$

Find the limit $\lim_{x\to2}(\frac{4}{x^2-4}-\frac{1}{x-2})$

Solution: $\lim_{x\to2}(\frac{4}{x^2-4}-\frac{1}{x-2})=\infty-\infty$

Using L'Hospital's Rule:

$$\lim_{x\to2}(\frac{4}{x^2-4}-\frac{1}{x-2})=\lim_{x\to2}\frac{4-(x+2)}{(x-2)(x+2)}=\lim_{x\to2}\frac{2-x}{x^2-4}=\lim_{x\to2}\frac{-1}{2x}=\frac{-1}{4}$$

Example 3: Indeterminant form of 1^{∞}

Find the limit $\lim_{x\to1}x^{\frac{1}{1-x}}$

Solution: $\lim_{x\to1}x^{\frac{1}{1-x}}=1^{\infty}$

Let y $=x^{\frac{1}{1-x}}$. Then lny $=\ln x^{\frac{1}{1-x}}=\frac{lnx}{1-x}$

Using L'Hospital's Rule:

$$\lim_{x\to1}lny=\lim_{x\to1}\frac{lnx}{1-x}=:\lim_{x\to1}\frac{\frac{1}{x}}{-1}=-\lim_{x\to1}\frac{1}{x}=-1$$

There fore $\lim_{x\to1}lny=-1$

$$\lim_{x\to1}x^{\frac{1}{1-x}}=\lim_{x\to1}y=e^{-1}=\frac{1}{e}$$

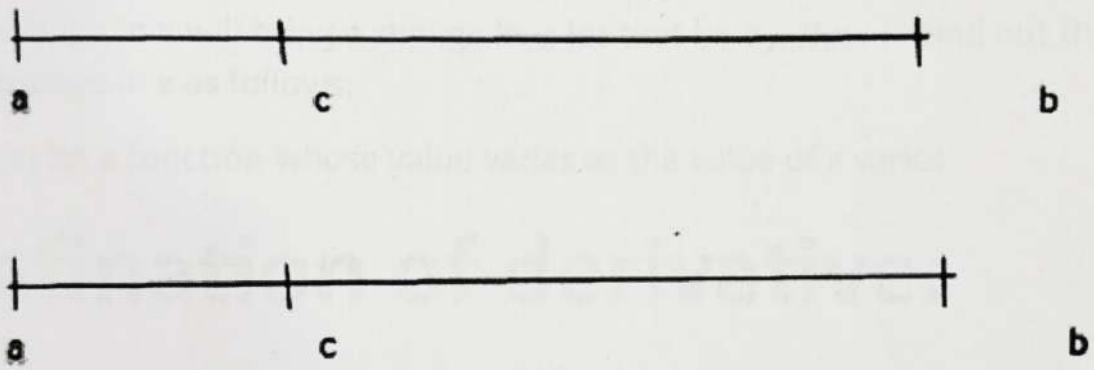
: 2. DERIVATIVES :

2.0 INTRODUCTION:

Derivatives in Maths refers to the instantaneous rate of change of a quantity with respect to the other. It helps to investigate the moment by moment nature of an amount.

Derivative Example:

Let a car takes 't' seconds to move from a point 'a' to 'b'.



But how long will it take to move from point 'a' to 'c'?

Or

How much distance will it cover in 't-1' seconds?

This can be known from the velocity that is as follows:

Velocity (v) = d(x)/d(t)

Where 'x' is the distance travelled and 't' is the time taken to cover that distance.

This will give you the distance covered per unit time so that we can analyze any distance covered in any interval of time.

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Derivatives in Math – Calculus

The process of finding the derivative is called differentiation. The inverse process is called anti-differentiation. Let's find the derivative of a function y = f(x). It is the measure of the rate at which the value of y changes with respect to the change of the variable x. It is known as the derivative of the function "f", with respect to the variable x.

If an infinitesimal change in xis denoted as dx, then the derivative of y with respect to x is written as **dy/dx.**

Here the derivative of y with respect to x is read as "dy by dx" or "dy over dx"

Example:

Let 'y' be a dependent variable and 'x' be an independent variable.

Consider a change in the value of x, that is dx.

This change in x will bring a change in y, let that be dy. Now to find out the change in y with a unit change in x as follows:

Let f (x) be a function whose value varies as the value of x varies

Defination of derivative:

$$f(x) = \lim_{h \to 0} \left(\frac{f(x+h)-f(x)}{h}\right)$$

NOTE:

1. A function f (x) is called differentiable to X = a If f (a) exists and f (x) Is called ,differentiable on an interval if the derivative exists for each point in the interval
2. If f(x) is differentiable at x=a then f(x) is continuous at x=a

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2.1 PROPERTIES OF DERIVATIVES:

Proof of sum / difference of two functions :

This is easy enough to prove using the definations of the derivative . We'll startv with the sum of two functions first plug the sum into the definition and rewrite the numerator a little

$$\left(f(x)+g(x)\right)' = \lim_{h\to 0}\left(\frac{f(x+h)+g(x+h)-\left(f(x)+g(x)\right)}{h}\right)$$

$$= \lim_{h\to 0}\left(\frac{f(x+h)-f(x)+g(x+h)-g(x)}{h}\right)$$

Now ,break up the fraction into two pieces and recall tat the limit of a sum is the sum of the limits using this fact we see that we end up with the definition of the derivative for each of the two functions .

$$\left(f(x)+g(x)\right)' = \lim_{h\to 0}\left(\frac{f(x+h)-\left(f(x)\right)}{h}\right)+\lim_{h\to 0}\left(\frac{g(x+h)-g(x)}{h}\right)$$

$$= f'(x)+g'(x)$$

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The proof of the difference of two functions in nearly identical so we will give it here without any explanation

$$(f(x)-g(x))' = \lim_{h\to 0}\left(\frac{f(x+h)-g(x+h)-\left(f(x)+g(x)\right)}{h}\right)$$

$$= \lim_{h\to 0}\left(\frac{f(x+h)-\left(f(x)\right)}{h}\right) - \lim_{h\to 0}\left(\frac{g(x+h)-g(x)}{h}\right)$$

$$= f'(x) - g'(x)$$

Example 1. $g(t) = 2t^6 + 7t^{-6}$

Soln: The point of this problem is to make sure that you deal with negative exponents correctly here is the derivative .

$$g'(t) = 2(6)t^6 + 7(-6)t^{-6}$$
$$= 12t^5 - 42t^{-7}$$

Make sure that you correctly deal with the exponents in these cases , especially the negative exponents it is an easy mistake to "go the other way " when the substracting one off from the negative exponent and get $-6t^{-5}$ instead of the correct $-6t^{-7}$.

Example 2. $h(x) = x^{pi} - x^{\sqrt{2}}$

Soln: in all of the previous examples the exponents have been nice integers or fractions .That is usually what we all see in this class.However ,the exponent only needs to be a number so don't get excited about problems like this one .they work exactly the same.

$$h'(x) = pi\left(x^{(pi-1)}\right) - \sqrt{2}x^{\sqrt{2}-1}$$

The answer is a little messy and we wont reduce the exponents down to decimals however ,this problem is not terribly difficult it just looks that way initially .

Product rule: $(fg)' = f'g + fg'$

As with the power rule above ,the product rule can be approved either by using the definition of the derivative or it can be proved using logarithmic we'll show both proofs here

Proof 1 :

This proof can be a little tricky when you first see it so lets be a little careful here. We'll first use the definition of the derivative on the product.

$$(fg)' = \lim_{h\to 0}\left(\frac{f(x+h)g(x+h) - f(x)g(x)}{h}\right)$$

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constant note that the function is probably not a constant however as far as the limit is concerned the function can be treated as a constant we get the lower limit on the right we get simply plugging h=0 into the function.

$$(fg)' = f(x)g'(x) + g(x)f'(x)$$

Example: $f(t) = (4t^2 - t)(t^3 - 8t^2 + 12)$

There isn't much to do here other than take the derivative using product rule

$$f'(t) = (8t - 1)(t^3 - 8t^2 + 12) + (4t^2 - t)(3t^2 - 16t)$$
$$= 20t^4 - 132t^3 + 24t^2 + 96t - 12$$

Quotient rule: $\left(\frac{f}{g}\right)' = \frac{f'g - fg'}{g\text{^}2}$

Again ,we can do this using the definition of the derivative or with logarithmic definition .

Now lets do the proof using logarithmic differentiation .we'll first call the quotient y,take the log of both sides and use a property of logs on the right side.

$$y = \frac{f(x)}{g(x)}$$

$$\ln y = \ln f(x) - \ln g(x)$$

Next ,we take the derivative of both sides andsolve for y'.

$$y' = y\left(\frac{f'(x)}{f(x)} - \frac{g'(x)}{g(x)}\right)$$

Next,plug in y and do some simplication to get the quotient rule

$$y' = \frac{f(x)}{g(x)}\left(\frac{f'(x)}{f(x)} - \frac{g'(x)}{g(x)}\right)$$

$$= \frac{f'(x)g(x) - f(x)g'(x)}{(g(x))^2}$$

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2.2 Differentiation Formulas for Trigonometric Functions :

Trigonometry is the concept of the relationship between angles and sides of triangles. Here, we have 6 main ratios, such as, sine, cosine, tangent, cotangent, secant and cosecant. You must have learned about basic trigonometric formulas based on these ratios. Now let us see the formulas for derivatives of trigonometric functions and hyperbolic functions.

1. $\frac{d}{dx}(sin\ x) = cos\ x$
2. $\frac{d}{dx}(cos\ x) = -sin\ x$
3. $\frac{d}{dx}(tan\ x) = sec^2x$
4. $\frac{d}{dx}(cot\ x = -cosec^2x$
5. $\frac{d}{dx}(sec\ x) = sec\ x\ tan\ x$
6. $\frac{d}{dx}(cosec\ x) = -cosec\ x\ cot\ x$
7. $\frac{d}{dx}(sinh\ x) = cosh\ x$
8. $\frac{d}{dx}(cosh\ x) = sinh\ x$
9. $\frac{d}{dx}(tanh\ x) = sech^2x$
10. $\frac{d}{dx}(coth\ x) = -cosech^2x$
11. $\frac{d}{dx}(sech\ x) = -sech\ x\ tanh\ x$
12. $\frac{d}{dx}(cosech\ x) = -cosech\ x\ coth\ x$

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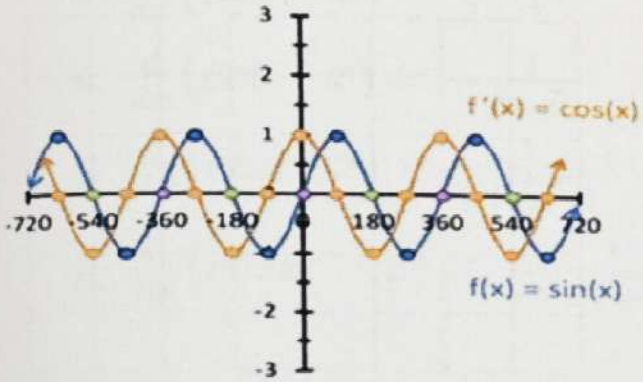
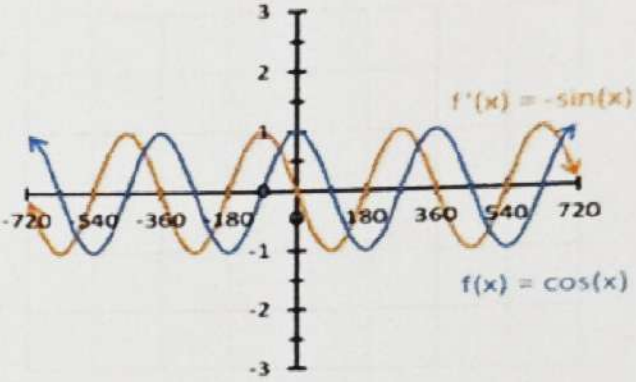
2.3 GRAPHS FOR THE DERIVATIVES OF TRIGNOMETRIC FUNCTIONS :

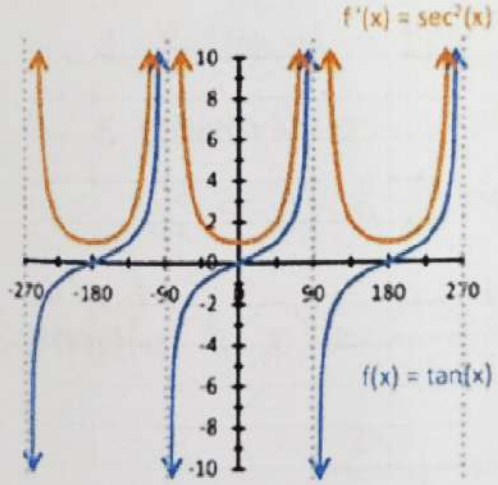
$$\frac{d}{dx}\sin(x) = \cos(x)$$



$$\frac{d}{dx}\cos(x) = -\sin(x)$$



$$\frac{d}{dx}\tan(x) = \sec^2(x)$$



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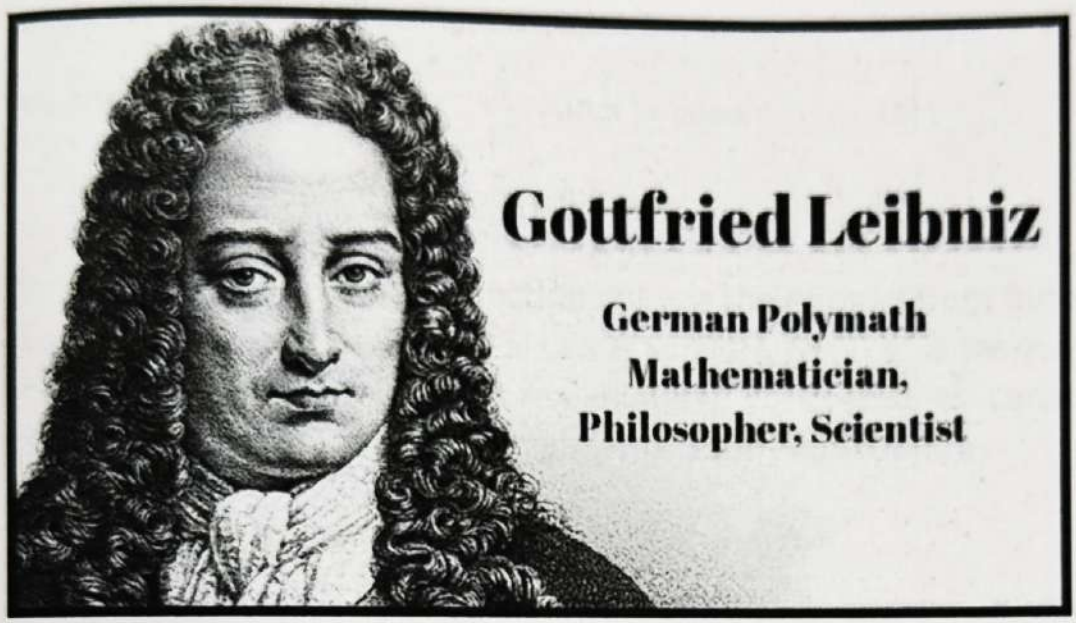
3.INTEGRALS

3.1 *Introduction*



If a function f is differentiable in an interval I, i.e., its derivative f' exists at each point of I, then a natural question arises that given f' exists at each point of I, can we determinate function? The functions that could possibly have given function as a derivative are called anti derivatives (or primitive) of the function. Further, the formula that gives all these anti derivatives is called the **indefinite integral** of the function and such process of finding anti derivatives is called integration. Such type of problems arise in many practical situations. For instance, if we know the instantaneous velocity of an object at any instant? There are several such practical and theoretical situations where the process of integration is involved . The development of integral calculus out of the efforts of solving the problems of the following types:

(a) The problem of finding a function whenever its derivative is given,
(b) The problem of finding the area bounded by the graph of a function under certain conditions.

These two problems lead to the two forms of the integrals , e.g., indefinite and definite integrals, which together constitute **Integral Calculus.**

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3.2 Integration as an Inverse Process of Differentiation

Integration is the inverse process of differentiation. Instead of differentiating a function, we are given the derivative of a function and asked to find its primitive, i.e., the original function. Such a process is called *integration* **or** *anti differentiation.*

Let us consider the following examples :

We know that $\frac{d}{dx}(\sin x) = \cos x$ ....(1)

$\frac{d}{dx}(e^x) = e^x$ ....(2)

We observe that in (1),the function cos x is the derived from function of sin x. we say that x is an anti derivative of cos x. Similarly in (2) e^x is there anti derivative of e^x . We know that for any real number C, treated as constant function,its derivative is zero and hence,we can write above equations as

$\frac{d}{dx}(\sin x + C) = \cos x$ and $\frac{d}{dx}(e^x + C) = e^x$

Notation: Given that $\frac{dy}{dx} = f(x)$, *we write* $y = \int f(x)\,dx$

Symbols/Terms/Phrases	*Meaning*
$\int f(x)dx$	Integral of f with respect to x
f(x) in $\int f(x)dx$	Integral
x in $\int f(x)dx$	Variable of integral
Integrate	Find the integral
An integral of f	A function F such that F'(x)= f(x)
Integration	The process of finding the integral
Constant of Integration	Any real number C, consider as constant function

Integrals of some functions, as listed below which will be used to find integrals of other functions.

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Example 1 Write an anti derivative for each of the following functions using the method of inspection:

(i) cos 2x (ii) $3x^2+4x^3$ (iii) $\frac{1}{x}$, $x \neq 0$

Solution

(i) We look for a function whose derivative is cos 2x. Recall that

$$\frac{d}{dx}\sin 2x = 2\cos 2x$$

Or $$\cos 2x = \frac{1}{2}\frac{d}{dx}(\sin 2x) = \frac{d}{dx}[\frac{1}{2}\sin 2x]$$

Therefore, an anti derivative of cos 2x is

(ii) We look for a function whose derivative is $3x^2 + 4x^3$. Note that

$$\frac{d}{dx}(x^3 + x^4) = 3x^2 + 4x^3.$$

Therefore, an anti derivative of $3x^2 + 4x^3$ is $x^3 + x^4$

(iii) We know that

$$\frac{d}{dx}(\log x) = \frac{1}{x} \quad x > 0 \text{ and } \frac{d}{dx}[\log(-x)] = \frac{1}{-x}(-1) = \frac{1}{x}, x < 0$$

Combining above, we get $\frac{d}{dx}[log|x|] = \frac{1}{x}$, $x \neq 0$

Therefore, $\int \frac{1}{x}dx = log|x|$ is one of the anti derivative of $\frac{1}{x}$.

Methods of Integration

3.4.Integration by substitution:

In this section,we consider the method of integration by substitution.

The given integral $\int f(x)dx$ can be transformed into another form by changing the independent variable x to t by substituting x = g(t)

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3.5 Integration by Partial Fractions:

Form of the rational function	Form of the partial fraction
1. $\frac{px+q}{(x-a)(x-b)}, a \neq b$	$\frac{A}{x-a}+\frac{B}{x-b}$
2. $\frac{px+q}{(x-a)^2}$	$\frac{A}{x-a}+\frac{B}{(x-a)^2}$
3. $\frac{px^2+qx+r}{(x-a)(x-b)(x-c)}$	$\frac{A}{x-a}+\frac{B}{(x-a)^2}+\frac{C}{x-b}$
4. $\frac{px^2+qx+r}{(x-a)^2(x-b)}$	$\frac{A}{x-a}+\frac{B}{(x-a)^2}+\frac{C}{x-b}$
5. $\frac{px^2+qx+r}{(x-a)(x^2+bx+c)}$	$\frac{A}{x-a}+\frac{Bx+C}{x^2+bx+c}$,

where $x^2 + bx + c$ cannot be factorised further

In the above table, A, B and C are real numbers to be determined suitably

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4 :DIFFERENTIAL EQUATION AND THEIR SOLUTION

4.0: Introduction of Differential Equation:

A differential equation is a mathematical equation that relates some function with its derivatives . Differential equation play a prominent role in many disciplines including engineering, physics, economics and biology .in biology and economics, differential equation are used to model the behavior of complex system, many fundamental laws of physics and chemistry can be formulated as differential equation.

Definition of Differential Equation:

An Equation involving derivatives of one or more dependent variable with respect to one or more independent is called differential equation or Equation containing the variables and their derivatives are called differential eqation.

Types of differential equation:

1) Ordinary Differential Equation
2) Partial Differential Equation
3) Linear Differential Equation
4) Homogeneous Differential Equation

1) Ordinary Differential Equatioin:

A Differential Equation which only are independent variable is called ordinary differential equation.

A differential equation involving derivatives with respect to a single independent variable is called ordinary differential equation.

For example:

1) $\frac{dy}{dx} = \sin x + \log x$

2) $\frac{dy}{dx} = 2sin, x \in (0, a], a > 0$

Is an ordinary differential equation where x is an independent variable and y is a dependent variable.

2) Partial Differential Equation :

A differential equation involving derivatives with respect to more than one independent variable is called an partial differential equation.

4.1 FORMATION OF A DIFFERENTIAL EQUATION:

It is obtained by eliminating the arbitrary constant and function from the given relation.

Consider the equation,

$y^2=4ax$ equation (1)

Now Differentiating Equation 1 w .r .t x we get $2y\frac{dy}{dx}=4a$

Substituting the value

$y^2=2xy\frac{dy}{dx}$ Equation (2)

Equation obtained from (1) by eliminating the arbitrary constant a. hence the differential equation (2) represents a family of parabolas given by(1).

In general suppose the equation

$F(x, y, a)=0$ equation(3)

Represents a family of curves in which a is the Patameter. Differentiating (3) w,r,t. x and eliminating a we get an equation of the form.

$$\emptyset\left(x, y, \frac{dy}{dx}\right) = 0, \quad \text{Equation(4)}$$

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Which is a differential equation of first order:

4.3 METHODS OF SOLVING DIFFERENTIAL EQUATION

Some of the analytical methods to get an exact solution are

1) Variable separable method
2) The method of undetermined co-efficients
3) Power Series method

Single Step Methods

1)Euler methods

2)Runge kutta methods

3)Implicit Runge methods

4)Extrapolation methods

Multi Step Methods

1)Predictor-corrector methods

2)Implicit multistep methods

3)Explicit multistep methods

4)Hybrid methods

5.Applications of Calculus

5.0Applications in Engineering

- Structural analysis
- Electrical circuits
- Fluiddynamics
- Signal Processing:Analyzing and designing filtersand communication systems.
- Control Systems:Designing systems that maintain desired outputs despite disturbances.
- Robotics:Path planning and optimization for robotic movement.

5.1Applications in Economics

- Costand revenue functions
- Consumer and producersurplus
- Optimization problems
- Supply and Demand Models:Understanding market equilibrium and consumer behavior.
- Risk Assessment:Calculating risk and returnin financial portfolios.
- Game Theory:Analyzing competitive strategies and outcomes.

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5.2Applications in Medicine and Biology

- Population dynamics
- Pharmaco kinetics
- Spread of diseases(epidemiologicalmodels)
- Medical Imaging:CalculusinCTscansandMRI technology, reconstructing images from data.
- Cardiovascular Modeling:Blood flow dynamics in arteries and veins.
- Neuroscience:Modeling neural activity.

5.5 Additional applications

1.EnvironmentalScience

Pollution Modeling:Calculus is used to model the dispersion of pollutants in the air and water. For example, differential equations can describe how pollutants spread and accumulate, helping in developing strategies to reduce environmental impact.

2.Computer Science

Machine Learning: Calculus is fundamental in training algorithms.Gradientsare used in optimization algorithms like gradient descent, crucial for minimizing loss functions is neural networks and other models.

Graphics and Animation:Calculus helps in creating smooth animations and realistic graphics.Calculating the motion of objects, lighting, and shading involves derivatives and integrals

3.Chemistry

Reaction Kinetics:Derivatives help in understanding reaction rates and how they change with concentration and temperature, which is vital in chemical engineering and pharmacology.

Thermodynamics:Integrals are used to calculate properties like entropy, enthalpy, and free energy changes in chemical processes.

4.Geology

Seismology: Calculus is used to model the propagation of seismic waves through the Earth.This helps in understanding earthquakes and designing structures to with stand them.

Erosionand Sediment Transport:Differential equations model how land scapes evolve over time due to erosion and sediment deposition.

5.AstronomyandAstrophysics

Orbital Mechanics:Calculus is essential in predicting the 5orbits of planets, satellites, and other celestial bodies. Newton's laws of motion and universal gravitation are applied using calculus. Cosmology: Understanding the expansion of the universe involves calculus.

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CERTIFICATE

This is to certify that Project work for thesubject of "Number Theory" by

NAME	REGISTER NUMBER
1. Doulatabi Mukkeri	U15CH21S0004
2. Gayatri Badiger	U15CH21S0008
3. Seema Patil	U15CH21S0009
4. Sakshi Kokatnur	U15CH21S0020
5. Prema Konakeri	U15CH21S0028

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A subjected to the project of Mathematics, satisfactorily completed their teamwork in course of B.Sc.(6th sem) during the year 2023-24

Date:12/08/2024

Project Guide
Miss : Veena Kamate

Head of Department
Smt . S. I. Nadaf

Principal
Prof. P.B.Burji

PRINCIPAL
S.S. Arts College & T.P. Science Institute
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Head of department

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NUMBER THEORY

Introduction:

Number theory is an interesting topic to learn and teach.Basically it is a branch of pure mathematics, specially it is called "The queen of mathematics". Number theorists study prime numbers as well as the properties of the object made out of integers,The older term of Number theory is Arithmetic.By the early twentieth century,it had been superseded by "number theory".

Here Fundamental Theorem of Aritmetic plays an important role in number theory,Division Algorithm,Congruences and its properties are also an interesting facts The important theorems on number theory are Wilsons's and Fermat's theorem for prime p.

Pierre de Fermat (born August 17, 1601, Beaumont-de-Lomagne, France—died January 12, 1665, Castres) was a French mathematician who is often called the founder of the modern theory of numbers. Together with rene descartes, Fermat was one of the two leading mathematicians of the first half of the 17th century.

Pierre de fermat (father of number theory)

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Even Numbers: The numbers that are evenly divided by 2 are called even numbers.

Even Numbers – 2, 4, 6, 8, 10, 12, 14, 16, 18, 20, 22 . . .

Odd Numbers: The numbers that are not evenly divided by 2 are called odd numbers.

Odd Numbers – 1, 3, 5, 7, 9, 11, 13, 15, 17, 19.....

Square Numbers: A number multiplied by itself is called square numbers.

Square Numbers – 4, 9, 16, 25, 36, 49, 64, 81,100 . . .

Cube Numbers: A number multiplied by itself 3 times is called cube numbers.

Cube Numbers – 8, 27, 64, 125, 216, 343, 512 . . .

Prime numbers:

A number 'p' is said to be prime if it is not divisible by any other number other than 1 and itself OR

A positive integer 'p' is said to be prime if

1] p>1

2]'p' has no divisors except 1 and itself

Ex:2,3,5,11,13,.....

Composite numbers:

An integer a>1 is called composite if it is not prime.

Ex:18 is a composite number because 2,3,6,9 are divisors of 18 other than 1 and 18.

Relatively prime and Co-prime numbers:

Two numbers A and B are said to be relatively prime if the greatest common divisor of [(a,b)=1] is 1.

Ex:9 and 8 are relatively prime numbers since their G.C.D is 1.

Note: Two numbers which are relatively prime need not be a prime number.

1 is called the unit number in the set of positive integers.

Twin numbers: A pair of numbers is said to twin primes if they differ by 2.

Ex:3,5 are twin primes.

Perfect numbers: A number 'n' is said to be perfect number if the sum of all divisors of'n'(including 'n') is equal to 2n.

Ex: 28 is a perfect number because divisor of 28 are 1,2,4,7,14,28

Therefore, sum of the divisors = 1+2+4+7+14=56

=2(28)

Common factor: A number 'h' is said to be common factor of a and b if h/a and h/b.

Divisibility:

Consider two integers a and b where a≠0, a divides b if 7.An integer 'K' such that b=Ka and is denoted by a/b.

Ex: 7 divides 28.

Because 7 is an integer and such that 28=4x7

Ex: 8 divides 72 .

Therefore, 72=9x8.

Note:when a/b we say that

1] a is divisor of b. therefore 'b' is a divisor by 'a'.

2] a is a factor of 'b' . therefore 'b' is a multiple of 'b'.

Properties of Divisibility:

1] If n/m, then there exits 'q' such that m= qxn.

2] The absolute value of both 'q' and 'n' are less than the absolute value of 'm'.

i.e.,|m| and |q| < |m|

Example 1]: 4/24 =24=4x6 and both 4 and 6 are less than 24.

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Some simple properties of divisibility:

Let l, m, n are integers, then

i] If l/m then l/m+n

ii] If l/m then l/m-n

iii] If then l/m

iv] If l/m and m/n then l/n

v] If l,m are natural numbers and l/m, m/l then l=m

vi] If l/m and l/n then l/mp + nq for all integral values of p and q.

vii] If l/m and m<1, where l,m are non – negative integers then m=0.

Proofs of above properties:

i] If l/m be given then there exist on integer K, such that,

$$m=lK \quad .....(1)$$

and also if l/n, then there exist an integer 'K'

such that, n=lK'

now, m+n = l(K + K')

Therefore, l/m+n

Where K and K' are some integers.

ii] From proof(1), similarly l/m +n this results is also holds.

If l\m is given by, then there exist an integer K

Such that, m=l K

Now multiplying 'n' on both sides,we have

mn = lKn

nm = l(Kn)

Where K is any integer ,

Therefore ,l/mn

iv] If l/m is given, then there exist an integer K

Such that, $m = lk$

And also m/n is given, then exist an integer K;

Such that, $n = mk$

Put $m=lk$ in equation (2) , we have

$$n = lKK'$$

where K and K' are some integer

therfore, l/n

v] If l, m are natural number and l/m is given then there exist a natural number K,

Such that, $m=lK$ ....(1)

And also, m/l is given , then there exist a natural number K, such that

$$L = mK' \quad ....(2)$$

Now put $l=mK'$ in equation (1), we have

$$m = mK'K$$

Therefore,

$$K K' = m/m$$

$$KK' = 1$$

Where K and K' are some natural numbers

Threfore K = 1 and K'=1

Now from equation (1) and (2)

$$l=m$$

vi] If l, m, n are any integers then l/m and m/l then to prove that l/mp + nq.

Proof: If l/m is given, then there exist on integer K.

Such that, $m= lk$ .....(1)

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And also if l/n is given, then there exist an integer K'.

Such that, $n = lK'$ ....(2)

Now, $mp + nq = lKp + lK'q$

$mp + nq = l(Kp + K'p)$

Where K and K' are some integers

Therefore, $l/mp + nq$

vii] If l/m and m<1, where l, m are non-negative integers then m=0.

Proof: Let l/m is given, then there exist an integer K.

Such that, $m = lK$.

If possible that $m \neq 0$

Therefore , $m \geq 0$ $|since\ m\ is\ non-negative\ integer$

i.e., $m \geq l$

but given that m<l

$\therefore$ *two results of above are controducts each other*

If m=0 then, the theorem is true.

Therefore,

If l/m and m<l then, only if m=0.

G.C.D (Greatest Common Divisor)

Common divisor: If a number 'C' divides by any two number a and b.

i.e., if c/a and c/b then c is known as a common divisors of a and b.

Gretest Common Divisor: If a number a d divides a and b and is divisible by all the common divisors of a and b, then d is known as the greatest common divisor(G.C.D) of a and b.

The Division Algorithm.

Statement: For any two integers a and b, then there exist a unique number q and r such that,

a = bq + r where $0 \leq r < b$

where r is remainder,q is quotient, b is divisor and a is dividend.

Proof: If a<b, then a = b.0 + r

If $a \geq b$

The set of multiple of b, consists of the numbers b, 2b, 3b, 4b,.....

In the beginning, the multiple of b are less than a, But after a certain stage we shall get a multiple of b such that, it is just less than or equal to a and the nextb multiple of b is greater than a.

Let bq denote the greatest multiple of b such that $a \geq bq$

Now, $a \geq bq \rightarrow a - bq \geq 0$

So, let a - bq = r where $r \geq 0$

Again, a < (q+1)b$\rightarrow a < bq + b$

$$\rightarrow a - bq < b \; where, r < b$$

$$\therefore we\ have\ two\ numbers\ q\ and\ r\ such\ that\ a - bq = r$$

$$or\ a = bq + r, \quad where\ 0 \leq r < b \ \ldots(1)$$

Now we show that, it is unique

If possible, Let there exist integers q1 and r1 such that,

$$a = bq1 + r1 \quad \ldots.(2)$$

Equating two values of a from (1) abd (2), we have

$$bq + r = bq1 + r1$$

$$bq = bq1 = r1 - r$$

$$b(q - q1) = r1 - r \quad \ldots..(3)$$

b/r1 – r where $0 \leq r < b \; and \; 0 \leq r1 < b$

but, |r1 – r| < b

Then there exist integer m and n such that

$$bc = ad$$

because (a, b) = 1 ...(1)

therefore, there exist integer m and n such that

$$am + bn = 1 \quad ...(2)$$

multiplying both sides by c, we have

$$acm + bcn = c \quad ....(3)$$

putting bc = ad from (1) and (3) , we get

$$acm + bcn = c$$

$$a(cm + dn) = c$$

therefore a/c.

Theorem 3: If (a, b) = 1 and c/a , then (c, b) = 1

Proof: Given that (a, b) = 1

Then there exist integers x and y such that

$$ax + by = 1 \quad ....(1)$$

since, c/a and there exist an integer m such that

$$a = cm$$

put the value of a in equation (1), we have

$$cmx + by = 1$$

$$c(mx) + b(y) = 1$$

therefore (c,b) = 1

Theorem 4: Prove that every two consecutive integers are co-prime to each other.

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Proof: Let n and (n + 1) be two consecutive integers

Let (n , n + 1) = d

Therefore, d/n and d/n+1

d/(n+1-n) or d/1

therefore , d = 1

therefore (n, n+1) = 1

n and (n+1) are relatively prime.

Theorem 5: Prove that the product of r consecutive integers is divisible by r!.

Proof: We know that,

$$nc_r = \frac{n!}{(n-r)!\,r!}$$

$$nc_r = \frac{n(n-1)(n-2)\ldots\{n-(r-1)\}(n-1)!}{(n-1)!\,r!}$$

$$nc_r = \frac{n(n-1)(n-2)\ldots\{n-(r-1)\}}{r!}$$

n(n-1)(n-2).....{n-r+1} = nc_r r!

product of r consecutive integers = (nc_r) r!

=Kr! Where $nc_r = K \in Z$

b = aK, K$\in z$

therefore, product of r-cosecutive integers is divisible by r!

Example 1: Prove that n(n + 1) (n+5) is multiple of 6.

Solution: Given that, n(n + 1)(n + 5)

=n(n + 1)[(n + 2) + 3]

=n(n + 1)(n + 2) + 3n(n + 1)

Now,n(n+1)(n+2) being the product of three consecutive integers is divisible by3! = 6 and n(n+1) being the product of two consecutive integers is divisible by 2! = 2.

Therefore 3n(n+1) is divisible by 3x2 = 6

Therefore n(n+1)(n+2) + 3n(n+1) is divsible by 6.

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Example 3: If n is even, Prove that n(n+1)(n+2) is divisible by 24.

Solution: Since, n is even, so let n = 2m

$n(n+1)(n+2) = 2m(2m+1)(2m+2)$

$=4m(2m+1)(m+1)$

$=4m(m+1)(2m+1)$

$n(n+1)(n+2)=4m(m+1)[(m+2)+(m-1)]$

$=4m(m+1)(m+2)+4m(m+1)(m-1)$

Now each of the two m(m+1)(m+2) and (m-1)m(m+1) being the product of three consecutive integers is divisible by 3! = 6

Therefore, each of the two 4m(m+1)(m+2) and 4m(m-1)m(m+1) is divisible by 4x6 = 24

Therefore for even n, (n+1)(n+2)

= 4m(m+1)(m+2)+4(m-1)m(m+1) is divisible by 24.

Example 4: Prove that $3^{2n}+7$ is multiple of 8.

Solution: $3^{2n}+7 = (3^2)^n+7 = 9^n + 7$

$=(9^n - 1) + 8$

$=(9n - 1n)+8$

$=(9 - 1)[9^{n-1} + 9^{n-2} + \ldots\ldots+1] + 8$

I We know that, $a^m - b^m = (a - b)[a^{m-1} + a^{m-2}.b + \ldots\ldots+b^{m-1}]$

$=8[9^{n-1} + 9^{n-2} + \ldots\ldots+1] + 8$

$=8[9^{n-1} + 9^{n-2} + \ldots\ldots1+1]$

Therefore, $3^{2n} + 7$ is a multiple of 8.

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Fundamental Theorem of Arithmatic:

statement : Each natural greater than 1 can be expressed as product of primes and the factorising of any positive integer n into primes is unique apart from the order primes.

Proof : Let n be natural number greater than 1(n>1) and n has a prime factors say p_1 i.e p_1/n.

Therefore there exists an integer n1 such that n=n1p1

$n=n_1p_1$ ------(1)

where $n>n_1$

if $n_1=1$, $n=p_1$, i.e n is a prime p_1

if $n_1>1$, then n_1 has a prime factor p_2

Therefore, there exists a positive integer n_2 such that

$n_1=p_2n_2$

where $n_1>n_2$

putting the value of n_1 equation 1 we get

$n=p_1p_2n_2$

where $n>n_1>n_2$

If $n_2=1$, then $n=p_1p_2$------(2)

i.e n is the product of primes p_1 and p_2

If $n_2>1$, we continue the above process,

But this process must be end after finite number of steps

Therefore there exist p_1,p_2,p_3.....pr such that

$n=p_1,p_2,p_3.....p_r$--------(3)

Now to show that it is unique

Let if possible

$n=q_1q_2.....q_s$-------(4)

be an alternative expression of n as a product of primes.

From (3) and (4)

p_1q_1.....p_r and q_1 q_2.....qs are identical

hence proof.

Euler's function

The number of integers ≤ and co-prime to n is called Euler's function for n and it is denoted by $\emptyset(n)$.

Examples : $\emptyset(1) = 1, \emptyset(2) = 1, \emptyset(5) = 4$

Euler's Theorem

Statement : if a and n are two positive integers such that (a,n)= 1 then prove that a^$\emptyset(n)$= 1 where $\emptyset(n)$ = number of integer less than n and relatively prime to n

Proof : Let a_1,a_2,a_3.....aa$\emptyset(n)$ which when divided by n leave different remainder lying between 1 and $\emptyset(n)$

Consider aa1, aa2,aa3.....aa$\emptyset(n)$ which when divided by n leave different reminder lying between 1 and $\emptyset(n)$

For otherwise if aar and aas leave the same remainder r_1 when divided by n,

Then

$aa_r = r_1 \pmod n$.....(1)

Where $1 \le r \le \emptyset(n)$ and $1 \le r_1 \le \emptyset(n)$

And $aa_s = r_2 \pmod n$.....(2)

Where $1 \le s \le \emptyset(2)$ and $1 \le r_1 \le \emptyset(n)$

Now equation (1) –(2) gives

$aa_r - aa_s = (r_1 - r_1) \pmod n$

n/a or $n/a_r - a_s$

but

(n,a) = 1 =n/a

Therefore $n/a_r - a_s$ which is not possible

aa_1, aa_2, aa_3,.....aa$\emptyset(n)$ leave different remainder when divided by n.

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Let $aa_1 = r_1 \pmod n$

$aa_2 = r_2 \pmod n$

.....

.....

$aa\emptyset(n) = r\emptyset(n) \pmod n$

Now multiplying above , we get

$aa_1, aa_2, aa_3 \ldots\ldots aa\emptyset(n) = (r_1, r_2, r_3, \ldots\ldots r\emptyset(n)$

$(a,a,a,\ldots\ldots a)(a_1,a_2, a_3\ldots\ldots a\emptyset(n) = (r_1,r_2, r_3\ldots\ldots r\emptyset(n) \pmod n$

But $r_1,r_2,r_3\ldots\ldots r\emptyset(n)$ and $a_1,a_2,a_3\ldots\ldots a\emptyset(n)$ are same order

Therefore

$a^{\emptyset(n)} (a_1, a_2, a_3\ldots\ldots a\emptyset(n)) = 1 (a_1,a_2,a_3\ldots\ldots a\emptyset(n)) \pmod n$

$(a_1,n) = 1, (a_2,n) = 2 , (a\emptyset(n), n) = 1$

$a^{\emptyset(n)} = 1 \bmod (n)$

Examples :

1) Find $\emptyset(8)$
   $8 = 2^3$
   We know that
   $\emptyset(n) = n(1-1/p1)$
   $\emptyset(8) = 8\ (1-1/2)$
   $= 8\ (2-1/2)$
   $= 4$
2) Find $\emptyset(24)$
   $24 = 2^3 \times 3$
   We know that
   $\emptyset(n) = n\ (1-1/p_1)\ (1-1/p_2)$
   $\emptyset(24) = 24(1-1/2)\ (1-1/3)$
   $=24/2\times 2/3$
   $= 8$

Theorem – 1 if p is prime number then prove that
$\emptyset(1)+\emptyset(p)+\emptyset(p^2)+\ldots\ldots+\emptyset(p^n) = p^n$

Proof : if p is prime number ,

Now ,

LHS= $\emptyset(1) + \emptyset(p) + \emptyset(p^2) + \ldots\ldots\ldots + \emptyset(p^n)$

$= 1 + p(1-1/p) + p^2(1-1/p) + \ldots\ldots\ldots + p^n(1-1/p)$

$= 1 + p(p-1/p) + p^2(p-1/p) + \ldots\ldots\ldots + p^n(p-1/p)$

$= 1 + (p-1) + p(p-1) + p^2(p-1) + \ldots\ldots\ldots + p^{n-1}(p-1)$

$= 1 + (p-1)(1 + p + p^2 + \ldots\ldots\ldots\ldots + p^{n-1})$

$= 1 + (p-1)[1(p^{n-1})/p-1$

$= 1 + p^{n-1}$

$= p^n$

Therefore $\emptyset(1) + \emptyset(p) + \emptyset(p^2) + \ldots\ldots\ldots\ldots + \emptyset(p^n) = p\hat{}n.$

Theorem : If p is a prime number and r is the positive integer then for Euler's function $\emptyset$, prove that $\emptyset(p^k) = p^k - p^{k-1}$. Also show $\emptyset(p^k) = p^k\ (1-1/p)$

Proof : let $n = p^k$ be the prime power factorisation of n. where p is prime number and K is the positive integer. In the set of positive integer from 1 to p^k the integers which are not relatively prime to p is given by

p, 2p , 3p, 4p, ...pp.....p^2p.....p^{k-1}p

which are p^{k-1} numbers

Therefore $\emptyset(p^k) = p^k - p^{k-1}$

$\emptyset(p^k) = p^k(1-p^{-1)}$

Therefore $\emptyset(p^k) = p^k(1-1/p)$

Hence proof

Theorem- 3 : if n is any composite and p1, p2, ... p_r are the distnict prime factors of n then prove that $\emptyset(n) = n(1-1/p_1)\ (1-1/p_2)\ (1-1/p_3)\ldots\ldots\ldots(1-1/p_r)$

Proof : if $n = p1^{k1}, p2^{k2}, p3^{k3}\ldots\ldots\ldots\ldots pr^{kr}$ where p1,p2,p3,.....pr are distinct prime factors of n.

$k_1, k_2, k_3\ldots\ldots\ldots k_r \in Z$

$\emptyset(n) = \emptyset(p_1^{k1}, p_2^{k2}, p_3^{k3}\ldots\ldots\ldots\ldots p_r^{kr})$

But $p_1, p_2, p_3\ldots\ldots\ldots p_r$ are relatively prime

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$\emptyset(p_1, p_2, p_3.....p_r) = \emptyset(p_1)\ \emptyset(p_2).....\emptyset(p_r)$

$\emptyset(n) = \emptyset(p_1^{k1})\ \emptyset(p_2^{k2})\ \emptyset(p_3^{k3}).....\emptyset(p_r^{kr})$

$\emptyset(n) = (p_1^{k1}\ p_2^{k2}\ p_3^{k3}.....p_r^{kr})\ (1-1/p_1)\ (1-1/p_2)\ (1-1/p_3).....(1-1/p_r)$

Therefore $\emptyset(n) = n(1-1/p_1)\ (1-1/p_2)\ (1-1/p_3).....(1-1/p_r)$

THE DIOPHANTINE EQUATIONS

The name honors the mathematician Diophantus,who initiated the study of such equation .Practically nothing is known of Diophantus as an individual,save that he lived in Alexndria sometime around 250 A.D The only positive evidence as to the date of his activity is that the Bishop of Laodicea, who began his episcopate in 270,dedicated a book on on Egtptian computation to his friend Diophantus.

It is customary to apply the term Diophantine equation to any equation in one or more unknowns which is to be solved in the integers . The simplest type of Diophantine equation that we shall consider is the linear Diophantine equation in two unknowns .

$$ax+by=c$$

where, a,b,c are given integers and

a,b not both zero

A solution of this equation is a pair of integers x_0,y_0 which when substituted into the equation satisfyit; that is,we ask that a $x_0+by_0=c$. Curiously enough,the linear equation does not appear in the extant works of Diophantinus.

Possibly because he viewed it is as trivial ;most of his problems dealt with finding squares or cubes with certain properties.

THEOREM: The linear Diophantine equation ac+by=c has a solutionif and only if d/c,where d=gcd(alb).If $x_0,y_0$is any particular solution of this equation ,then all other solutions are given by

$$x=x_0+(b/d)t,\quad y=y_0-(a/d)t\ .$$

for varying integers t

Proof: To establish second assertion of the theorem,Let us suppose that solution x_0,y_0 of the given is known ,if x',y' is any other solution ,then

$$Ax_0+by_0=c=ax'+by'.$$

Which is equivalent to

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$a(x'-x_0)=b(y_0-y')$.

By the corollary to theorem ,there exist relatively prime integers r and s such that a=drab=ds.Substituting these values into the last written equation and cancelling the common factor d, we find that

$$r(x'-x_0)=s(y_0-y')$$

The situation is now this :$r|s(y_0-y')$,with gcd(r,s)=1.Using Euclid's Lemma, it must be the case that $r|(y_0-y')$;or ,in other words ,$y_0-y'=rt$ for some integer t. substituting ,we obtain

$$x'-x_0 =st$$

this is leads us to the formulas

$$x'=x_0+st =x_0+(b/d)t,$$

$$y'=y_0-rt=y_0-(a/d)t.$$

It is easy to see that these values satisfy the Diophantine equation ,regardless of the choice of the integer t; for,

$$Ax'+by' =a[x_0+(b/d)t]+b[y_0-(a/d)t]$$

$$=(ax_0+by_0)+(ab/d-ab/d)t$$

$$=c+c.t=c$$

Thus there are an infinite number of solution of the given equation ,one each value of t.

Characterstics of Diophantine Equation:

Stripe 1. The general form of Diophantine equation is a linear Diophantine equation in one variable ax=b, when x=b/a must be integral.

To illustrate ,If $3/4^{th}$of a number is more than $1/3^{rd}$ of the number than what is the integral

$$3x/4 - x/3 = 4$$

Stripe 2. A linear Diophantine equation in two unknowns x and y which is of the form :ax+by=c.With the restriction that the solution be only in integers ,if $x=x_0,y=y_0$ satisfy the above equation we write the solution as(x_0,y_0).

To illustrate ,2x+3y=10 is alinear Diophantine equation one it solution is x=2,y=2. Since ,(2*2)+(3*2)=10.

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1.The Factorial Method

Given the equation $f(x_1,x_2,.....,x_n)=0$, we write it in the equivalent form

$f_1(x_1,x_2,.....,x_n)f_2(x_1,x_2,....,x_n).....f_k(x_1,x_2,.....x_n)=a,$

where $f_1,f_2,.....f_k \in Z[X_1,X_2,....X_n]$ and $a \in Z$. Given the prime factorization of a, we obtain finitely many decompositions into k integer factors $a_1,a_2,....,a_k$. Each such factorization yields a system of equations

$$\begin{cases} f_1(x_1,x_2,....x_n)=a_1, \\ f_2(x_1,x_2,....x_n)=a_2, \\ . \\ . \\ . \\ f_k(x_1,x_2,....x_n)=a_k. \end{cases}$$

Solving all such systems gives the complete set of solutions to (1).

We illustrate this method by presenting a few examples.

Example 1. Find all integral solutions to the equation

$(x^2+1)(y^2+1)+2(x-y)(1-xy)=4(1+xy).$

Solution: Write the equation in the form

$X^2y^2-2xy+1+x^2+y^2-2xy+2(x-y)(1-xy)=4,$

Or

$(xy-1)^2+(x-y)^2-2(x-y)(xy-1)=4.$

This is equivalent to

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$$[xy-1-(x-y)]^2=4,$$

Or

$$(x+1)(y-1)=\pm 2.$$

If $(x+1)(y-1)=2$,we obtain the systems of equations

$$\begin{cases} x+1=2, \\ y-1=1, \end{cases} \quad \begin{cases} x+1=-2, \\ y-1=-1, \end{cases}$$

$$\begin{cases} x+1=1, \\ y-1=-1, \end{cases} \quad \begin{cases} x+1=-1, \\ y-1=-2, \end{cases}$$

yielding the solutions (1,2),(-3,0),(0,3),(-2,-1).

If $(x+1)(y-1)=-2$,we obtain the systems

$$\begin{cases} X+1=2, \\ y-1=-1, \end{cases} \quad \begin{cases} x+1=-2, \\ y-1=1, \end{cases}$$

$$\begin{cases} x+1=1, \\ y-1=-2, \end{cases} \quad \begin{cases} x+1=-1, \\ y-1=2, \end{cases}$$

whose solutions are(1,0),(-3,2),(0,-1),(-2,3).

All eight pairs that we have found satisfy the given equation.

2.Solving Diophantine Equations Using Inequalities

This method consists in restricting the intervals in which the variables lie using appropriate inequalities. Generally ,this process leads to only finitely many possibilities for all variables or for some of them.

Example1. Find all pairs (x,y) of integers such that

$$X^3+y^3=(x+y)^2.$$

Solution:Note that all pairs of the form (k,-k),$k\in Z$,are solutions.

If $x+y\neq 0$,the equation becomes

$$X^2-xy+y^2=x+y,$$

Which is equivalent to

$$(x-y)^2+(x-1)^2+(y-1)^2=2.$$

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Solution: Setting z=-y, the equation becomes $x^3=x^2+2y^2$.

Taking y=mx, m∈Z, yields $x=1+2m^2$.we obtain the infinite family of solutions

$X=2m^2+1$, $y=m(2m^2+1)$, $z=-m(2m^2+1)$, m∈Z.

Example 2.Find all triples(x,y,z) of positive integers such that

$1/x+1/y=1/z$.

Solution: The equation is equivalent to

$Z=xy/x+y$.

Let d=gcd(x,y).Then x=dm,y=dn,with gcd(m,n)=1 it follows that gcd(mn,m+n)=1.Therefore

$Z=dmn/m+n$,

Which implies $(m+n)|d$,i.e.,$d=k(m+n)$,$k\in Z_+$.

The solutions to the equation are given by

$X=km(m+n)$, $y=kn(m+n)$, $z=kmn$,

Where $k,m,n\in Z_+$.

Remark.

(1) If a,b,c are positive integers with no common factor such that

$1/a+1/b=1/c$,

Then a+b is a square. Indeed ,k=1,a=m(m+n),b=n(m+n),

And hence $a+b=(m+n)^2$.

(2) If a,b,c are positive integers satisfying

$1/a+1/b=1/c$,

Then $a^2+b^2+c^2$ is a square. Indeed,

$a^2+b^2+c^2=k^2[m^2(m+n)^2+n^2(m+n)^2+m^2n^2]$

$=k^2[(m+n)^4-2mn(m+n)^2+m^2n^2]$

$=k^2[(m+n)^2-mn]^2$.

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Real Life Application In Diophantine Equation

Word Difficulty1.

Prakathi did her nursery one year ago $1/5^{th}$ of her life and $1/6^{th}$ of her life from one year she doing primary is 2 years. What is her present age?

p-1/5 +p+1/6 =2

=6 (present age).

Word Difficulty 2.

Shella lasted her childhood $1/8^{th}$ of her life, her hear grew after $1/14^{th}$ more, after $1/9^{th}$ more. She got married and her daughter born 7 years later. The daughter lived half her mother's age and the mother died 6 years after her daughter.

x/8+x/14+x/9+7+x/2+6=x

=68 (her age).

Word Difficulty On Business.

Aravind invested a part of his investment in 0.05 produser A and a part in 0.1 producer B. His interest income during first year is rupee 2000. If be invests 0.5 more in 0.05 producer A and 0.05 more in 0.1 producer B his income during second year increases by rupee 1000. Find his initial investments.

Feature

Let his investment be rupee x and y in producer A and B respectively.

Then for first year

0.05x+0.1y=2000

And for second year 0.025x+0.005y=3000 solve there equation as AX=B.

Since ,|A|=-0.00225≠0 so A is invertible.

Then $X=A^{-1}B$

$$=1/-0.00225 \begin{vmatrix} 0.005 & -0.025 \\ -0.1 & 0.05 \end{vmatrix} \begin{vmatrix} 2000 \\ 3000 \end{vmatrix}$$

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$$=1/-0.00225 \begin{vmatrix} -65 \\ -50 \end{vmatrix}$$

$$X= \begin{vmatrix} 28.889 \\ 22.222 \end{vmatrix}.$$

Conclusion :

In finite or infinite number of variables are solvable in many linear as well as non-linear Diophantine equation also used in real life, they can be really helpful and have wide application.

References :

1. For number theory :- N. Ramesh Text Book
2. Fundamental Theorem of Arithmetic :- N. Ramesh Text Book
3. Modular Arithmetic :- John L. Berggren
4. Diophantine Equation :- Mordell, L.J.

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DEPARTMENT OF CHEMISTRY

A Project Report On

"SYNTHESIS OF Co_3O_4 NANOPARTICLES BY CHEMICAL REDUCTION METHOD"

Submitted by

B.sc VI Sem students

Under the guidance of

Miss. Shivani Sutar

Lecturer

Department of Chemistry,

S.S. ARTS COLLEGE & T.P. SCIENCE

INSITUTE,SANKESHWAR.

2023-2024

S.D.V.S Sangh's

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S.S. Arts College & T.P. Science, Institute * Dept. of Chemistry * Sankeshwar

DEPARTMENT OF CHEMISTRY

CERTIFICATE

This is to certify that the project work entitled "Synthesis of Co_3O_4 by Chemical Reduction Method"of the following students submitted by the partial fulfillment of the academic curriculum of sixth semester ,BSc. in Chemistry, S.S arts and T.P science institute, sankeshwar, during academic year 2023-2024.

MR – GANGADHAR S NAIK	**U15CH21S0021**
MR – YASH S MAHAJAN	**U15CH21S0047**
MR – SUPREET S MYAGADEYAVAR	**U15CH21S0048**
Miss – SHWETA S INAMDAR	**U15CH21S0063**

Guide

Head of The Chemistry Department

PRINCIPAL
S.S Arts College & T. P. Science Institute
SANKESHWAR

S.S. Arts College & T. P. Science Institute * SANKESHWAR. 591313

Place : Sankeshwar

DECLARATION

We do here by declare that the project work entitled **"Synthesis of Co_3O_4 Nanoparticles Chemical Reduction Method"** has been done under the supervision and guidance of **MISS SHIVANI SUTAR,** lecturer, Department of Chemistry ,S.S arts and T.P science institute, sankeshwar, during academic year 2023-2024.,and is now being submitted to the department for the partial fulfilment of the academic curriculum of the sixth semester of B.Sc. Course

Name of the Student	Reg. Number	Signature
MR – GANGADHAR S NAIK	**U15CH21S0021**	
MR – YASH S MAHAJAN	**U15CH21S0047**	
MR – SUPREET S MYAGADEYAVAR	**U15CH21S0048**	
MISS – SHWETA S INAMDAR	**U15CH21S0063**	

Place: SANKESHWAR

Date: 14/08/2024

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"SYNTHESIS OF Co_3O_4 NANOPARTICLES BY CHEMICAL REDUCTION METHOD"

Abstract:

Nanoparticles (NPs; 1–100 nm in size) have a special place in nanoscience and nanotechnology, not only because of their properties resulting from their reduced dimensions, but also because they are promising building blocks for more complex Nano structures. The nanomaterial's field includes subfields which develop or study materials having unique properties arising from their nanoscale dimensions. Interface and colloid science has given rise to many materials which may be useful in nanotechnology, such as carbon nanotubes and other fullerenes, and various nanoparticles and Nano rods. Nanomaterials with fast Ion transport are related also to nanoionics and Nano electronics.

In the present work, cobalt nanoparticles have been synthesized by simple chemical reduction method. The sodium borate has been used as the reducing agent for the preparation of nanoparticles. The effect of the concentration of the reactant has been varied by keeping the temperature and heating time, constant. It was found that different types of nanoparticles are obtained. First type of nanoparticles are the one which showed uniform and tetragonal shape with low aggregation of particles named as (Co_3O_4-S1), second type of nanoparticles which shows slightly deformed spherical with more aggregation of particles (Co_3O_4-S2), third type of nanoparticles, Co_3O_4-S3 Nanoparticles which shows deformed and tetragonal shape with more aggregation of particles and the fourth type include Co_3O_4-S4 nanoparticles which showed non uniform or slightly deformed spherical shape with more aggregation of particles. The synthesized nanoparticles are characterized by the SEM, XRD, and UV-Visible spectrophotometric techniques. Further, the synthesized nanoparticles are used for the reduction of organic pollutants such as 4-nitrophenol. It was observed that S3 type of cobalt nanoparticles showed maximum reduction efficiency with high catalytic rate. So it can be concluded that the S3 type of nanoparticles can be used for the waste water treatment of organic pollutants in the near future.

Abbreviations:

- S1: 2 g cobalt oxalate and 1 g Urea (Heating for 3 hrs about 550^0C)
- S2: 2 g cobalt oxalate and 2 g Urea (Heating for 3 hrs about 550^0C)
- S3: 2 g cobalt oxalate and 3 g Urea (Heating for 3 hrs about 550^0C)
- S4: 2 g cobalt oxalate only (Heating for 3 hrs about 550^0C)
- 4-NP: 4 –Nitro phenol

CONTENTS

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1. Introduction:

Metal oxide nanoparticles have drawn significant amount of attention which leads towards synthesizing different metal oxide nanoparticles with dramatic characteristics. Nano chemistry is the combination of chemistry and nanoscience. Nano chemistry is associated with the synthesis of building blocks which are dependent on size, surface, shape and defect properties [C. H. Kuo, M. H. Huang, Nano Today 2010, 5, 106–116]. Nanoscale materials can also be used for bulk applications; most present commercial applications of nanotechnology are of this fever. Progress has been made in using these materials for medical applications, Nano medicine. Nanoscale materials such as Nano pillars are sometimes used in solar cells which combats the cost of traditional silicon solar cells. Development of applications incorporating semiconductor nanoparticles to be used in the next generation of products, such as display technology, lighting, solar cells and biological imaging; see quantum dots. Recent application of nanomaterials includes a range of biomedical applications, such as tissue engineering, drug delivery, and biosensors.

Nano chemistry is being used in chemical, materials and physical science as well as engineering, biological and medical applications. Nano chemistry and other nanoscience fields have the same core concepts but the usages of those concepts are chemistry is a relatively young branch of chemical research. Even 30 years ago, these words would have sounded puzzling to many scientists despite the fact that nanoparticles, primarily in the form of dust and smoke, have always existed in nature [American chemicals society(2016). Nanoparticles were utilized in construction materials, pigments, and stained glass well before their nature and properties were uncovered and understood. For more than a century, transition metal nanoparticles were widely used as heterogeneous catalysts and generated impressive revenues for petrochemical companies. Despite these all-pervading examples, nanoparticle chemistry did not evolve into a rigorous academic field until the end of the 20^{th} century, when the availability of electron microscopy and other modern characterization techniques equipped researchers with tools suitable for analysing nano meter sized objects [Richards Feyman (1959)], Ankur Soam et al. Ceram. Int.(2019)]. In the last decades, metal oxide nanoparticles are being used in various applications such as microelectronic circuits, sensors, energy storage devices, piezoelectric devices and fuel cells [A.V. Nikam et al. Cryst. Eng. Comm. (2018)]. Metal oxide nanoparticles have proved as suitable candidates for supercapacitor. They exhibited larger capacitance than carbon based materials [Chengxiang Wang et al. (2010)]. Metal oxides have been combined with conducting carbon materials in

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order to get optimum performance from the hybrid electrode in supercapacitor [Angshuman Pal et al. (2007)]. Researchers have attempted to synthesize different nanoparticles by different methods in order to get cost effective, easy process, lesser time with effective manner and rectifying the purity of the synthesized product and characterizing the same with different methods.

Researchers have been focused to synthesize cobalt oxide (Co_3O_4) nanoparticles because of their unique properties and applications [M. Amini, H.Naslhajian,2016]. Co_3O_4 nanoparticles have been utilized in sensors, electrode for energy storage systems, capacitors, field emission materials, magneto resistive devices and catalysis [M. B. Gawande, A. Goswami,2017]. In recent years, Co_3O_4 is being considered as a potential candidate for supercapacitor and battery. Carbon nanotubes and Co3O4 nanocomposite have been reported as electrode for supercapacitor in which cobalt oxide improved the capacitance of the electrode [R. G. Saratale, G. D. Saratale, J. S. Chang, S. P. Govindwar, J. Taiwan Inst.Chem. Engrs. 2011].

Therefore, present study is about synthesizing Co_3O_4 nanoparticles powder by using cobalt nitrate as the source of cobalt oxide. The Co_3O_4 nanoparticles was further rectified for its structural purity by XRD and also analyzed by Scanning Electron Microscope (SEM) for their morphology.

Nanostructured materials have been widely investigated for the fundamental scientific and technological interests in accessing new classes of functional materials with unprecedented properties and applications1-3. In recent years, there has been an increasing interest in the synthesis of nanosized crystalline metal oxides because of their large surface areas, unusual adsorptive properties, surface defects and fast diffusivities. Co3O4 is a very important material extensively used in catalysis, gas sensors, electrochromic films, battery cathodes, heterogeneous catalytic materials and magnetic materials4,5. Due to their small size, nanoparticles exhibit novel material properties that are significantly different from those of their bulk counterparts. Co3O4 nanoparticles have been synthesized by various methods like sol–gel, surfactant-mediated synthesis, thermal decomposition, polymer-matrix assisted †Presented to the National Conference on Chemistry Solutions at SRM University, India RESEARCH ARTICLE [S48 Chem Sci Trans., 2013, 2(S1), S47-S50] synthesis and [spray-pyrolysis6,7]. Some of the above methods suffer from the difficulty in size-homogeneity and well dispersion of Co3O4 nanoparticles. Recently, several methods have been developed to prepare ultrafine Co3O4 powder, including low

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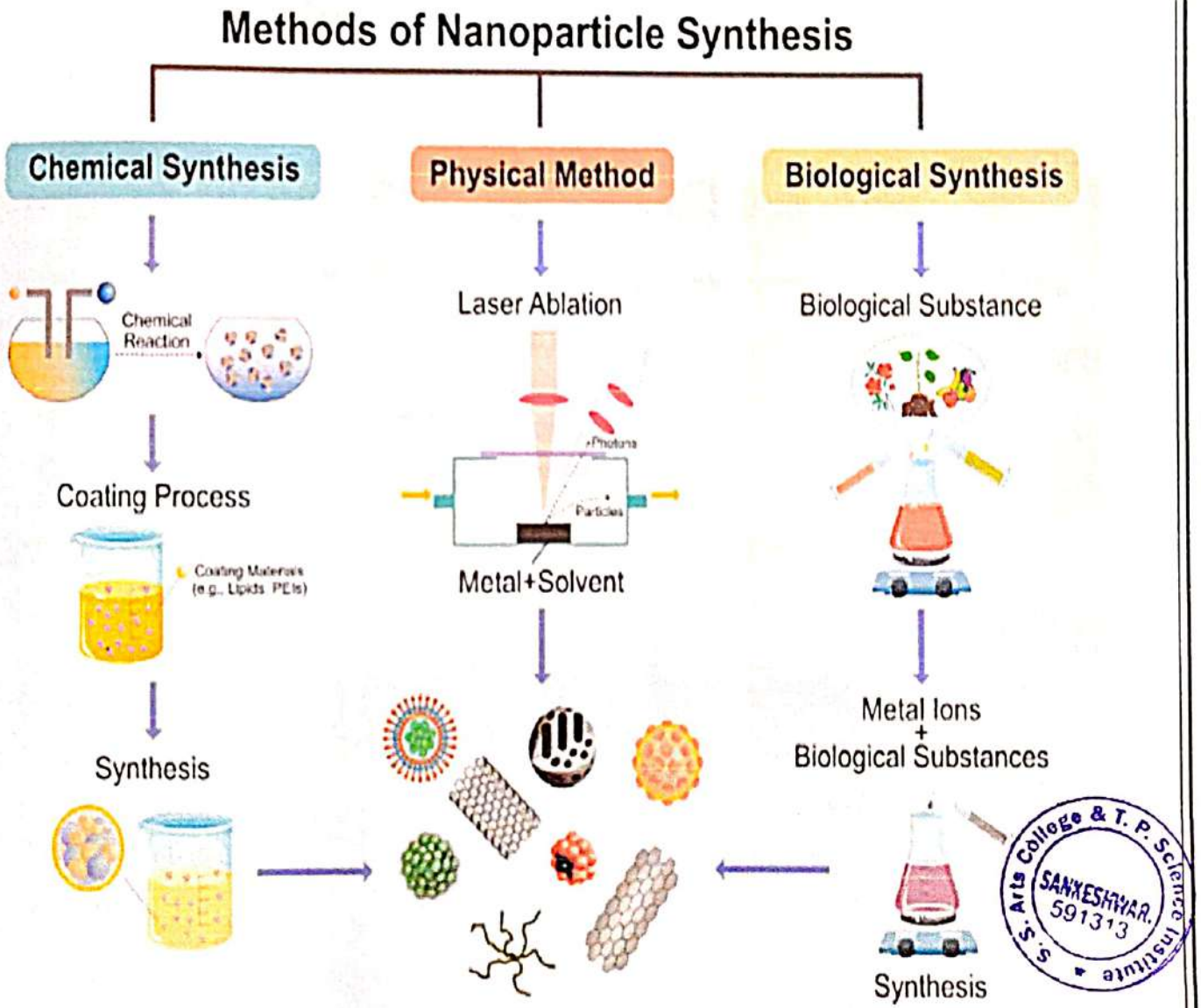
pressure spray pyrolysis, optical gas sensors, antiferromagnetic layers, solar thermal absorbers, etc. In this study, we have reported the synthesis of Co3O4 nanoparticles using thermal decomposition method and characterized its structural, morphological properties. Additionally we have performed the electrocatalytic activity of the synthesized Co3O4 towards the detection of NB. Experimental Cobalt chloride hexahydrate (CoCl2·6H2O), nitrobenzene, ammonium

1.1: Nanoparticles

A nanoparticle is a small particle that ranges between 1 to 100 nanometres in size. Undetectable by the human eye, nanoparticles can exhibit significantly different physical and chemical properties to their larger material counterparts.

The definition given by the European Commission states that the particle size of at least half of the particles in the number size distribution must measure 100 nm or below. Most nanoparticles are made up of only a few hundred atoms.



Different Shapes of the Nanoparticles

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The table below shows the size of Nano particles compared to other structure.

PARTICLE SIZE	DIAMETER SIZE RANGE
• Atom and small molecules	0.1 nm
• Nanoparticles	0.1 Nm
• Fine particles	100 to 2500 nm
• Course particles(dust)	2500 to 10,000 nm
• Thickness of paper	100,000 nm

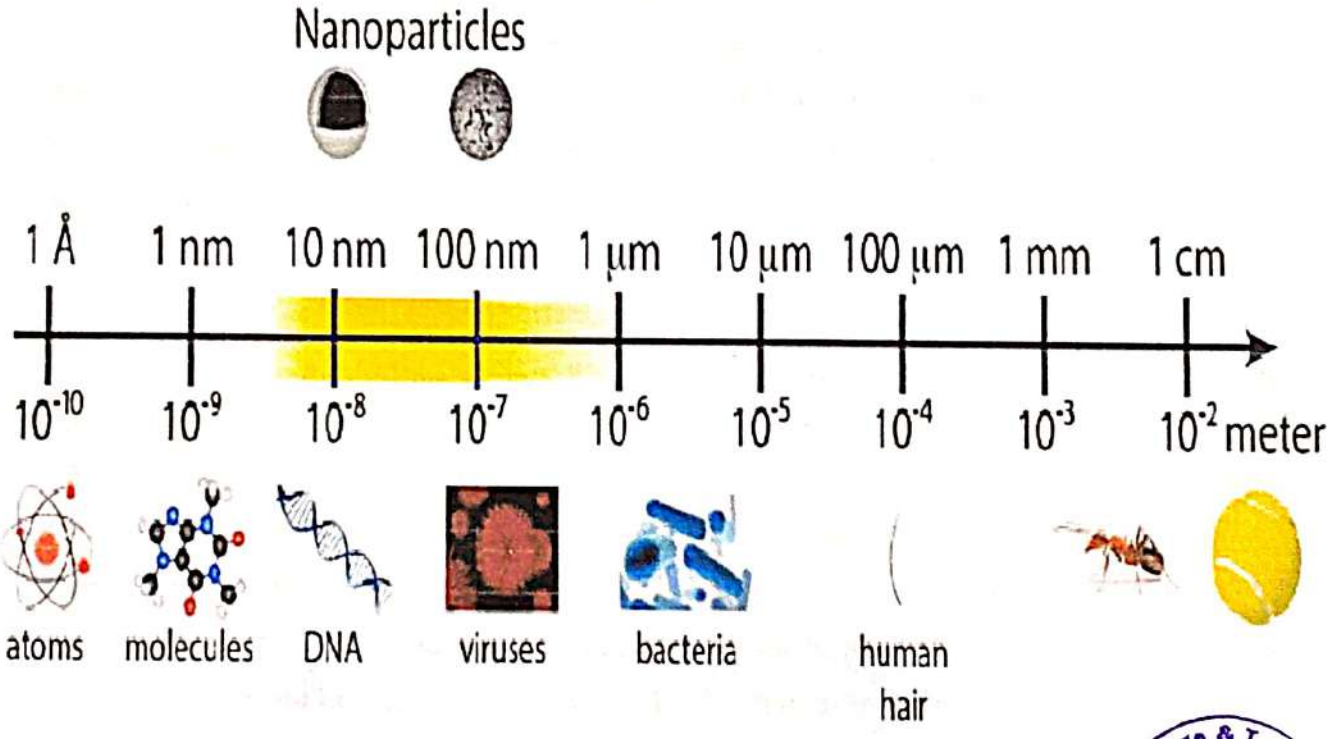

Fig. 2: Size of nanoparticles

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1.2: Chemical Methods:

1.2.1 Chemical reduction method:

In 1857, Michael Faraday, for the first time reported a systematic study of the synthesis and colours of colloidal gold using chemical reduction route. The chemical reduction of cobalt salts is the easiest, simplest and the most commonly used synthetic method for cobalt nanoparticles. In fact, the production of Nano sized metal cobalt particles with good control of morphologies and sizes using chemical reduction of cobalt salts can be achieved.

1.2.2 Micro emulsion/colloidal method:

In1943, Hiraletal. observed that an appropriate amount of water, oil, surfactant and an alcohol- or amine-based co-surfactant produced clear and homogeneous solutions that Hirai called Micro emulsion. Micro emulsion is a technique for the synthesis of nanoparticles in which two immiscible fluids such as water in oil (W/O) or oil in water (O/W) or water in supercritical carbon dioxide (W/Sc. CO_2) become a thermodynamically stable dispersion with the aid of a surfactant. A typical emulsion is a single phase of three components, water, oil and a surfactant. Normally oil and water are immiscible but with the addition of a surfactant, the oil and water become miscible because the surfactant is able to bridge the interfacial tension between the two fluids.

Micro emulsion consists of surfactant aggregates that are in the ranges of 1 nm to 100 nm. The location of water, oil and surfactant phases affects the geometry of aggregate.
The micro-emulsion is said to be oil in water (O/W) if water is the bulk fluid and oil is in less quantity, with small amounts of surfactant. Similarly, the system is said to be water in oil (W/O), if oil is the bulk fluid and water is present in less quantity. The product of oil in water and surfactant (O/W) is called micelles, which is an aggregate formed to reduce free energy. Hydrophobic surfactants in nanoscale oil and micelles point towards the centre of aggregate, whereas the hydrophobic head groups towards water, the bulk solvent. The water in oil Micro emulsion carries oil or organic solvent as bulk. The system is thermodynamically stable and called reverse micelles.

1.2.3 Sonochemical method:

In 1857, Michael Faraday In the sonochemical process, powerful ultrasound radiations (20 kHz to 10 MHz) was applied to molecules to enhance the chemical reaction. Acoustic cavitation is a physical phenomenon which is responsible for sonochemical reaction. This method, initially proposed for the synthesis of iron nanoparticles, nowadays used to synthesize different metals and metal oxides. The main advantages of the

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sonochemical method are its simplicity, operating conditions (ambient conditions) and easy control of the size of nanoparticles by using precursors with different concentrations in the solution. Ultrasound power affects the occurring chemical changes due to the cavitation phenomena involving the formation, growth and collapse of bubbles in liquid. The sonolysis technique involves passing sound waves of fixed frequency through a slurry or solution of carefully selected metal complex precursors. In a solvent with vapour pressure of a certain threshold, the alternating waves of expansion and compression cause cavities to form, grow and implode. Sonochemical reactions of volatile organometallics have been exploited as a general approach to the synthesis of various nano phase materials by changing the reaction medium. There are many theories presented by different researchers that have been developed to explain the mechanism of breakup of the chemical bond under 20 kHz ultrasonic radiations. They have explained the sonochemistry process in these theories i.e., how bubble creation, growth and its collapse is formed in the liquid. One of these theories explains the mechanism of breaking of a chemical bond during a bubble collapse. According to one of these theories, bubble collapse occurs at very high temperatures (5000 K-25000 K) during the sono chemical process. Upon the collapse of the bubble, which occurs in less than a nanosecond, the system undergoes a very high cooling rate K/Sec. The organization and crystallization of nano particles is hindered by this high cooling rate. The creation of amorphous particles is well fined while the nano structured particles are not clear. The reaction will occur in a 200-nm ring surrounding the collapsing bubble if the precursor is a non volatile compound. The temperature of the bulk is lower compared to the ring, and temperature of collapsing bubble will be higher than the temperature of the ring. Sono electro chemical synthesis employs both electrolytes and ultrasonic pulses for the production of nano particles.

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1.2.4 Electrochemical method:

In1943, Hiral et al., the electrochemical synthesis method for the production of nano particles, electricity is used as the driving or controlling force. Electrochemical synthesis is achieved by passing an electric current between two electrodes separated by an electrolyte. That is, the synthesis takes place at the electrode-electrolyte interface. The main advantages of electro chemical techniques include avoidance of vacuum systems as used in physical techniques, low costs, simple operation, high flexibility, easy availability of equipment and instruments, less contamination (pure product) and environment-friendly process (eco-friendly). Much research work has been done on the electrochemical technique in advancing the basic understanding and industrial applications, but still many aspects of this technique

are under study.

1.2.5 Solvothermal decomposition:

J. Kou, A. Saha, C. Bennett-Stamper,R. S. Varma, Chem. Commun. 2012, 48, 5862–5864; In the Solvothermal processes, the chemical reaction takes place in a sealed vessel such as bomb or autoclave, where solvents are brought to temperatures well above their boiling points. When water is used as solvent, it is called a hydrothermal process. There are many advantages in using super critical conditions such as, simplicity, very low grain size, presence of a single phase and synthesis of high purity nanocrystals with high crystallinity and eco friendliness nature.

2) EXPERIMENTAL:

2.1: Materials:

Chemicals used:

NaOH(Poona chemical labrotary),

dil Hcl (By molechem mumbai)

$NaNo_2$, oxalic acid (Poona chemical labrotary)

Sodium borate (Reidel india chemicals, Delhi)

Urea (Research lab, Mumbai).

2.2 : Synthesis of Cobalt Oxide Nanoparticles:

To the 1000 ml of 0.05M Cobalt acetate (12.45g) solution and 0.05M Oxalic acid (6.301g) was added pinch wise for several times at room temperature with continuous stirring. A reduction process occurs from the solution to change dark pink to light pink colour to obtain the product Cobalt oxalate. The product was filtered and washed with distilled water for several times and dried in hot air oven. During this process, Co^{+2} was oxidized to Co^{+3}. Using this Cobalt oxalate with different amount of urea was added to prepared three compounds below;

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Fig 3: Reaction of cobalt acetate and oxalic acid.

(i) The cobalt oxalate (2g) was ground to fine powder with 1g Urea. The powder was calcined at 550 °C for 3 hours to form completely oxidised back coloured product.

(ii) The cobalt oxalate (2g) was ground to fine powder with 2g Urea. The powder was calcined at 550 °C for 3 hours to form completely oxidised black coloured product

(iii) The cobalt oxalate (2g) was ground to fine powder with 3g Urea. The powder was calcined at 550 °C for 3 hours to form completely oxidised black coloured product.

Furthermore,

(iv) Cobalt oxalate was ground to fine powder. The powder was then calcined at 550^0 C for 3 hours to form completely oxidized black coloured product Co3O4.

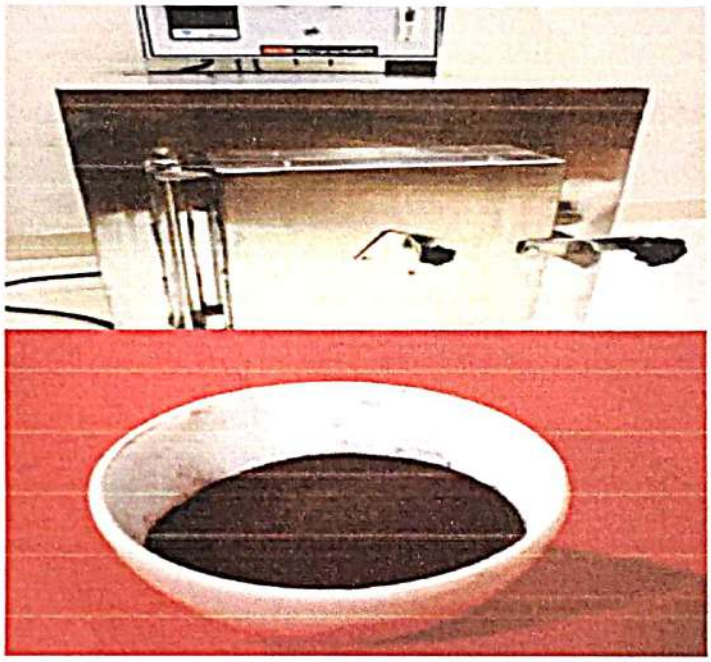

Fig 4: Synthesized cobalt nanoparticles

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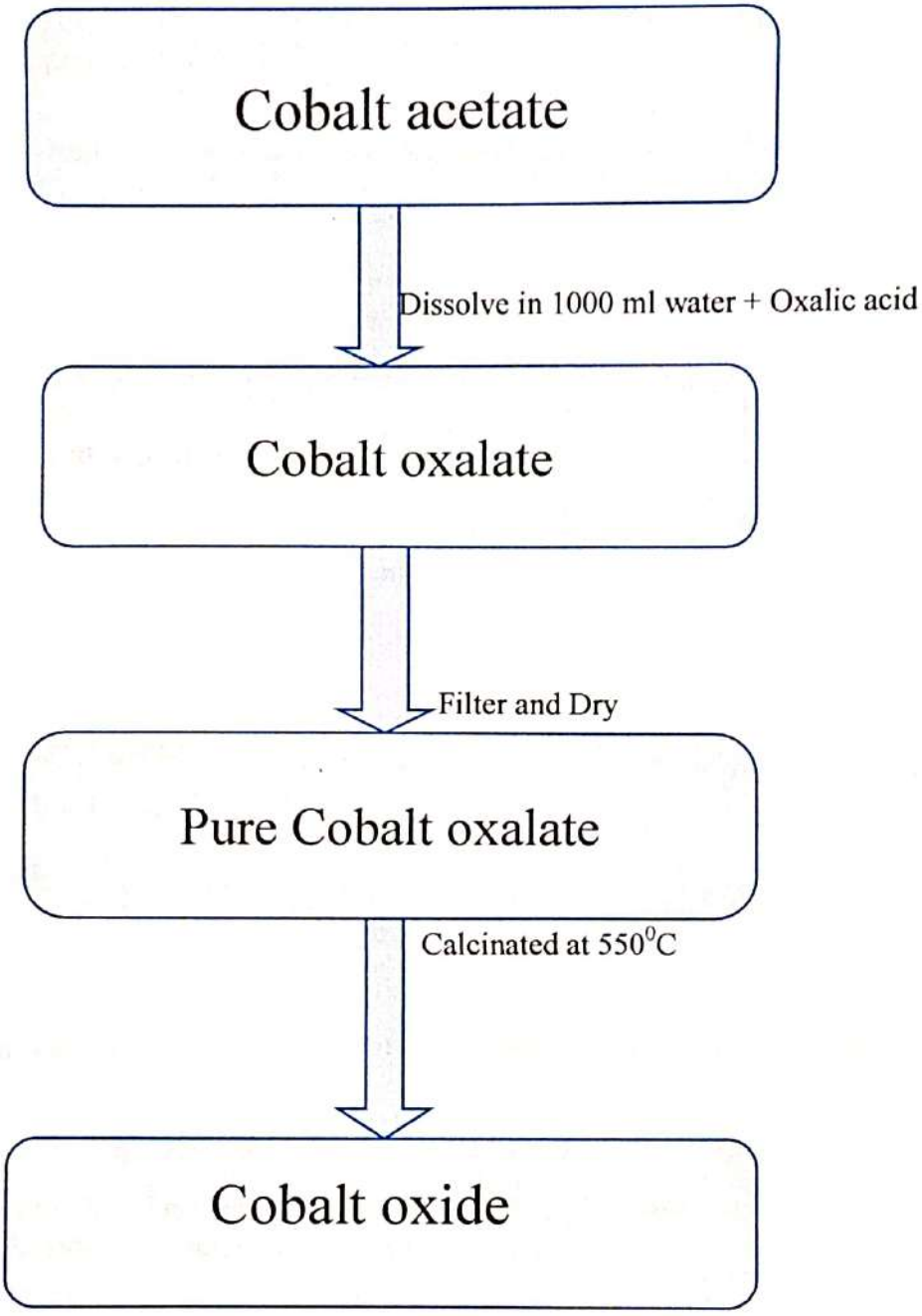

Fig. 5: Flow chart involving the preparation of cobalt oxide NP's

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Experimental procedure :

Step1- Take 1000 ml beaker, to that add 12.45 g of Cobalt acetate, dissolve it completely.

Then connect to magnetic sterer add frequently pinch of oxalic acid.

- Cobalt acetate 12.45 g
- Oxalic acid 6.30 g

Step2- Let that mixture to settle down (1day) filter the solution and dry it.

Step3-weigh the compound and make four portion.

[Found to be 8.4 g]

1) 2 g compound + 1 g urea
2) 2 g compound + 2 g urea
3) 2 g compound + 3 g urea
4) 2 g compound.

Step4- Heat the compound containing crucible upto 550°C for continues 3 hours, let it cool.

Step5- 9.73 gram of o-nitrophenol is taken in 500 cc volumetric flask and added up to the mark.

Step6- 100 ml of o-nitrophenol is taken in beaker to that 0.5 g of catalyst 1 is added and 7.56 g of sodium borate is added and stered up to color turn to redish.

Step7- 2 ml compound+ 2ml dilute Hcl taken in test tube1. NaNo2 (2.5%) in test tube2.

Betanaphtol + NaoH test tube3.

Step8- By adding the above solution scarlet red compound is obtain.

3) RESULTS AND DISCUSSION:

3.1 : XRD ANALYSIS

XRD is used for the primary characterisation of material properties like crystal structure, crystalline size. The XRD pattern of Co_3O_4 typically exhibits characteristic peak that corresponds to the crystal structure of the material. The most common crystal structure of $Co_3O_4$is trigonal.

The Debye-Scherrer formula is used to calculate the average crystalline size of a material from its XRD pattern. This formula is based on the principles of XRD and assumes that the crystallites in the material randomly oriented and have hollow spherical shape.(JCPDC ofCo_3O_4 card No.:431003)

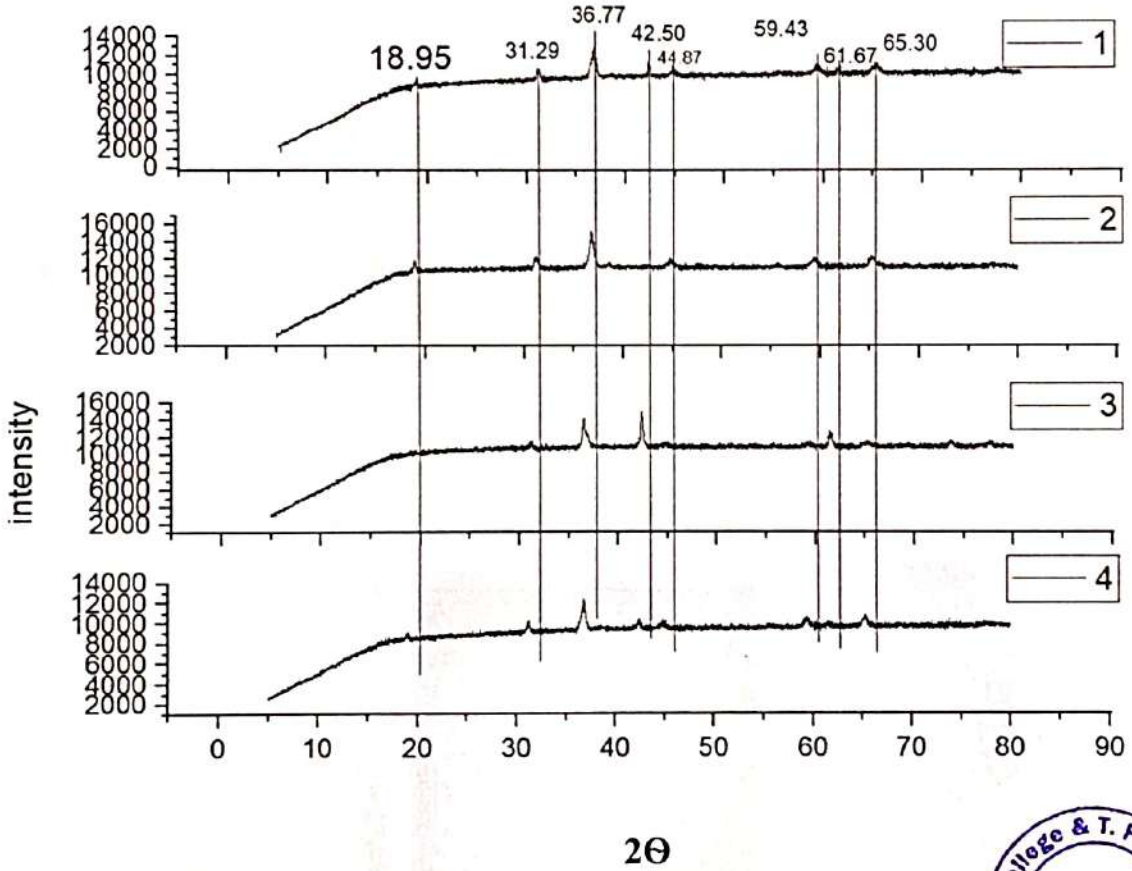

Fig.6: XRD pattern of Co_3O_4

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3.2 : SEM

SEM is the powerful analytical technique to perform analysis on a widerange of materials, at high magnification, and to produce high resolution images. The SEM isan instrument that produces largely magnified images by using electrons instead of light to from an image. The main components of SEM includes source of electrons, electromagneticlenses to focus on electron, electron detectors, sample chamber, computer and display view the image.

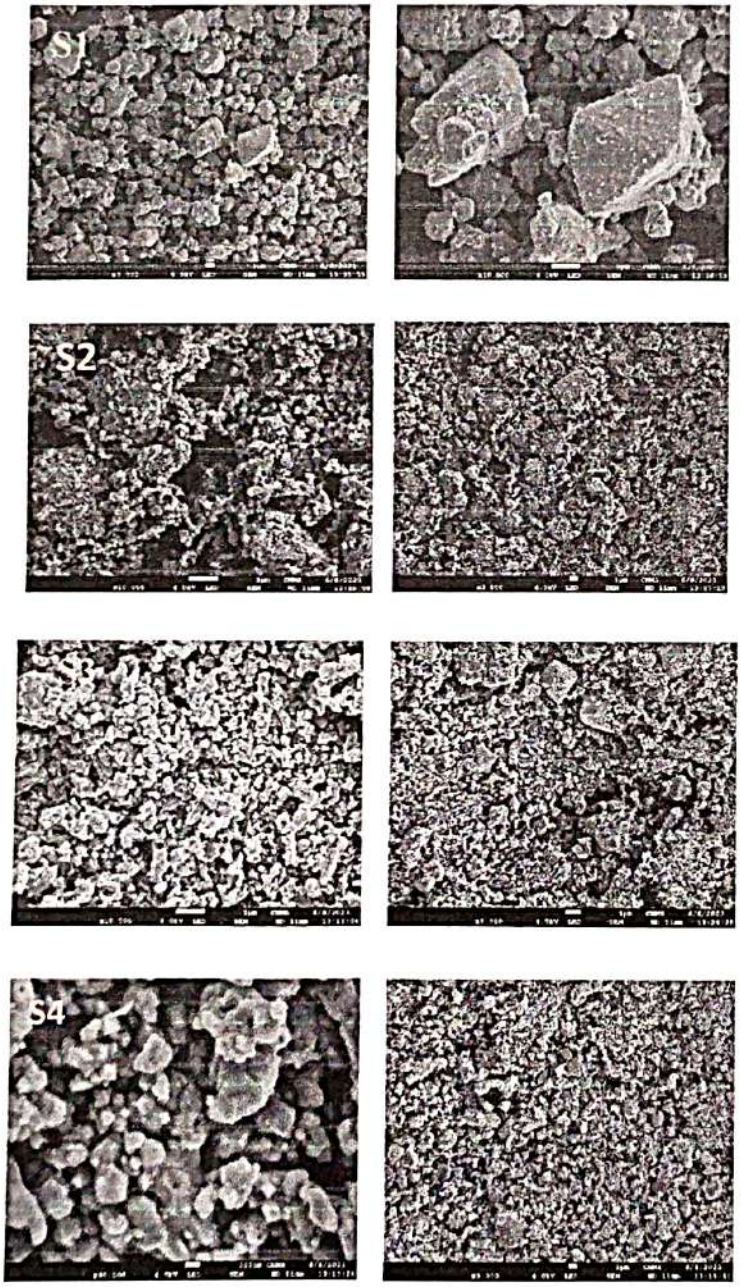

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Fig.7: SEM images of Co_3O_4-S1, Co_3O_4-S2, Co_3O_4-S3, Co_3O_4-S4

The surface morphologies of synthesised Co_3O_4 Nanoparticles were studied by SEM and the results are presented in Fig 7.

Fig 7 (S1) is A SEM Image of Co_3O_4-S1 Nanoparticles which shows uniform and tetragonal shape with low aggregation of particles.

Fig 7 (S2) is A SEM Image of Co_3O_4-S2 Nanoparticles which shows slightly deformed spherical with more aggregation of particles.

Fig 7 (S3) is A SEM Image of Co_3O_4-S3 Nanoparticles which shows deformed and tetragonal shape with more aggregation of particles.

Fig 7 (S4) is ASEM Image of Co_3O_4-S4 Nanoparticles which shows non uniform or slightly deformed spherical shape with more aggregation of particles.

3.3: 4-Nitrophenol (NP) REDUCTION

Different volumes of 0.14 mM of 4 –nitro phenol solution was taken in beaker to that add 7.56 mg of solid $Na_2B_4O_5(OH)_4.8H_2O$ which acts as reducing agent, to the above solution add 10 mg of Co_3O_4 nanoparticles as a catalyst, the solution was stirred continuously on a stirrer .

For 0.14 mM concentration of 4-NP (100 ml) solution in a beaker, 5 mM $Na_2B_4O_5(OH)_4.8H_2O$, 18.91 mg) was added , followed by addition of 10 mg catalysts, respectively. Then, the solutions were stirred continuously using magnetic stirrer and corresponding absorbance changes were observed after every colour changes to brown and by carrying out the amino group test.

The 4-NP (100 ml) solution which is taken in a beaker, 5 mM $Na_2B_4O_5(OH)_4.8H_2O$ was added and 10 mg of (S1,S2,S3,S4) catalyst was added and the reaction progress was observed for all the 4 catalysts using amino test after colour changing . From the observation, a better reduction was observed for S3 that is 1 hour for 100 ml solution. By comparing all the above four (100 ml) solutions a better reduction was observed for 100 ml solution is S3 catalyst.

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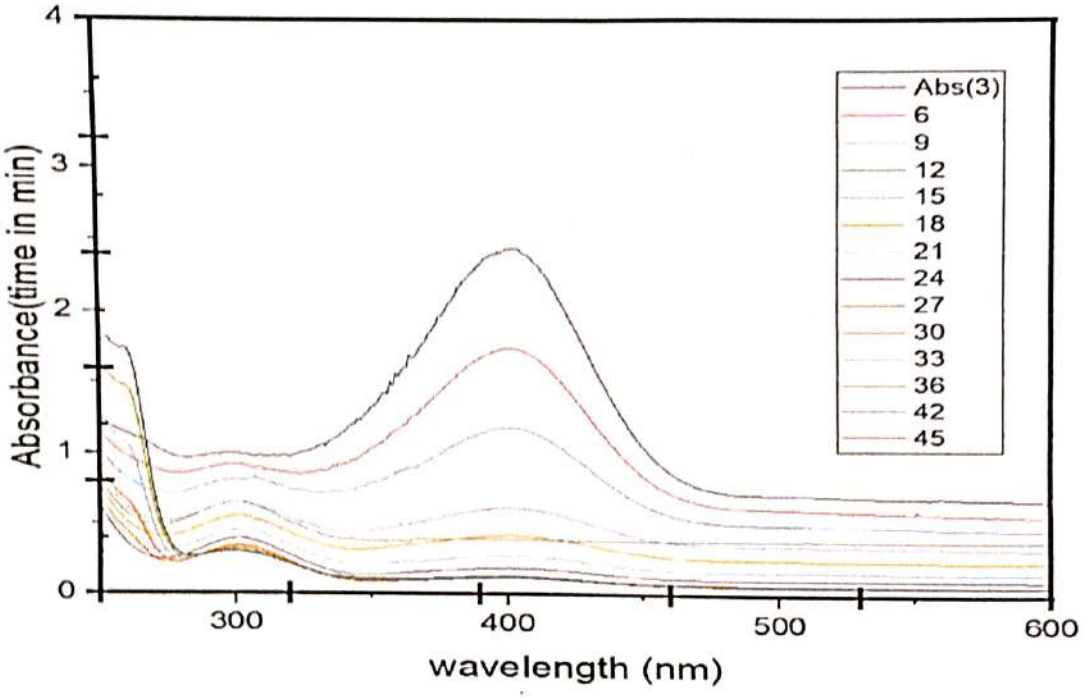
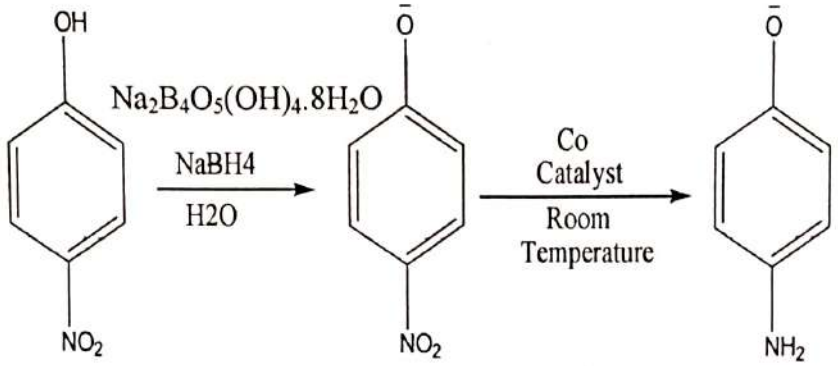


Fig.8: Time dependent UV- vis spectra of 4-NP reduction in $Na_2B_4O_5(OH)_4.8H_2O$ with Co catalyst [reaction conditions: 4-NP= 100 ml (0.14 mM) $Na_2B_4O_5(OH)_4.8H_2O$ (5 mM), catalyst = 10 mg].

The above figure shows that, the time dependent UV-Vis spectra of 4-NP reduction in $Na_2B_4O_5(OH)_4.8H_2O$ using Co catalyst. It was observed that the, intensity of 4-nitrophenolate ion at λ_{max} 400 nm was gradually decreasing, simultaneously a new peak starts appearing at λ_{max} 298 nm, which corresponds to 4-AP, the reaction completed with yellow to a brown solution.

The reaction of this reduction process may be written as shown below. The addition of Na2B4O5(OH)4.8H2O in the 4-NP solution gives a 4-nitrophenolate ion, shifting λ_{max} to a longer wavelength giving dark yellow colour solution. Further, the addition of catalyst decreases the intensity of the solution and becomes brown at the end of the reaction.



4-nitrophenol $Na_2B_4O_5(OH)_4.8H_2O$ 4-aminophenol

Scheme1: Catalytic reduction of 4-NP to 4- AP using Co_3O_4 catalyst

Fig 9: Before and after the addition of Co nanoparticle catalyst for the reduction of 4-Nitro phenol.

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Fig 10: After reduction of 4-NP results in the formation of 4-Amino phenol

The reaction of this reduction process may be written as shown below. The addition $Na_2B_4O_5(OH)_4.8H_2O$ in the 4-NP solution gives a 4-nitrophenolate ion, shifting λ_{max} to a longer wavelength giving dark yellow colour solution. Further, the addition of catalyst decreases the intensity of the solution and becomes brown at the end of the reaction.

4) CONCLUSION:

Materials to obtain different types of nano systems with various applications. All these aspects may significantly impact on their physico-chemical properties. Here, we have successfully reported the synthesis of stable Co particles from Cobalt acetate using a mild reducing agent and oxalic acid. The obtained NP's were stable and exhibited excellent catalytic activity towards the reduction of organic pollutants such as 4-NP in the presence of $NaBH_4$. The 4-NP is commonly used Co_3O_4 nanoparticles can be synthesised by various methods, and by using various bulk in many industries and remain in the industrial effluent. They have an adverse effect on the environment if not treated properly. Therefore, it is essential to develop a convenient method to remove such toxic chemical from waste water. Here, the prepared S3 catalyst gives the better reduction compare to other catalyst, the synthesised Co_3O_4 were utilised for 4-NP reduction in the presence of $Na_2B_4O_5(OH)_4.8H_2O$, Co_3O_4 NPs have surface area and can absorb a wide range of pollutants onto their surfaces. They can be used to remove heavy metals, organic compound and dyes from waste water.

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System as adsorbents effectively capturing contaminants and improving water quality. Therefore we believe that the present method is simple and environmentally benign towards synthesising catalysts and it's application in waste water treatment.

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CERTIFICATE

This is certify that project work for the subject of "Indian mathematics and their contributions" by

1. Deepak.G.Khot	U15CH21S0003
2. Ningappa.D.Maradi	U15CH21S0054
3. Omkar.P.Bhovi	U15CH21S0057
4. Rohit.S.Khanase	U15CH21S0079
5. Sachin.S.Jinarali	U15CH21S0084
6. Mudassir.D.Jamadar	U15EN21S0035

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A Subjected to the project of mathematics satisfactorily completed their teamwork in course of B.sc – VI Sem during the year 2023-2024.

Date: 10.08.2024

Project guide
(smt.S.I.Nadaf)

HOD

Principal
S. S. Arts College & T.P. Science Institute
SANKESHWAR

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We are deeply indebted and wish to express my sincere gratitude to my guide **Smt.Shama.I.Nadaf** Department of Mathematics, **S.D.V.S.Sangh's S.S.Arts and T.P.Science Institution Sankeshwar.** For her invariable guidance, encouragement,critical comments and constant inspiration through out of the course of this Work.

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We thanks all of my friends giving us moral support.

At last we thank all who directly or indirectly helped us in successful completion of this work.

Examiner's signature

HOD

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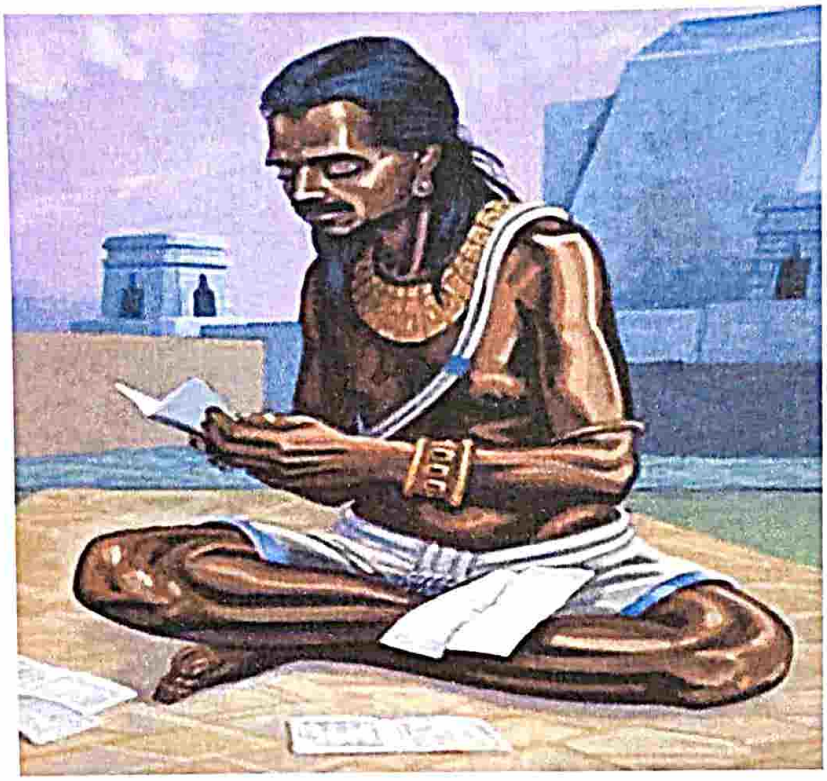
1:BRAHMAGUPTA:-



- Brahmagupta (c. 598 – c. 668 CE) was an Indian mathematician and astronomer. He is the author of two early works on mathematics and astronomy: the Brāhmasphuṭasiddhānta (BSS, "correctly established doctrine of Brahma", dated 628), a theoretical treatise, and the Khaṇḍakhādyaka ("edible bite", dated 665),

Brahmagupta gave the solution of the general linear equation in chapter eighteen of Brahmasphuṭasiddhānta,

The difference between rupas, when inverted and divided by the difference of the [coefficients] of the [unknowns], is the unknown in the equation. The rupas are [subtracted on the side] below that from which the square and the unknown are to be subtracted.

which is a solution for the equation bx + c = dx + e where rupas refers to the constants c and e. The solution given is equivalent to $x = \frac{e - c}{b - d}$.

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•BRAHMAGUPTA'S FORMULA:-

Brahmagupta's formula gives the area K of a cyclic quadrilateral whose sides have lengths a, b, c, d as

$$K = \sqrt{(s-a)(s-b)(s-c)(s-d)}$$

where s, the semiperimeter, is defined to be

$$s = \frac{a+b+c+d}{2}.$$

This formula generalizes Heron's formula for the area of a triangle. A triangle may be regarded as a quadrilateral with one side of length zero. From this perspective, as d approaches zero, a cyclic quadrilateral converges into a cyclic triangle (all triangles are cyclic), and Brahmagupta's formula simplifies to Heron's formula.

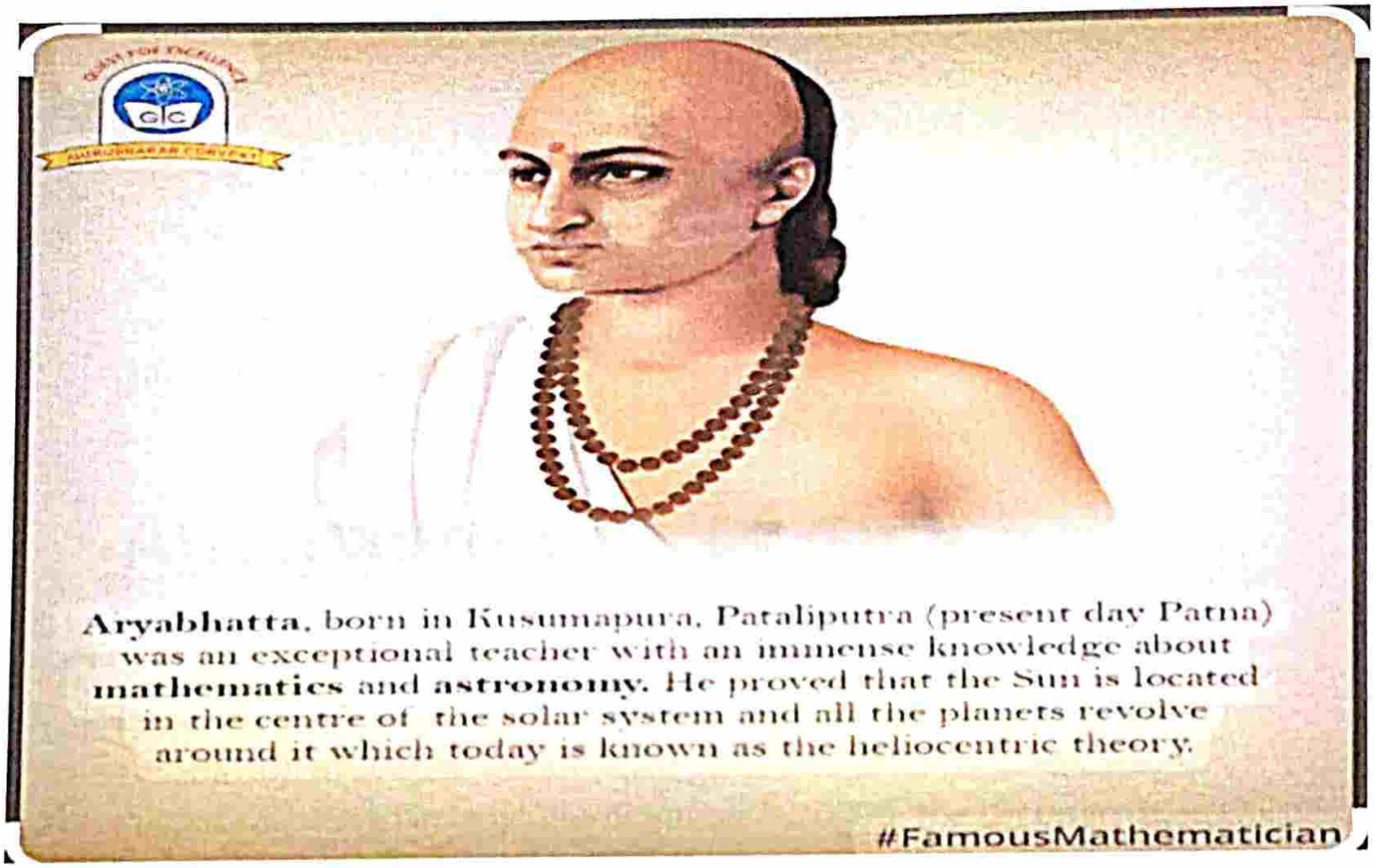
If the semiperimeter is not used, Brahmagupta's formula is

$$K = \frac{1}{4}\sqrt{(-a+b+c+d)(a-b+c+d)(a+b-c+d)(a+b+c-d)}.$$

Another equivalent version is

$$K = \frac{\sqrt{(a^2+b^2+c^2+d^2)^2 + 8abcd - 2(a^4+b^4+c^4+d^4)}}{4}.$$

2:ARYABHATTA:-



Aryabhata or Aryabhata I was the first of the major mathematician-astronomers from the classical age of Indian mathematics and Indian astronomy. His works include the Āryabhaṭīya and the Arya-siddhanta. For his explicit mention of the relativity of motion, he also qualifies as a major early physicist. Wikipedia

Born: 476 AD, Pataliputra

Died: 550 AD (age 74 years), Pataliputra

Era: Gupta era

Influenced: Lalla, Bhaskara I, Brahmagupta, Varahamihira

Main interests: Mathematics, astronomy

Notable works: Āryabhaṭīya, Arya-siddhanta

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Contribution in mathematics :-

- Place value system and zero
- The place-value system, first seen in the 3rd-century Bakhshali Manuscript, was clearly in place in his work. While he did not use a symbol for zero, the French mathematician Georges Ifrah argues that knowledge of zero was implicit in Aryabhata's place-value system as a place holder for the powers of ten with null coefficients.
- However, Aryabhata did not use the Brahmi numerals. Continuing the Sanskritic tradition from Vedic times, he used letters of the alphabet to denote numbers, expressing quantities, such as the table of sines in a mnemonic form.

Approximation of π:-

i.e,abhata worked on the approximation for pi (π), and may have come to the conclusion that π is irrational. In the second part of the Aryabhatiyam (gaṇitapāda 10), he writes:
This implies that for a circle whose diameter is 20000, the circumference will be 62832
This implies that for a circle whose diameter is 20000, the circumference will be 62832
I.e,π=62832/20000=3.1416,which is accurate to two parts in one million.
It is speculated that Aryabhata used the word āsanna (approaching), to mean that not only is this an approximation but that the value is incommensurable (or irrational). If this is correct, it is quite a sophisticated insight, because the irrationality of pi (π) was proved in Europe only in 1761 by Lambert.[23]
After Aryabhatiya was translated into Arabic (c. 820 CE), this approximation was mentioned in Al-Khwarizmi's book on algebra.[10]

Indeterminate equations

- A problem of great interest to Indian mathematicians since ancient times has been to find integer solutions to Diophantine equations that have the form ax + by = c. (This problem was also studied in ancient Chinese mathematics, and its solution is usually referred to as the Chinese remainder theorem.) This is an example from Bhāskara's commentary on Aryabhatiya:
- Find the number which gives 5 as the remainder when divided by 8, 4 as the remainder when divided by 9, and 1 as the remainder when divided by 7
- That is, find N = 8x+5 = 9y+4 = 7z+1. It turns out that the smallest value for N is 85. In general, diophantine equations, such as this, can be notoriously difficult. They were discussed extensively in ancient Vedic text Sulba Sutras, whose more ancient parts might date to 800 BCE. Aryabhata's method of solving such problems, elaborated by Bhaskara in 621 CE, is called the kuṭṭaka (कुट्टक) method. Kuṭṭaka means "pulverizing" or "breaking into small pieces", and the method involves a recursive algorithm for writing the original factors in smaller numbers. This algorithm became the standard method for solving first-order diophantine equations in Indian mathematics, and initially the whole subject of algebra was called kuṭṭaka-gaṇita or simply kuṭṭaka.
- **Mathematical Discoveries:-** In Aryabhatiya Indian Mathematical Literature was extensively mentioned. The Vedic way to solve mathematical problems was explored and unsurprisingly this has also survived to modern times. The details of algebra, arithmetic, plane trigonometry, spherical trigonometry were discussed. He followed the Sanskrutik tradition or method of calculations that were prevalent in the Vedic Times. The title of 'Father Of Algebra' was given to Aryabhata, due to his notable understanding and explanation of planetary systems using it. Aryabhata correctly concluded the value of pi up to 2 decimal places, 3.14. He also used null coefficients and very rightly was aware of the use of zero in such a place. He used Sanskritic tradition that was mainly denoted by letters and alphabets, unlike the Brahmi numerals.
- **Astronomy Discoveries:-** Aryabhatta rightly insisted that the earth rotates daily on its axis around the sun and the movement of stars appeared to be because of the relative motion caused due to the rotation of the earth. This was in contrast to the then very popular belief that it was the sky that rotates. With calculated evidence, it was explained that heliocentrism is the rotation of planets around the sun, axially.
-

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3:Srinivas Rumanujan:-

- Srinivasa Ramanujan[a] (22 December 1887 – 26 April 1920) was an Indian mathematician. Though he had almost no formal training in pure mathematics, he made substantial contributions to mathematical analysis, number theory, infinite series, and continued fractions, including solutions to mathematical problems then considered unsolvable.
- Srinivasa Ramanujan: Indian math prodigy.
- Born on December 22, 1887.
- Self-taught, no formal training.
- Brilliant contributions to mathematics.
- Focus on number theory.
- Explored infinite series, continued fractions.
- Collaboration with G.H. Hardy.
- Published groundbreaking papers.

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National Mathematics Day 2023 is celebrated on December 22 every year. Check the timeline of events in Srinivasa Ramanujan's life.

National Mathematics Day 2023 is celebrated on December 22 every year. Check the timeline of events in Srinivasa Ramanujan's life.

The celebration of this day began in 2012 when then Prime Minister Manmohan Singh declared December 22 as National Mathematics Day to honor the life and achievements of Ramanujan in the field of Mathematics.

Know about Srinivasa Ramanujan's life and his works in the timeline given here.

1887: The great mathematician was born on this day in Tamil Nadu's Erode to a Brahmin Iyengar family. Since his childhood days, he had a liking for mathematics which led him to master trigonometry at the age of 12. He was also eligible for a scholarship at the Government Arts College in Kumbakonam.

1912: Srinivasa Ramanujan started to work as a clerk in Madras Port Trust in 1912. There, his mathematics genius was recognized by some of his colleagues and one of them referred him to Professor GH Hardy of Trinity College, Cambridge University. He met Hardy in 1913, after which he went to Trinity College.

1916: This year the Ramanujan received his Bachelor in Science degree. After this, he published several papers on his subject with Hardy's help.

1917: Ramanujan was elected to the London Mathematical Society.

1918: The great mathematician was elected to the prestigious Royal Society for his research on Elliptic Functions and theory of numbers. He was also the first Indian to be elected a Fellow of the Trinity College.

1919: Ramanujan returned to India.

1920: On April 26, he breathed his last owing to deteriorating health. He was just 32 years old.

Srinivasa Ramanujan never received any formal training in pure maths, but he made impactful contribution in the field of mathematics. His areas of work include infinite series, continued fractions, number theory and mathematical analysis. He also made notable contributions like the hypergeometric series, the Riemann series, the elliptic integrals, the theory of divergent series, and the functional equations of the zeta function. He is said to have discovered his own theorems and independently compiled 3,900 results.

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Hardy-Ramanujan number 1729

- The number 1729 is known as the Hardy–Ramanujan number after a famous visit by Hardy to see Ramanujan at a hospital. In Hardy's words:
- I remember once going to see him when he was ill at Putney. I had ridden in taxi cab number 1729 and remarked that the number seemed to me rather a dull one, and that I hoped it was not an unfavorable omen. "No", he replied, "it is a very interesting number; it is the smallest number expressible as the sum of two cubes in two different ways."
- Immediately before this anecdote, Hardy quoted Littlewood as saying, "Every positive integer was one of [Ramanujan's] personal friends."
- The two different ways are:
- $1729=1^3+12^3=9^3+10^3$
- Generalised of this idea have created the notion of "taxicqb numbers".

•MATHAMATICAL ACHIEVEMENTS:-

Although there are numerous statements that could have borne the name Ramanujan conjecture, one was highly influential on later work. In particular, the connection of this conjecture with conjectures of André Weil in algebraic geometry opened up new areas of research. That Ramanujan conjecture is an assertion on the size of the tau-function, which has a generating function as the discriminant modular form Δ(q), a typical cusp form in the theory of modular forms. It was finally proven in 1973, as a consequence of Pierre Deligne's proof of the Weil conjectures. The reduction step involved is complicated. Deligne won a Fields Medal in 1978 for that work.

In his paper "On certain arithmetical functions", Ramanujan defined the so-called delta-function, whose coefficients are called τ(n) (the Ramanujan tau function).[122] He proved many congruences for these numbers, such as $\tau(p) \equiv 1 + p11 \bmod 691$ for primes p. This congruence (and others like it that Ramanujan proved) inspired Jean-Pierre Serre (1954 Fields Medalist) to conjecture that there is a theory of Galois representations that "explains" these congruences and more generally all modular forms. Δ(z) is the first example of a modular form to be studied in this way. Deligne (in his Fields Medal-winning work) proved Serre's conjecture. The proof of Fermat's Last Theorem proceeds by first reinterpreting elliptic curves and modular forms in terms of these Galois representations. Without this theory, there would be no proof of Fermat's Last Theorem.

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Ramanujan's Formula for $\zeta(2n+1)$

Bruce C. Berndt and Armin Straub

1 Introduction

As customary, $\zeta(s) = \sum_{n=1}^{\infty} n^{-s}$, $\operatorname{Re} s > 1$, denotes the Riemann zeta function. Let B_r, $r \geq 0$, denote the r-th Bernoulli number. When n is a positive integer, Euler's formula

$$\zeta(2n) = \frac{(-1)^{n-1} B_{2n}}{2(2n)!} (2\pi)^{2n} \tag{1.1}$$

not only provides an elegant formula for evaluating $\zeta(2n)$, but it also tells us of the arithmetical nature of $\zeta(2n)$. In contrast, we know very little about the odd zeta values $\zeta(2n+1)$. One of the major achievements in number theory in the past half-century is R. Apéry's proof that $\zeta(3)$ is irrational [2], but for $n \geq 2$, the arithmetical nature of $\zeta(2n+1)$ remains open.

Ramanujan made many beautiful and elegant discoveries in his short life of 32 years, and one of them that has attracted the attention of several mathematicians over the years is his intriguing formula for $\zeta(2n+1)$. To be sure, Ramanujan's formula does not possess the elegance of (1.1), nor does it provide any arithmetical information. But, one of the goals of this survey is to convince readers that it is indeed a remarkable formula.

Theorem 1.1 (Ramanujan's formula for $\zeta(2n+1)$). *Let B_r, $r \geq 0$, denote the r-th Bernoulli number. If α and β are positive numbers such that $\alpha\beta = \pi^2$, and if n is a positive integer, then*

Bruce C. Berndt
Department of Mathematics, University of Illinois at Urbana–Champaign, 1409 W. Green St., Urbana, IL 61801, USA
e-mail: berndt@illinois.edu

Armin Straub
Department of Mathematics and Statistics, University of South Alabama, 411 University Blvd N, Mobile, AL 36688, USA
e-mail: straub@southalabama.edu

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$$\alpha^{-n}\left(\frac{1}{2}\zeta(2n+1)+\sum_{m=1}^{\infty}\frac{1}{m^{2n+1}(e^{2m\alpha}-1)}\right)$$
$$-(-\beta)^{-n}\left(\frac{1}{2}\zeta(2n+1)+\sum_{m=1}^{\infty}\frac{1}{m^{2n+1}(e^{2m\beta}-1)}\right)$$
$$=2^{2n}\sum_{k=0}^{n+1}(-1)^{k-1}\frac{B_{2k}}{(2k)!}\frac{B_{2n+2-2k}}{(2n+2-2k)!}\alpha^{n+1-k}\beta^{k}. \tag{1.2}$$

Theorem 1.1 appears as Entry 21(i) in Chapter 14 of Ramanujan's second notebook [59, p. 173]. It also appears in a formerly unpublished manuscript of Ramanujan that was published in its original handwritten form with his lost notebook [60, formula (28), pp. 319–320].

The purposes of this paper are to convince readers why (1.2) is a fascinating formula, to discuss the history of (1.2) and formulas surrounding it, and to discuss the remarkable properties of the polynomials on the right-hand side of (1.2). We briefly point the readers to analogues and generalizations at the end of our paper.

In Section 2, we discuss Ramanujan's aforementioned unpublished manuscript and his faulty argument in attempting to prove (1.2). Companion formulas (both correct and incorrect) with the same parentage are also examined. In the following Section 3, we offer an alternative formulation of (1.2) in terms of hyperbolic cotangent sums. In Sections 4 and 5, we then discuss a more modern interpretation of Ramanujan's identity. We introduce Eisenstein series and their Eichler integrals, and observe that their transformation properties are encoded in (1.2). In particular, this leads us to a vast extension of Ramanujan's identity from Eisenstein series to general modular forms.

In a different direction, (1.2) is a special case of a general transformation formula for analytic Eisenstein series, or, in another context, a general transformation formula that greatly generalizes the transformation formula for the logarithm of the Dedekind eta function. We show that Euler's famous formula for $\zeta(2n)$ arises from the same general transformation formula, and so Ramanujan's formula (1.2) is a natural analogue of Euler's formula. All of this is discussed in Section 6.

In Section 7, we discuss some of the remarkable properties of the polynomials that appear in (1.2). These polynomials have received considerable recent attention, with exciting extensions by various authors to other modular forms. We sketch recent developments and indicate opportunities for further research. We then provide in Section 8 a brief compendium of proofs of (1.2), or its equivalent formulation with hyperbolic cotangent sums.

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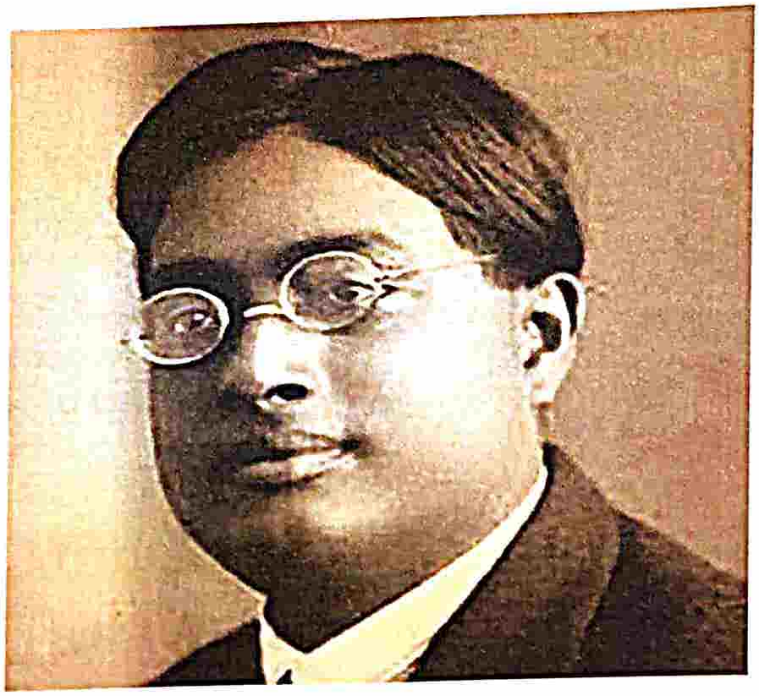
4:S.N.BOSE:-



- **Satyandrnath Bose:**1 January 1894 – 4 February 1974) was an Indian theoretical physicist and mathematician. He is best known for his work on quantum mechanics in theearly 1920s, in developing the foundation for Bose–Einstein statistics and the theory of the Bose–Einstein condensate. A Fellow of the Royal Society, he was awarded India's second highest civilian award, the Padma Vibhushan, in 1954 by the Government of India.
- **Contributions of Satyendra Nath Bose**
- Bose wrote a brief article titled "Planck's Law and the Hypothesis of Light Quanta" after adapting a lecture he gave at the University of Dhaka on the theory of radiation and the ultraviolet catastrophe.
- By treating radiation as a gas of photons (Photon gas) and using new statistical techniques for counting photon states, Bose provided a new derivation of Planck's law.
- Einstein received a brief paper he had written on the subject and immediately recognised its importance.
- In agreement with him, Bose's article "Planck's Law and Hypothesis of Light Quanta" was translated by Einstein into German and published in Zeitschrift für Physik in 1924 under Bose's name.

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5:BHASKARACHARYA:-

- Bhāskara II[a] ([bʰɑ:skərə]; c.1114–1185), also known as Bhāskarāchārya (lit. 'Bhāskara the teacher'), was an Indian polymath, mathematician, astronomer and engineer. From verses in his main work, Siddhāṁta Śiromaṇī, it can be inferred that he was born in 1114 in Vijjadavida (Vijjalavida) and living in the Satpuda mountain ranges of Western Ghats, believed to be the town of Patana in Chalisgaon, located in present-day Khandesh region of Maharashtra by scholars.[6] In a temple in Maharashtra, an inscription supposedly created by his grandson Changadeva, lists Bhaskaracharya's ancestral lineage for several generations before him as well as two generations after him.[7][8] Henry Colebrooke who was the first European to translate (1817) Bhaskaracharya II's mathematical classics refers to the family as Maharashtrian Brahmins residing on the banks of the Godavari.

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CONTRIBUTION OF BRHMACHARYA IN MATHEMATICS

- Proof of the Pythagorean theorem by calculating the same area in two different ways and then cancelling out terms to get a2 + b2 = c2.[21]
- In Lilavati, solutions of quadratic, cubic and quartic indeterminate equations are explained.[22]
- Solutions of indeterminate quadratic equations (of the type ax2 + b = y2).
- Integer solutions of linear and quadratic indeterminate equations (Kuṭṭaka). The rules he gives are (in effect) the same as those given by the Renaissance European mathematicians of the 17th century.
- A cyclic Chakravala method for solving indeterminate equations of the form ax2 + bx + c = y. The solution to this equation was traditionally attributed to William Brouncker in 1657, though his method was more difficult than the chakravala method.
- The first general method for finding the solutions of the problem x2 − ny2 = 1 (so-called "Pell's equation") was given by Bhaskara II.

• ALEGEBRA:-

- •His Bījaganita ("Algebra") was a work in twelve chapters. It was the first text to recognize that a positive number has two square roots (a positive and negative square root).[25] His work Bījaganita is effectively a treatise on algebra and contains the following topics:
- Positive and negative numbers.
- The 'unknown' (includes determining unknown quantities).
- Determining unknown quantities.
- Surds (includes evaluating surds and their square roots).
- Kuṭṭaka (for solving indeterminate equations and Diophantine equations).
- Simple equations (indeterminate of second, third and fourth degree).
- Simple equations with more than one unknown.
- Indeterminate quadratic equations (of the type ax2 + b = y2).
- Solutions of indeterminate equations of the second, third and fourth degree.
- Quadratic equations.
- Quadratic equations with more than one unknown.
- Operations with products of several unknowns.
- Bhaskara derived a cyclic, chakravala method for solving indeterminate quadratic equations of the form ax2 + bx + c = y.[25] Bhaskara's method for finding the solutions of the problem Nx2 + 1 = y2 (the so-called "Pell's equation)is of the considerable importance

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• Trigonometry

- The Siddhānta Shiromani (written in 1150) demonstrates Bhaskara's knowledge of trigonometry, including the sine table and relationships between different trigonometric functions. He also developed spherical trigonometry, along with other interesting trigonometrical results. In particular Bhaskara seemed more interested in trigonometry for its own sake than his predecessors who saw it only as a tool for calculation. Among the many interesting results given by Bhaskara, results found in his works include computation of sines of angles of 18 and 36 degrees, and the now well known formula for sin(a+b) and sin(a-b).

• Calculus:

His work, the Siddhānta Shiromani, is an astronomical treatise and contains many theories not found in earlier works.[citation needed] Preliminary concepts of infinitesimal calculus and mathematical analysis, along with a number of results in trignometry, differential calculus and integral calculus that are found in the work are of particular interest.

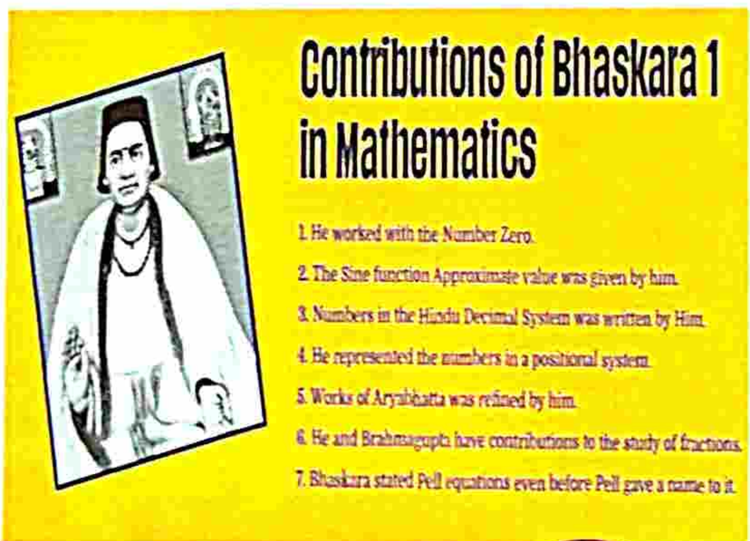
Evidence suggests Bhaskara was acquainted with some ideas of differential calculus.[25] Bhaskara also goes deeper into the 'differential calculus' and suggests the differential coefficient vanishes at an extremum value of the function, indicating knowledge of the concept of 'infinitesimals'.

मख्यादि रहितं कर्म वक्ष्यते तत्समासतः ।
चक्रार्धांशकसमूहाद्विशोध्या ये भुजांशकाः ॥ १७ ॥
तच्छेषगुणिता द्विष्ठाः शोध्याः खाभ्रेषुखाब्धितः ।
चतुर्थांशेन शेषस्य द्विष्ठमन्त्यफलं हतम् ॥ १८ ॥
बाहुकोट्योः फलं कृत्स्नं क्रमोत्क्रमगुणस्य वा ।
लभ्यते चन्द्रतीक्ष्णांश्वोस्ताराणां वापि तत्त्वतः ॥ १९ ॥

(*Mahābhāskarīya*, VII, 17–19)

Bhaskara's Formula for Sine in Modern Notation:

$$\sin(x) \approx \frac{16x(\pi - x)}{5\pi^2 - 4x(\pi - x)}$$



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6:D.R.KAPREKAR:-

- DatJanuaryBombay andra Kaprekar (Marathi: दत्तात्रेय रामचंद्र कापरेकर; 17 January 1905 – 1986) was an Indian recreational mathematician who described several classes of natural numbers including the Kaprekar, harshad and self numbers and discovered the Kaprekar's constant, named after him. Despite having no formal postgraduate training and working as a schoolteacher, he published extensively and became well known in recreational mathematics circles.
- **Born**:17 january *1905* , Dahaanu bomabay presidency,Indian.
- **Died**: 1986 (Devalali, Maharashtra)
- **Occupation:** School Teacher.
- **Known for:** Contribution to recreational mathematics.

Kaprekar's work on partitioning numbers has important implications for number theory, and has led to further research in the field. He has also contributed to the field of recreational mathematics, and his work continues to inspire and fascinate mathematicians today.

Kaprekar passed away on June 17, 1986, but his contributions to mathematics will be forever remembered. His work on Kaprekar constant and Kaprekar numbers are still studied by mathematicians and students. He had also published several papers in mathematical journals, and his work continues to be referenced in mathematical literature. Kaprekar's legacy is one of innovation and discovery, and his contributions to mathematics will be remembered for years to come.

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KAPREKAR NUMBER:-

- Another class of numbers Kaprekar described are Kaprekar numbers.[9] A Kaprekar number is a positive integer with the property that if it is squared, then its representation can be partitioned into two positive integer parts whose sum is equal to the original number (e.g. 45, since 452=2025, and 20+25=45, also 9, 55, 99 etc.) However, note the restriction that the two numbers are positive; for example, 100 is not a Kaprekar number even though 1002=10000, and 100+00 = 100. This operation, of taking the rightmost digits of a square, and adding it to the integer formed by the leftmost digits, is known as the Kaprekar operation.
- Some examples of Kaprekar numbers in base 10, besides the numbers 9, 99, 999, ..., are (sequence A006886 in the OEIS)

Number	Square	Decomposition
703	$703^2 = 494209$	419+209= 703
2728	$2728^2 = 7441984$	744+1984= 2728

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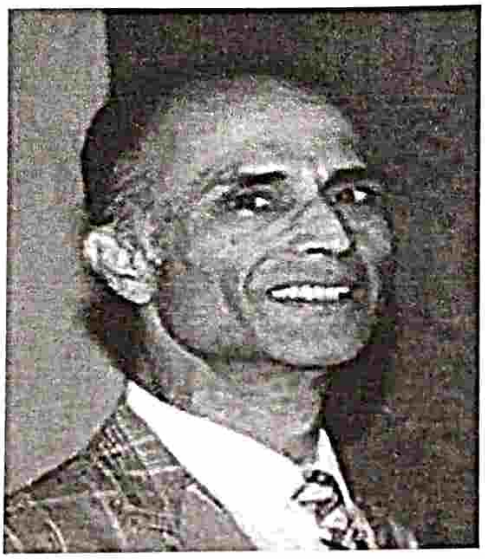
7:HARISH-CHANDRA:-



- Harish-Chandra Mehrotra. (11 October 1923 – 16 October 1983) was an Indian-American mathematician and physicist who did fundamental work in representation theory, especially harmonic analysis on semisimple Lie groups.
- **Born:-**11 October 1923 Kanpur,British Indian.
- **Died:-**16 October 1983 (aged 60)
- **Citizenship:-**United states
- **Known for:-**
- Harish-Chandra's c-function
- Harish-Chandra's character formula
- Harish-Chandra homomorphism
- Harish-Chandra isomorphism
- Harish-Chandra module
- He received his doctorate in physics during his time at the University of Cambridge, under the direction of Paul Dirac — also a Nobel Prize winner in Physics, in 1933 — but, upon completing it, he decided to change his research topic to mathematics. This transfer between disciplines is more common than you might think. Fundamental physics, since the middle of the 20th century, needs increasingly advanced mathematics to be formalized, which is why many physicists who are approaching the frontier of mathematical research decide to go one step further and modify their specialization

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CONTRIBUTION TO THE MATHEMATICS:-

Harish-chandra's function:-

- In mathematics, Harish-Chandra's c-function is a function related to the intertwining operator between two principal series representations, that appears in the Plancherel measure for semisimple Lie groups. Harish-Chandra (1958a, 1958b) introduced a special case of it defined in terms of the asymptotic behavior of a zonal spherical function of a Lie group, and Harish-Chandra (1970) introduced a more general c-function called Harish-Chandra's (generalized) C-function. Gindikin and Karpelevich (1962, 1969) introduced the Gindikin–Karpelevich formula, a product formula for Harish-Chandra's c-function.
- In mathematics, the Weyl character formula in representation theory describes the characters of irreducible representations of compact Lie groups in terms of their highest weights.[1] It was proved by Hermann Weyl (1925, 1926a, 1926b). There is a closely related formula for the character of an irreducible representation of a semisimple Lie algebra.[2] In Weyl's approach to the representation theory of connected compact Lie groups, the proof of the character formula is a key step in proving that every dominant integral element actually arises as the highest weight of some irreducible representation.[3] Important consequences of the character

  formula are the Weyl dimension formula and the Kostant multiplicity formula.

• HARISH-CHANDRA'S CHARACTER FORMULA

- By defination , the character χ of a represention π of G is the trace of $\pi(g)$, as a function of group element $g \in G$. The irreducible represention in this case are all finite-dimension (this is part of the peter-way theorem); so the nation of trace is the usual one from linear algebra. Knowledge of the character χ of π gives a lot information about π itself.
- Among the most prestigious awards in the field of mathematics is the Frank Nelson Cole Prize given by the American Mathematical Society in recognition of notable research work in algebra that has been published in a recognized and peer-reviewed venue. In 1954, the prize was given to Indian mathematician Harish Chandra for his work - in particular for his paper on some applications of the universal enveloping algebra of a semisimple Lie.
- It was a complex piece of work, difficult for commoners to follow. But by linking algebra, analysis, geometry, and group theory, it became the cornerstone for much of the modern work in areas like differential geometry, mathematical physics and number theory.

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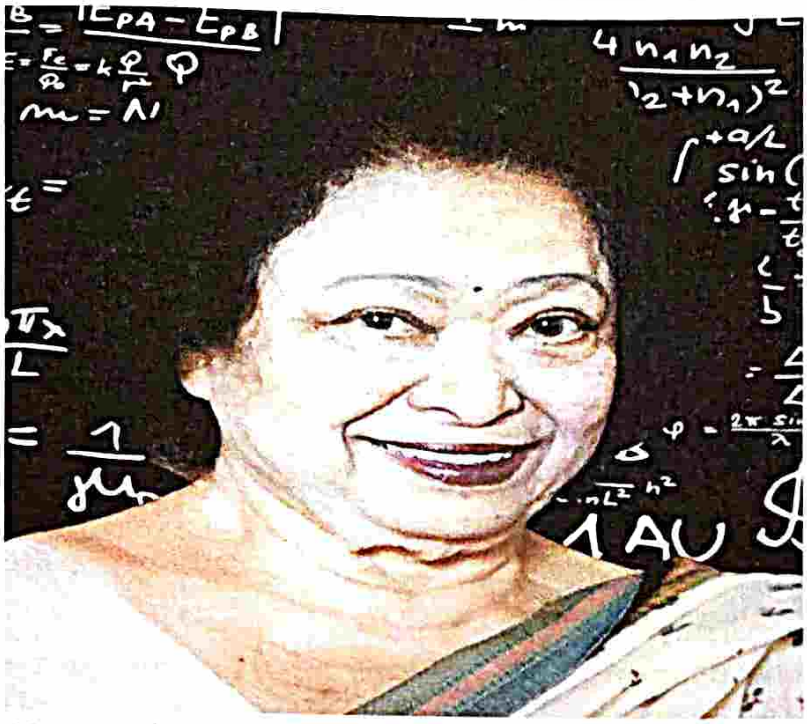
8:SHAKUNTALA DEVI:-



1. **Born** : 4 November 1929
   Bangalore, Kingdom of Mysore, British India (Now in Karnataka, India)
2. **Died** : 21 April 2013 (aged 83)
   Bengaluru, Karnataka, India
3. **Other names :** Human Computer
4. **Occupations :** Authormental calculatorastrologer
5. **Spouse** : Paritosh Banerj

-:CONTRIBUTION OF SHAKUNTALA DEVI IN MATHEMATICS:-

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- Early as five years of her age, the world could realize that she was a child prodigy. She was found to be an expert in highly complex mental arithmetic. Her passion to expand the human capacity made her develop the concept known as 'Mind Dynamics'.
- The most unique book she authored

She had a soft heart towards homosexuals. She treated homosexuality in a positive vein and wrote a book titled The World of Homosexuals, which is the first ever book on homosexuality in India. She argued that all people exhibit different sexual tendencies and orientations at different times and there is nothing called homosexuality or hetero sexuality in the world. She has also authored a number of books on astrology and cooking

-:MENTAL CALCULATOR:-

at the University of California, Berkeley. Jensen tested her performance at several tasks, including the calculation of large numbers. Examples of the problems presented to Devi included calculating the cube root of 61,629,875 and the seventh root of 170,859,375.[5][15] Jensen reported that Devi provided the solution to the above-mentioned problems (395 and 1Devi travelled to several countries around the world demonstrating her arithmetic talents. She was on a tour of Europe throughout 1950 and was in New York City in 1976.[4] In 1988, she travelled to the US to have her abilities studied by Arthur Jensen, a professor of educational psychology 5, respectively) before Jensen could copy them down in his notebook.[5][15] Jensen published his findings in the academic journal Intelligence in 1990.[5][15][16]
In 1977, at Southern Methodist University, she gave the 23rd root of a 201-digit number in 50 seconds.[10][15] Her answer, which was 546,372,891, was confirmed by calculations done at the US Bureau of Standards by the UNIVAC 1101 computer, for which a special program had to be written to perform such a large calculation, which took a longer time than for her to do the same.

-:feats of Shakuntala Devi and her contribution to maths:-

-:Some of the feats of Shakuntala Devi include:-

In Dallas at Sothern Methodist College, she calculated the 23rd cube root of 201 digit number in 50 seconds giving the answer 546,372,891 in comparison to a UNIVAC 1101 computer which took more time to around 12 more seconds to do the same calculation.
At Imperial College London, 1980 she multiplied 7686369774870 and 2465099745779 calculating the 26 digit answer in 28 seconds. She holds Guinness Book of World Record for this fastest human computation.
At Stanford University US, 1988,

- She calculated cube root of 95443993 as 457 in 2 seconds
- She calculated cube root of 2373927704 as 1334 in 10 seconds
- She calculated the 8th root of 20047612231936 as 46 in 10 seconds

As per New York Times "She could give you the cube root of 188,132,517 — or almost any other number — in the time it took to ask the question. If you gave her any date in the last century, she would tell you what day of the week it fell on"

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- **Writings/ Selected Works of Shakuntala Devi:-**

- Mathability: Awaken the Math Genius in Your Child
- More Puzzles to Puzzle
- Astrology for You
- Book of Numbers
- Figuring: The Joy of Numbers
- In the Wonderland of Numbers
- Perfect Murder
- Puzzles to Puzzle You
- Super Memory: It Can Be Yours

- **Interesting facts about Shakuntala Devi:-**

- **She never liked the title – Human-Computer.**
- This title was given to her when she appeared in an interview with BBC Channel. This show was hosted by Leslie Mitchell on October 5, 1950. The channel had asked a very difficult question to her to which she replied correctly. But the channel was not having the same answer and hence they described the answer incorrect. However, when they checked it later, the answer was absolutely correct as given by Shakuntala Devi. Thereby she got the title as Human-Computer and became a household name.
- **She did not receive any formal schooling**
- . She belonged to a poor family and her parents could not pay the school fee because of which she could not complete the school studies.
- **She was honored in 2013 with a Google Doodle.**
- This was done on 84 birth anniversary.
- **Writing of Books**
- She had written a book" Figuring – A joy of numbers" still under print.
- **Study of her Abilities**
- Arthur Jenson, who was a professor of educational psychology studied Shakuntala Devi's abilities in 1988.
- **Lok Sabha Elections**
- **She fought Lok Sabha elections in 1980 against Indra Gandhi**. According to an article in New York Times, she as an independent candidate had fought from Mumbai and Medak but she lost the elections and came to 9th position.

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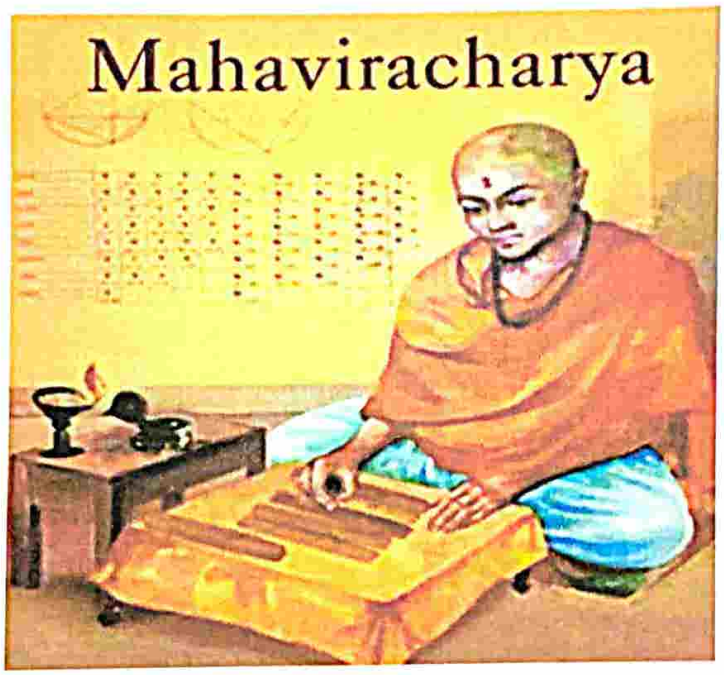
9:MahavIra or mahaviracharya:-



*** Mahāvīra (or Mahaviracharya, "Mahavira the Teacher") was a 9th-century Indian Jain mathematician possibly born in Mysore, in India.[1][2][3] He authored Gaṇita-sāra-saṅgraha (Ganita Sara Sangraha) or the Compendium on the gist of Mathematics in 850 CE.[4] He was patronised by the Rashtrakuta emperor Amoghavarsha.[4] He separated astrology from mathematics. It is the earliest Indian text entirely devoted to mathematics.**

-:CONTRIBUTION:-

He discovered algebraic identities like $a^3 = a\,(a + b)\,(a - b) + b^2\,(a - b) + b^3$.[3]
He also found out the formula for ${}^nC_r$ as
$[n\,(n - 1)\,(n - 2)\,\ldots\,(n - r + 1)]\,/\,[r\,(r - 1)\,(r - 2)\,\ldots\,2 * 1]$.[10] He devised a formula which approximated the area and perimeters of ellipses and found methods to calculate the square of a number and cube roots of a number.
He asserted that the square root of a negative number does not exist.[12] Arithmetic operations utilized in his works like Gaṇita-sāra-saṅgraha(Ganita Sara Sangraha) uses decimal place-value system and include the use of zero. However, he erroneously states that a number divided by zero remains unchanged.[13]

Rules for decomposing fractions

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-:The only known book by Mahavira is Ganita Sara Samgraha ,it consists of 9 chapters :-

1.Terminology
2. Arithmetical operations
3. Operations involving fractions
4. Miscellaneous operations
5. Operations involving the rule of three
6. Mixed operations
7. Operations relating to the calculations of areas
8. Operations relating to excavations
9. Operations relating to shadows

-:Mahavira in his '*Ganitsarasangraha*' has given the general formula for combination:-

* in Mathematics, Combination (nCr) is a selection of items from a collection. The formula is as follows:

nCr = n(n−1)(n−2).....(n−r+1) / r(r−1)(r−2) .....2·1

His book, '*Ganitsarasangraha*' contains rules for adding fractions of unequal denominators by finding *niruddha* or L.C.M (least common multiple).

This book gives the rule for area and circumference of *Ayatavritta* (elongated circle, similar to ellipse), which is one of the most complicated calculations of mathematics. According to him, area of an ellipse is √(πa^2×πb^2)=πab and the circumference is 2√((6b^2+4a^2)), where *a* is the major axis and *b* is the minor axis. Though this formula for circumference does not give accurate value but it has too much importance. Later many Mathematicians gave many formulae for finding the circumference, but only Ramanujan's formula using calculus gives the most accurate value.

He enumerated six types of fractions and the use of unit fractions is one of the unique contributions of Mahavira and is illustrated in his book. He also found methods to calculate the square root of a number and cube root of a number. He asserted that the square root of a negative number did not exist because it is not a square root of any real number.

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-:Rules for decomposing fractions:-

- Mahāvīra's *Gaṇita-sāra-saṅgraha* gave systematic rules for expressing a fraction as the sum of unit fractions.[14] This follows the use of unit fractions in Indian mathematics in the Vedic period, and the Śulba Sūtras' giving an approximation of √2 equivalent to $1 + 1\,3 + 1\,3 \cdot 4 - 1\,3 \cdot 4 \cdot 34$.[14]
- In the *Gaṇita-sāra-saṅgraha* (GSS), the second section of the chapter on arithmetic is named *kalā-savarṇa-vyavahāra* (lit. "the operation of the reduction of fractions"). In this, the *bhāgajāti* section (verses 55–98) gives rules for the following:[14]
- To express 1 as the sum of *n* unit fractions (GSS *kalāsavarṇa* 75, examples in 76):[14]
- rūpāṃśakarāśīnāṃ rūpādyās triguṇitā harāḥ kramaśaḥ / dvidvitryaṃśābhyastāv ādimacaramau phale rūpe //
- When the result is one, the denominators of the quantities having one as numerators are [the numbers] beginning with one and multiplied by three, in order. The first and the last are multiplied by two and two-thirds [respectively].
- $1 = 1\,1 \cdot 2 + 1\,3 + 1\,3\,2 + \cdots + 1\,3\,n-2 + 1\,2\,3 \cdot 3\,n-1$ To express 1 as the sum of an odd number of unit fractions (GSS *kalāsavarṇa* 77):[14]
- $1 = 1\,2 \cdot 3 \cdot 1/2 + 1\,3 \cdot 4 \cdot 1/2 + \cdots + 1\,(2n-1) \cdot 2n \cdot 1/2 + 1\,2n \cdot 1/2$ To express a unit fraction 1 / q as the sum of *n* other fractions with given numerators $a_1, a_2, \ldots, a_n$ (GSS *kalāsavarṇa* 78, examples in 79):
- $1\,q = a_1\,q\,(q + a_1) + a_2\,(q + a_1)\,(q + a_1 + a_2) + \cdots + a_{n-1}\,(q + a_1 + \cdots + a_{n-2})\,(q + a_1 + \cdots + a_{n-1}) + a_n\,a_n\,(q + a_1 + \cdots + a_{n-1})$ To express any fraction p / q as a sum of unit fractions (GSS *kalāsavarṇa* 80, examples in 81):[14]
- Choose an integer *i* such that q + i p is an integer *r*, then write $p\,q = 1\,r + i\,r \cdot q$ and repeat the process for the second term, recursively. (Note that if *i* is always chosen to be the *smallest* such integer, this is identical to the greedy algorithm for Egyptian fractions.) To express a unit fraction as the sum of two other unit fractions (GSS *kalāsavarṇa* 85, example in 86):[14]
- $1\,n = 1\,p \cdot n + 1\,p \cdot n\,n-1$ where p is to be chosen such that $p \cdot n\,n-1$ is an integer (for which p must be a multiple of $n-1$). $1\,a \cdot b = 1\,a\,(a + b) + 1\,b\,(a + b)$ To express a fraction p / q as the sum of two other fractions with given numerators a and b (GSS *kalāsavarṇa* 87, example in 88):[14]
- $p\,q = a\,a\,i + b\,p \cdot q\,i + b\,a\,i + b\,p \cdot q\,i \cdot i$ where i is to be chosen such that p divides a i + b Some further rules were given in the *Gaṇita-kaumudi* of Nārāyaṇa in the 14th century.[14]

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10:DINANATH ATAMARA DALVI:-

Dinanath atmaram dalvi

Born	c. 1844
Died	February 1897 Place Bombay
Nationality	British Indian
Alma mater	Elphinstone College
Occupations	•Judge •Mathematician

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He systematically examined Newton's rule for finding the number of imaginary roots and In 1869 he wrote and published a book entitled "An Examination of Sir Isaac Newton's Rule for finding the Number of Imaginary Square Roots in an Equation", in which he provides mechanical and geometric theorems and gives a direct and ...

-:CONTRUBUTION:-

He systematically examined Newton's rule for finding the number of imaginary roots and in 1869 he wrote and published a book entitled *"An Examination of Sir Isaac Newton's Rule for finding the Number of Imaginary Square Roots in an Equation"*, in which he provides mechanical and geometric theorems and gives a direct and complete proof and disproof of the equation. He does not use equations or particular classes of equations but uses direct method of algebraic inequalities to show the failure of Newtons law. He thus established a Rule for forming equation of failure of Newtons rule and came to a conclusion that the rule may not be universally true and that there may be imaginary roots where there are none. He was challenged on this with various articles for and against him in The Times of India. One of his critics while writing to the Editor pointed out that in 1669, when Sir Isaac Newton was Lucasian Professor of Mathematics, he used to jot down portions of his lectures, definitions, propositions, examples partially wrought out as were necessary. In such a manuscript never intended for publication much would have been omitted which he could supply or vary as needed and such a rule for finding square roots of imaginary numbers was just one of it, which he was likely to omit. Professor Colin McLaurin of the McLaurin series, James Stirling famous for Stirling permutations who had proved the correctness of Newton's classification of cubic plane curves supplied demonstrations and analysis of this rule.

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11:GANESH PRASAD:-

- Professor of MathemBorn15 November 1876
  Ballia, Uttar Pradesh, India
- Died9 March 1935 (aged 58)
  Agra, Uttar Pradesh, India
- NationalityIndianAlma materUniversity of Allahabad, University of Calcutta, University of Cambridge,
- University of Göttingen Known forEstablishing the culture of organised mathematical research in IndiaNotable work*A Treatise on Spherical Harmonics and the Functions of Bessel and Lame*TitleHardinge atics
- Ganesh Prasad
- Born15 November 1876
  Ballia, Uttar Pradesh, India
- Died9 March 1935 (aged 58)
  Agra, Uttar Pradesh, India
- NationalityIndianAlma materUniversity of Allahabad, University of Calcutta, University of Cambridge,
- University of Göttingen Known forEstablishing the culture of organised mathematical research in IndiaNotable work*A Treatise on Spherical Harmonics and the Functions of Bessel and Lame*TitleHardinge Professor of Mathematics

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Early days:-

- Ganesh Prasad was born on 15 November 1876 at Ballia, Uttar Pradesh. He obtained the B.A. degree from Muir Central College, Allahabad, M.A. degree from the Universities in Allahabad and Calcutta and the D.Sc. degree from Allahabad University. After teaching at the Kayasth Pathshala, Allahabad, and at the Muir Central College, Allahabad, for about two years, he proceeded to Cambridge for higher studies and research. While at Cambridge he became acquainted with mathematicians like E.W. Hobson and Andrew Forsyth. He also sat, though unsuccessfully, for the Adams prize competition.
- Later he moved to Göttingen where he was associated with Arnold Sommerfeld, David Hilbert and Georg Cantor. In Göttingen, Prasad showed his paper titled *On the constitution of matter and the analytical theories of heat*, the one he had submitted for the Adams prize competition, to Felix Klein, who appreciated it very much and arranged its publication in the Göttingen Abhandlungen. Ganesh Prasad spent altogether about five years in Europe.

Mathematical career:-

- Prasad returned to India from Europe in 1904 and was appointed professor of mathematics at the Muir Central College, Allahabad. Within a year of his appointment at Allahabad, Prasad was sent to the Queen's College, Banaras and he continued there till 1914 when he was invited to head the mathematics department of Calcutta University. Ganesh Prasad was the Ras Behari Ghosh Chair of Applied Mathematics of Calcutta University (he was the first person to occupy this Chair[3]) from 1914 to 1917 and Hardinge Professor of Mathematics in the same University from 1923 till his death on 9 March 1935. In between these two assignments he served Banaras Hindu University as professor of mathematics (1917–1923). While at Banaras, he helped found the Banaras Mathematical Society. Ganesh Prasad was elected President of the Calcutta Mathematical Society and the Vice-President of the Indian Association for Advancement of Science, Calcutta in 1924 and continued in the same position till his death. He was a founder member of the National Institute of Sciences, India, which has now been rechristened as the Indian National Science Academy. Ganesh Prasad authored 11 books including ***"A Treatise on Spherical Harmonics and the Functions of Bessel and Lame"*** and over fifty research papers in mathematics.

Other areas of work:-

- Ganesh Prasad worked hard for the promotion of education in general in the rural areas of Uttar Pradesh. He was instrumental in the introduction of compulsory primary education in villages in Uttar Pradesh. He donated from his private savings an amount of Rs. 22,000 for the education of girls in Ballia. He also donated an amount of Rupees two hundred thousand for establishing prizes for the toppers at the M.A. and MSc examinations of the Agra University. He donated large amounts of money to the Allahabad and Banaras Universities also.

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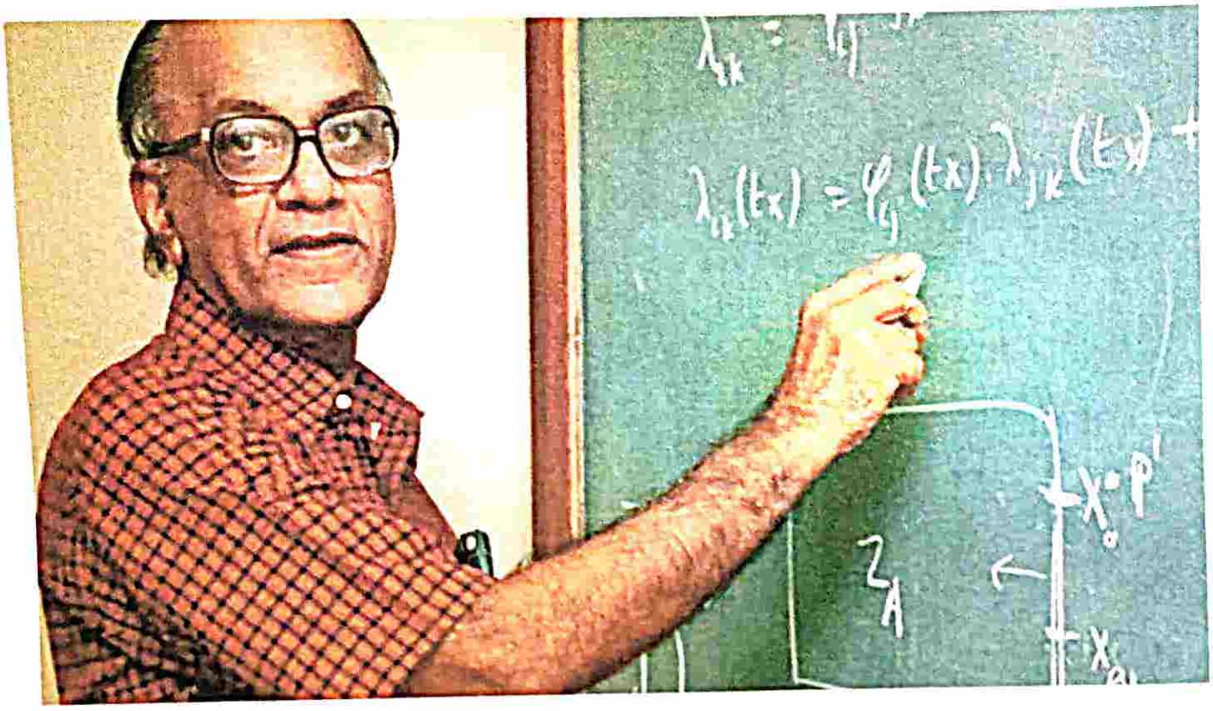
12:C.S.SESHADRI:-



Conjeevaram Srirangachari Seadri [1]FRS (29 February 1932 – 17 July 2020) was an Indian mathematician.[2] He was the founder and director-emeritus of the Chennai Mathematical Institute, and is known for his work in algebraic geometry.[3] The Seshadri constant is named after him. He was also known for his collaboration with mathematician M. S. Narasimhan, for their proof of the Narasimhan–Seshadri theorem which proved the necessary conditions for stable vector bundles on a Riemann surface.

He was a recipient of the Padma Bhushan in 2009, the third highest civilian honor in the country.

Degrees and posts

Seshadri was born into a Hindu Brahmin family in Kanchipuram, Tamil Nadu.[5] He received his B.A. (Hons) degree in mathematics from Madras University in 1953 and was mentored by the Jesuit priest Fr. Charles Racine and S. Naryanan there.[6][7] He completed his PhD from Bombay University in 1958 under the supervision of K. S. Chandrasekharan.[8] He was elected Fellow of the Indian Academy of Sciences in 1971.

Degrees and posts

Seshadri was born into a Hindu Brahmin family in Kanchipuram, Tamil Nadu.[5] He received his B.A. (Hons) degree in mathematics from Madras University in 1953 and was mentored by the Jesuit priest Fr. Charles Racine and S. Naryanan there.[6][7] He completed his PhD from Bombay University in 1958 under the supervision of K. S. Chandrasekharan.[8] He was elected Fellow of the Indian Academy of Sciences in 1971.[9]

Seshadri worked in the School of Mathematics at the Tata Institute of Fundamental Research in Bombay from 1953 to 1984 starting as a Research Scholar and rising to a senior professor. From 1984 to 1989, he worked at the Institute of Mathematical Sciences, Chennai. From 1989 to 2010,.

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Accredited at 'B^{++}'Level by NAAC

DEPARTMENT OF CHEMISTRY

A Project Report On

"ANALYSIS OF CALCIUM CONTENT IN EGGSHELL & MILK SAMPLES BY SIMPLE TITRIMETRIC METHOD"

Submitted by

Deepa Desai	-U15CH21S0002
Shilpa Shekhanavar	-U15CH21S0006
Ashwini Madig	-U15CH21S0010
Veena Narasannavar	-U15CH21S0012
Jayalaxmi Kakoli	-U15CH21S0025

B.Sc VI sem

Under the Guidance of

Dr. Vijayalakshmi Edalli

Department of Chemistry

S.S Arts College & T.P Science Institute, Sankeshwar.

S.S Arts College & T.P. Science Institute SANKESHWAR 591313

2023-24

S.D.V.S Sangh's

S.S Arts College & T.P Science Institute, Sankeshwar

DEPARTMENT OF CHEMISTRY

S. S. Art's College & T.P. Science Institute * Sankeshwar * Dept. of Chemistry

CERTIFICATE

This is to certify that the project work entitled **"ANALYSIS OF CALCIUM CONTENT IN EGGSHELL & MILK SAMPLES BY SIMPLE TITRIMETRIC METHOD"** submitted by Deepa Desai, Shilpa Shekhanavar, Jayalaxmi Kakoli, Ashwini Madig & Veena Narasannavar, of BSc VI semester is a record of project work carried out at S.S Arts College & T.P science Institute, Sankeshwar, during the academic year 2023-24.

14/08/24

GUIDE

14/08/24

HOD

Head of The Chemistry Department

Approved and submitted to Department of Chemistry

S. S. Arts College & T. P. Science Institute * SANKESHWAR. 591313

Principal

PRINCIPAL
S.S Arts College & T. P. Science Institute
SANKESHWAR.

DECLARATION

We hereby declare that the matter embodied in this project report entitled "ANALYSIS OF CALCIUM CONTENT IN EGGSHELL & MILK SAMPLES BY SIMPLE TITRIMETRIC METHOD" is the result of the work carried out by us at S.S Arts College & T.P Science Institute, Sankeshwar under the guidance **Dr. Vijaylakshmi Edalli,** HOD, Department of Chemistry, S. S Arts College & T. P. Science Institute Sankeshwar.

We further declare that the work reported in this dissertation is proprietary work at the college and we shall not publish this work elsewhere for any other purpose.

Place: Sankeshwar

BSc VI sem students

Deepa Desai	U15CH21S0002	D.M.Desai
Shilpa Shekhanavar	U15CH21S0006	Shilpa
Ashwini Madig	U15CH21S0010	Madig
Veena Narasannavar	U15CH21S0012	Veena
Jayalaxmi Kakoli	U15CH21S0025	Jskakoli

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Anything that ends without gratefulness will not help anyone to grow. Hence, it will be meaningless if we forgot to thank all those who have helped us.

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I am very thankful to **Dr. Vijaylakshmi. A. Edalli** , HOD, and all the teaching faculty **Dr. Honnur Krishna, Miss Anusuya Mahalingpur** and **Miss Shivani Sutar** of department of chemistry.

We also thankful to Department of Mathematics for providing computer facilities for the project work.

We thank all teaching faculty, in **S. S. Arts College T. P. Science Institute, Sankeshwar,** for providing us to well guidance, support and Laboratory facilities for completion of our Project.

We also thank non teaching faculty, Shri Shankar and Smt. Prabhavati for their support and assistant to carry out the project work.

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Place: Sankeshwar

Date:

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ANALYSIS OF CALCIUM CONTENT IN EGGSHELL & MILK SAMPLES BY SIMPLE TITRIMETRIC METHOD

INTRODUCTION

Calcium, an essential mineral for humans supplied through the diet, is mainly present in bone and teeth being involved in several biological processes (Burrow, Young, McConnell, Carne, & Bekhit, 2018). Body requirements for bone development and maintenance vary throughout life, resulting higher during childhood/adolescence, pregnancy/lactation, and in the elderly (Kruger, Awan, Poulsen, & Kuhn-Sherlock, 2017). "Calcium is a nutrient that all living organisms need, including humans. Dietary sources of calcium include dairy products, green leafy vegetables, nuts, seeds, and fortified products". Calcium is the most abundant mineral in the body. Humans need calcium to build and maintain strong bones, and 99% Trusted Source of the body's calcium is in the bones and teeth. It is also necessary for maintaining healthy communication between the brain and other parts of the body. It plays a role in muscle movement and cardiovascular function. Alongside calcium, people also need vitamin D, as this vitamin helps the body absorb calcium. Vitamin D comes from fish oil, fortified dairy products, and exposure to sunlight. Calcium rich food are Dried beans (Soya beans, kindly beans, navy beans, etc.), dairy products (milk, butter milk, low fat yogurt, cheddar cheese, etc.), green leafy vegetables (broccoli, turnip greens, collards, dandelion greens) and other sources like bones, meat, carrots, okra, blackstrap molasses etc.

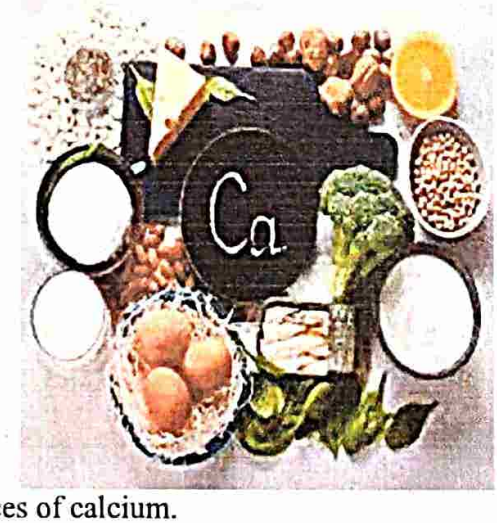

Figure 1: Different sources of calcium.

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Calcium content in milk

Bovine milk and dairy products are the main food group contributing to calcium intake in humans' diet. Cheese represents the main source of calcium in the elderly, whereas milk-based infant formulas (MIF) are the prevailing alternative to breast-feeding during infancy. The knowledge of the amount of this essential mineral in such complex matrices is a major concern to several areas such as health, quality control and research (Masotti et al., 2020)

Calcium exists in two main forms in milk. Roughly 66 % is present as colloidal calcium phosphate (CCP), where the calcium ion is ionically bound to phosphate that is in turn covalently linked to caseins at a number of serine residues. The rest is present as free calcium ion, ionically balanced with phosphate, chloride, carbonate, bicarbonate, sulphate and citrate. However, the proportion of calcium as CCP and free ions varies from the 2:1 ratio in response to changes in overall concentration of calcium in milk, temperature, ionic strength, pH and the origins of the milk (diet, breed, time of year) (Fox and McSweeney, 1998). Different milk processing methods such as ultrafiltration (UF) of milk, yoghurt and cheese manufacturing, can affect the amount of calcium in the final product. Milk is principally comprised of about 3.2 % protein, 4.6 % carbohydrate (as lactose), 3.9 % fat, 0.2 % ash and rest water. It also contains organic acids such as citrate, and a range of vitamins that do not fit conveniently into the four major categories.

In milk, proteins do not exist as individual molecules. Caseins, together with phosphate, calcium and traces of citrate form structures called casein micelles. Calcium content in milk and dairy products varies of approximately, ranging on average from 180 mg kg-1 in butter to 12800 mg kg-1 in skim milk powder (SMP).The wide variability observed in milk is explained by several factors, including breed, feeding system, stage of lactation, cows' nutritional and health status and, to a less extent, by season (Akkerman et al., 2019). Cheese is recognized as a rich source of bioavailable calcium, with most hard varieties containing approximately 8000 mg calcium kg-1 and up to 12000 mg kg-1 in Parmesan type cheeses. In comparison to rennet coagulated cheeses, sour varieties contain about tenfold lower amounts of calcium due to the solubilisation of colloidal calcium phosphate. Also commercial MIF are characterized by variable calcium contents as a function of the recipe used by manufacturers who have to fulfil with both requirements laid down at national level and with minimum and maximum levels reported by EU Commission, i.e., 50 mg and 140 mg of calcium per 100 kcal, respectively (EU

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Regulation, 2019). These threshold levels were set up to meet nutritional requirements of infants and on the basis of an established history of apparent safe use.

Egg shells and Calcium content

Hen eggshell typically consists of ceramic materials constituted by a three-layered structure, namely the cuticle on the outer surface, a spongy (calcareous) layer and an inner lamellar (or mammillary) layer (Stadelman, 2000). The spongy and mammillary layers form a matrix composed of protein fibers bonded to calcite (calcium carbonate) crystal. The two layers are also constructed in such a manner that there are numerous circular openings (pores). This structure permits gaseous exchange throughout the shell. The outer surface of the eggshell is covered with a mucin protein that acts as a soluble plug for the pores in the shell. The cuticle is also permeable to gas transmission. The chemical composition (by weight) of by-product eggshell has been reported as follows: calcium carbonate (94%), magnesium carbonate (1%), calcium phosphate (1%) and organic matter (4%) (Stadelman, 2000). Notably, the by-product eggshell generated from food processing and manufacturing plants is inevitably composed of calcium carbonate (eggshell) and eggshell membrane (ESM).

Major minerals	$mg.L^{-1}$	Minor minerals	$mg.L^{-1}$
Potassium	1,500	Zinc	4,000
Calcium	1,200	Aluminium	500
Sodium	500	Iron	400
Magnesium	120	Copper	120
Phosphate	3,000	Molybdenum	60
Chloride	1,000	Manganese	30
Sulphate	100	Nickel	25
		Silicon	1,500
		Bromine	1,200
		Boron	200
		Fluorine	150
		Iodine	60

Table 1: Different mineral composition of milk sample.

The textural structure examination of eggshell and eggshell membrane particles can be observed from the SEM photographs as shown below.

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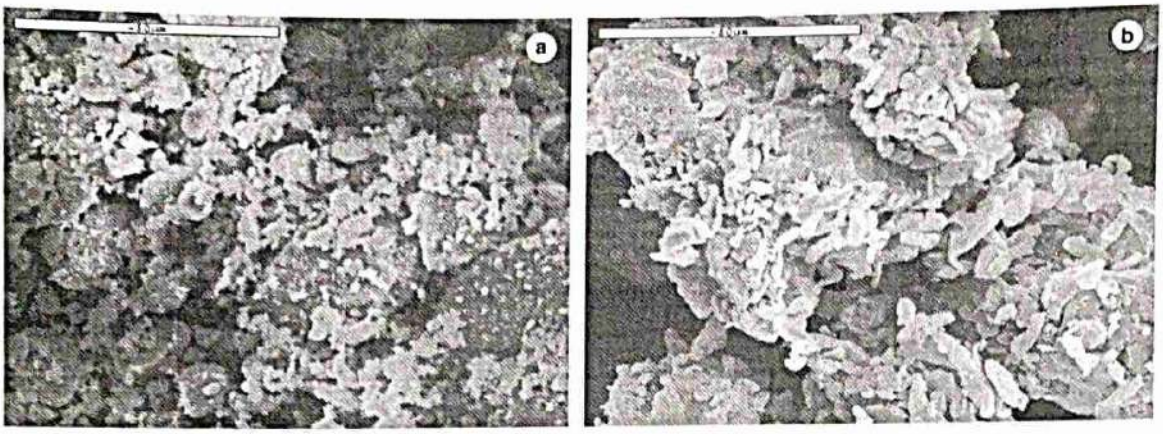

Figure 2: SEM images of (a) eggshell, and (b) eggshell membrane particles.

The chemical functional groups from the FTIR data present in the eggshells and eggshell membrane samples is as shown below in the figure;

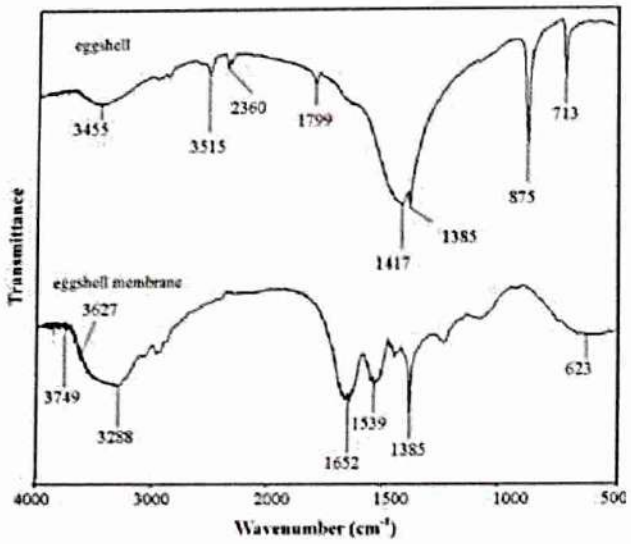

Figure 3: FTIR spectra of eggshell and eggshell membrane particles

Analytical methods for calcium determination

Through years, laboratory methods for calcium measurement have evolved into instrumental techniques, which brought to significant enhancements in analytical performances and sample throughput. (Masotti et al., 2020). Various methods are developed to determine the concentration of calcium such as titrimetric method, precipitation method, electrochemical method like voltammetry, potentiometric method, colorimetric methods, spectrophotometric methods, spectroflourimetric method, ion selective method, ICPMS, X-ray fluorescence techniques, Laser induced breakdown spectroscopy, gravimetry, capillary electrophoresis, AAS, etc.

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Atomic absorption spectrometry (AAS)

Basic principles of atomic absorption spectrometry (AAS), instrumentation components as well as applications in the food analysis have been overviewed in the literature (López-García & Hernández-Córdoba, 2015). This technique has been used since the end of the 20th century for mineral and trace mineral analysis (Fernandez, Lobo, & Pereiro, 2019) being advantaged for (i) simple instrumental arrangement, (ii) high selectivity and specificity, (iii) reduced spectral interference and (iv) robustness of atomizers (Machado et al., 2020). Anyway, by AAS the measurement of a single analyte at a time is possible. Main variants of AAS, classified as a function of the type of atomizer, include flame AAS (FAAS) and ET-AAS, the latter having an electro-thermal graphite furnace replacing the flame/burner arrangement. ET-AAS has been mainly adopted for trace mineral determination, due to its sensitiveness at ppb levels (i.e., up to two orders of magnitude lower than FAAS)

Flame atomic absorption spectrometry

FAAS is a popular technique applied extensively for measuring minerals in different food matrices due to its relative simplicity (López-García & Hernández-Córdoba, 2015). It is the least expensive and most suitable for the determination of calcium and other macro-minerals among atomic spectrometric techniques. To overcome chemical interferences (mainly phosphates) in the determination of calcium, the sample is usually supplemented with lanthanum as a releasing agent (matrix modifier). Through FAAS, liquid samples are easily introduced as aerosols into the analyzer after a preliminar treatment by conventional ashing or wet digestion. To increase the sample throughput rate, digestion with pressure control and MAWD is often recommended (Sola-Larrañaga & Navarro-Blasco, 2009)

Atomic emission spectrometry

In atomic emission spectrometry (AES), analyte atoms in solution are aspirated into an excitation area, where they are desolvated, vaporized and free atoms are created under high temperature by different atomization sources (mostly flame or plasma). The excited atoms from high-energy levels decay back to lower levels by emitting light. The analyte concentration is determined by the spectrometric measurement of the emitted photons.

Among these techniques, titrimetric method is considered to be the most suitable method because of its simplicity, reliable, reproducible, cost effective techniques, and rapid method. The

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following figure shows the different selection criteria for the choice of the analytical technique for calcium determination.

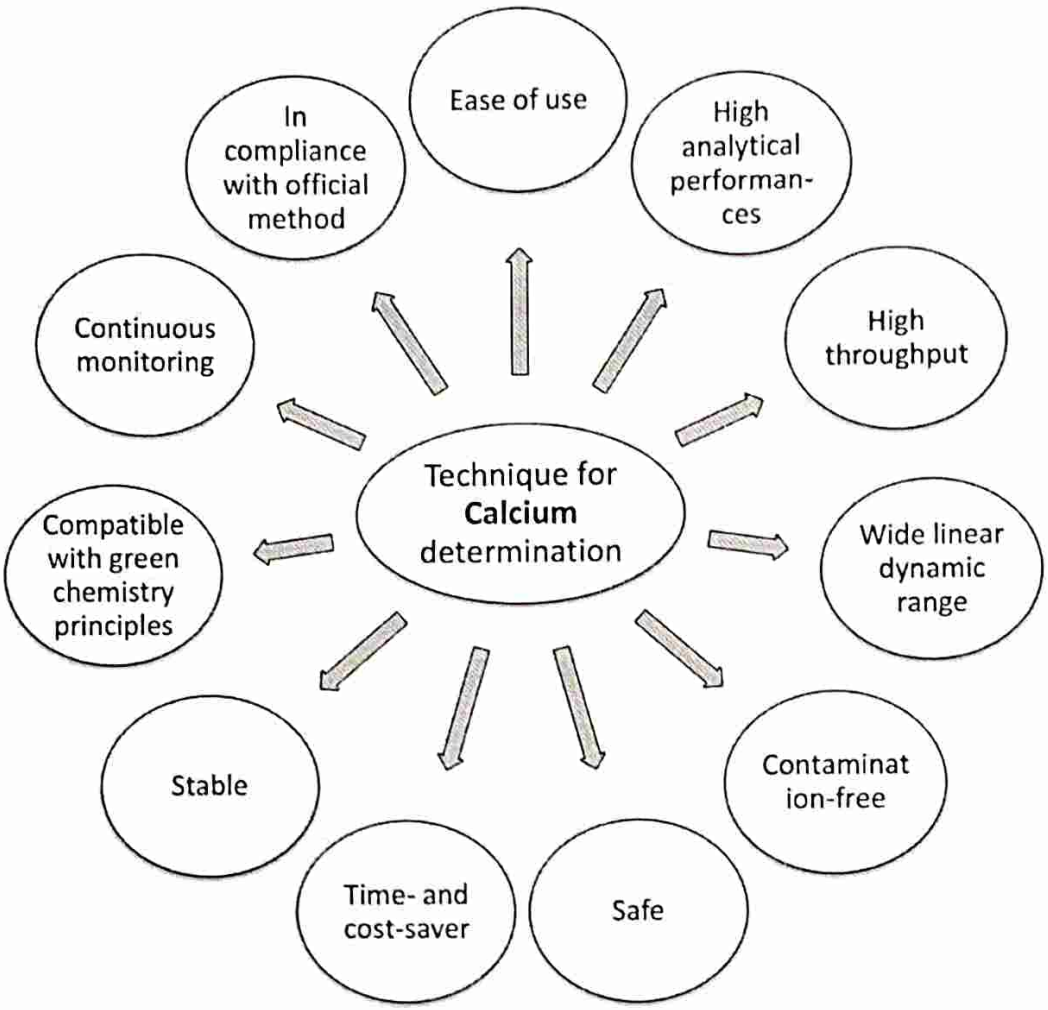

Figure 4: Selection criteria for the choice of the analytical technique for calcium determination in bovine milk, dairy products and milk-based infant formulas.

Titrimetry

Complexometric titration is one of the oldest techniques adopted for calcium determination in the analysis of milk. It has been mostly used for routine analysis of milk due to its simplicity and lower cost. This titration method consists in a preliminary step of protein precipitation by trichloroacetic acid and the subsequent precipitation of total calcium as oxalate followed by the separation of the calcium oxalate. Skilled titrations with potassium permanganate of the dissolved precipitate should provide results with repeatability (absolute difference between two single tests) lower than 0.002%. An alternative approach is based on

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precipitation of proteins by salicylic acid followed by calcium titration directly with ethylenediamine tetraacetic acid, in the presence of indicator palladiazo. These complexometric methods are single-analyte and no longer in use for routine application, being laborious and time-consuming (Alegría et al., 2010; Masotti et al., 2020).

Determination of calcium by precipitation as oxalate

Calcium is precipitated as the insoluble oxalate (Kirk and Sawyer, 1991, p. 32-33). The precipitate is solubilised with sulphuric acid and the oxalate is titrated with potassium permanganate. Although a cheap method, it involved ashing and various steps thus it was unsuitable as a rapid method.

Determination of calcium by calcium ion specific electrodes

The literature describes an ion selective field effect transistor (ISFET)-based calcium sensor (Bratov et al., 2000). This method is being used in medical and biological laboratories and also has a food industry application to control the calcium ion in cheese production. Research publications claim high accuracy and precision, but in industrial situation with relatively unskilled labour, data can often be unreliable (O.A Young, personnel communication) due to poor calibration, slow response time and electrode contamination.

Calcium determination by the EDTA method

EDTA is a dairy industry standard method for measuring calcium in liquid and powdered milks and was available from NZTM 3 Chemical Methods Manual. EDTA is widely used as a chelator and forms strong 1:1 complexes with most of the metal ions (Harris, 2003, p. 259). Method was trialled as a reference method.

Determination of calcium by a colorimetric method

Some spectrophotometric methods to determine calcium in different matrixes (Nyman and Ivaska, 1995; Tesfaldet et al., 2004; Stern and Lewis 1957) are available from literature. However in recent literature there is scant evidence for direct colorimetric methods applied to calcium determination in milk, other than one very old one by Stern and Lewis (1957). Though few methods were available in the literature involving direct colorimetric determinations, it was still a cheap and rapid option. The capital outlay can be less than $10,000 for rugged colorimeters or spectrophotometers, and the use of cheap disposable cuvettes was a further attraction.

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Clinical importance of calcium element in human beings:

Some of the key physiological roles of calcium in humans can be listed as follows;

- ✓ Calcium ions are present as phosphate in the bones of the both human beings and animals, these ions also play an important role in the muscle contraction.
- ✓ The malnutrition in children is mainly due to the deficiency of calcium ions.
- ✓ Both magnesium and calcium ions catalyze the formation of pyrophosphate linkages which control the various biological systems. The pyrophosphates undergo hydrolysis with the release of the energy. This process is controlled by calcium ions.
- ✓ Calcium ions assist in blood clotting. Calcium signaling proteins acts as intracellular messengers and metal ion activated protiens. Muscle movement is stimulated by calcium binding protein called Troponin C.
- ✓ Calmodulin protein roles include activating protein kinases that catalyze phosphyraltion of protein and activating NO synthase, an iron containing enzyme respond for generating intracellular signaling molecule nitric oxide.
- ✓ It plays an important role in regulating normal heart rhythms and nerve functions.

Individual	**Daily requirement (in mg)**
Adult	500
Children	1200
Pregnancy	1500
Old age	1500

Table 2: Daily requirement of the calcium content for human beings in different stages.

Calcium plays various roles in the body. These include the following:

Bone health

Around 99% of the calcium in the human body is in the bones and teeth. Calcium is essential for the development, growth, and maintenance of bone.

As children grow, calcium contributes to the development of their bones. After a person stops growing, calcium continues to help maintain the bones and slow down bone density loss, which is a natural part of the aging process.

Females who have already experienced menopause can lose bone density at a higher rate than males or younger people. They have a higher risk of developing osteoporosis, and a doctor may recommend calcium supplements.

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Muscle contraction

Calcium helps regulate muscle contraction. When a nerve stimulates a muscle, the body releases calcium. The calcium helps the proteins in muscle carry out the work of contraction. When the body pumps the calcium out of the muscle, the muscle will relax.

Cardiovascular system

Calcium plays a key role in blood clotting. The process of clotting is complex and has a number of steps. These involve a range of chemicals, including calcium. Calcium's role in muscle function includes Trusted Source maintaining the action of the heart muscle. Calcium relaxes the smooth muscle that surrounds blood vessels. Various studies have indicated a possible link between high consumption of calcium and lower blood pressure.

Vitamin D is also essential for bone health, and it helps the body absorb calcium.

Other roles

Calcium is a co-factor for many enzymes. Without calcium, some key enzymes cannot work efficiently.

Studies have also suggested that consuming enough calcium can result in:

- a lower risk of developing conditions involving high blood pressure during pregnancy
- lower blood pressure in young people
- lower blood pressure in those whose mothers who consumed enough calcium during pregnancy
- improved cholesterol values
- A lower risk of colorectal adenomas, a type of non-cancerous tumor.

In the present work, two simple analytical methods have been followed for the determination of calcium in milk samples (Buffalo and native cow) and egg shells (hybrid hen and native hen). One method is based on the reaction between calcium chloride and ammonium oxalate method which is a back titration method against standard potassium permanganate reagent. Second method is the simple complexometric titration of the reaction between calcium and EDTA as the chelating agent. Both the methods are used for the comparison of the results obtained for calcium determination.

Deficiency of calcium content:

The following conditions or lifestyle habits may result in low calcium levels, also known as hypocalcemia:

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- Over consumption of magnesium
- long-term use of laxatives
- prolonged use of some medicines, such as chemotherapy or corticosteroids
- lack of parathyroid hormone
- People who eat a lot of protein or sodium may excrete calcium.
- high consumption of caffeine, soda, or alcohol
- some surgical procedures, including removing the stomach
- kidney failure
- Vitamin D deficiency & phosphate deficiency.

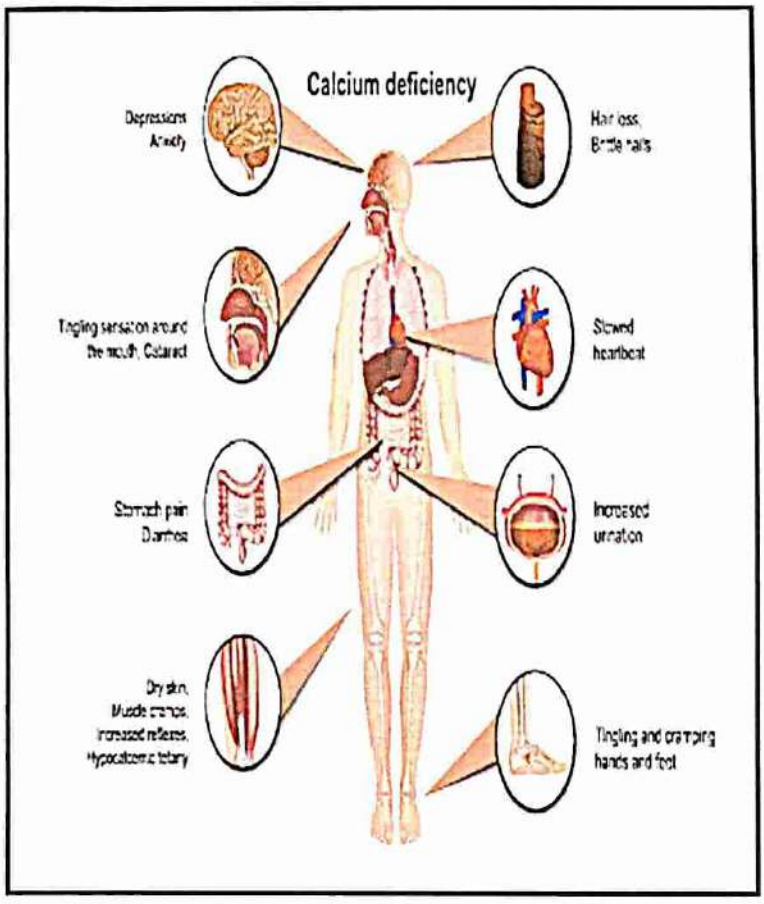

Figure 5: Depicts the deficiency of the calcium content in human body.

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MATERIALS AND METHODS:

Reagents preparation

Potassium permanganate, Hydrochloric acid, Zinc sulphate, Oxalic acid, Ethylene diamine tetraacetic acids, Patton and Reader indicators. are purchased from Nice chemicals private limited, Kerala, India. Sulpuric acid & Ammonia are purchased from Loba chemie private limited, Mumbai, India. Doubled distilled water is used throughout the experiments for solution preparation and dilution of the samples.

The required sample solutions were prepared according to the requirements of the experiments. The procedure of solution preparation and its concentration is as described in the experimental section.

Sample preparations:

Traditional analytical techniques for total calcium determination imply a preliminar decomposition of the organic matrix and the dissolution of the minerals. This is usually carried out by dry or wet decomposition of the samples in open or closed systems, using thermal, ultrasonic or microwave energy.

1. Eggshell sample preparations:

Different sources of calcium content have been purchased from local market. The samples include eggshells from hybrid hen and eggshells from native hen. The eggshell membrane is removed by washing with water, rinsed with distilled water and later on dried under oven by keeping at temperature 100℃ for a period of 15 minutes. The eggshells are finely powdered by using mortar and pestle. A suitable amount of the sample is taken for further analysis.

2. Milk samples preparation:

The milk samples are collected from hybrid cow and native buffalo from the local milk vendors. A suitable volume of milk sample is taken and centrifuged according to the procedure as mentioned in the experimental part.

Instruments:

For drying the samples, Hot air oven, Lab Hosp Corporation, Mumbai, India was used. To remove the solid suspended impurities centrifugation was carried out. The centrifuge with 1000 rpm capacity, Coslab, India was used. The obtained residue was collected for further analysis and the supernatant was discarded.

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All the weights of the samples and chemicals have been measured by using electronic digital balance with 0.0001 g accuracy, shimadzu corporation, Japan.

Methods:

1. Estimation of Ca in varieties of eggshells and milk samples by Back Titration Method
2. Estimation of Ca in varieties of eggshells by Complexometric Titration Method

Experimental section:

Experiment no. 1: Estimation of calcium in milk

Reagents:

1. Ammonium oxalate solution (4%)—50 mL
2. Dilute Ammonia solution (25%)
3. Potassium permanganate ($KMnO_4$) (0.01N)—100 mL
4. Standard oxalic acid solution(0.01N)
5. 2N H_2SO_4 - 50 mL

Procedure:

1. Pipette out 4 mL of calcium containing sample and 4mL of distilled water separately into two different centrifuge tubes.
2. Add to both the tubes add 4mL of ammonium oxalate solution and mix well and let it stand for at least 30 min. at room temperature.
3. Centrifuge at 3000 rpm for 10 min. and discard the supernatant invert the tubes allow it to drain on the pad of filter paper for 3 min.
4. Add 3ml of dilute ammonia solution to wash down all the oxalate from the sides and immediately centrifuge at 3000 rpm for 10 min.
5. Discard the supernatant and 2ml of 2N of H_2SO_4 by rotating the tubes to wash down the sides.
6. Place the tubes in water bath at 70 to 80^0c for 5 min. dissolve the ppt.
7. Titrate the contents with standard KMnO4 solution till pale pink colour is observed at the end point.
8. Let this value be the titre value (A ml)
9. Perform a blank titration with 4mL of 2N H_2SO_4 kept in water bath for 5 min. Let this titre value (B mL).

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COW MILK

Observation:

Blank titration:

Burette: 0.01N $KMnO_4$ solution

Conical flask: 4 mL 2N H_2SO_4 + 4 mL water

Indicator: $KMnO_4$ itself

Colour change: Colourless to pale pink

Sl. no.	Initial reading (mL)	Final reading (mL)	Volume of $KMnO_4$ (mL)
1.	0.0	0.3	0.3
2.	0.3	0.6	0.3
3.	0.6	0.9	0.3

Main titration:

Burette: 0.01N KMnO4 solution

Conical flask: Residue + 4 mL 2N H_2SO_4 + 4 mL water

Indicator: $KMnO_4$ itself

Colour change: Colourless to pale pink

TABULAR COLUMN:

Sl no.	Initial Reading (mL)	Final reading (mL)	Volume of $KMnO_4$ (mL)
1.	0.0	13.3	13.3
2.	13.3	26.6	13.3
3.	26.6	39.9	13.3

BUFFALO MILK

Observation:

BLANK TITRATION:

Burette: 0.01 N $KMnO_4$ solution

Conical flask: 4 mL 2N H_2SO_4 + 4mL water

Indicator: $KMnO_4$ itself

Colour change: Colourless to pale pink

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TABULAR COLUMN:

Sl. no.	Initial reading (mL)	Final reading(mL)	Volume of $KMnO_4$(mL)
1.	0.0	0.3	0.3
2.	0.3	0.6	0.3
3.	0.6	0.9	0.3

MAIN TITRATION:

Burette: 0.01 N $KMnO_4$ solution

Conical flask: residue + 4 mL 2 N H_2SO_4 + 4 mL water

Indicator: $KMnO_4$ itself

Colour change: Colourless to pale pink

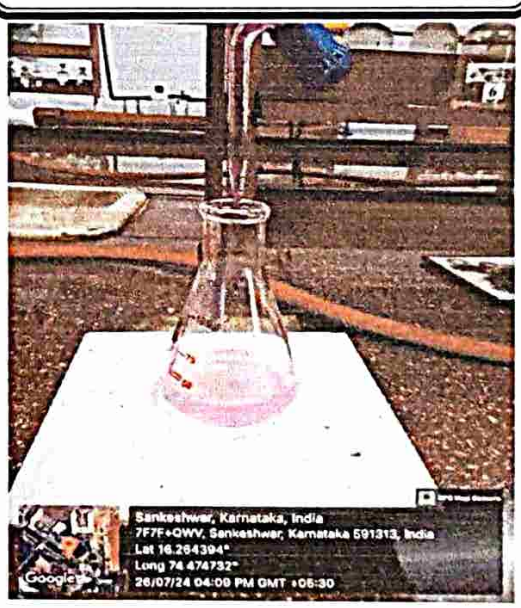
TABULAR COLUMN:

Sl no.	Initial reading (mL)	Final reading (mL)	Volume of $KMnO_4$ (mL)
1.	0.0	20.5	20.5
2.	20.5	41.0	20.5
3.	0.0	20.5	20.5

Samples and chemicals

END POINT

(COLOUR CHANGE)



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REACTION

$CaCl_2 + (NH_4)_2C_2O_4 \longrightarrow CaC_2O_4 + NH_4Cl \downarrow$

(Ca oxalate) (White ppt formed)

$CaC_2O_4 + H_2SO_4 \longrightarrow H_2C_2O_4 + CaSO_4$

(oxalic acid)

$[H_2C_2O_4 + KMnO_4 + H_2SO_4 + 3H_2SO_4 + 2KMnO_4 \longrightarrow K_2SO_4 + 2MnSO_4 + 3H_2O + S(O)$

$[H_2C_2O_4 + (O) \longrightarrow 2CO_2\uparrow + H_2O]5]$

Redox Equation,

$2KMNO_4 + 5H_2C_2O_4 + 3H_2SO_4 \longrightarrow K_2SO_4 + 2MnSO_4 + 10CO_2 + H_2O$

From the above equation:

$5CaC_2O_4 = 5Ca$

$2KMnO_4$ = 200 g of Ca

2*158 = 200 g of Ca

31.69m of $KMnO_4$ = 20 g of Ca

1000 cc of 1 N $KMnO_4$ = 0.2 g of Ca

1 cc of 0.01 N $KMnO_4$ = 0.0002 g of Ca

= 0.2 mg of Ca

CALCULATION

1 mL of 0.01N $KMnO_4$ = 0.2 mg of Ca

Blank reading (B) = 0.3 mL

Main Titration Reading (A) =

Buffalo	Cow
20.5mL	13..3mL

Buffalo Milk:

- Titre value = A-B
  = 20.5-0.3
  = 20.2 mL
- The amount of Ca Milk in 4 mL of Sample = (A-B)*0.2 = 20.2*0.2
  = 4.04 mL
- The amount of Ca Milk in 100 mL of Sample = $\frac{(A-B)*0.2*100}{4} = \frac{4.04*100}{4}$
  = 101 mg/100 mL

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Therefore Amount of Ca in 100 mL of Buffalo Milk is = 101 mg

Cow Milk:

- Titre Value = A - B

  =13.3 - 0.3

  =13 mL

- The amount of Ca in 4mL of Sample = (A-B)*0.2 = 13*0.2

  = 2.6 mL

- The amount of Ca in 100 mL of Sample = $\frac{(A-B)*0.2*100}{4}$ = $\frac{2.6*100}{4}$

  = 65 mg/100 mL

Therefore, amount of Ca in 100 mL of Cow Milk is = 65 mg.

Experiment no. 2: Estimation of calcium in egg shell

Reagents:

- Ammonium oxalate solution (4%) - 50 mL
- Dilute Ammonia solution (25%)
- Potassium permanganate ($KMnO_4$) (0.01N) – 100 mL
- Standard oxalic acid solution (0.01N)
- 2 N H_2SO_4 – 50 mL

Procedure:

1. Pipette out 4 mL of Calcium containing sample and 4 mL of distilled water separately into two different centrifuge tubes.
2. Add to both the tubes add 4 mL of ammonium oxalate solution and mix well and let it stand for atleast 30 min. at room temperature.
3. Centrifuge at 3000 rpm for 10 min. and discard the supernatant invert the tubes allow it to drain on the pad of filter paper for 3 min.
4. Add 3 mL of dilute ammonia solution to wash down all the oxalate from the sides and immediately centrifuge at 3000 rpm for 10 min.
5. Discard the supernatant and 2 mL of 2 N of H_2SO_4 by rotating the tubes to wash down the sides.
6. Place the tubes in water bath at 70 to 80 ^{0}C for 5 min. dissolve the ppt.

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7. Titrate the contents with standard KMnO4 solution till pale pink colour is observed at the end point.
8. Let this value be the titre value (A mL)
9. Perform a blank titration with 4mL of 2N H_2SO_4 kept in water bath for 5 min. Let this titre value (B mL).

HYBRID EGG SHELL

Observation:

BLANK TITRATION:

Burette: 0.01N KMnO4 solution

Conical flask: 4 mL 2N H_2SO_4 + 4mL water

Indicator: $KMnO_4$ itself

Colour change: colourless to pale pink

Sl. no.	Initial reading (mL)	Final reading(mL)	Volume of $KMnO_4$ (mL)
1.	0.0	0.3	0.3
2.	0.3	0.6	0.3
3.	0.6	0.9	0.3

MAIN TITRATION:

Burette: 0.01N KMnO4 solution

Conical flask: Residue + 4 ml 2 N H_2SO_4 + 4 mL water

Indicator: $KMnO_4$ itself

Colour change: Colourless to pale pink

TABULAR COLUMN:

Sl no.	Initial Reading(mL)	Final reading(mL)	Volume of $KMnO_4$(mL)
1.	0.0	27.0	27.0
2.	0.0	27.0	27.0
3.	0.0	27.0	27.0

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JAWARI EGG SHELL

Observation:

BLANK TITRATION :

Burette: 0.01N KMnO4 solution

Conical flask: 4mL 2N H_2SO_4 +4mL water

Indicator: $KMnO_4$ itself

Colour change: Colourless to pale pink

Sl. no.	Initial reading (mL)	Final reading(mL)	Volume of $KMnO_4$ (mL)
1.	0.0	0.3	0.3
2.	0.3	0.6	0.3
3.	0.6	0.9	0.3

MAIN TITRATION:

Burette: 0.01N KMnO4 solution

Conical flask: Residue +4 ml 2 N H_2SO_4 + 4 mL water

Indicator: $KMnO_4$ itself

Colour change: colourless to Pale pink

TABULAR COLUMN:

Sl no.	Initial Reading (mL)	Final reading (mL)	Volume of $KMnO_4$ (mL)
1.	0.0	31.0	31.0
2.	0.0	31.0	31.0
3.	0.0	31.0	31.0

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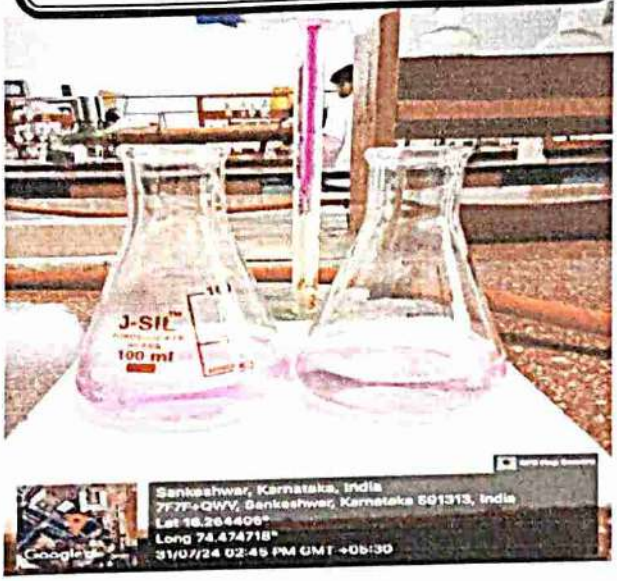
END POINT

(COLOUR CHANGE)



CALCULATION

1 mL of 0.01 N $KMnO_4$ = 0.2 mg of Ca

Blank Reading = 0.3 mL

Main Titration Reading =

Hybrid Eggshell	Jawari Eggshell
27 mL	31 mL

Hybrid Eggshell:

- Titre value = A - B = 27 - 0.3
  = 26.7 mL
- The amount of Ca in 4 mL of sample = (A-B)*0.2 = 26.7*0.2
  = 5.34 mL
- The amount of Ca in 100 mL of Sample = $\frac{(A-B)*0.2*100}{4} = \frac{5.34*100}{4}$
  = 133.5mg/100 mL

Therefore, amount of Ca in 100 mL of Hybrid eggshell is = 133.5 mg.

Jawari Eggshell:

- Titre value = A - B = 31 - 0.3
  = 30.7 mL
- The amount of Ca in 4 mL of Sample = (A-B)*0.2 = 30.7*0.2
  = 6.14 mL

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❖ The amount of Ca in 100 mL of sample $= \frac{(A-B)*0.2*1000}{4} = \frac{6.14*100}{4}$

$= 153.5$ mg/100 mL

Therefore, amount of Ca in 100 mL of Jawari Egg shell is = 153.5 mg.

Experiment no. 3: Estimation of Calcium in Eggshell

Aim: To determine the amount of calcium in eggshell by complexometric titration.

Principle: Eggshell consists of calcium and magnesium carbonate and minor constituents such as iron, aluminium, titanium, manganese, sulphur, sodium, potassium and organic matter. The eggshell ore is converted into a solution by dissolving the ore in dilute hydrochloric acid. To determine the percentage of calcium carbonate in the ore, the diluted solution is titrated against EDTA using Patton and Reeder indicator which make it possible to determine calcium the buffer is used in this titration is 8 M NaOH.

Experimental procedure:

Standardization of EDTA:

Weigh 0.280 g of $ZnSO_4 .7H_2O$ crystals and transfer to 100 mL standard flask. Dissolve and make it up to the mark using distilled water. Pipette out 10 mL of this solution into a conical flask and titrate it against EDTA using pH 10 buffers and Erichrome black T. End point is colour change from violet to blue, repeat the titration to get concordant value.

Determination of calcium ions in filtrate:

Pipette out 10 mL of solution into a clean conical flask and titrate standard EDTA solution using patton reader and 5 mL of 8M NaOH solution. End point is color change from pink to blue. Repeat the titration to get the concordant value.

OBSERVATION AND CALCULATIONS

Standardization of EDTA:

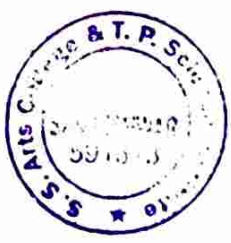
Weight of zinc sulphate crystal taken: W = 0.280 g

Strength of zinc sulphate solution:

$$N_{ZnSO4.H2O} = \frac{W*10}{\text{Molecular weight of zinc sulphate}}$$

$$= \frac{0.280*10}{287.5}$$

$$= 0.0097 \text{ N}$$



Burette Reading:

Trial No	Initial point (mL)	Final Point (mL)	Volume of EDTA (mL)
1.	0.0	9.3	9.3
2.	9.3	18.7	9.4

Volume of EDTA consumed = 9.3 mL

Strength of EDTA solution = $\frac{\text{Strength of } ZnSO_4.7H_2O * \text{Volume of } ZnSO_4.7H_2O}{\text{Volume of EDTA}}$

$= \frac{0.00973*10}{9.3}$

$= 0.0104$ N

Hybrid Egg shell:

Weight of eggshell taken: 0.35 g

Burette Reading:

Trail No.	Initial point (mL)	Final point (mL)	Volume of EDTA (mL)
1	0.0	26.5	26.5
2	0.0	26.5	26.5

Volume of EDTA consumed: 26.5 mL

- Strength of Ca ions = $\frac{\text{Strength of EDTA} * \text{Burette Reading}}{10}$

$= \frac{0.104*26.5}{10}$

$= 0.02756$ N

- Mass of Ca in 100ml solution = $\frac{\text{Strength of CA ion} * \text{molecular weight of Ca}}{10}$

$= \frac{0.02756*40}{10}$

$= 0.11024$ g

Jawari (Native) Egg shell:

Weight of eggshell = 0.35 g

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Burette Reading:

Trial No.	Initial point (mL)	Final point (mL)	Volume of EDTA (mL)
1.	0.0	31.0	31.0
2.	0.0	31.0	31.0

❖ Strength of Ca ions = $\frac{\text{Strength of EDTA} * \text{Burette reading}}{10}$

$= \frac{0.0104 * 31}{10}$

$= 0.03224$ N

❖ Mass of Ca in 100 mL solution = $\frac{\text{Strength of Ca ion} * \text{molecular weight of Ca}}{10}$

$= \frac{0.03224 * 40}{10}$

$= 0.12896$ g

End point

Results:

1. Mass of Ca ion in given sample of Egg shell (Jawari/Native)= 0.2896 g
2. Mass of Ca ion in given sample of Egg shell (Hybrid)= 0.11024 g

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RESULTS AND DISCUSSIONS:

A wide array of techniques is available for calcium measurement and official international bodies have standardized several procedures. Classic sample pre-treatments, consisting in ashing or wet digestion, were joined by other effective and green-friendly solutions such as slurry sampling or direct solid sampling, when made feasible by the subsequent detection technique. Atomic spectrometry methods, complying with several standardized acceptability criteria, are nowadays largely used. Among these, applicability under usual laboratory conditions, accuracy, sensitivity, specificity, speed of analysis, high throughput, labour and infrastructure costs, as well as recommendations from standardization bodies are crucial. The multi-analyte capability is an additional criterion of choice of paramount importance for analytical laboratories.

Sampling	Sample preparation	Detection technique
Liquid, solid, slurry	Solubilization (ashing, digestion)	Flame atomic absorption spectrometry
Liquid, solid, slurry	Solubilization (ashing, digestion)	Inductively coupled plasma techniques
Liquid, solid	Homogenization	Infrared spectroscopy
Liquid, solid	Homogenization	X-ray fluorescence
Liquid, solid	Homogenization	Laser assisted spectrometry
Liquid	Stirring	Potentiometry (ISE)[a]
Liquid, solid	Homogenization and extraction	Titrimetry
Liquid, solid	Homogenization and extraction	Ion chromatography

Figure 6: Sampling, sample treatments and detection techniques of analytical methods for the determination of calcium in bovine milk, dairy products and milk-based infant formulas. a: detection of soluble calcium.

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From the experiments it was observed that the calcium content was found to be higher in buffalo milk samples (101 mg/100 mL) than cow milk samples (65 mg/100 mL).

Part 1: Estimation of calcium in milk by back titration method.

In this method, the calcium content present in the milk sample is extracted in the form of calcium oxalate by using ammonium oxalate by centrifuging the milk samples. Again the centrifuge process is repeated to remove any suspended impurities and excess ammonia. The residue is collected and analysed for the determination of calcium. The collected residue is treated with 2 N H_2SO_4 and the solution is heated nearly 70 to 80 °C for five minutes. Later, in the hot condition the sample solution is titrated against the standard solution of $KMnO_4$ till the pale pink colour is obtained at the end point.

Initially the calcium is in the form of its chloride radical which is converted to its oxalate form through different chemical procedure and the mechanism of the reaction is as shown in the experimental part.

Merits of the back titration:

The merits of the back titration are the following

The excess reagent can be added until the analyte is completely reacted with the reagent which can give more accurate results than direct titration. Back titration can be performed even when the sample is insoluble in water.

When the sample is not soluble in water, when the sample contains impurities that interfere with forward titration, or when the end point is more easily identified than in forward titration.

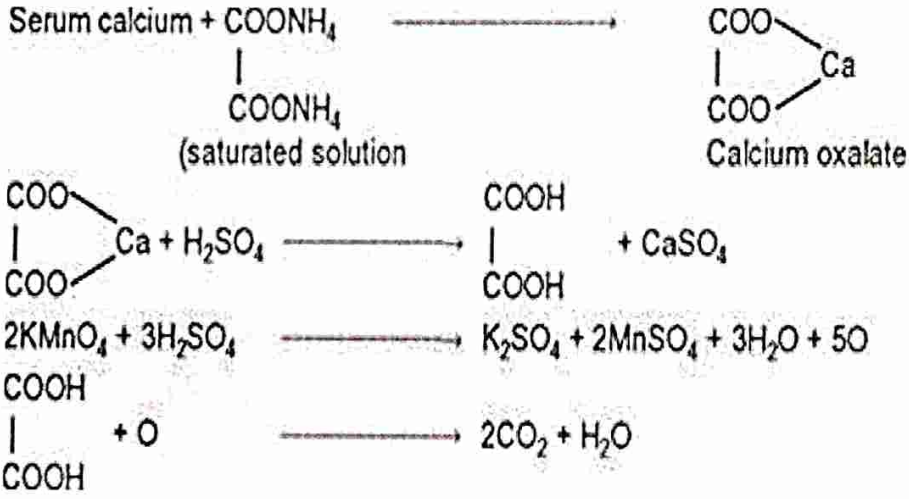

Figure 7: Reaction of calcium with potassium permanganate in the acidic medium.

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Part 2: Estimation of calcium in eggshell by complexometric titration method using EDTA.

This method is used for the determination of calcium in the eggshell. The method utilizes reaction between EDTA and the samples by using Patton and Reeder's indicator. The reaction is carried out using 8 M NaOH until the end point of pink colour to blue colour is changed. The calcium forms a six coordinated octahedral complex with EDTA which acts as a chelating agent. This method is very simple, rapid, economical and easy to perform when compared to other types of analytical techniques. The method is more accurate and highly precise relative to other sophisticated instrumental techniques.

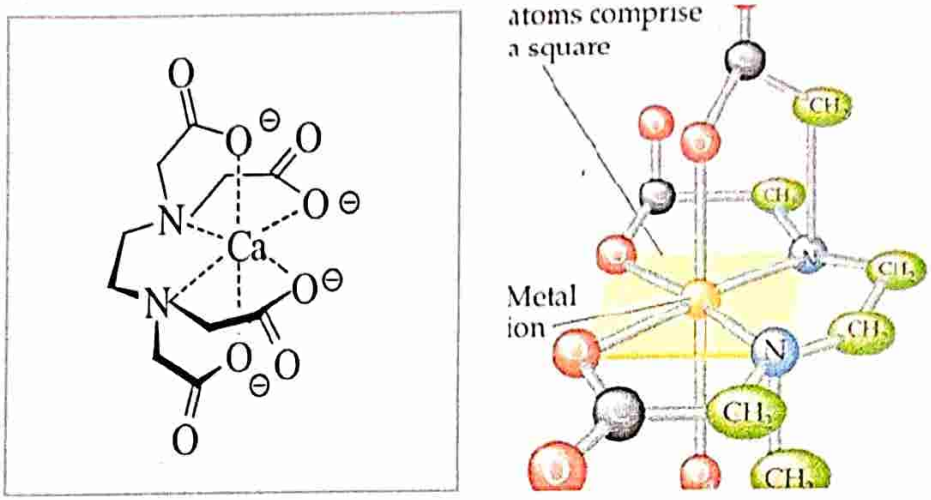

Figure 8: Metal-EDTA structure with octahedral geometry.

The reaction involving metal and EDTA ligand can be as shown in the figure;

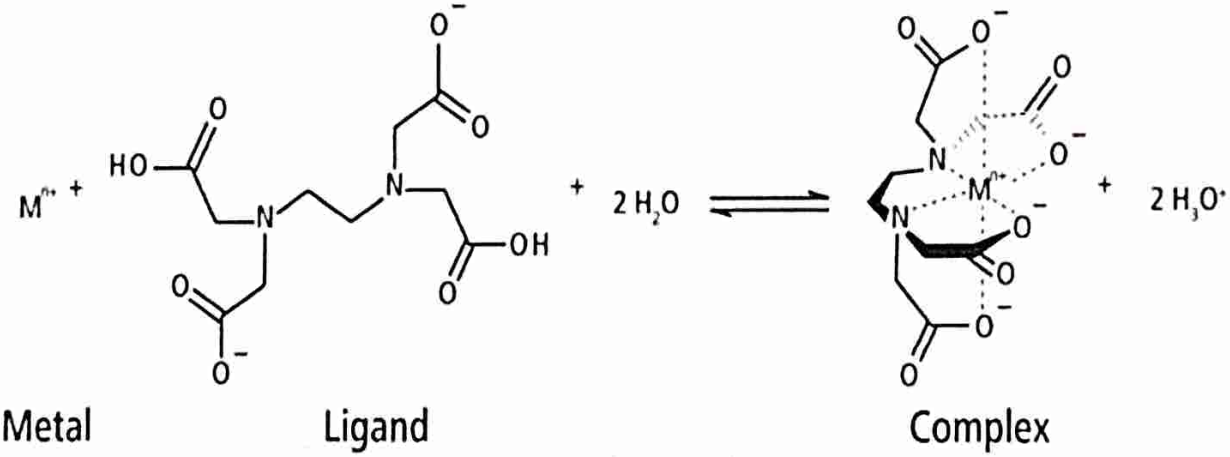

Figure 9: Reaction of metal ions and EDTA chelating ligand.

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CONCLUSIONS:

When compare to all other sophisticated analytical techniques, the present method of titration is very simple, rapid, economical with high accuracy and reproducible results.

It was observed that the calcium content was found to be higher in buffalo milk samples (101 mg/100 mL) than cow milk samples (65 mg/100 mL). It is also observed that the calcium content in Jawari (Native) egg shell is found to be higher (0.2896 g) than hybrid egg shell (0.1104g). Both methods trialed and the results compared are in good agreement.

The present dissertation work enhanced not only the knowledge and but also different sets of skills required for the conduction of any scientific based project work is acquired. The following are the significant learning outcome of the project work.

- ✓ The art of reviewing a project work i.e., scientific based literature survey.
- ✓ Interpretation of the theoretical and experimental results and drawing probable conclusions.
- ✓ Research methodology and design.
- ✓ Literature review and critical analysis.
- ✓ Samples collection, data collection and analysis techniques.
- ✓ Interpretation of results and drawing conclusions.
- ✓ Academic writing and communication skills.
- ✓ Time management and organization.
- ✓ Attention to detail and accuracy.
- ✓ Collaboration and teamwork.

By engaging in research article writing, one can gain a deeper understanding of our chosen topic, develop valuable skills.

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S D V S Sangh's

S.S Arts College and T.P Science Institution Sankeshwar

Accrediated at 'B++' by NAAC

PROJECT REPORT ON

ULTRASONIC PARAMETERS OF CASTOR OIL BY ULTRASONIC INTERFEROMETER

Submitted by final B.Sc students

Miss Laxmi Jakappa Maradi

Miss Vidhya Mallapa Badkundri

Miss Shweta Mutnal

Miss Sanika Ashok Gurav

Guided by

Dr. Sunil Kumar Asst. Professor

Department of Physics

S.S Arts College and T.P Science Institute Sankeshwar

.S.ARTS COLLEGE AND T.P. SCIENCE INSTITUTE, SANKESHWAR

Arts College & T. P. Science Institute Sankeshwar
Physics Dept.

CERTIFICATE

DEPARTMENT OF PHYSICS

2023-24

This is to certify that **Miss Laxmi Jakappa Maradi, Miss Vidya Mallapa Badkundri , Miss Shweta Mutnal , Miss Sanika Ashok Gurav** has satisfactorily completed project course entitled **"Ultrasonic parameters of Castor oil by Ultrasonic interferometer"**

Project Guide

Head
Department of Physics
B.S. Arts College & T.P. Science Institute
SANKESHWAR

Principal

AKNOWLEDGEMENT

We have a great pleasure to express our heartfelt gratitude to my project supervisor Dr. Sunil Kumar Assistant Professor in Department of Physics of S.S Arts College & T. P Science Institute, Sankeshwar. For his excellent guidance and constant encouragement at all stages of the project work.

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The writing of this project work could not be possible without the support of H.O.D Shri M. R. Patil and Physics department staff.

I wish to express my gratitude to all those who have directly and indirectly helped me in smooth completion of the project work.

Project Students

Contents

"There's plenty of room at the bottom"

Feynman

1. Introduction

Ultrasonic, thermo-physical and thermodynamic properties of liquid mixtures are of great significance in obtaining an in depth knowledge of inter and intra-molecular interactions, structural and physiochemical behavior and also in verifying various liquid state theories which attempt in estimating the properties of liquid mixtures.

Systematic study of thermodynamic properties of solutions with a new type of multi-frequency ultrasonic interferometer is done for precise measurement of the velocity of sound in liquids. The path length in the cell is varied by motion of a reflector, at the electrical reaction of the cell upon the oscillator is used to fix standing wave position at a standard frequency, and their locations are determined with a suitable cathetometer. An investigation in the possible change of thermodynamic properties of mixtures and their degree of deviation from ideality has been found to be an excellent quantitative way to elicit information about molecular structure and intermolecular forces in liquid mixtures. This has given impetus to the theoretical and experimental investigation of excess thermodynamic properties of liquid mixtures. Measurement of physiochemical properties such as density and ultrasonic velocity of pure components and their binary mixtures are being increasable used as tools for investigations of the properties of pure components and the nature of intermolecular interactions between the components of liquid mixtures. The significance reasons for the study of thermo-physical and

ermodynamic properties of multi-component liquid mixtures are as llows:

hey provide way for studying the physical forces acting between olecules of different species. The study of liquid mixtures provides ppearance of new phenomena, which are absentт in pure liquids. The nost interesting of these are the new types of phase equilibria, which are ntroduced by the variation in the promotion of the pure components. Liquid mixtures are the most direct source for studying the various parameters.

The study of thermo-physical and thermodynamic properties of liquid mixtures helps in obtaining in depth knowledge about molecular interactions.

Theory

- Ultrasonic interferometer is a simple and direct device which yields accurate and consistent data, from which one can determine the velocity of ultrasonic sound in a liquid medium with a high degree of accuracy. A crystal controlled interferometer (model 81D) supplied by Mittal Enterprises, New Delhi, operating frequencies 2 MHz and 5 MHz has been used to measure the ultrasonic velocity.
- ultrasonic sound refers to sound pressure with a frequency greater than the human available range (20 hz to 20 khz). when an ultrasonic wave propagates through a medium, the molecules in that medium vibrate over short distance in a direction parallel to the longitudinal

wave. during this vibration, momentum is transferred among molecule. This causes the wave to pass through the medium.

Ultrasonic Interferometer

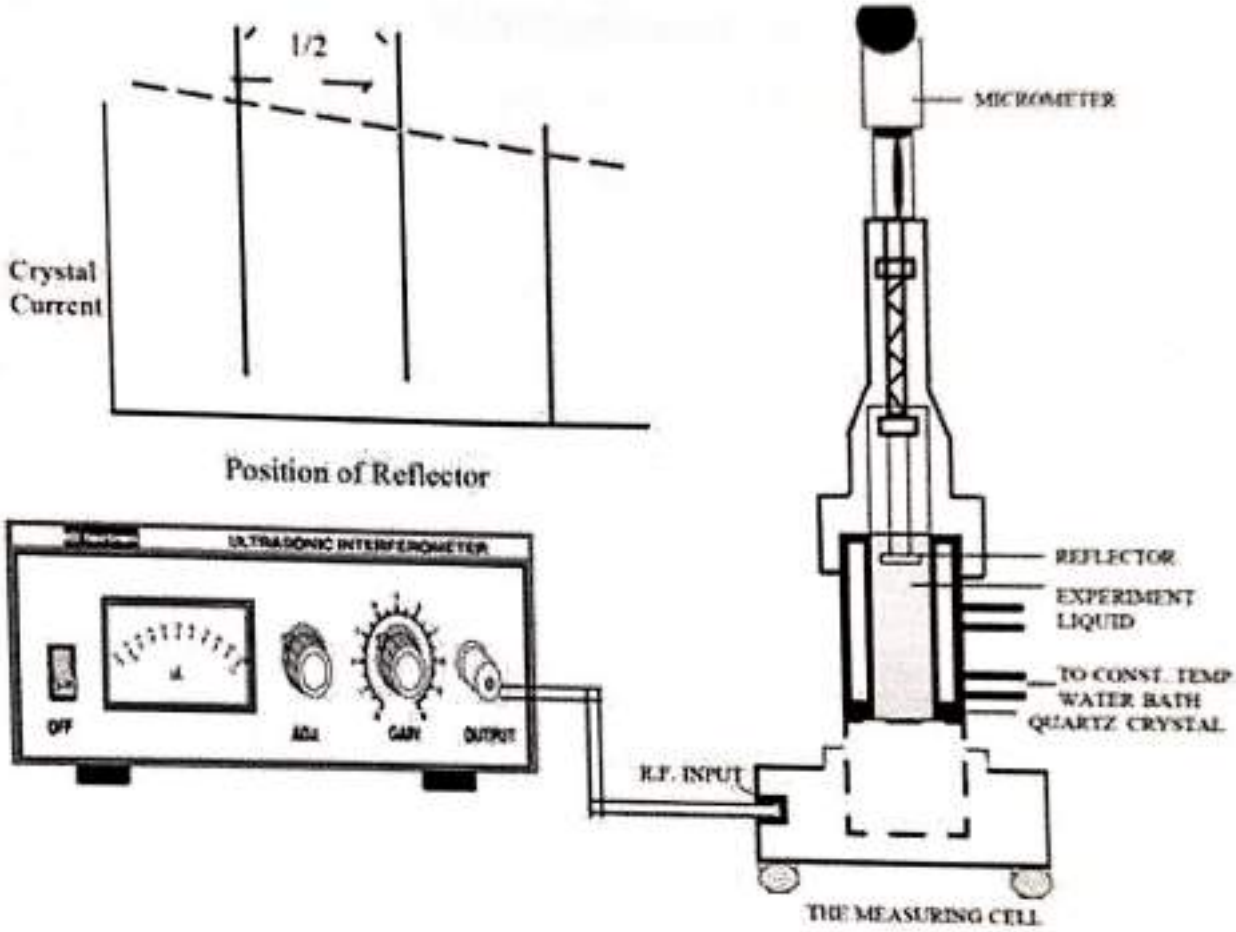
An Ultrasonic Interferometer is a simple and direct device to determine the ultrasonic velocity in liquid with a high degree of accuracy.

Experimental setup for ultrasonic interferometer. The salient features of ultrasonic interferometer are given below:

The salient features of ultrasonic interferometer are given below:

- It is a simple in design, rugged and gives very accurate and reproducible results.
- Experiments may be performed over a wide range of temperature from 30 0C to +80 0C on all liquids except those which reacts with the plating of cell and crystal.

- Nearly 10 ml of experimental liquid is required.
- There is no danger of any change such as depolymerisation, due to ultrasonic effect since a very small ultrasonic energy is require.



Cross section of the liquid cell and graph plotted position of reflector versus crystal current.

In an ultrasonic interferometer, the ultrasonic waves are produced by the piezoelectric methods. At a fixed frequency variable path interferometer, the wavelength of the sound in an experimental liquid medium is measured, and from this one can calculate its velocity through that medium. The ultrasonic cell is consists of a double walled brass cell with chromium plated surfaces having a capacity of 10 ml. The double wall allows water

circulation around the experimental liquid to maintain it at a known constant temperature. The micrometer scale is marked in units of 0.01 mm and has an overall length of 25 mm. Ultrasonic waves of known frequency are produced by a quartz crystal which is fixed at the bottom of the cell. There is a movable metallic plate parallel to the quartz plate, which reflects the waves. The waves interfere with their reflections, and if the separation between the plates is exactly an integer multiple of half wave length of sound, standing waves are produced in the liquid medium.

Under these circumstances, acoustic resonance occurs. The resonant waves are a maximum in amplitude, causing a corresponding maximum in the anode current of the piezoelectric generator.

2. Objectives

The primary objectives of this project are:

- To understand the working principle of an ultrasonic interferometer.
- To measure the velocity of ultrasonic waves in various liquid media.
- To calculate the adiabatic compressibility of the liquids.
- To analyze the effect of temperature and other variables on the ultrasonic wave velocity.

3. Apparatus and Materials

1. High-frequency generator

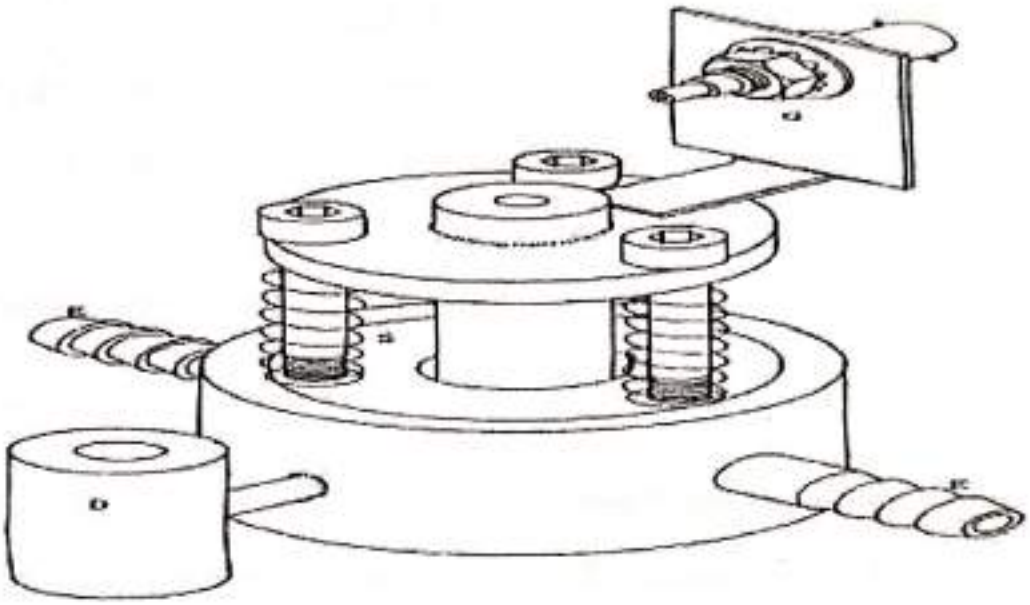
2. The measuring cell:

- Quartz crystal

- Movable reflector
- Micrometer screw gauge

3. Constant temperature bath

4. Liquids to be tested (Castor Oil)



Ultrasonic interferometer cell liquid mixtures

➢ **Constant temperature bath**

Construction

Constant temperature water bath is double walled in construction. The units are insulated with high grade glass wool/PUF.

Technical Specification

Controlling System

Two separate imported microprocessors based auto tune PID controller with CE mark & dual display of set value & process value for precise control of temperature.

Heating System

SS tubular heaters (water immersion type) is used at the bottom for better heat distribution.

Water Circulation

The water circulation pump is provided for better uniformity of temperature instead of the stirrer. The side mounted circulating pump provides the minimum capacity of 15 ltr per min.

- **Liquids to be tested (Castor Oil)**

Castor oil

Castor oil is a versatile vegetable oil derived from the seeds of the castor plant (Ricinus communis). It has a wide range of applications across various industries due to its unique properties. Here's an overview of key aspects of castor oil:

1. Source:

Castor oil is extracted from the seeds of the castor plant, which is native to tropical regions but now cultivated worldwide.

2. Composition:

As mentioned earlier, it's primarily composed of ricinoleic acid triglycerides (85-95%).

3. Major applications:

❖ **Pharmaceuticals and Medicine:**

- **Laxative:**

Castor oil is a well-known stimulant laxative. It works by increasing the movement of the intestines.

- **Skin treatments:** Used in ointments and creams for treating skin conditions like dermatitis and psoriasis.
- **Wound healing:** Some studies suggest it may promote wound healing and reduce inflammation.
- **Labor induction:** Historically used to induce labor, though this is less common in modern medical practice.

❖ **Cosmetics and Personal Care:**

- **Hair care:** Promotes hair growth, moisturizes the scalp, and adds shine to hair. Used in shampoos, conditioners, and hair oils.
- **Skin care:** Acts as an emollient and moisturizer in lotions, creams, and lip balms. Its antimicrobial properties may help with acne.
- **Makeup:** Used in lipsticks and other cosmetics for its moisturizing properties and as a glossing agent.
- **Nail care:** Strengthens nails and softens cuticles.

❖ **Industrial Uses:**

- **Lubricants:** High viscosity and stability make it excellent for high-temperature and high-pressure applications in machinery.

- **Plasticizers:** Used in the production of polyurethane and other plastics to increase flexibility.
- **Coatings and paints:** Improves gloss, durability, and drying properties of paints and varnishes.
- **Inks:** Component in printing inks, especially in high-speed printing processes.
- **Adhesives:** Used in the production of various adhesives and sealants.

❖ **Biodiesel Production:**

- **Renewable fuel source:** Castor oil can be converted into biodiesel, which is considered more environmentally friendly than fossil fuels.
- **High cetane number:** Castor oil-based biodiesel has a high cetane number, indicating good combustion quality.

❖ **Food Industry:**

- **Food additive :** Used as a flavoring agent and food additive in small quantities.
- **Packaging:** Component in food-grade plastics and coatings for food packaging.

❖ **Textile Industry:**

- Finishing agent: Improves the feel and appearance of fabrics.
- Water-repellent coatings: Used in the production of waterproof textiles.
- Dyeing aid: Helps in the dyeing process of certain fabrics.

4. Production:

Castor oil is typically produced through cold pressing or hot pressing of castor seeds, followed by refining processes to remove impurities.

5. Environmental impact:

Castor plants are relatively drought-resistant and can grow in marginal soils, making them a potentially sustainable crop. However, large-scale cultivation can have environmental impacts.

❖ **Chemical properties of Castor oil:**

1. Composition:

Castor oil is primarily composed of triglycerides of ricinoleic acid, which makes up about 85-95% of its fatty acid content. The remaining composition includes small amounts of oleic acid, linoleic acid, stearic acid, and other minor fatty acids.

2. Chemical formula of ricinoleic acid:

C18H34O3 is the molecular formula for ricinoleic acid. This 18-carbon fatty acid has a unique structure with a hydroxyl group on the 12th carbon, which contributes to many of castor oil's distinctive properties.

3. Unsaturated fatty acid content:

Castor oil has a high content of unsaturated fatty acids, primarily due to the presence of ricinoleic acid. This unsaturation contributes to its liquid state at room temperature and its reactivity in various chemical processes.

4. Hydroxyl groups:

The presence of hydroxyl (-OH) groups, particularly in ricinoleic acid, makes castor oil more polar than many other vegetable oils. This polarity affects its solubility, reactivity, and ability to form hydrogen bonds.

5. Iodine value:

The iodine value of castor oil typically ranges from 82-90. This measure indicates the degree of unsaturation in the oil, with higher values suggesting more double bonds. The relatively high iodine value of castor oil reflects its unsaturated nature.

6. Saponification value:

Castor oil has a saponification value between 176-187. This value represents the number of milligrams of potassium hydroxide required to saponify one gram of the oil. It's an indicator of the average molecular weight of the fatty acids in the oil.

❖ **Physical Properties:**

1. Appearance:

Castor oil is a pale yellow to colorless, viscous liquid at room temperature. Its clarity and color can vary slightly depending on the processing method and purity.

2. Odor:

It has a mild, characteristic odor that is generally described as slightly nutty or fatty. High-quality, well-refined castor oil should have minimal odor.

3. Density:

The density of castor oil is between 0.95-0.97 g/cm³ at 20°C. This makes it slightly less dense than water but denser than many other vegetable oils.

4. Boiling point:

Castor oil has a high boiling point of approximately 313°C (595°F). This high boiling point contributes to its stability at elevated temperatures and its use in high-temperature applications.

5. Melting point:

The melting point of castor oil ranges from -10 to -18°C (14 to 0°F). This low melting point ensures that it remains liquid at room temperature and in most climates.

6. Viscosity:

Castor oil is known for its high viscosity, which is about 6-8 times greater than most vegetable oils. This property makes it valuable as a lubricant and in various industrial applications.

7. Solubility:

Castor oil is soluble in alcohol and most organic solvents but insoluble in water. Its solubility in alcohol is unique among vegetable oils and is due to its high ricinoleic acid content and the presence of hydroxyl groups.

8. Refractive index:

The refractive index of castor oil is between 1.477-1.481 at 20°C. This property is useful for identifying and assessing the purity of the oil.

These detailed properties contribute to castor oil's wide range of applications in industries such as cosmetics, pharmaceuticals, lubricants, and biodiesel production. Its unique chemical structure, particularly the

presence of ricinoleic acid, gives it properties that set it apart from other vegetable oils.

4. Working principle:

The principle used in the measurement of velocity (U) based on the accurate determination of the wavelength((λ) is in the medium. Ultrasonic waves of known frequency (f) are produced by quartz crystal fixed at the bottom of the cell. These waves are reflected by a movable metallic plate kept parallel to the quartz crystal. If the separation between these two plates is exactly a whole multiple of the sound wavelength, standing waves are formed in the medium. This acoustic resonance gives rise to an electrical reaction on the generator driving the quartz crystal and anode current of the generator become a maximum. If the distance is now increased or decreased and the variation is exactly one half wavelengths (λ/2) or multiple of it, anode current become maximum.

The relation between wavelength and velocity

$$\text{Velocity} = \text{Wavelength} \times \text{Frequency}$$

$$\mathbf{U = \lambda \times f}$$

Procedure:

1. Unscrew the knurled cap of cell and lift it away from double walled construction of the cell. In the middle position of it pour experimental liquid and screw the knurled cap. Wipe out excess liquid overflowing from the cell.

2. Insert the cell in the heavy base socket and clamp it with the help of a screw provided on its side.

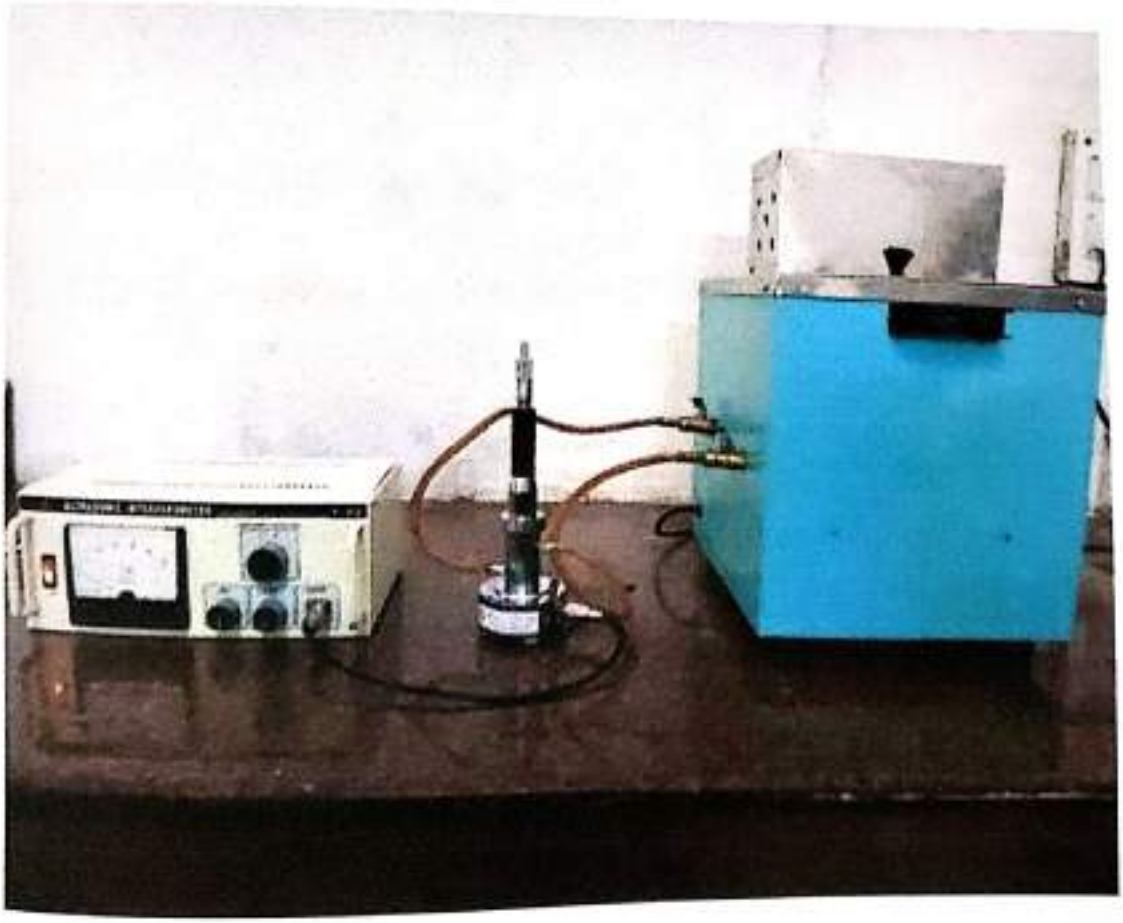
3. Connect the high frequency generator with cell by coaxial cable provided with the instrument. In ultrasonic interferometer frequency selector knob should be positioned at desired frequency (same frequency as that of liquid cell chosen).

4. Move the micrometer slowly in either clockwise or anticlockwise direction till the anode current on the ammeter on the high frequency generator shows a maximum or minimum.

5. Note the reading of micrometer corresponding to the maximum or minimum (which is sharper) in micro ammeter. Take about 50 reading of consecutive maximum or minimum and tabulate them

6. Take average of all differences ($\lambda/2$).

7. Once the wavelength (λ) is known the velocity (U) in the liquid can be calculated with the help of the relation.



5. Applications:

Ultrasonic interferometry is a precise and versatile technique used to measure the acoustic properties of materials. It has found widespread applications in various scientific and industrial fields due to its ability to provide detailed information about the mechanical properties of liquids, solids, and gases. This analysis explore the wide applications of ultrasonic interferometers, highlighting their importance in materials science, industrial processes, biomedical engineering, and environmental monitoring.

Ultrasonic waves can be categorized according to its frequency into two categories that are: (1) Low-frequency category which has frequency ranging from 20 to 1000 kHz. The applications of this category are used at high-power intensities in industrial applications, ultrasonic therapy, sono chemistry, and nanotechnology. (2)High frequency category which has a frequency above 1 MHz and is being used at low-power intensities for non destruc-tive quality checking.

Applications in Materials Science

1. Characterization of Liquids and Solutions:

Ultrasonic interferometry is widely used to study the acoustic properties of liquids and solutions. This includes measuring the sound velocity and attenuation to gain insights into molecular interactions, viscosity, and compressibility. Applications include the study of pure liquids, binary mixtures, and polymer solutions.

2. **Analysis of Solids:**

In solid materials, ultrasonic interferometry helps determine elastic constants, such as Young's modulus, shear modulus, and Poisson's ratio. These measurements are crucial for understanding the mechanical behavior of metals, ceramics, polymers, and composite materials under various conditions.

3. **Phase Transitions:**

Ultrasonic interferometry is valuable for studying phase transitions in materials. By monitoring changes in acoustic properties, researchers can investigate phenomena such as melting, crystallization, and glass transitions, providing insights into the fundamental physics of these processes.

Industrial Applications

1. Quality Control and Non-Destructive Testing (NDT):

In industries such as aerospace, automotive, and manufacturing, ultrasonic interferometry is employed for non-destructive testing of materials and components. It can detect flaws, cracks, and voids within materials, ensuring structural integrity and safety without damaging the tested items.

2. Process Monitoring:

Ultrasonic interferometry is used to monitor industrial processes in real-time. For example, it can measure the concentration of solutes in solutions, monitor polymerization reactions, and control mixing processes. This helps optimize production processes, improve product quality, and reduce waste.

Biomedical Engineering

1. Medical Diagnostics:

Ultrasonic interferometry is a cornerstone of medical imaging techniques, such as ultrasound imaging. It provides detailed images of internal organs, tissues, and blood flow, aiding in the diagnosis of various medical conditions. Applications include obstetrics, cardiology, and oncology.

2. Tissue Characterization:

Ultrasonic interferometry can assess the mechanical properties of biological tissues, such as elasticity and density. This information is valuable for understanding tissue health, diagnosing diseases, and developing medical treatments and implants.

Environmental Monitoring

1. Water Quality Assessment:

Ultrasonic interferometry is used to monitor water quality in environmental studies. It can detect contaminants, measure salinity, and assess the concentration of dissolved gases and particles. This helps in managing water resources and ensuring safe drinking water.

2. Air Pollution Monitoring:

In air quality monitoring, ultrasonic interferometry can detect airborne particles and gases. By measuring the acoustic properties of air, researchers can assess pollution levels and identify sources of contamination, contributing to environmental protection efforts.

6. Results and discussion

Variation of ultrasonic velocity with temperature:

The variation of ultrasonic velocity with temperature of pure castor oil is as shown in Fig. 1. The ultrasonic velocity is more in castor oil than palm oil. It is due to the fact that castor oil has high viscosity. The similar ultrasonic velocity of castor oil was 1480 m/s at 30°C. The ultrasonic velocity was decreased with increase in temperature for pure castor oil. The similar trend of ultrasonic velocity of heated and unheated castor oil was observed. The heating time was increased from 30 to 120 minutes and the ultrasonic velocity decreased from 1480 to 1340m/s respectively. The ultrasonic velocity of castor oil samples decreases with increase in temperature. Due to temperature, thermal energy increases and thus, intermolecular free length increases.

The molecules at high temperature have high energy states and vibrate fast and therefore, ultrasonic waves can travel slower. With increase in quantity of castor oil, with increase in intermolecular free length and hence that reduces ultrasonic velocity.

Table: Variation of ultrasonic velocity, impedance, density and compressibility with temperature

Temperature (K)	No. of oscillation	Screw gauge reading		D=d1-d2 (mm)	$\lambda=\frac{2D}{n}$ (mm)	V=λf	ρ	Acoustic Impedance Z=Vρ	Adiabatic Compressibility $\beta=\frac{1}{\rho V^2}$
		D1 (mm)	D2 (mm)						
303	5	0.57	1.31	0.74	0.296	1480	0.954	1411.92	4.78551E-07
313	5	1.44	2.17	0.73	0.292	1460	0.95	1387	4.93822E-07
318	5	0.11	0.83	0.72	0.288	1440	0.948	1365.12	5.08706E-07
323	5	4.59	5.30	0.71	0.284	1420	0.945	1341.9	5.24797E-07
328	5	0.11	0.81	0.7	0.28	1400	0.942	1318.8	5.41618E-07
333	5	0.69	1.38	0.69	0.276	1380	0.94	1297.2	5.58617E-07
338	5	0.11	0.57	0.68	0.272	1360	0.935	1271.6	5.78243E-07
343	5	0.75	1.42	0.67	0.268	1340	0.933	1250.22	5.9691E-07

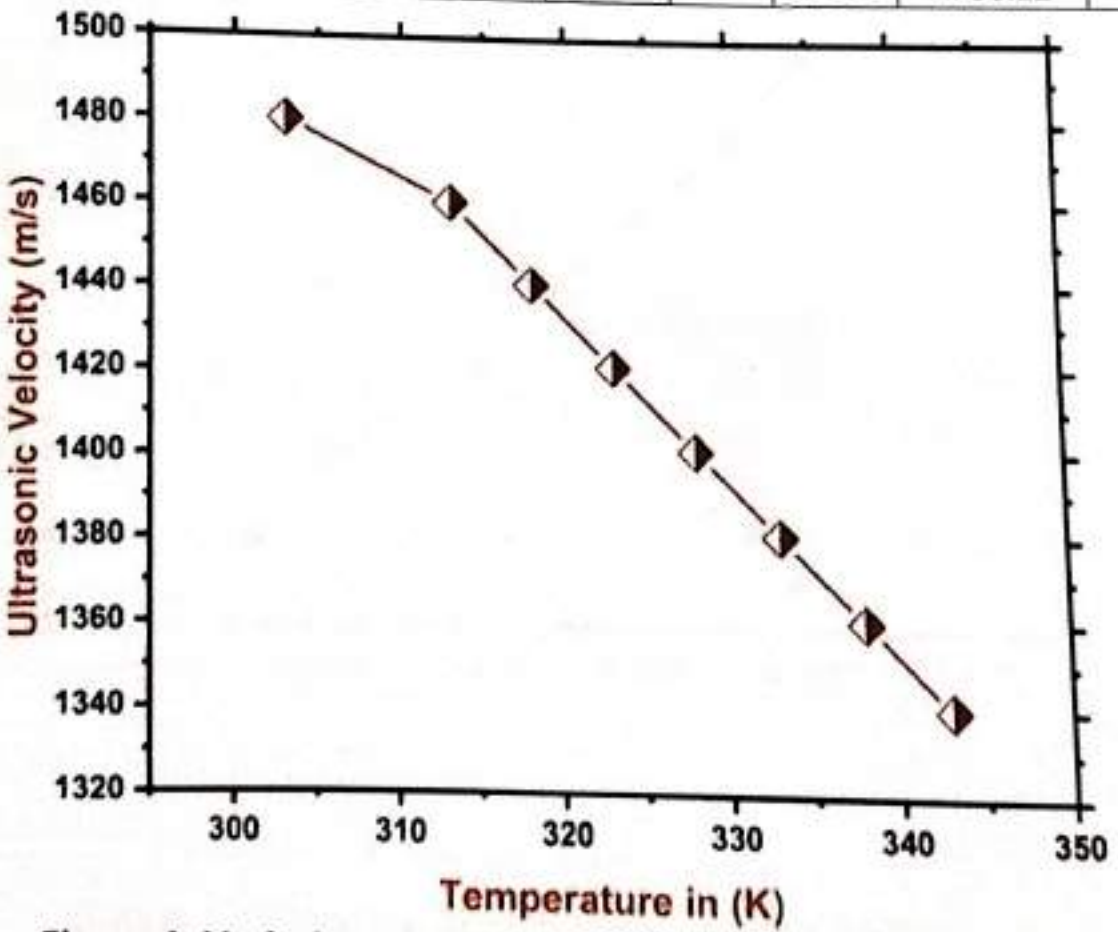


Figure 1. Variation of ultrasonic velocity with temperature

❖ **Variation of ultrasonic velocity with density**

The ultrasonic velocity versus density is plotted in figure 2 for castor oil. Pure castor oil has high density. The ultrasonic velocity is increasing with the rise in density of the medium as shown in figure 2. Reason for such variation is the increase of density, which forms strong bonds between the molecules of castor oil. This increases the packing of molecules of castor oil and it will help sound waves to propagate easily through the medium. This will results in the increase of ultrasonic velocity with increase of density.

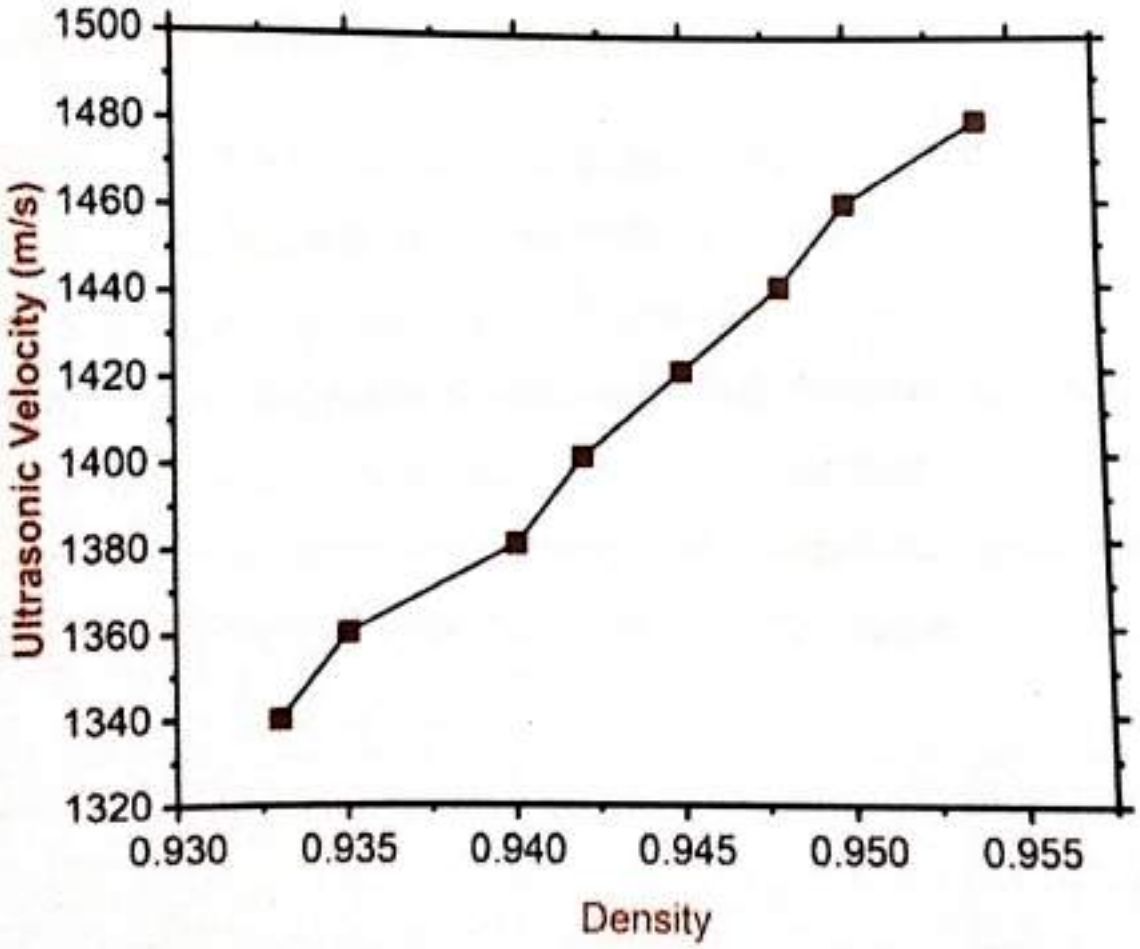


Figure 2. Variation of ultrasonic velocity with density

❖ **Variation of ultrasonic velocity with acoustic impedance and compressibility**

Adiabatic compressibility was observed to increase by increasing the temperature of the castor oil. With increase in temperature, magnitude of interaction between the molecules decreases and attributes to easy movement of molecules. This results in increase in adiabatic compressibility. This increase in adiabatic compressibility decrease ultrasonic velocity through castor oil.

The acoustic impedance is the resistance offer to the flow of sound waves. Acoustic impedance is increasing with the ultrasonic velocity in castor oil. Since ultrasonic velocity is proportional to the impedance. With increase in temperature, the Acoustic impedance and ultrasonic velocity decreases. As it is the measure of resistance offered to the path of ultrasonic waves. The decrease in ultrasonic velocity with temperature gives information about the easy flow of sound waves through the sample.

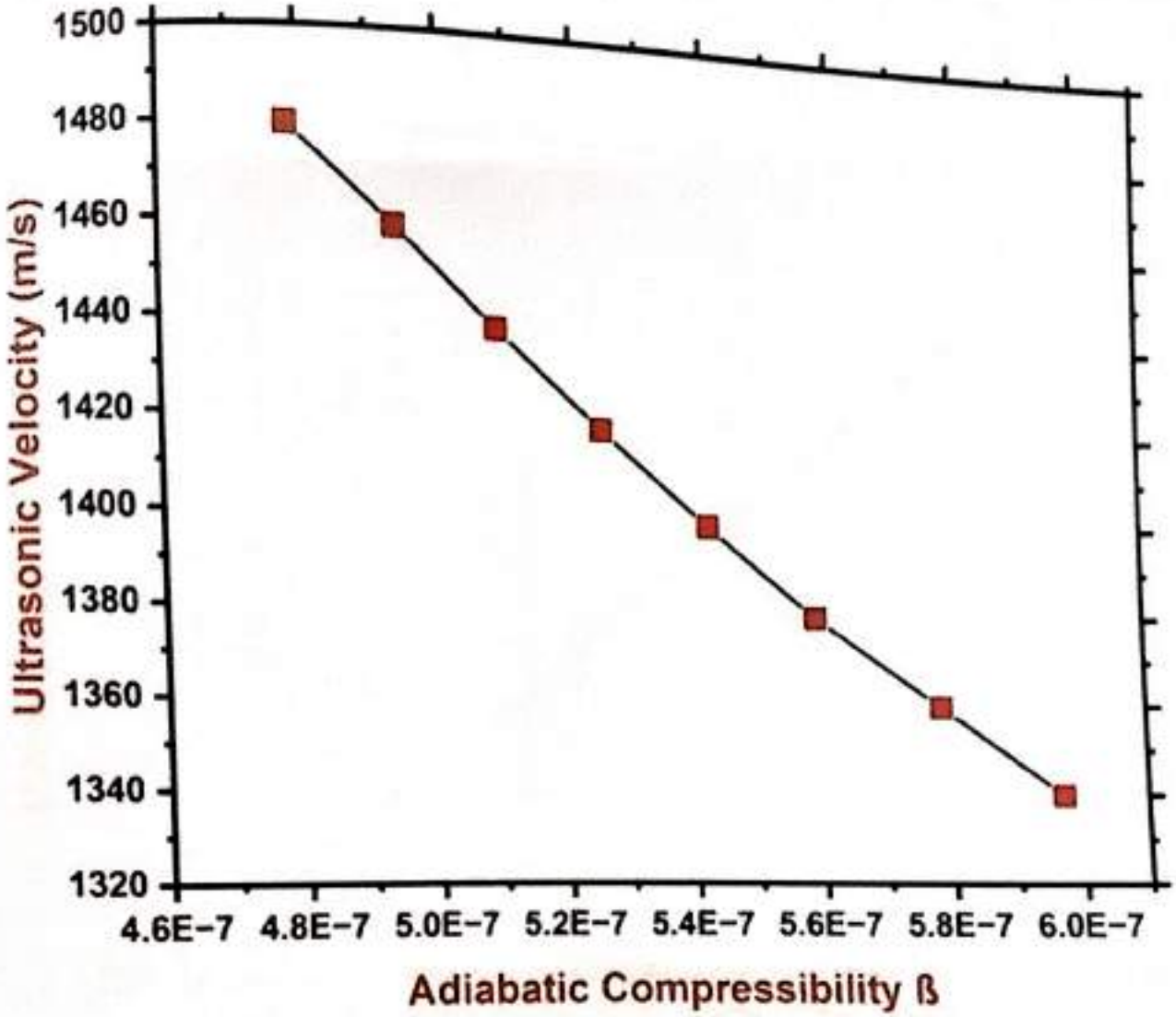


Figure 3. Variation of ultrasonic velocity with adiabaticcompressibility

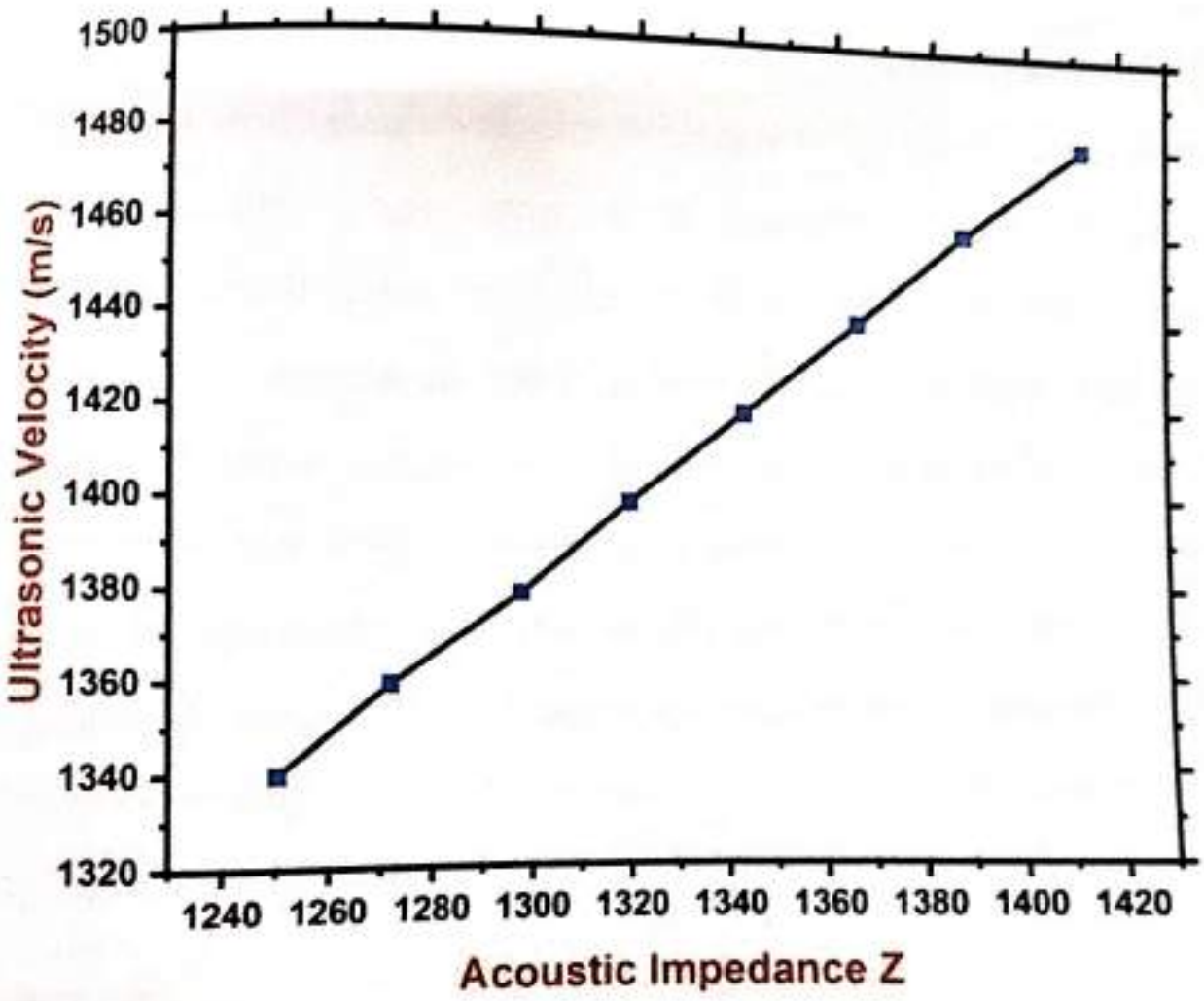


Figure 4. Variation of ultrasonic velocity with Acoustic Impedance

7. Conclusion:

The temperature variation of ultrasonic velocity shows interesting behaviour, that is ultrasonic velocity decreases with temperature rise. This is due to the fact that at high temperature, molecule of castor oil has high energy states and vibrates fast and therefore, ultrasonic waves moves slower. Acoustic impedance, density and ultrasonic velocity has direct connection, all these parameters fall with rise in temperature. Oly the factor adiabatic compressibility increases with the temperature, because it has inverse connection with the density and ultrasonic velocity of the given castor oil sample. The ultrasonic measurement provides prospects for non-invasive sensing of quality indicators in food products. Like checking quality of edible oils, milk, ghee and etc.

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DEPARTMENT OF CHEMISTRY

A Project Report On

"THE CHEMISTRY OF HAEMOGLOBIN AND ITS CLINICAL SIGNIFICANCE"

Submitted by

B.Sc VI Sem Students

Under the guidance of

Dr. Honnur Krishna

Assistant professor,

Department of Chemistry,

S.S Arts College and T.P Science Institute,

Sankeshwar.

S.S. Arts College & T. P. Science Institute SANKESHWAR 591313

2023-2024

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S.S. Art's College & T.P. Science, Institute * Sankeshwar * Dept. of Chemistry

DEPARTMENT OF CHEMISTRY

CERTIFICATE

This is to certify that the project work Entitled **"THE CHEMISTRY OF HEMOGLOBIN AND ITS CLINICAL SIGNIFICANCE"** Submitted by **Suteertha Holeppagol, Sudha Todal, Shruti Munnoli, Prashant Bedakihal, Mahalaxmi Daddi** of B.Sc 6th semester is a record of project work carried out at S.S.Arts College And T.P.Science Institute, Sankeshwar, during the academic year 2023-2024.

GUIDE
14/8/24

14/8/24
HOD
Head of The
Chemistry Department

PRINCIPAL
S.S Arts College & T. P. Science Institute
SANKESHWAR.

Place: Sankeshwar

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DECLARATION

We hereby declare that the matter embodied in this project report entitled "**The Chemistry of Hemoglobin and Its Clinical Significance**" is the result of the work carried out by us at S.S Arts College and T. P. Science Institute, sankeshwar under the guidance **Dr.Honnur Krishna**, Assistant professor, Department of Chemistry, S. S. Arts College and T. P. Science Institute, Sankeshwar.

We further declare that the work reported in this Dissertation is a proprietary work at the college and we shall not publish this work elsewhere for any other purpose.

Suteertha Holeppagol –U15CH21S0035

Sudha Todal –U15CH21S0041

Shruti Munnoli –U15CH21S0043

Prashant Bedakihal –U15CH21S0046

Mahalaxmi Daddi –U15CH21S0062

Place: Sankeshwar

Date: 14|08|2024

S.S. Arts College & T. P. Science Institute ★ SANKESHWAR. 591313

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Last but not least my teaching faculty members of Chemistry Department for great inspiration to us.

Date: 14/08/2024

Place: Sankeshwar

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THE CHEMISTRY OF HEMOGLOBIN AND ITS CLINICAL SIGNIFICANCE

Introduction

Hemoglobin or haemoglobin symbolized as Hb or Hgb is the inorganic molecules which also have suspended particles. Suspended particles in blood are red blood cells (erythrocytes), white blood cells (leukocytes) and platelets. Blood without suspended particles is called blood plasma. Blood serum is obtained when fibrinogen, a particular protein is removed from plasma. The major blood constituents are shown in **Figure 1.** When blood is drawn and allowed to clot, a clear liquid (serum) licudes from the Hemoglobin or haemoglobin symbolized as Hb or Hgb is the iron-containing oxygen-transporting metalloprotein found in red blood cells (RBC) or erythrocytes of all vertebrates **[1]** (except Channichthyidae fish family) **[2]** and also in the tissues of some invertebrates. Hemoglobin is present in the RBC of the body. Each RBC contains approximately 280 million hemoglobin molecules. Chemically hemoglobin is a tetrameric globular protein consisting of two each of alpha and beta chains **[3]**.The alpha and beta chains are fixed by different loci and are differentially regulated during human development. Of the four chains of hemoglobin each encloses an iron-containing heme co-factor, which binds the oxygen. It is the main function of hemoglobin to capture oxygen from the lungs and deliver the same to all tissues for respiration, and in turn transport carbon dioxide back from tissues to lungs. One hemoglobin molecule can transport up to 4 oxygen molecules. In addition, hemoglobin also plays vital role in regulating blood flow and blood pressure.

Red blood cell (RBC) transfusion is one of the most frequently performed clinical procedures and therapies to improve tissue oxygen delivery in hospitalized patients worldwide. Generally, the cross-match is the mandatory test in place to meet the clinical needs of RBC transfusion by examining donor-recipient compatibility with antigens and antibodies of blood groups. Blood groups are usually an individual's combination of antigens on the surface of RBCs, typically of the ABO blood group system and the RH blood group system. Accurate and reliable blood group typing is critical before blood transfusion. Serological testing is the routine method for blood group typing based on hemagglutination reactions with RBC antigens against specific antibodies. Nevertheless, emerging technologies for blood group testing may be alternative and supplemental approaches when serological methods cannot determine blood groups. Moreover, some new technologies, such as the evolving applications of blood group genotyping, can precisely identify variant antigens for clinical significance. Therefore, this review mainly presents a clinical overview and perspective of emerging technologies in blood group testing based on the literature. Collectively, this may highlight the most promising strategies and promote blood group typing development to ensure blood transfusion safety.

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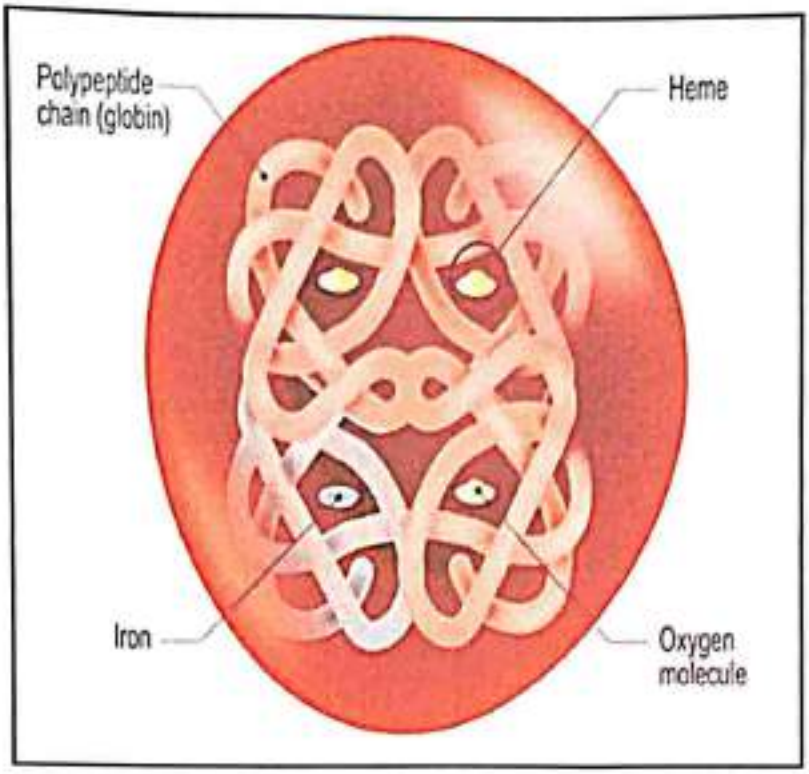

Figure 1: Structure of hemoglobin protein inside the red blood cell.

Blood group antigens in human red blood cells (RBC) can evoke immune antibodies capable of causing immune-mediated hemolysis. That is, blood group antigen testing is essential to save the lives of patients undergoing blood transfusion. Generally, a cross-match test is necessary to observe and assess the compatibility between donor and recipient blood groups before blood transfusion. Currently, there are 43 blood group systems containing 345 antigens for human RBCs recognized by the International Society of Blood Transfusion **[4]**. Working Party, which was established in 1980 in England, works in conjunction with the International Blood Group Reference Laboratory to develop a professional numerical terminology based on blood group genetics and plays a key role in ensuring patient safety in blood transfusion. A blood group system comprises inherited antigens by a single gene or a cluster of two or more closely linked homologous genes and is defined serologically by a specific antibody. The 43 blood group systems are genetically determined by 48 genes. A blood group system-associated number and symbol was terminology designated and maintained by the ISBT Working Party for Red Cell Immunogenetics and Blood Group Li and Guo Blood Group Testing Emerging technologies for blood group typing. Image created with BioRender.com. Terminology, for example, "001" and "ABO" for the ABO blood group system, "004" and "RH" for the RH blood group system. Patients who are awaiting transfusion, pregnant women, blood donors, etc., needed to be routinely tested for the ABO and RH (D) antigens, which are the essential antigens for ensuring patient transfusion safety. Blood transfusions may lead to hemolytic transfusion reactions without ABO and RH(D) compatibility testing. Testing for other blood

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group antigens, such as MNS, Lewis, Duffy and Kidd, is sometimes necessary for patients who harbor or are significantly likely to develop antibodies against these antigens. Correct blood group typing is critical for ensuring blood transfusion safety and is also essential for several clinical tests and research settings. Considerable advances have been made in recent years in identifying different blood groups and novel techniques have been developed for blood group testing. In this review, we have summarized the current blood group testing methods and discussed the clinical applications of novel typing techniques **[5]**.

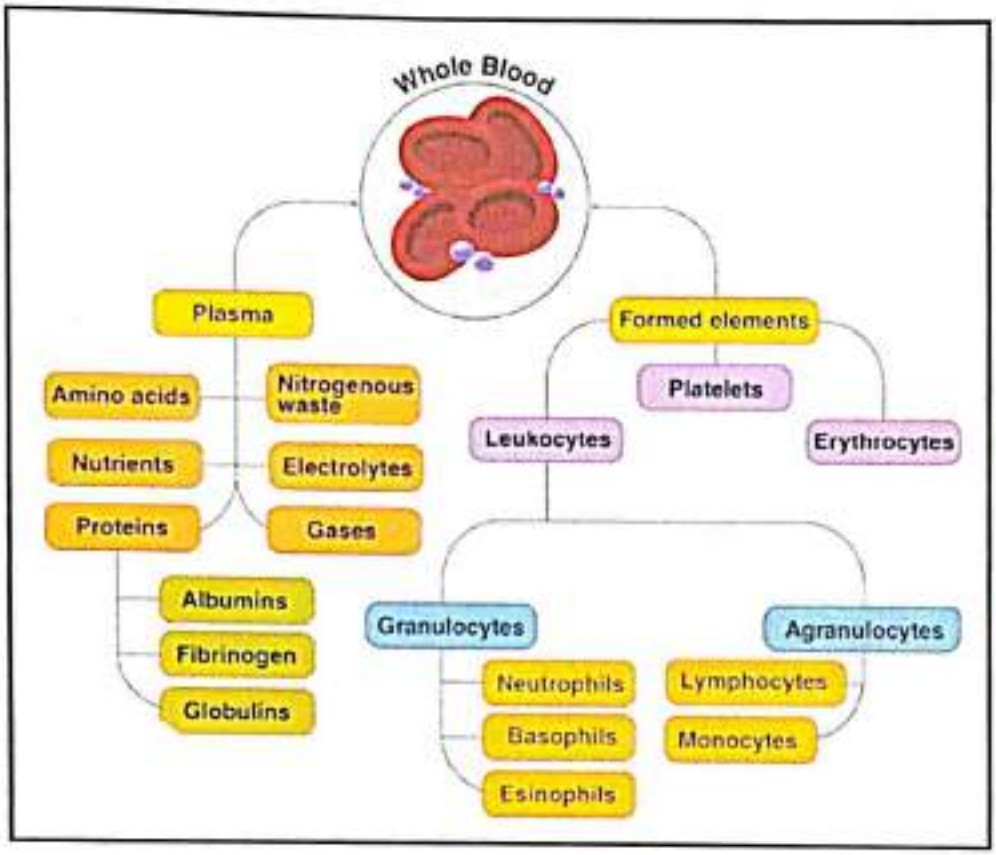

Figure 2: Different chemical constituents present in blood.

Constituents of Blood

The chemistry composition of blood is complex. It is an aqueous solution of ions and clotted. Plasma on the other hand separates the cells only when blood is prevented from clotting b. The blood clot is formed by a protein (fibrinogen) which is present in the soluble form in the plasma and which is transformed to an insoluble network of fibrous material (fibrin , the substance of the blood clot) by the clotting mechanism c. The change of fibrinogen into fibrin is caused by thrombin, which in fluid blood looks as prothrombin. The conversion of prothrombin depends on the action of thromboplastin and calcium.

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Anticoagulants: Clot formation may be prevented by a number of substances as well by vitamin K deficiency. Dicemerol, related to coumarin which comes from clover, inhibits prothrombin synthesis in the liver. It may be used clinically when there is danger of thrombosis by reducing clotting tendency.

Heparin: Heparin A sulphated polysaccharide which inhibits the formation of thrombin from prothrombin synthesis in the liver. It may be used clinically when there is danger of thrombosis by reducing clotting tendency. Heparin Heparin A sulphated polysaccharide which inhibits the formation of thrombin from prothrombin, is the most satisfactory, Anticoagulant, since it produced no change in the composition of the blood. However, oxalate and citrate have most widely used as they are cheaper. Use of more of these salts may bring appreciable changes in the distribution of water between the cells and plasma.

Potassium Oxalate: It has been most commonly used since it is more soluble. It acts by precipitating calcium ions as calcium oxalate.

Sodium citrate: Citrate dose not precipitate calcium but converts it to nonionized form. Citrated plasma is not as satisfactory as serum for calcium estimation. Ethylenediamine tetra acetic acid (EDTA) and its salts act by chelating calcium ions.

Sodium fluoride: It also acts as an anticoagulant but large amounts are required. For blood glucose estimation a mixture of sodium fluoride and potassium oxalate is used as fluoride acts as a preservative by inhibiting glycolytic enzymes.

Structure of hemoglobin

Hemoglobin was discovered by Hünefeld in 1840 **[6]** and its molecular structure was depicted by X-ray crystallography in 1959 by Max Perutz **[7].** Ever since the discovery of the relation between its structure and function by Max Perutz in 1978 after almost 20 years of research, hemoglobin is presently the most thoroughly understood protein thus far. The common hemoglobin molecule is the assembly of four globular protein consisting of two subunits, two alpha chains, each with 141 amino acids **[8]** and two beta chains, each with 146 amino acids **[9]**. Each subunit is composed of a protein chain tightly associated with a non-protein heme group. Each protein chain arranges into a set of alpha-helix structural segment connected together in a globin fold arrangement; this folding pattern contains a pocket that strongly binds the heme group. In this protein molecule, the globin portion is approximately 94% while the heme comprises of 6%.

A heme group consists of an iron (Fe) ion (charged atom) held in a heterocyclic ring, known as porphyrin. This porphyrin ring consists of four pyrrole molecules cyclically linked together by methene bridges with the iron ion being bound at the center. The iron ion, which is the site of oxygen binding, coordinates with four nitrogens atoms in the center of the ring, all of which lie in one plane.

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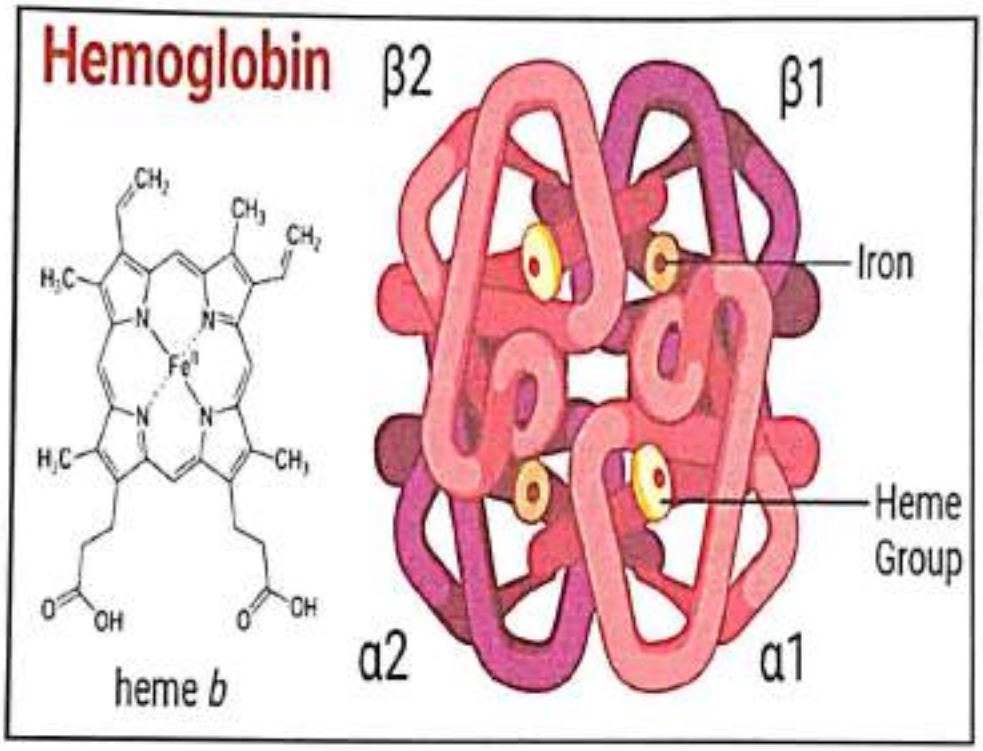

Figure 3: Chemical Structure of Heme protein – Hemoglobin

The heme molecule contains the iron atom in ferrous (Fe^{2+}) state to allow the binding of oxygen. But if the iron is in ferric (Fe^{3+}) state then there is no binding of oxygen and it is known as oxyhemoglobin **[10]**. In this case the molecule is referred to as methemoglobin or ferrihemoglobin. When O_2 binds to the ferrous ion, all the forces get balanced equally and the iron is pulled back to the center. Hemoglobin exists either in relaxed state (R-state) or intense state (T-state) and in these forms they differ both in their structure and affinity for oxygen **[11]**. They also differ in the number and energy of the interactions between hemoglobin subunits. In the T-state, constraints between subunits oppose the structural changes resulting in ligand binding, whereas in the R-state, these constraints are released, thereby enhancing ligand-binding affinity. Both T and R states of hemoglobin.

Types of Hemoglobin

Based on the non-alpha subunits, normal hemoglobin is mainly of three types:

1. Haemoglobin A: It is the predominant type of hemoglobin accounting for about 95 to 98% of total adult hemoglobin. It contains two alpha subunits and two beta subunits.

2. Hemoglobin A2: It accounts for about 2 to 3% of total adult hemoglobin. It contains two alpha subunits and two gamma subunits.

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3. Hemoglobin F: It is the hemoglobin of fetuses and newborns and it is present in scanty amounts, below 1%, in adults. It contains two alpha subunits and two delta subunits.

Synthesis of hemoglobin

Synthesis of hemoglobin involves a complex series of steps. The heme part and globin part are synthesized separately [12.]. The heme part is synthesized in a series of steps in the mitochondria and the cytosol of immature red blood cells, while the globin protein parts are synthesized by ribosomes in the cytosol.

Heme synthesis

Heme is synthesized in a complex series of steps involving multi enzymes in the mitochondrion and in the cytosol of the cell. Synthesis of heme starts in mitochondrion with the condensation of succinyl CoA and glycine by aminolevulic acid (ALA) synthase [13] to form 5-aminolevulic acid. This molecule is transported to the cytosol where a series of reactions produce a ring structure called coproporphyrinogen III. This molecule returns to the mitochondrion where by an addition reaction protoporhyrin IX is produced. The enzyme ferrochelatase inserts iron into the ring structure of protoporphyrin IX to produce heme. This heme is strongly bound to the globin groups by histidine.

Functions of Hemoglobin

Hemoglobin is a vital protein in red blood cells that plays a crucial in transporting oxygen from the lungs to the body's tissues and carbon dioxide from the tissues to the lungs. Its unique structure and function enable it to bind and release oxygen efficiently, making it essential for life.

1. Hemoglobin is essential for transferring oxygen in your blood from the lungs to the tissues.
2. It impacts the red colour in blood etc.
3. Regulation of Blood pH and buffering function.
4. Other gases/Ion transport.
5. Carbon dioxide transport.

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Materials and methods:

Reagents used and their preparation.

The chemicals used in the determination of the haemoglobin are of laboratory grade, unless stated otherwise and kept under refrigeration at 0-10 °C temperature, until use. Double distilled water was used throughout the experiment.

The blood samples were collected from the volunteers after obtaining their consent and used immediately for performing the experiments. Freshly collected blood samples were used for all the experiments.

HCl solution is procured from Molychem, Mumbai, India. N/10 HCl solution is prepared by using concentrated HCl solution having the stock concentration of 11.34 N and diluted according to the requirement with distilled water.

Antigens A, B and D are procured from J. Mitra and co. private limited, New Delhi, India.

Leishman's stain solution (Eosin methylene blue compound) Labo research laboratory, a division of Labo cheme India. A few drops of the stain was mixed with two or three drops of blood and smeared on the surface of glass slide before the analysis.

Ethanol solution is procured from Changshu Hongsheng Fine chemical Co., Ltd changshu city, Jiangsu province, China.

Instruments

Optical microscope (10X) (Almicro, Ultra, Micro measures and Instruments, India) was used for the measurement of number of WBC cells using Leishman's stain solution.

Haemometer, (Superior Marienfeld, Laboratory glass ware, Germany) was used for the determination of concentration of haemoglobin in the blood samples in terms of mg/dL.

Experiment 1: Estimation of haemoglobin:

Aim: To estimate amount of haemoglobin in the blood sample by Sahil's Method **[14]**.

Principle: Heamoglobin is converted into stable acid haematin by addition of N/10 HCl. This concentrated solution is diluted with water till its colour density matches with that of standard.

Apparatus and Requirements:

- Sahil's Comparator
- Sahil's tube (haemoglobin tube)
- Sahil's pipette (haemoglobin pipette)
- Thin glass rod stirrer
- N/10 HCl and Distilled water
- Spirit Swab and Lancet
- Filter paper

Procedure:

- Take a clean and dry Sahil's tube and place it in the comparator
- With the help of dropper, add N/10 HCl upto 2 g mark on the percentage scale
- Under aspetic conditions prick the finger
- Wipe the first one or two drops of blood
- Obtain a good sized drop of blood and draw blood upto 0.02 mL (20mm3) mark.
- Avoid any air bubbles, if present, discard and repeat
- Dip the pipette immediately in Sahil's tube containing HCl and gently blow till the blood is expelled.
- Rinse the pipette immediately in Sahil's tube containing HCl and gently blow till the blood is expelled. Repeat rinsing twice or thrice.
- Mix the contents gently by stirring with glass rod.
- Place the tube in comparator and wait for 10 mins(during this time RBC's rupture and Hb is released which then reacts with HCl to form stable acid Haematin)
- Go on adding distilled water drop by drop and mix it till color matches with that of standard tinted glass against natural light source.
- When the colour of the solution matches, note down the lower meniscus reading.
- Express the haemoglobin content as _____ g per 100 mL.

Calculation:

- Haemoglobin level is = 12
- O_2 carring capacity = Haemoglobin in grams x 1.34

- =12 x 1.34
- =16.08 mL/100 mL of blood

- NOTE: 1 g of Hb carries 1.34 mL of O_2
- 1 g of Hb carries 3.34 mg of Fe.

Extensions of mendelism and genes, environment:

Multiple alleles: (gene polymorphism)

"When a single gene for a character occur in more than two alternative forms, occupying the same locus on homologous chromosomes it is called multiple allelism"

Example: ABO blood group in man

It was discovered by karl Landsteiner in 1901. He was awarded Nobel Prize in 1930 for his outstanding work on blood groups.

He categorized blood groups into 4 major types based on the presence and absence of antigens and antibodies.

In humans, blood contains components such as RBC, WBC plasma and platelets.

The term antigen (Ag) is used to describe any foreign substance or protein (glycoprotein) that can enter into our body and elicits a response by provoking the production of antibodies (Abs).

The blood type of a person depend on the presence of glycoproteins on the membrane of RBC which are called antigens or agglutinogens.

There are 2 main antigens and are represented by capital letters they are antigen 'A' and antigen 'B'.

A person having antigen A belongs to blood group 'A', A person having antigen 'B' belongs to blood group 'B', A person having both antigens 'A' and 'B' belongs to group 'AB' and A person who does not possess either antigen 'A' or 'B' belongs to blood group 'O'.

Antibodies: antibodies (Abs) are proteins produced by our body in presence to any antigen (Ag).

Antibodies are also known as agglutinins present in our plasma of the blood that are the opposite of the antigens Antibodies are always represented by small letters antibody 'a' and antibody 'b'.

Therefore a person belonging to blood group 'A' will posses antibody 'b', A person belonging to blood group 'B' will posses antibody 'a', A person belonging to blood group 'AB' will cannot afford to have either antibodies 'a' or 'b' hence there are no corresponding antibodies and A person belonging to blood group 'O' will have both antibodies 'a' and 'b'.

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Table 1: Identifying the blood types involving chemical interactions with respect to antigen and antibodies.

Blood types	Antigen	Antibodies
A	A	b
B	B	a
AB	AB	-
O	-	a and b

Rh Factor:

Apart from the four types of blood group mentioned above we are also aware that we could be Rh^{+ve} or Rh^{-ve}. 'Rh' stands for Rhesus factor or Rhesus antigen. The Rh antigen is similar to the antigen seen in the blood of the Rhesus monkey. Individuals possessing this antigen are said to be Rh^{+ve} those persons who do not possess this antigen are said to be Rh^{-ve}. The Rh factor was discovered by K. Landsteiner and A. S. Wiener.

Blood typing:

- To find out the blood group of an individual a simple test or blood typing is done in any laboratory.
- The blood test is based on the property of coagulation of blood when similar antigen and antibodies are brought together.
- To test the blood group antiserum is required.

[**Note**: preparation of antiserum: the antiserum is obtained by injecting the antigen into the blood of an animal such as guinea pig, rabbit or horse; the animals body will produce antibodies against the antigen after about 15 days the plasma is extracted , the , antibodies are harvested and stored]

- These are 3 antiserums are present namely antiserum 'A' antiserum 'B' and antiserum 'D'.
- 3 drops of blood taken on a clean and dry slide and named those 3 blood drops as A,B and D
- Add antiserum A,B and D to that of blood drops taken on a slide and named as A,B and D respectively.
- A clot formation or agglutination is seen when similar antigens and antibodies come together and blood type can be known.

[**Note**: Antiserum 'A' contains antibody 'a'.

Antiserum 'B' contains antibody 'b'

Antiserum 'D' is for Rh^{+ve}/Rh^{-ve}]

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- If clotting occurs in antiserum and antiserum D the person belongs to group A^{+ve}.
- If clotting occurs in antiserum A only then person belongs to blood group A^{-ve}
- If clotting occurs in antiserum B and antiserum D the person belongs to blood group B^{+ve}.
- If clotting only in antiserum B then person belongs to blood group B^{-ve}.

- If clotting occurs in all the 3 antiserum (A,B and D) then the person belongs to blood group AB^{+ve}.
- If clotting occurs in antiserum A and antiserum B only then person belongs to blood group AB^{-ve}.
- If clotting occurs in antiserum 'D' only person belongs to blood group O^{+ve}.
- If clotting, clumping or agglutination in all the 3 antiserum (A,B and D) then the person belongs to blood group O^{-ve}.

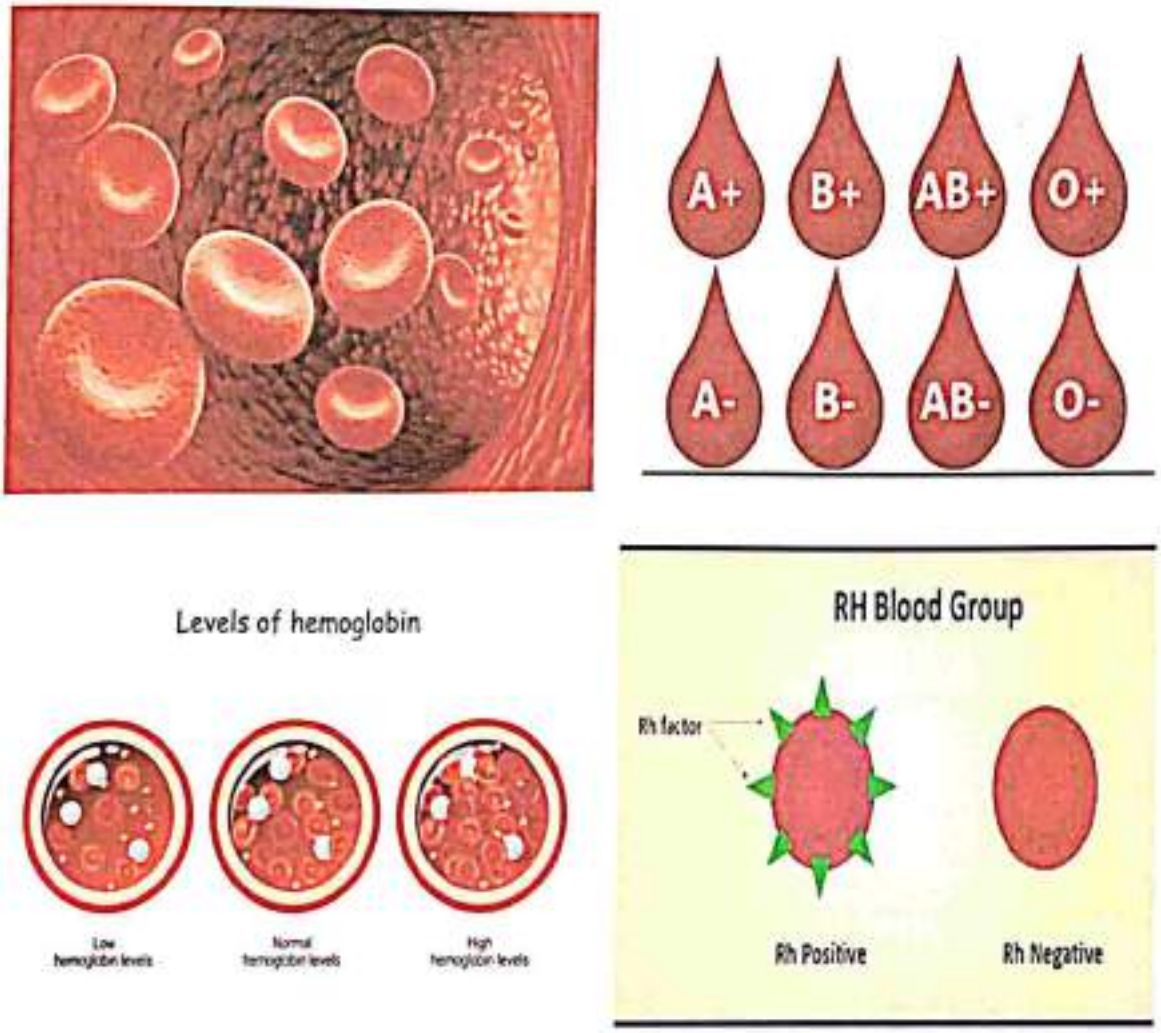

Figure 4: From the clockwise. 4A. Movement of RBCs inside blood veins. 4B. Types of Blood group. 4C. RH blood group. Different levels of Hb in RBCs.

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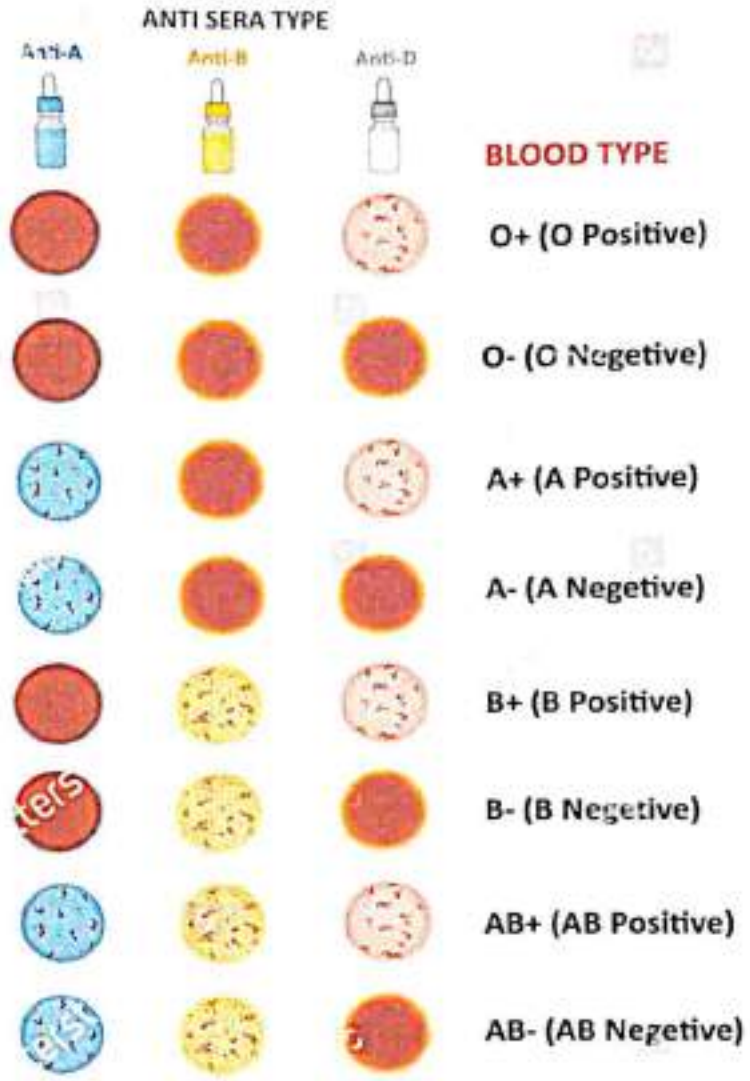

Figure 5: ABO Blood Grouping interpretation

Blood transfusion

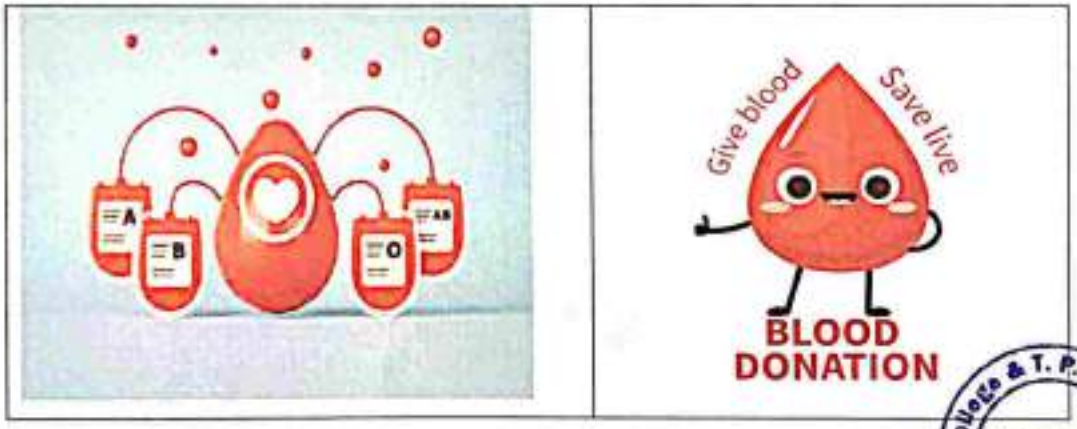

Figure 6: Blood transfusion.

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It is common to hear about requests made for specific type of blood like B^{+ve} or O^{-ve} etc. Over the radio or TV for patients undergoing surgery or who have met with an accident. Just like the A or B antigens, the Rh factor is equally important during blood transfusion.

A Rh-ve person can give blood to a Rh^{+ve} person but a Rh^{-ve} person should not receive blood from a Rh^{+ve} person. If the Rh^{-ve} person receives blood, from a Rh^{+ve} person the Rh antigen will provoke the production of antibodies against the Rh antigen.

Therefore, during transfusion, there should be a perfect match between the blood of the donor and the recipient. If the recipient is A^{+ve} it is best to find a A^{+ve} donor. A person who is O^{-ve} is thus a universal donor as he can donate blood to persons of all blood types. The people who are AB^{+ve} are universal recipients as they can receive blood from everyone.

Table 2: Blood match between donors and receivers.

Blood types	Can donate to	Can receive from
A^{+ve}	A^{+ve} and AB^{+ve}	A^{+ve}, A^{-ve}, O^{+ve}, O^{-ve}
A^{-ve}	A^{-ve}, A^{+ve}, AB^{-ve}, AB^{+ve}	$A^{-ve}$and O^{-ve}
B^{+ve}	B^{+ve}, AB^{+ve}	B^{+ve}, B^{-ve}, O^{+ve}, O^{-ve}
B^{-ve}	B^{-ve}, AB^{-ve}, B^{-ve}, O^{-ve}	B^{-ve}, O^{-ve}
AB^{+ve} (Universal recipient)	Only AB^{+ve}	A^{+ve}, A^{-ve}, B^{+ve}, B^{-ve}, AB^{+ve}, AB^{-ve}, O^{+ve},O^{-ve}
AB-ve	AB^{+ve},AB^{-ve}	A^{-ve},B^{-ve},AB^{-ve},O^{-ve}
O^{+ve}	A^{+ve}, B^{+ve}, AB^{+ve}, O^{+ve}	O^{+ve},O^{-ve}
O^{-ve}(Universal donor)	A^{+ve}, A^{-ve}, B^{+ve}, B^{-ve}, AB^{+ve}, AB^{-ve}, O^{+ve}, O^{-ve}	Only O^{-ve}

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Experiment 2: Differential count of White Blood Cell's

Aim: Determination of percentage of WBC's

Principle: A blood film stained with Leishman's Stain is examined for different types of white blood. Cell and the percentage distribution of these cells are then determined.

Apparatus:

1. Glass Slide
2. Leishman's Stain.
3. Microscope
4. Distilled water
5. Lancet
6. Spirit Swab

Composition of Leishman's Stain:

- Contains Eosin and Ethylene blue (in acetone free methyl alcohol).
- Methyl alcohol fixes the Smear on Slide (by Precipitating Protiens).
- Eosine Stains, Cytoplasm and basic granules.
- Methylene blue Stain d the nucleus and acedic granules.

Chamber for differential Count of cells (10X10)

N	N	N	M	N	B	N	L	N	L
N	M	E	N	N	M	N	M	M	M
E	N	L	N	L	N	L	N	L	L
L	L	N	M	E	M	N	B	M	N
N	L	N	N	N	L	N	L	N	L
E	N	M	M	B	N	N	L	N	N
E	L	N	L	N	L	N	L	N	L
N	E	L	N	M	N	N	E	N	L
L	N	N	N	L	N	N	L	M	L
N	L	N	L	N	M	N	L	N	E

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N = Neutrophil, **B**=Basophil, **E**=Eosinophil, **L**=Lympocyte, **M**=Monocyte

Procedure:

To make smear.

1. Take two grease free slides with smooth edges and select one as a spreader.
2. With a septic precautions prick the finger.
3. Place a medium sized blood drop near one end of slide (do not touch the slide).
4. With the left middle finger and thumb, hold the slide.
5. Place the edge of spreader just in front of blood group.
6. Draw the spreader back until it touches the drop of blood.
7. Let the blood spread over the edges of the spreader.
8. Maintain an approximate angle of 30-45^0 between the 2 slides.
9. Push the spreader to other end of the slide by smooth quick and uniform movement.
10. Prepare the second smear quickly by waving the slides in the air.

Note:

An ideal smear has thick area of head and gradually thin out at the body and tail end. It is tongue shaped with no windows or striations (longitudinal or transverse).

White blood cells

The number of the different varieties of WBC is expressed in percentage absolute count: It is the total number of particular type of WBC present in 1 cu.mm of blood, suppose the Total WBC count is 10,000 per cu.mm of blood & then

Absolute count = differential count %/100xTLC

1. Absolute Neutrophill count = 47/100 x 10,000 =47%
   = 4700 cells/cu.mm.
2. Absolute Monocyte count = 14/100 x 10,000 =14%
   = 1400 cells/cu.mm.
3. Absolute Basophils count = 3/100 x 10,000 =3%
   = 300 cells/cu.mm.
4. Absolute Lymphocytes count = 28/100 x 10,000 =28%
   = 2800 cells/cu.mm.
5. Absolute Eosinophills count = 8/100 x 10,000 = 8%
   = 800 cells/cu.mm.

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Clinical significance of hemoglobin:

The primary function of hemoglobin is to bind the oxygen from lungs and transport it to various parts of the body and in turn bring back carbon dioxide to lungs. Hemoglobin in its tetrameric state has got 4 iron molecules attached to globin group via a histidine molecule. Each iron molecule can bind with either one oxygen molecule or one carbon dioxide molecule. Thus each hemoglobin molecule at a time can transport four oxygen or carbon dioxide molecules. Hemoglobin combines with oxygen and carbon monoxide cooperatively. Very high hemoglobin concentration causes high blood viscosity, which results in compromised oxygen delivery to tissues and also creates cerebrovascular complications. Studies have also shown that a high maternal hemoglobin concentration leads to increased risk of poor pregnancy **[15].**

Reference ranges of hemoglobin

The hemoglobin level is measured in grams per deciliter. The normal ranges of hemoglobin levels are dependent on the age and gender **[16].**

Table3: Reference range of hemoglobin in human blood.

Age	Male (g / dL)	Female (g / dL)
New born	14.7–18.6	12.7–18.3
6 months – 2years	10.3–12.4	10.4–12.4
2 - 12 years	11.0–13.0	10.7–13.3
12 -18 years	11.0–13.3	10.9–13.3
> 18 years	10.9–15.7	10.7–13.5

Different conditions of haemoglobin in human beings

Diseases

When the hemoglobin levels in the blood deviate from its normal range then it leads to various kinds of diseases and these include

Lower hemoglobin level may be due to:

- Anemia
- Bleeding
- Bone marrow being unable to produce new red blood cells. This may be due to leukemia, other cancers, drug toxicity, radiation therapy, infection or bone marrow disorder.
- Chronic illness
- Chronic kidney disease
- Destructive of red blood cells
- Leukemia

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- Malnutrition
- Too little iron, folate, vitamin B12, and vitamin B6, in the diet
- Too much water in the body

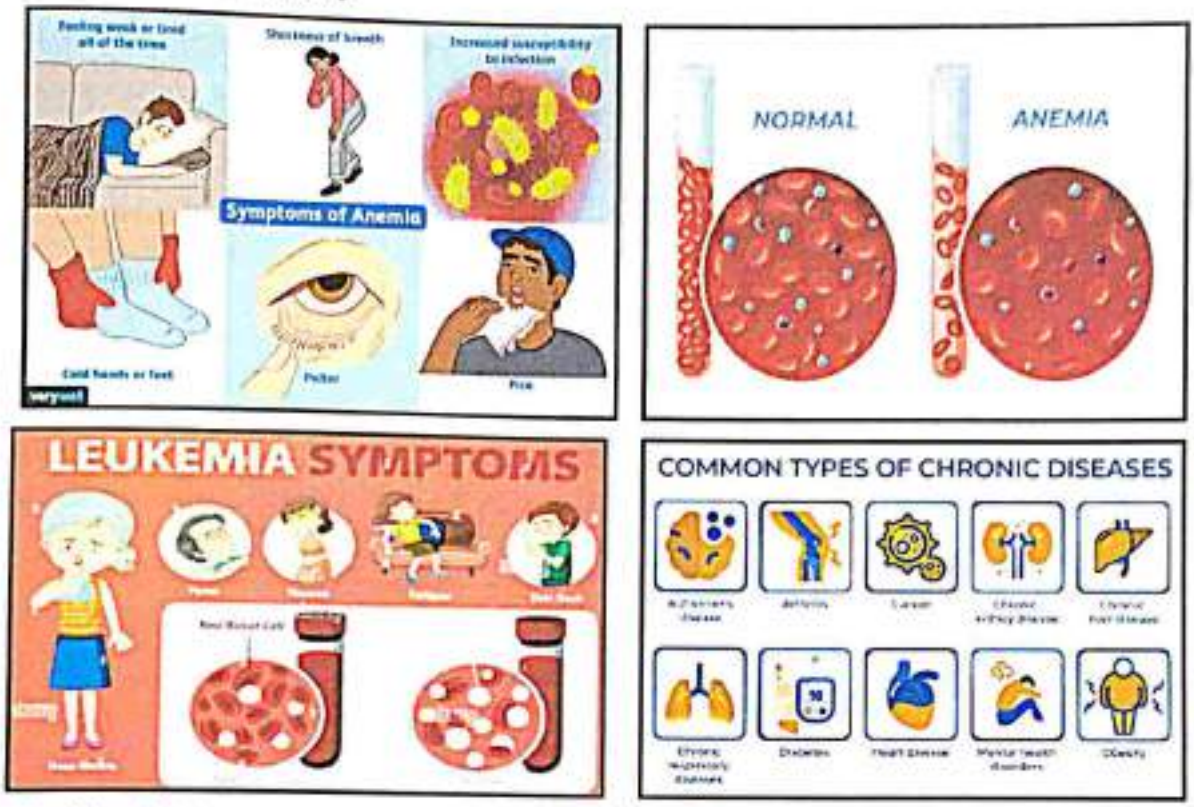

Figure 7: Variation in Hb content results in different types of medical symptoms.

The sources of hemoglobin include the following

- ❖ Iron-rich foods
- ❖ Vitamin A
- ❖ Foods rich in vitamin C
- ❖ Fruits
- ❖ Exercise

Higher than normal hemoglobin:

Higher hemoglobin level is most often caused by low oxygen levels in the blood. Present over a long period of time. Common reasons include:

- Bone marrow disease that causes abnormal increase in red blood cells
- Congenital heart disease
- Exposure to high altitude
- Failure of the right side of the heart
- Low levels of oxygen in the blood

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- Scarring or thickening of the lungs
- Too little water in the body.

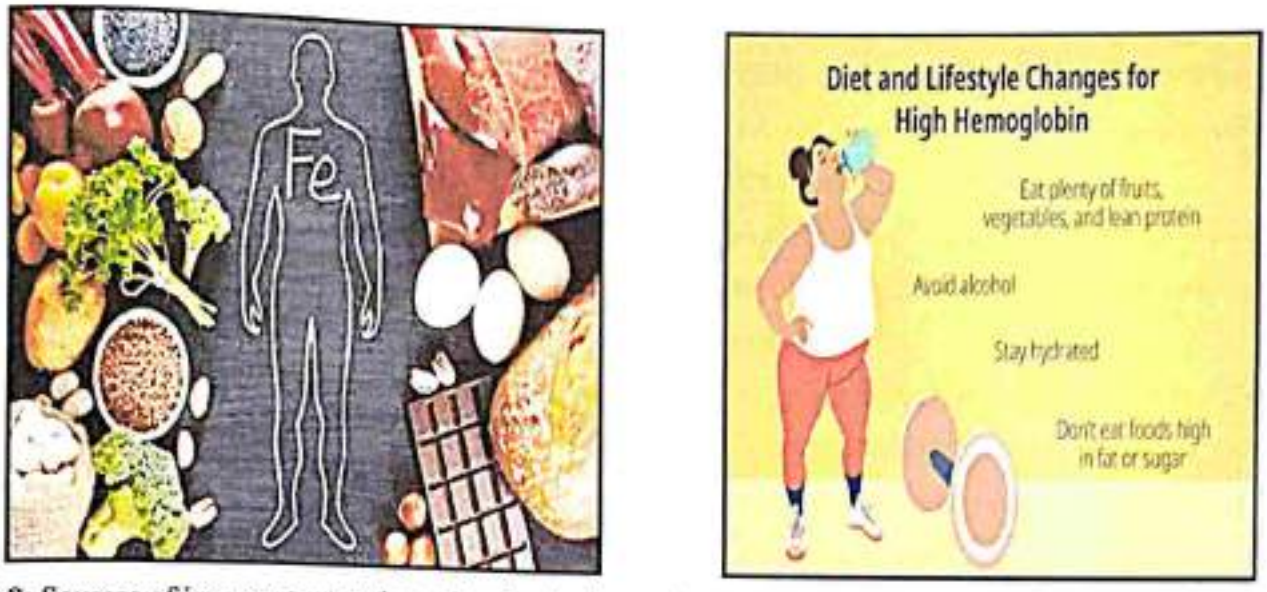

Figure 8: Sources of iron content and regular physical exercises helps its maintenance in human body.

How to prevent high hemoglobin count

You can't always prevent high hemoglobin. But you can lower your risk of developing high hemoglobin with a few lifestyle changes:

- Avoid using performance enhancing drugs.
- Eat a nutritious diet with plenty of fruits and vegetables
- Stay hydrated by drinking plenty of water and other liquids
- Quit smoking

Results and discussion:

Part 1: To estimate amount of haemoglobin in the blood sample by Sahil's Method.

A new colour scale has been devised for estimating haemoglobin levels by matching the blood sample with ten levels of haemoglobin (3, 4, 5, 6, 7, 8, 9, 10, 12 and 14 gldl) on the scale. Preliminary results show good correlations with spectrophotometric readings. The new device is being field tested and if the initial promise is confirmed, will provide a simple and reliable method for estimating haemoglobin where laboratory facilities are not available.

Causes of inaccuracy and imprecision

The main sources of error in the use of the haemo globin colour scales currently available are:

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(1) The colours of the printed scales vary between manufacturers and may not even look like blood at all, particularly at lower hemoglobin levels, perhaps because they were not prepared by matching with fresh blood.

(2) The absorbent papers supplied with these colour scales also show much variation and are unsuitable because: - the blood spreads unevenly and too widely, causing dilution of the colour; - the blood takes too long to be absorbed, especially at higher hemoglobin levels (from several seconds to many minutes), which is inconvenient for practical use; and - the paper is too thin and therefore very translucent when damp.

(3) The design of the hemoglobin scale booklets, with their absorbent papers in front and the colour scale at the back, makes it impossible to use them without light entering from behind the scale; the blood stains on the test paper, being damp and translucent, then become unmatchable.

(4) Even if the colour scale and the test and background papers are held close together, light is reflected from the white background through the damp blood stain, giving too bright a colour which cannot be matched.

(5) The circular apertures of 5-6 mm diameter in the colour scales, through which the blood stains are viewed, are too small to permit proper matching because the margin casts a shadow.

Development of a new method

By eliminating, as far as possible, the identified sources of error it proved possible to develop a de vice and colour scale with absorbent papers that gave reproducible results and an acceptable degree of accuracy.

Practical features

It is essential that a device of this type should: be inexpensive and not require batteries, cuvettes, chemicals or maintenance; be reliable, durable and replaceable at low cost; be suitable for use also by relatively junior health staff (provided they are instructed in the method); allow the detection of mild, moderate or severe degrees of anemia (whatever the age, sex, state of pregnancy, or altitude); permit health staff to detect improvement or deterioration in individual patients following therapy; provide the basis for a set of guidelines for the recognition and management of anemia (especially where laboratory facilities are not readily available) in children, pregnant women, adults and those with malaria or other parasitic conditions (e.g., ancylostomiasis); and allow the identification of potential blood donors (i.e., those with hemoglobin levels at or above 12 or 14 g/dl, depending on national norms). The ten colour standards in the scale make it possible to achieve a fair degree of precision in estimating hemoglobin levels (0.5 g/dl) but the number could be reduced if desired, although this would increase the margin of error at some hemoglobin levels. Matching of test strips may be done from behind or at the side of the colour scale, depending on local lighting conditions. The design of the card ensures that it remains closed when not in use so as to reduce the risk of colours fading.

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Figure 9: SEM image of red blood cells.

Part 2: Determination of percentage of WBC's

How the Test is Performed?

A blood sample is needed.

A laboratory specialist takes a drop of blood from your sample and smears it onto a glass slide. The smear is stained with a special dye, which helps tell the difference between various types of white blood cells.

Five types of white blood cells, also called leukocytes, normally appear in the blood:

- Neutrophils
- Lymphocytes (B cells and T cells)
- Monocytes
- Eosinophils
- Basophils

A special machine counts the number of each type of cell. The test shows if the number of cells are in proper proportion with one another, and if there is more or less of one cell type.

How to Prepare for the Test?

No special preparation is necessary.

When the needle is inserted to draw blood, some people feel moderate pain. Others feel only a prick or stinging. Afterward, there may be some throbbing or slight bruising. This soon goes away.

Why the Test is performed?

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This test is done to diagnose an infection, anemia, or leukemia. It may also be used to monitor one of these conditions or to see if treatment is working.

Normal reference results

The different types of white blood cells are given as a percentage of all white cells:

- Neutrophils: 40% to 60%
- Lymphocytes: 20% to 40%
- Monocytes: 2% to 8%
- Eosinophils: 1% to 4%
- Basophils: 0.5% to 1%
- Band (young neutrophil): 0% to 3%

What abnormal results mean?

Any infection or acute stress increases your number of white blood cells. High white blood cell counts may be due to inflammation, an immune response, or blood diseases such as leukemia. Abnormal or immature white blood cells may indicate leukemia or bone marrow invasion by cancer or infection.

It is important to realize that an abnormal increase in one type of white blood cell can cause a decrease in the percentage of other types of white blood cells.

An increased percentage of neutrophils may be due to:

- Acute infection
- Inflammation
- Acute stress
- Eclampsia (seizures or coma in a pregnant woman)
- Gout (type of arthritis due to uric acid buildup in the blood)
- Acute or chronic forms of leukemia
- Myeloproliferative diseases
- Rheumatoid arthritis
- Rheumatic fever (disease due to an infection with group A streptococcus bacteria)
- Thyroiditis (a thyroid disease)
- Trauma
- Cigarette smoking

A decreased percentage of neutrophils may be due to:

- Aplastic anemia
- Chemotherapy
- Influenza (flu)

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- Radiation therapy or exposure
- Viral infection
- Widespread severe bacterial infection (sepsis)

An increased percentage of lymphocytes may be due to:

- Chronic bacterial infection
- Infectious hepatitis (liver swelling and inflammation from bacteria or viruses)
- Infectious mononucleosis, or mono (viral infection that causes fever, sore throat, and swollen lymph glands)
- Tuberculosis
- Lymphocytic leukemia (a type of blood cancer)
- Multiple myeloma (a type of blood cancer)
- Viral infection (such as mumps or measles)

A decreased percentage of lymphocytes may be due to:

- Chemotherapy
- HIV/AIDS infection
- Leukemia
- Radiation therapy or exposure
- Sepsis (severe, inflammatory response to bacteria or other germs)
- Steroid use

An increased percentage of monocytes may be due to:

- Chronic inflammatory disease
- Leukemia
- Parasitic infection
- Tuberculosis, or TB (bacterial infection that involves the lungs)
- Viral infection (for example, infectious mononucleosis, mumps, or measles)

An increased percentage of eosinophils may be due to:

- Addison disease (adrenal glands do not produce enough hormones)
- Allergic reaction
- Cancer
- Chronic myelogenous leukemia
- Collagen vascular disease
- Hypereosinophilic syndromes
- Parasitic infection

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Conclusion:

The present dissertation work enhanced not only the knowledge and but also different sets of skills required for the conduction of any scientific based project work is acquired. The following are the significant learning outcome of the project work.

- ✓ The art of reviewing a project work i.e., scientific based literature survey.
- ✓ Interpretation of the theoretical and experimental results and drawing probable conclusions.
- ✓ Research methodology and design.
- ✓ Literature review and critical analysis.
- ✓ Samples collection, data collection and analysis techniques.
- ✓ Explore a topic in-depth.
- ✓ Assessment, standardization or optimization of the suitable analytical method development and its validation details for the analysis and its determination for haemoglobin analyte.
- ✓ The art of experimental design and procedure involved in the analysis of haemoglobin content in the blood.
- ✓ Interpretation of results and drawing conclusions.
- ✓ Academic writing and communication skills.
- ✓ Time management and organization.
- ✓ Critical thinking and problem-solving prior to the analysis of the blood samples.
- ✓ Attention to detail and accuracy.
- ✓ Collaboration and teamwork.

By engaging in research article writing, one can gain a deeper understanding of our chosen topic, develop valuable skills.

The present work explores the determination of hemoglobin in blood samples, analysis of blood group, and the analysis of total counts of Hb.

Maintaining healthy hemoglobin levels is vital for overall well-being, as deficiencies can lead to anemia, fatigue, and other complications. Factors like diet, lifestyle, and genetics influence hemoglobin levels, emphasizing the importance of a balanced diet, regular exercise, and medical check-ups.

Hemoglobin is a remarkable molecule that deserves appreciation for its critical role is sustaining life. By understanding its significance and taking steps to maintain healthy levels, we can ensure optimal oxygen delivery and overall health.

Hemoglobin plays crucial role in the diagnosis of various medical conditions, including anemia, sickle cell disease, thalassemia, chronic kidney disease, diabetes, Blood transfusion.

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By analyzing hemoglobin levels, structure, and function, healthcare providers can diagnose and manage various medical conditions, ensuring timely and effective treatment.

By sahil's method it is conclude that,

- Since a good correlation has been obtained in the statistical analysis, we finally conclude that hemoglobin concentration determined by Sahil's method is as reliable automatic method.
- In the developing country like India, Sahil's method is used as common method for the estimation of hemoglobin.
- Since it is relatively inexpensive, simple to use, doesn't require electricity, and requires only small amount of blood it can be used as reliable method for hemoglobin estimation especially in rural areas and laboratories.
- Cheap and easy inaccurate and has subjective bias so it can be used for screening purpose but not diagnosis and follow-up of anemia.

By blood group test it is conclude that,

- There are many Antigens besides the major once (A,B and Rh).Many minor ones are not routinely detected during blood typing.
- If they are not detected,You may still have a reaction when receiving certain types of blood, even if the A,B and Rh antigens are matched.
- The results of blood typing will determine if you are type A, B, AB or O and if you are Rh- negative or Rh-positive.
- The results will tell the health care provider what blood or blood components will be safe for you to receive if necessary.

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Photo gallery –

Haemometer and its accessories

Optical microscope (10X)

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Determination of WBCs by stain method.

Smeared slide

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DEPARTMENT OF PHYSICS.

A Project Report On

"DEAD TIME OF GM - COUNTER"

Academic year 2023-24 submitted by B.Sc VIth Sem students.

Under the guidance of Prof. M. R. Patil sir.

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S. D. V. S. Sangh's

S. S. Arts College and T.P.Science Institute, Sankeshwar

CERTIFICATE

This is to certify that the following students of B.Sc-VI Sem have satisfactorily completed project course entitled "Dead Time of a Geiger Muller Counter"

Name of the Students	*Register Number*
1. Vishwas Barakale	*U15CH21S0034*
2. Miss. Sushmita Chougala	*U15CH21S0058*
3. Miss. Sahana Diwakar	*U15CH21S0077*
4. Miss. Nastayeen Athani	*U15CH21S0070*
5. Mr. Rahul Magadum	*U15CH210071*

Head of the Department

Head
Department of Physics
S.S. Arts College & T.P. Science Institute
SANKESHWAR

Principal

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GIEGER MULLER COUNTER:

(Determination of Dead time of G M Counter)

INTRUDUCTION:

Geiger Muller counter (G M counter), is an electronic device that detects and measures ionizing radiation like Alpha, Beta, and Gamma rays. It works by measuring the pulses produced when radiation particles pass through a gas -filled tube and cause ionization.

The GM counter is made up of a hollow metallic chamber that acts as a cathode, a thin wire anode, and a sealed window for radiation to enter. The chamber is filled with an inert gas at low pressure, like argon, and the anode is given a voltage of around +400 volts. When radiation enters the chamber, the charges ionize the gas, making it conductive. This produces electrons that are accelerated towards the anode, knocking more electrons off gas atoms and creating an avalanche effect.

The electrons eventually reach the anode, which is connected to a counter that counts them. The current flowing through resistance also generates a voltage spike that can be measured. This device used for the detection and measurement of ionizing radiation. It is mainly used for applications like the nuclear industry, radiological protection, radiation dosimetry, and experimental physics. It is one of the best devices for the detection of radiation.

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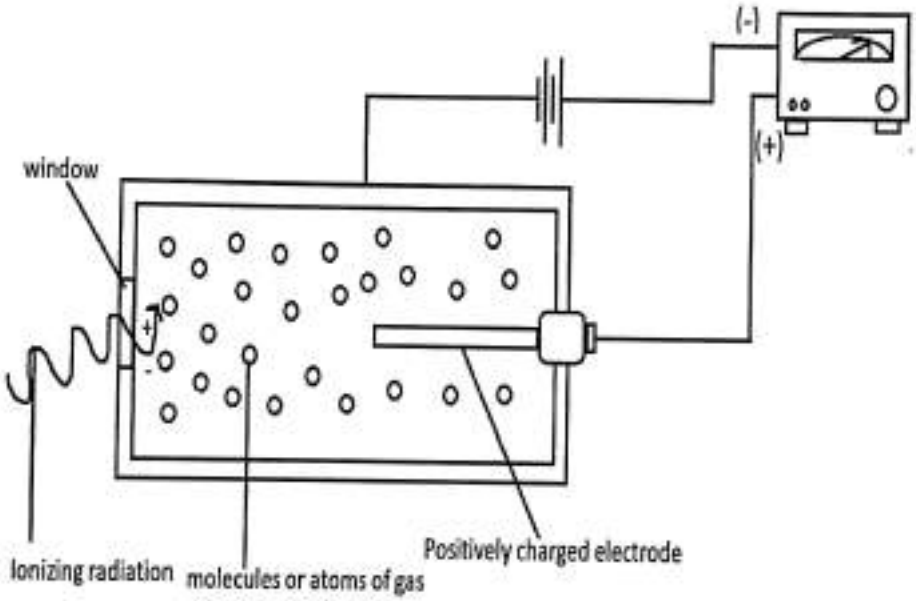
Principle:

Charged particle ionizes the gas through which they pass the electrons so produced during ionization get accelerated under high potential and further produce ionization.

Construction and working :



Geiger Muller counters which operate in the Geiger Muller are still one of the most widely used radiations detectors; through they were invented in the early part of the present century. They are used to record and count the arrival of the individual ionizing particles.

The GM counter consists of a cylindrical sealed glass tube of radius 2 to 3 cm enclosing a co axial metal cylinder serving as the cathode. Along the axis of the cylinder is stretched. A very thin metal wire, usually of tungsten

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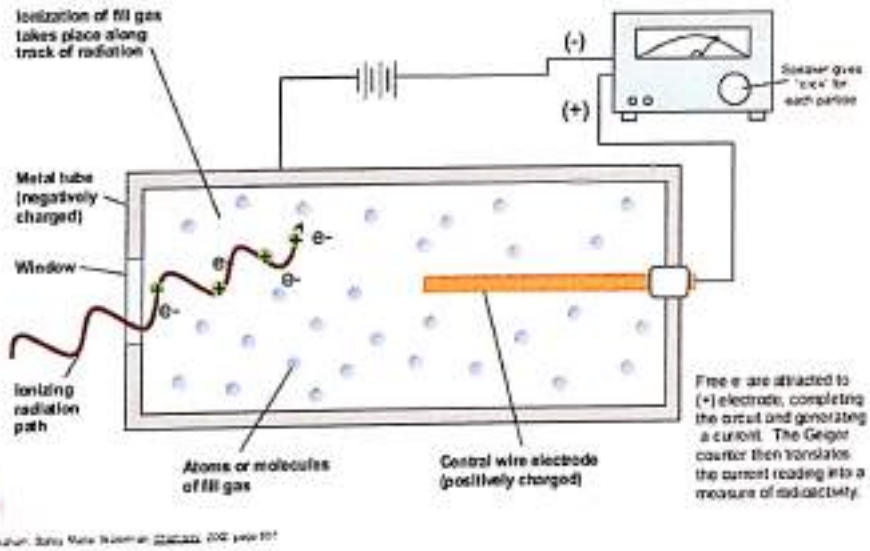
(diameter 0.1mm) which serves as the anode. Electrical connections are provided by metallic leads sealed through the glass tube. The tube is filled with an inert gas like argon mixed with the vapour of some volatile compound like ethyl alcohol (quenching vapour) in the ration 10:1 at a total pressure of 10cm of mercury.

The potential difference between the anode and cathode of these tubes is usually around 1000 volts. In some counters neon gas mixed with traces of a halogen, Eg. Bromine, as the quenching vapour is used the total gas pressure in these is lower and potential difference required for their operation is also much lower. (300 to 400 volts).

Geiger Counter



The gases used must be free of electro-negative impurities (Eg. oxygen,

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water vapours, CO_2 etc) since these tends to form negative ions which will move slowly towards the cathode and will initiate secondary avalanches. Since the ionizing radiations must enter the counting gas to be detected, only those able to penetrate through the glass wall of the counter (thickness 1mm) can be detected and recorded by the above type of counters Eg. Gamma rays, high energy muons in the cosmic rays etc. For counting less penetrating radiation Eg. Alpha or Beta rays a thin q window W made of mica or other material must be provided at one end through which they can enter the counter gas.

Because of the cylindrical geometry, the electric field $x \alpha 1/r$ given by equation. So the field is very high near the surface of the central wire. The Townsend avalanche created due to this high field near the central wire by a single original electron can now trigger a second avalanche at some other point within the GM tube. This gives rise to what is known as the Geiger discharge. The second avalanche is triggered due to the emission of UV charges during the de-excitation of the excited gas molecules within the first avalanche. These photons, in reaching the cathode surface, emit photoelectrons, which while moving towards the central wire initiates the second avalanche.

The absorption of the UV charges may also occur in the gas of the counter,

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this second avalanche can then initiate a third avalanche by exactly the same mechanism, which in turn may initiate yet another avalanche, and so on. Thus in the Geiger discharge , a single electron formed in the initial ionizing event produces repeated no of avalanches within very short time. This gives raise to a dense envelop of electron pairs immediately surrounding the central wire throughout its entire length independent of the initial ionizing event. The electrons are very quickly collected by the anode wire. The positive ions being heavy, do not move appreciably during this time and remain in the immediate vicinity of the central, producing a space charge sheath surrounding the former. This reduces the field near the central wire which lowers the gas multiplication, ultimately stopping the process of Geiger discharge.

For a given voltage on the anode, the voltage pulse produced at the anode is determined by the space charge collected around the anode wire to stop the discharge. It does not depend on the size of the primary ionization and is determined by the applied voltage. The voltage pulse produced at the anode raises very rapidly during the time the electrons are collected by the former. The positive ions being heavy then begin to move away slowly towards the cathode cylinder. They reach the cathode in the time 10^{-4}s where they can capture an electron from the former.

In the process, an amount of energy E_i-W usually in the form of an UV photon is liberated. If this exceeds w, an electron from cathode surface may

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be ejected by its absorption which then initiates another Geiger discharge. Thus repeated Geiger discharge may be produced at intervals of 10^{-4}s which must be quenched for the counter to operate properly.

The large number of electrons collected at the anode, charges of the latter along with the other distributed capacitance connected between the anode and the positive terminal of the supply voltage. The flow of negative charge through R gives rise to a momentary electric current which produces the potential drop IR across R. This sudden change of potential at the anode appears as voltage pulse which is amplified and recorded. The rate of the ionizing radiation at the counter can thus be counted.

THEORY OF G.M. COUNTER

The ionization effect of the radiation used in the Geiger Muller (GM) tube is as means of detecting the radiation. The GM tube is a hallow cylinder filled with gas at low pressure. The tube has thin window made of mica at the one end. There is a central electrode in GM tube. A voltage supply is connected across the casing of the tube and the central electrode as shown in figure.

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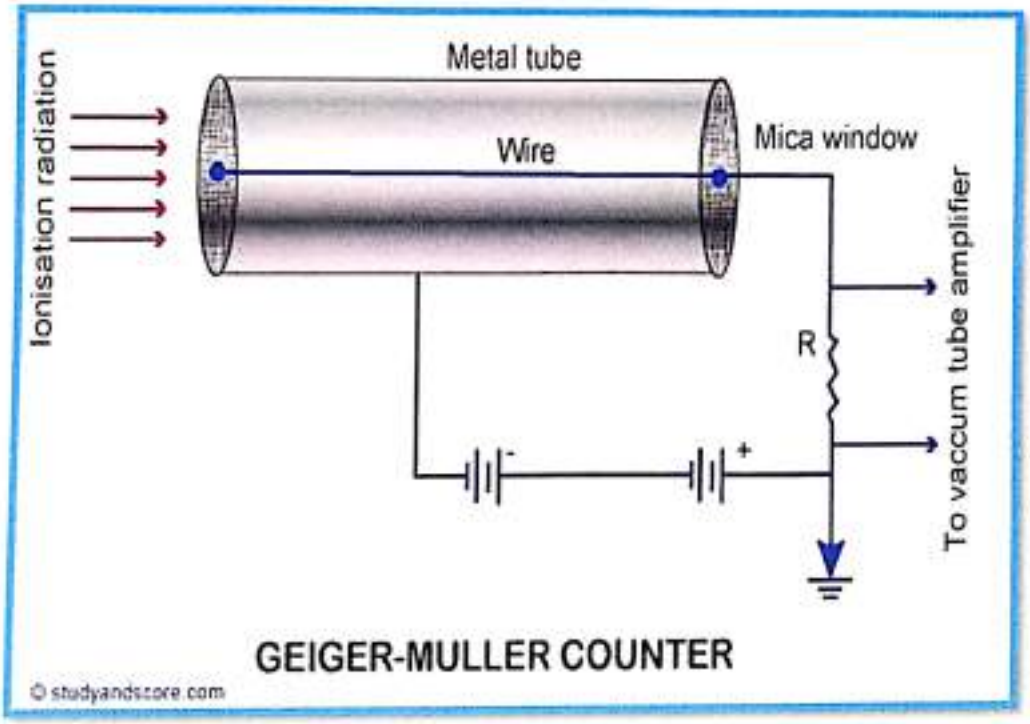

When alpha, beta and gamma radiation enters the tube it produces ions into the gas which enable the tube to conduct. A current is produced in the tube for the short time. The current produces a voltage pulse. Each voltage pulse corresponds to one ionizing radiation entering the G M tube. The voltage pulse is amplified and counted. The greater the level of radiation, the more ionization in the tube so the greater number of counts.

The GM tube counting the number of ionization may not provide a completely accurate reading, as the number of counts simply keeps increasing.

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The quantity activity gives an indication how the radioactive substance is. Radioactivity can be detected using Geiger Muller counter. When radiation enters the tube, atoms inside are ionized by the radiation. These ions are counted and shown as counts per seconds or counts per minute.

Radioactivity can be detected using Geiger Muller counter. When radiation enters the tube, atoms inside is ionized by the radiation. These ions are counted and shown as counts per seconds or counts per minute.

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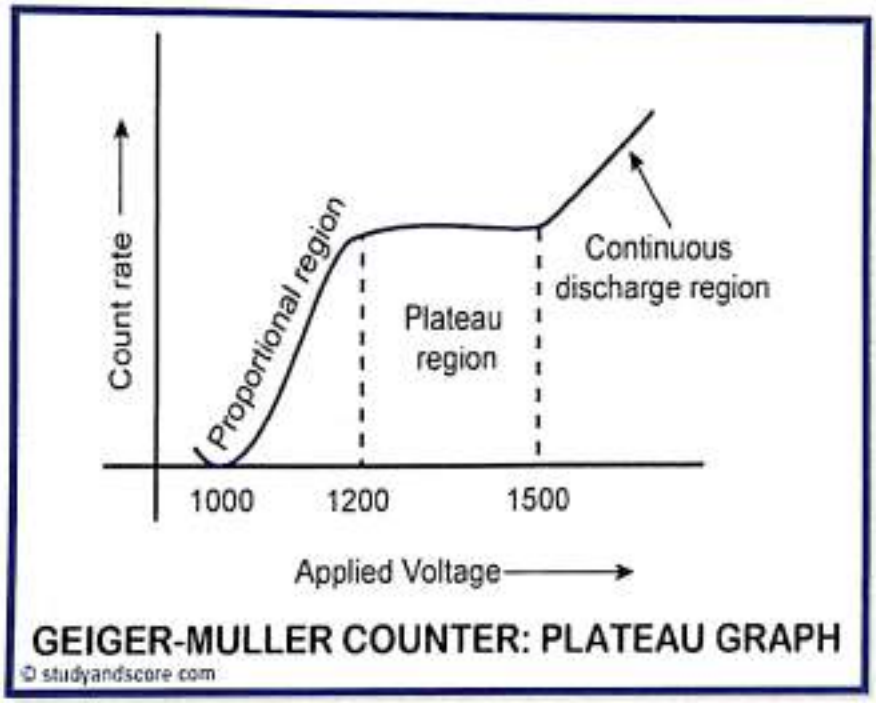
Characteristics of G.M. counter:



In order to decide the operating voltage of the GM tube, graph between applied voltage and count rate is plotted. The counting rate rises when and soon Geiger region is reached when pulses due to all ionizing particles become same size and are recorded. this is called Geiger threshold. When voltage is increased beyond the threshold the counting rate remains the same for large variation. This is the straight portion of the curve called Plateau region. This plateau continuous, till the excess potential over the threshold, called over voltage.

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Quenching of the discharge:

To quench the repeated discharge of the counter due to the production of fresh avalanches by positive ions arriving at the cathode, then the counter gas is usually mixed with organic vapour. During the travel of positive ions and the organic molecules towards the cathode. Then the argon ions are neutralized by collision with neutral alcohol molecules which are ionised in this process. The energy liberated in neutralization of argon ions is sufficient to ionise the alcohol molecules therefore argon has high ionisation potential than ethyl alcohol. In the reverse process, the positive ions of alcohol reach the cathode and get neutralized by capturing electrons from the cathode .this give rise to ejection of photoelectrons from the cathode to initiate the second Geiger discharge.

The excess of energy liberated during the neutralization of argon ions is in the form of UV radiation, is absorbed by alcohol vapour and hence does not eject any electrons from cathode to start another discharge. Due to dissociation of alcohol molecules, the counter has limited life. Counters using the mixture of an inert gas and Quenching vapour are called self Quenching.

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Advantages of G.M. counter:

- It counts the alpha, beta, gamma rays as well as cosmic rays.
- It has high sensitivity.
- Power supply need not be precisely regulated as the pulse height is constant over the large range.
- Because of the fact that output pulse is very high. So the amplification needed is also very subtle.
- Large output signal is produced from tube.

Disadvantages of G.M. counter:

- It cannot measure the energy of the radiation.
- Cannot measure the high radiation rates due to dead time.
- It cannot be detect unchanged particles like neutron.
- It is less efficient due to the large paralysis time limits and large dead time.
- Quenching agent used in this counter often de composes, leading to less life time of G.M. counter.

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Applications:

- Used for radiological protection.
- Used in radiation dosimetry.
- Used in nuclear industries.
- Used in physics laboratories for experiment.
- To check environmental levels of radioactivity.

Determination of the dead time of G.M. Counter by the two source method.

Aim:

The aim of the project is determination of parameter characteristics for the G. M .Counter, which is the dead time of the counter.

Apparatus:

G. M. counter with two source holder, Two radiation source Strontium and Cesium.

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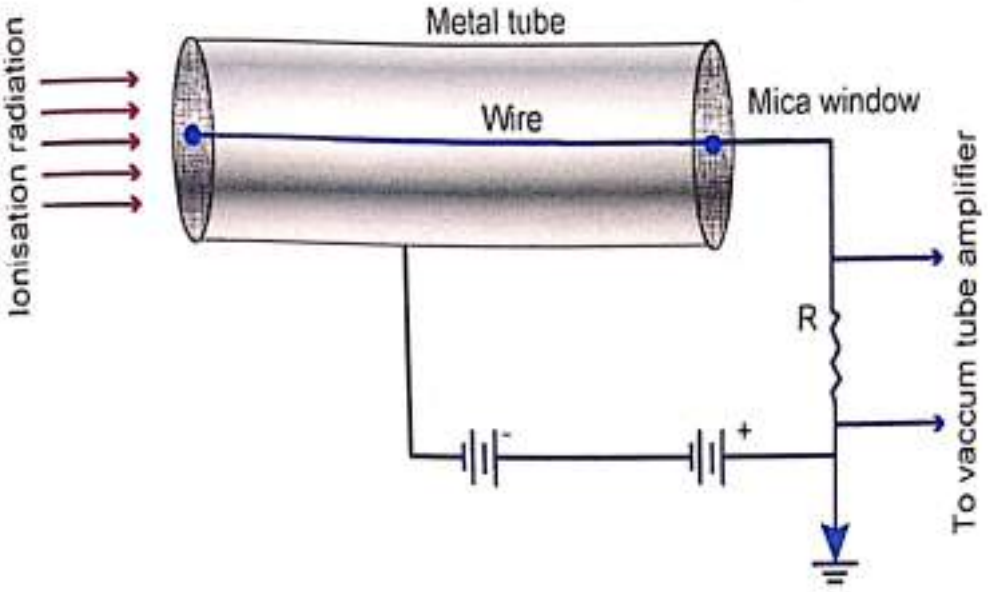

GEIGER-MULLER COUNTER

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Introduction:

In many problems of nuclear techniques it is important to determine the detector dead time. In practice, there are two types of detectors. "non paralyzable and paralyzable". For the first measurement of the dead time, there are two methods 'two source method [1,2] and the method of short lived single source [1]

Theory:

Two source method of detector dead time measurement involves measuring the count rates for two radioactive sources separately, and then measuring the count rate from both radioactive sources together. For non

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paralyzable detector is allows to easily determine the dead time

Symbols:

m = count rate recorded by a detector of the dead time τ.

n = count rate recorded by an ideal detector with zero dead time.

The following relationships occur

$$m = \frac{n}{1 + n\tau}$$

$$n = \frac{m}{1 - m\tau} \quad \text{---------- (1)}$$

The following indexes are added for the count rate symbols.

1 – Measurement for the first source,

2 – Measurement for the second source,

1,2 – Measurement for both sources together.

For the measurement procedure used to measure the dead time one can write equation.

$$n_1 + n_2 = n_{12} \quad \text{---------- (2)}$$

The count rate n can be replaced by expressions dependant on the respective count rate.

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$$\frac{m_1}{1-m_1\tau}+\frac{m_2}{1-m_2\tau}=\frac{m_{12}}{1-m_{12}\tau} \quad \text{---------- (3)}$$

After simple transformation quadratic equations form can be obtained

$$m_1m_2m_{12}\tau^2-2m_1m_2\tau+(m_1+m_2-m_{12})=0 \quad \text{---------- (4)}$$

The solutions to this equation are the two roots.

$$\tau'=\frac{1-\sqrt{\left(1-\frac{m_{12}}{m_1}\right)\left(1-\frac{m_{12}}{m}\right)}}{m_{12}} \quad \text{---------- (5)}$$

$$\tau''=\frac{1+\sqrt{\left(1-\frac{m_{12}}{m_1}\right)\left(1-\frac{m_{12}}{m_2}\right)}}{m_{12}}$$

Due to the physical interpretation, only the first root is correct, it can be represented as.

$$\tau=\frac{m_1m_2-\sqrt{m_1m\ (m_{12}-m_1)(m_{12}-m_2)}}{m_1m_2m_{12}} \quad \text{---------- (6)}$$

The equation (6) allows to determine the dead time of the detector based on the count rate measurements m_1,m_2 and m_{12}.

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Practical Readings:

Sources	Time of measurement t (s).	Number of counts C.
1	300	12076
1	300	11808
1	300	11772
1	300	11892
1	300	11831
2	300	236877
2	300	238999
2	300	239881
2	300	240479
2	300	240174
1,2	300	150212
1,2	300	151163
1,2	300	153026
1,2	300	154368
1,2	300	157296

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Calculations of dead time of GM Counter results.

$$\tau = \frac{12706*236877 - \sqrt{12706*236877(150212-12076)(150212-263877)}}{12706*236877*150212}$$

$$\tau = \frac{3009759162 - \sqrt{3009759162(138136)(-113665)}}{4.52101*10^{14}}$$

$$\tau = \frac{3009759162 - \sqrt{(3009759162)(-129366228440)}}{4.52101*10^{14}}$$

$$\tau = \frac{3009759162 + \sqrt{\left(3.009*10^{9}\right)\left(12.936*10^{9}\right)}}{4.52101*10^{14}}$$

$$\tau = \frac{3009759162 + \sqrt{22.4393*10^{18}}}{4.5210*10^{14}}$$

$$= 6657286371.2540*10^{9}*10^{-14}$$

$$= 2.540*10^{-6} S$$

$$\tau = 2.540\,\mu S$$

Calculated value of the dead time.
$5.2356\,\mu S$

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Accrediated at 'B++' by NAAC

PROJECT REPORT ON

ULTRASONIC VELOCITY OF NAI SOLUTION AND CMC SOLUTION BY ULTRASONIC INTERFEROMETER

Submitted by final B.Sc students

Miss Pratiksha R. Magadum , Miss Ankita A. Magadum

Miss Shivranjini Basalingundi , Miss Vidhya L. Badaganvi

Miss Shradha Ramesh Shinge

Guided by

Dr. Sunil Kumar Asst. Professor

Department of Physics

S.S Arts College and T.P Science Institute Sankeshwar

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S.S.ARTS COLLEGE AND T.P. SCIENCE INSTITUTE, SANKESHWAR

CERTIFICATE

DEPARTMENT OF PHYSICS

2023-24

This is to certify that **Miss Pratiksha R Magadum, Miss Ankita A Magadum, Miss Shivranjini Basalingundi, Miss Vidhya L. Badaganvi, Miss Shradha Ramesh Shinge** has satisfactorily completed project course entitled **"Ultrasonic velocity of NaI solution and CMC solution by Ultrasonic interferometer"**

Project Guide

HOD
Head
Department of Physics
S.S. Arts College & T.P. Science Institute
SANKESHWAR

Principal

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AKNOWLEDGEMENT

We have a great pleasure to express our heartfelt gratitude to my project supervisor Dr. Sunil Kumar Assistant Professor in Department of Physics of S.S Arts College & T. P Science Institute, Sankeshwar. For his excellent guidance and constant encouragement at all stages of the project work.

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Project Students

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Contents

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1. Introduction

Ultrasonic, thermo-physical and thermodynamic properties of liquid mixtures are of great significance in obtaining an in depth knowledge of inter and intra-molecular interactions, structural and physiochemical behavior and also in verifying various liquid state theories which attempt in estimating the properties of liquid mixtures.

Systematic study of thermodynamic properties of solutions with a new type of multi-frequency ultrasonic interferometer is done for precise measurement of the velocity of sound in liquids. The path length in the cell is varied by motion of a reflector, at the electrical reaction of the cell upon the oscillator is used to fix standing wave position at a standard frequency, and their locations are determined with a suitable cathetometer. An investigation in the possible change of thermodynamic properties of mixtures and their degree of deviation from ideality has been found to be an excellent quantitative way to elicit information about molecular structure and intermolecular forces in liquid mixtures. This has given impetus to the theoretical and experimental investigation of excess thermodynamic properties of liquid mixtures. Measurement of physiochemical properties such as density and ultrasonic velocity of pure components and their binary mixtures are being increasable used as tools for investigations of the properties of pure components and the nature of

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The study of thermo-physical and thermodynamic properties of liquid mixtures helps in obtaining in depth knowledge about molecular interactions.

Theory

- Ultrasonic interferometer is a simple and direct device which yields accurate and consistent data, from which one can determine the velocity of ultrasonic sound in a liquid medium with a high degree of accuracy. A crystal controlled interferometer (model 81D) supplied by Mittal Enterprises, New Delhi, operating frequencies 2 MHz and 5 MHz has been used to measure the ultrasonic velocity.
- Ultrasonic sound refers to sound pressure with a frequency greater than the human available range (20 hz to 20 khz). when an ultrasonic wave propagates through a medium, the molecules in that medium

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vibrate over short distance in a direction parallel to the longitudinal wave. during this vibration, momentum is transferred among molecule. This causes the wave to pass through the medium.

ltrasonic Interferometer

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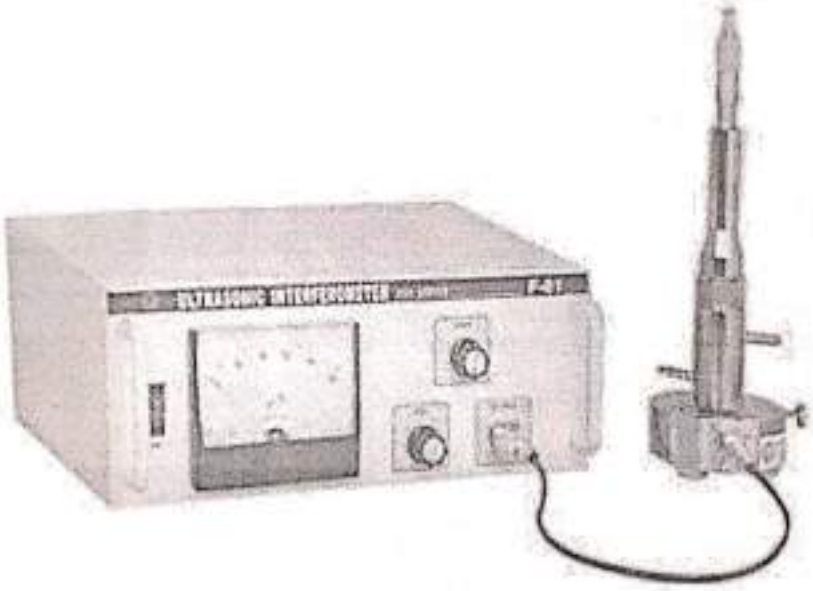

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- It is a simple in design, rugged and gives very accurate and reproducible results.
- Experiments may be performed over a wide range of temperature from 30 0C to +80 0C on all liquids except those which reacts with the plating of cell and crystal.

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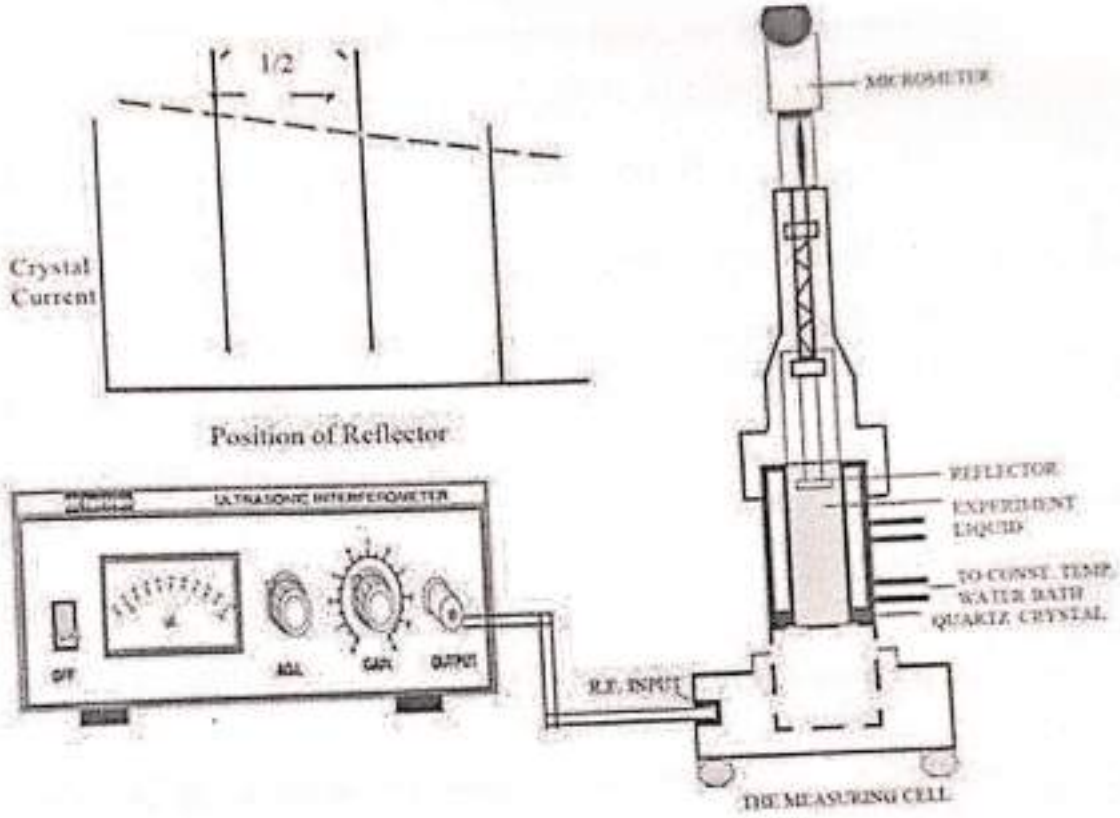
- Nearly 10 ml of experimental liquid is required.
- There is no danger of any change such as depolymerisation, due to ultrasonic effect since a very small ultrasonic energy is require.



Cross section of the liquid cell and graph plotted position of reflector versus crystal current.

In an ultrasonic interferometer, the ultrasonic waves are produced by the piezoelectric methods. At a fixed frequency variable path interferometer, the wavelength of the sound in an experimental liquid medium is measured, and from this one can calculate its velocity through that medium. The ultrasonic cell is consists of a double walled brass cell with chromium plated surfaces having a capacity of 10 ml. The double wall allows water

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circulation around the experimental liquid to maintain it at a known constant temperature. The micrometer scale is marked in units of 0.01 mm and has an overall length of 25 mm. Ultrasonic waves of known frequency are produced by a quartz crystal which is fixed at the bottom of the cell. There is a movable metallic plate parallel to the quartz plate, which reflects the waves. The waves interfere with their reflections, and if the separation between the plates is exactly an integer multiple of half wave length of sound, standing waves are produced in the liquid medium.

Under these circumstances, acoustic resonance occurs. The resonant waves are a maximum in amplitude, causing a corresponding maximum in the anode current of the piezoelectric generator.

2. Objectives

The primary objectives of this project are:

- To understand the working principle of an ultrasonic interferometer.
- To measure the velocity of ultrasonic waves in various liquid media.
- To calculate the adiabatic compressibility of the liquids.
- To analyze the effect of temperature and other variables on the ultrasonic wave velocity.

3. Apparatus and Materials

1. High-frequency generator

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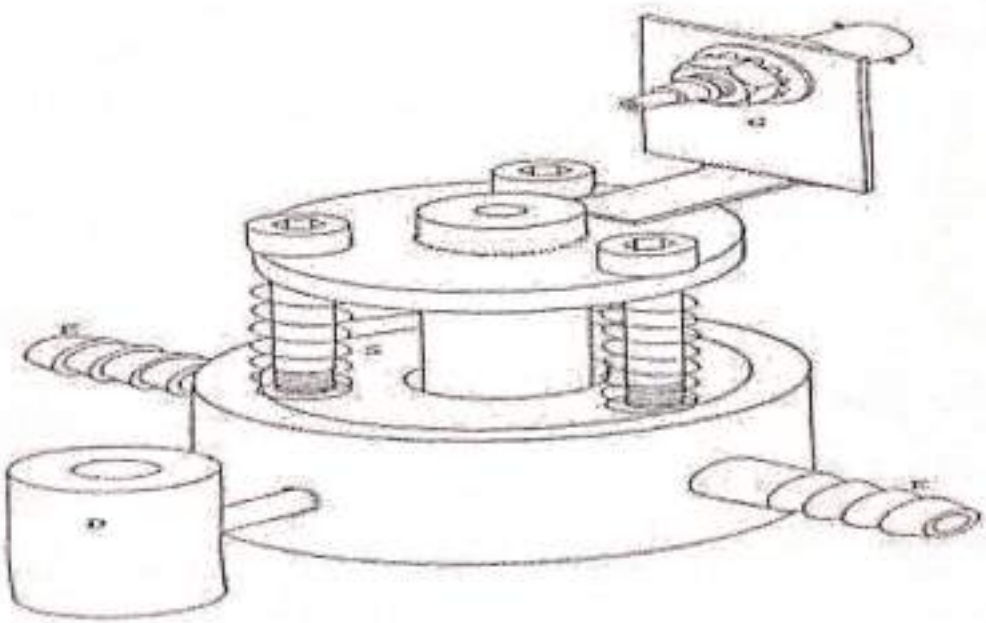
The measuring cell:

- Quartz crystal
- Movable reflector
- Micrometer screw gauge

. Constant temperature bath

. Liquids to be tested (water and glycerol)



Ultrasonic interferometer cell liquid mixtures

➢ **Constant temperature bath**

Construction

Constant temperature water bath is double walled in construction. The units are insulated with high grade glass wool/PUF.

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Technical Specification

Controlling System

Two separate imported microprocessors based auto tune PID controller with CE mark & dual display of set value & process value for precise control of temperature.

Heating System

SS tubular heaters (water immersion type) is used at the bottom for better heat distribution.

Water Circulation

The water circulation pump is provided for better uniformity of temperature instead of the stirrer. The side mounted circulating pump provides the minimum capacity of 15 ltr per min.

Liquids to be tested (NAI solution and CMC solution)

- **Sodium Iodide (NAI):**

Sodium iodide (NaI) is an inorganic compound commonly used in various applications such as medical imaging, radiation detection, and as a reagent in organic synthesis. Here are its physical and chemical properties:

Physical Properties:

- Molecular Formula: NaI
- Molar Mass: 149.89 g/mol
- Appearance: White, crystalline solid
- Odor: Odorless

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- Density: 3.67 g/cm³ (solid)
- Melting Point: 651°C (1204°F)
- Boiling Point: 1,304°C (2,379°F)
- Solubility in Water: Highly soluble; 184 g/100 mL at 25°C
- Solubility: Slightly soluble in ethanol; insoluble in acetone
- Refractive Index: 1.774
- Crystal Structure: Cubic

Chemical Properties:

- Ionic Compound: Sodium iodide is an ionic compound composed of sodium (Na^+) and iodide (I^-) ions.
- Hygroscopic: Sodium iodide is hygroscopic, meaning it readily absorbs moisture from the air, which can lead to the formation of a hydrate.
- Reactivity:
    - Reaction with Water: Dissolves readily in water, dissociating into Na^+ and I^- ions.
    - Reaction with Acids: Reacts with strong acids to release hydroiodic acid (HI).
    - Oxidation: Iodide ions can be oxidized to iodine (I_2) by strong oxidizing agents.

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- Stability: Stable under normal conditions, but can be oxidized to iodine upon exposure to air or light, especially in the presence of moisture.
- Thermal Decomposition: On heating, sodium iodide can decompose, particularly in the presence of moisture or light, leading to the release of iodine gas (I_2).

NaI is readily dissolvable in water, due to these exceptional features of NaI. NaI is used as Ultrasonic testing salt to determine the variation of ultrasonic velocity with salt concentration and temperature variation.

➢ **Carboxymethyl cellulose (CMC)**

Carboxymethyl cellulose (CMC) is a cellulose derivative widely used as a thickener, stabilizer, and emulsifier in various industries such as food, pharmaceuticals, and cosmetics. Here are its physical and chemical properties:

Physical Properties:

- **Molecular Formula:** Variable (dependent on the degree of substitution), commonly represented as $[C_6H_7O_2(OH)_{3-x}(OCH_2COOH)_x]_n$, where xxx is the degree of substitution.
- **Molar Mass:** Varies based on the degree of polymerization and substitution, typically ranging from 90,000 to 700,000 g/mol.
- **Appearance:** White or off-white powder or granules

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- **Odor:** Odorless
- **Density:** 0.6–0.9 g/cm³ (bulk density)
- **Solubility in Water:** Soluble; forms a colloidal solution when dissolved in water
- **Solubility:** Insoluble in most organic solvents such as ethanol, acetone, and benzene
- **Viscosity:** Varies depending on the degree of substitution and concentration; typically forms highly viscous solutions in water
- **pH:** Aqueous solutions typically have a pH range of 6.5–8.5
- **Hygroscopic:** Absorbs moisture from the air

Chemical Properties:

- **Polymeric Structure:** Carboxymethyl cellulose is a polymer derived from cellulose, where some of the hydroxyl groups (-OH) on the glucose units are replaced by carboxymethyl groups (-CH_2COOH).
- **Degree of Substitution (DS):** The degree of substitution refers to the average number of hydroxyl groups per glucose unit that have been replaced by carboxymethyl groups, typically ranging from 0.4 to 1.4.
- **Ionic Character:** CMC is an anionic polyelectrolyte due to the presence of carboxylate groups, which can dissociate in water, contributing to its solubility and ability to interact with other substances.

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- **pH Sensitivity:** CMC is stable over a wide pH range, but its solubility and viscosity can be affected by pH changes.
- **Reactivity:**
    - **With Acids and Bases:** CMC is stable in mild acidic and basic conditions but may degrade under strong acidic or basic conditions.
    - **Crosslinking:** CMC can be crosslinked with multivalent cations (e.g., calcium ions) to form gels.
    - **Biodegradability:** CMC is biodegradable under certain conditions, as it is derived from cellulose, a natural polymer.

These properties make carboxymethyl cellulose a versatile additive in various applications.

4. Working principle:

The principle used in the measurement of velocity (U) based on the accurate determination of the wavelength((λ) is in the medium. Ultrasonic waves of known frequency (f) are produced by quartz crystal fixed at the bottom of the cell. These waves are reflected by a movable metallic plate kept parallel to the quartz crystal. If the separation between these two plates is exactly a whole multiple of the sound wavelength, standing waves are formed in the medium. This acoustic resonance gives rise to an electrical reaction on the generator driving the quartz crystal and anode current of the generator become a maximum. If the distance is now increased or decreased and the variation is exactly one half wavelengths (λ/2) or multiple of it, anode current become maximum.

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The relation between wavelength and velocity

$$\text{Velocity} = \text{Wavelength} \times \text{Frequency}$$

$$U = \lambda \times f$$

Procedure:

1. Unscrew the knurled cap of cell and lift it away from double walled construction of the cell. In the middle position of it pour experimental liquid and screw the knurled cap. Wipe out excess liquid overflowing from the cell.

2. Insert the cell in the heavy base socket and clamp it with the help of a screw provided on its side.

3. Connect the high frequency generator with cell by coaxial cable provided with the instrument. In ultrasonic interferometer frequency selector knob should be positioned at desired frequency (same frequency as that of liquid cell chosen).

4. Move the micrometer slowly in either clockwise or anticlockwise direction till the anode current on the ammeter on the high frequency generator shows a maximum or minimum.

5. Note the reading of micrometer corresponding to the maximum or minimum (which is sharper) in micro ammeter. Take about 50 reading of consecutive maximum or minimum and tabulate them

6. Take average of all differences ($\lambda/2$).

7. Once the wavelength (λ) is known the velocity (U) in the liquid can be calculated with the help of the relation.

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5. Applications:

Ultrasonic interferometry is a precise and versatile technique used to measure the acoustic properties of materials. It has found widespread applications in various scientific and industrial fields due to its ability to provide detailed information about the mechanical properties of liquids, solids, and gases. This analysis explore the wide applications of ultrasonic interferometers, highlighting their importance in materials science,

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industrial processes, biomedical engineering, and environmental monitoring.

Ultrasonic waves can be categorized according to its frequency into two categories that are: (1) Low-frequency category which has frequency ranging from 20 to 1000 kHz. The applications of this category are used at high-power intensities in industrial applications, ultrasonic therapy, sono chemistry, and nanotechnology. (2)High frequency category which has a frequency above 1 MHz and is being used at low-power intensities for non destruc-tive quality checking.

Applications in Materials Science

1. **Characterization of Liquids and Solutions:**

Ultrasonic interferometry is widely used to study the acoustic properties of liquids and solutions. This includes measuring the sound velocity and attenuation to gain insights into molecular interactions, viscosity, and compressibility. Applications include the study of pure liquids, binary mixtures, and polymer solutions.

2. **Analysis of Solids:**

In solid materials, ultrasonic interferometry helps determine elastic constants, such as Young's modulus, shear modulus, and Poisson's ratio. These measurements are crucial for understanding the mechanical behavior of metals, ceramics, polymers, and composite materials under various conditions.

3. **Phase Transitions:**

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Ultrasonic interferometry is valuable for studying phase transitions in materials. By monitoring changes in acoustic properties, researchers can investigate phenomena such as melting, crystallization, and glass transitions, providing insights into the fundamental physics of these processes.

Industrial Applications

1. Quality Control and Non-Destructive Testing (NDT):

In industries such as aerospace, automotive, and manufacturing, ultrasonic interferometry is employed for non-destructive testing of materials and components. It can detect flaws, cracks, and voids within materials, ensuring structural integrity and safety without damaging the tested items.

2. Process Monitoring:

Ultrasonic interferometry is used to monitor industrial processes in real-time. For example, it can measure the concentration of solutes in solutions, monitor polymerization reactions, and control mixing processes. This helps optimize production processes, improve product quality, and reduce waste.

Biomedical Engineering

1. Medical Diagnostics:

Ultrasonic interferometry is a cornerstone of medical imaging techniques, such as ultrasound imaging. It provides detailed images of internal organs, tissues, and blood flow, aiding in the diagnosis of various medical conditions. Applications include obstetrics, cardiology, and oncology.

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2. Tissue Characterization:

Ultrasonic interferometry can assess the mechanical properties of biological tissues, such as elasticity and density. This information is valuable for understanding tissue health, diagnosing diseases, and developing medical treatments and implants.

Environmental Monitoring

1. Water Quality Assessment:

Ultrasonic interferometry is used to monitor water quality in environmental studies. It can detect contaminants, measure salinity, and assess the concentration of dissolved gases and particles. This helps in managing water resources and ensuring safe drinking water.

2. Air Pollution Monitoring:

In air quality monitoring, ultrasonic interferometry can detect airborne particles and gases. By measuring the acoustic properties of air, researchers can assess pollution levels and identify sources of contamination, contributing to environmental protection efforts.

Ultrasonic interferometer finds application in many other fields such as to measure fat layer thickness in live animals, to predict carcass traits as a livestock management part, and it has been used to improve homogenized milk quality. In addition, the ultrasonic application technology is utilized in the pest control that includes the expulsion or killing of insects.

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6. Results and discussion

Variation of Ultrasonic velocity with concentration of NaI

The velocity of ultrasonic waves in a solution is influenced by the physical and chemical properties of the solution, such as density, viscosity, compressibility, and intermolecular interactions. As the concentration of the solute in the solution changes, these properties are also altered, leading to a change in ultrasonic velocity.

There is a linear trend was observed between variation of salt concentration with ultrasonic velocity. This may be due to the fact that As the NaI salt concentration, the density of the water increases, which can lead to an increase in the ultrasonic velocity. This is because the solution becomes less compressible as the NaI particles occupy more space and interact more strongly with the water molecules. As the interaction between the solute and the solvent molecule increases the adiabatic compressibility decreases results in an increase in the speed of sound through the solution.

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Table 1. Variation of ultrasonic velocity with Concentration

Sl.No	Concentration	No. of oscillation	Screw gauge reading		D=d1-d2 (mm)	$\lambda = \frac{2D}{n}$ (m m)	V=λf
			D1(mm)	D2(mm)			
1	Pure water	5	1.13	1.86	0.73	0.29	1460
2	0.2	5	1.86	2.62	0.76	0.30	1520
3	0.4	5	1.54	2.31	0.77	0.30	1540

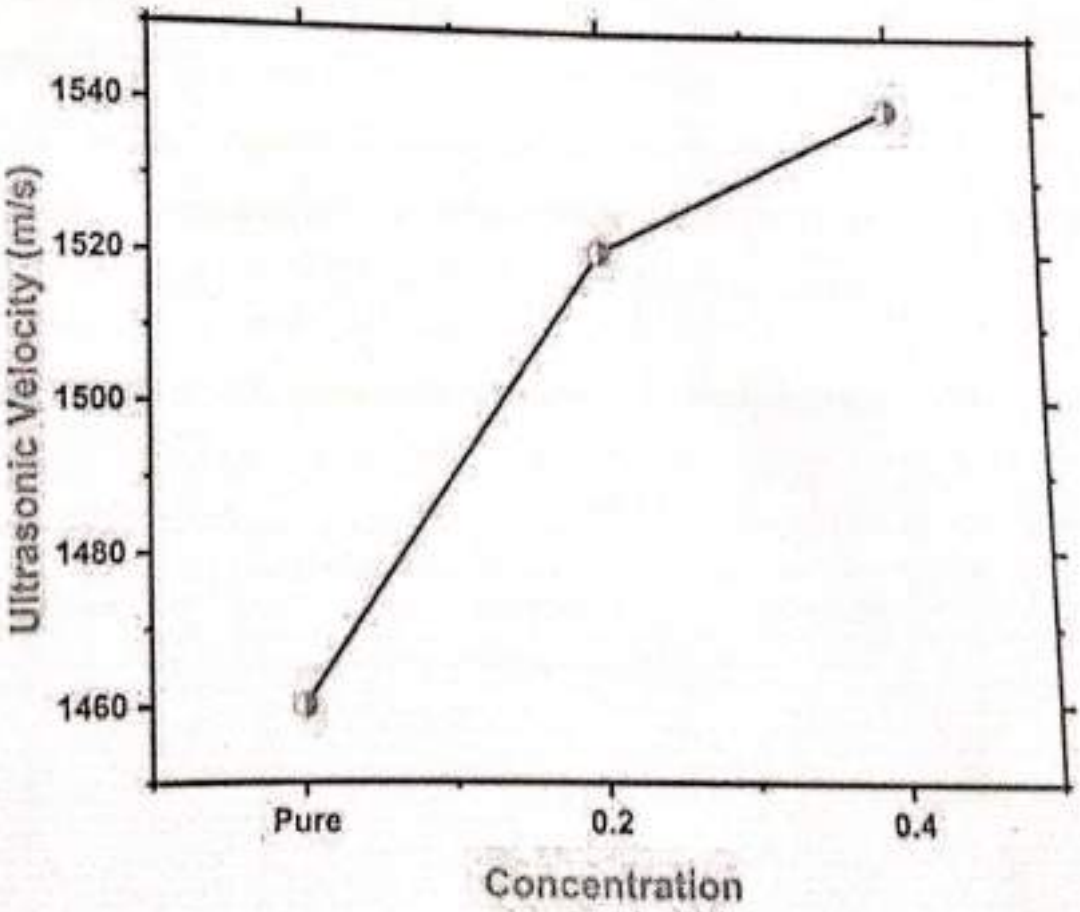

Figure 1. Variation of ultrasonic velocity with Concentration

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Variation of ultrasonic velocity with temperature

The ultrasonic velocity is more in CMC. It is due to the fact that CMC has high viscosity. Ultrasonic velocity of CMC (0.04 wt %) was 1500 m/s at 35°C. The ultrasonic velocity was decreased with increase in temperature for CMC. The ultrasonic velocity was decreased from 1500 to 1300 m/s with increase in temperature from 35 °C to 55°C respectively.

The ultrasonic velocity of CMC samples decreases with increase in temperature due to intermolecular free length.

By increasing the temperature, thermal energy increases and thus, intermolecular free length increases. The molecules at high temperature have high energy states and vibrate fast and therefore, ultrasonic waves can travel slower. The decrease in velocity with temperature in cmc might be due to chain length, thermal conduction and degree of unsaturation.

Table 2. Variation of ultrasonic velocity with temperature (CMC :0.04)

Sl.No	Temperature (K)	No. of oscillation	Screw gauge reading		D=d1-d2 (mm)	$\lambda=\frac{2D}{n}$(mm)	V=λf m/s
			D1(mm)	D2(mm)			
1.	35	1	0.45	0.6	0.15	0.3	1500
2.	45	1	0.8	0.94	0.14	0.28	1400
3.	55	1	0.7	0.83	0.13	0.26	1300

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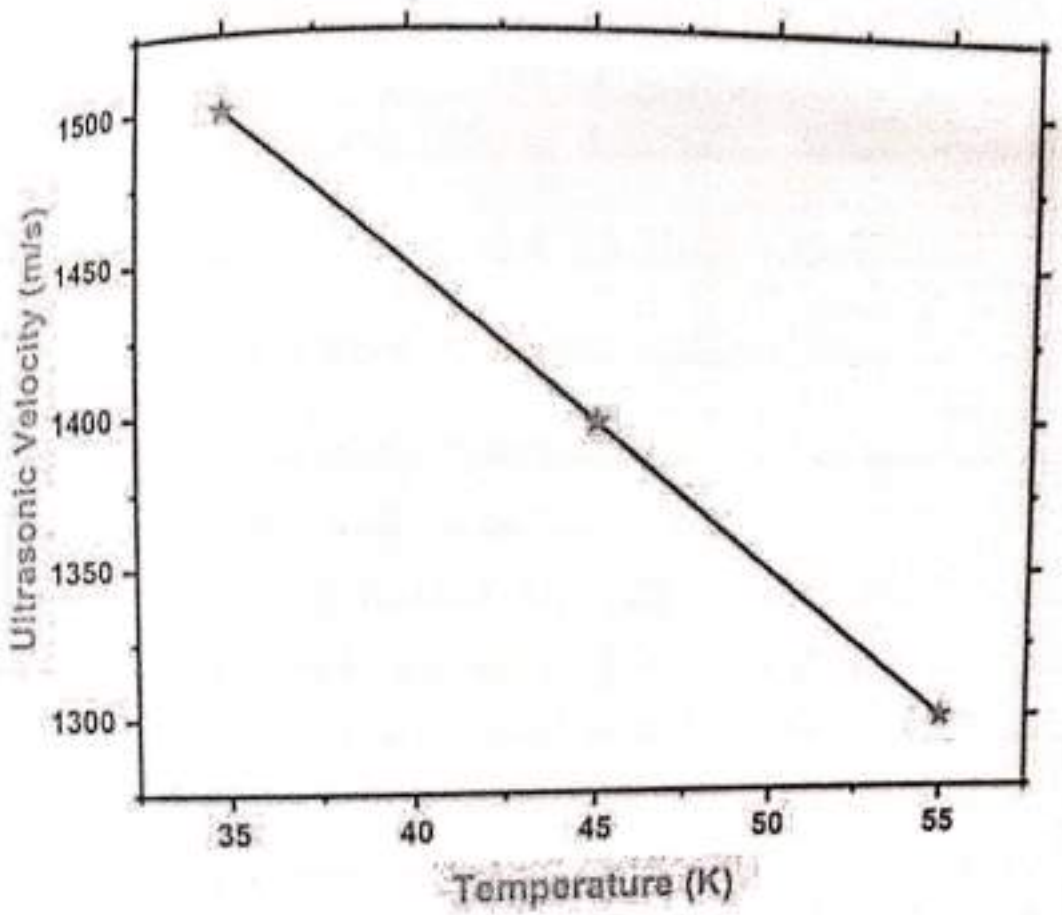

Figure 2. Variation of ultrasonic velocity with temperature (CMC :0.04)

7. Conclusion:

The ultrasonic interferometer is a well-known and advanced method in quality checking and other industrial applications. The ultrasonic interferometer method was successfully adopted to determine the sound velocity in different liquid samples (NaI and CMC). A linear variation of sound velocity with the variation of concentration of the salt and temperature was observed, which is in good agreement with the literature review. This type of research will help in various industrial applications especially in food processing and quality checking.

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S.S Arts College and T.P Science Institution Sankeshwar

Accrediated at 'B++' by NAAC

PROJECT REPORT ON

ULTRASONIC VELOCITY OF GLYCEROL AND WATER BY ULTRASONIC INTERFEROMETER

Submitted by final B.Sc students

Miss Preetika R Shettennavar,

Miss Priyanka Hiremath,

Mr. Rehan Jamadar

Guided by

Dr. Sunil Kumar Asst. Professor

Department of Physics

S.S Arts College and T.P Science Institute Sankeshwar

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S.S.ARTS COLLEGE AND T.P. SCIENCE INSTITUTE, SANKESHWAR

Physics Dept.

CERTIFICATE

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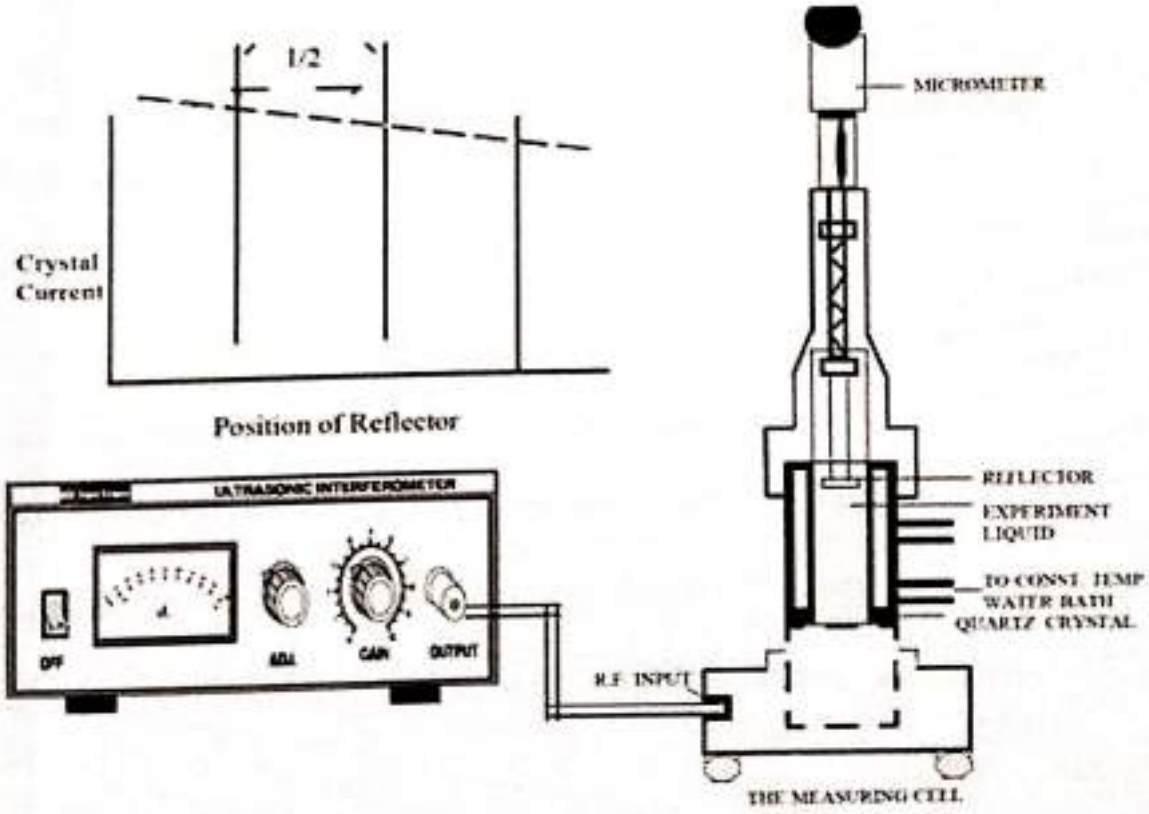

Cross section of the liquid cell and graph plotted position of reflector versus crystal current.

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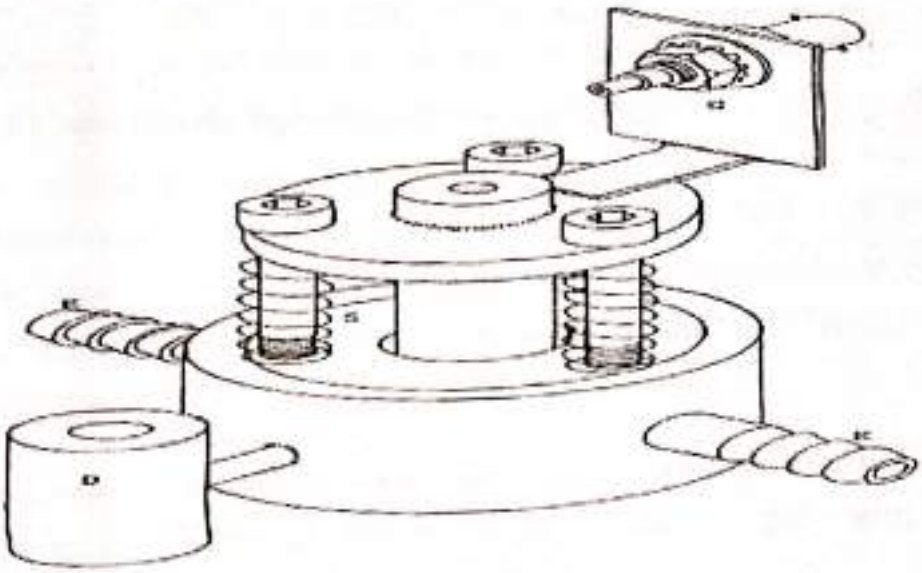

Ultrasonic interferometer cell liquid mixtures

➢ **Constant temperature bath**

Construction

Constant temperature water bath is double walled in construction. The units are insulated with high grade glass wool/PUF.

Technical Specification

Controlling System

Two separate imported microprocessors based auto tune PID controller with CE mark & dual display of set value & process value for precise control of temperature.

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Heating System

SS tubular heaters (water immersion type) is used at the bottom for better heat distribution.

Water Circulation

The water circulation pump is provided for better uniformity of temperature instead of the stirrer. The side mounted circulating pump provides the minimum capacity of 15 ltr per min.

- **Liquids to be tested (water and glycerol)**

Water: Water is an essential medium in ultrasonic interferometer experiments due to its well-characterized acoustic properties, efficient sound transmission, and sensitivity to temperature changes. Its role as a standard reference medium, coupled with its practical applications in various fields, underscores its importance in both fundamental research and applied science. Through careful control and calibration, water enables precise and reliable measurements that contribute to our understanding of acoustic phenomena and material properties.

Ultrasonic interferometry is a technique used to measure the velocity of sound waves in a medium, which can provide valuable information about the medium's properties, such as density, elasticity, and viscosity

Medium for Sound Propagation

1. Standard Reference Medium:

Water is often used as a standard reference medium in ultrasonic experiments due to its well-known and stable acoustic properties. The speed of sound in water at a given temperature and pressure is well-documented, making it an ideal baseline for calibrating ultrasonic instruments and comparing results across different studies.

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2. Efficient Sound Transmission:

Water is an excellent medium for transmitting ultrasonic waves because of its low acoustic attenuation and high transmission efficiency. This allows for precise measurements of sound velocity and other related parameters.

Temperature Control and Calibration

1. Temperature Dependence:

The speed of sound in water is highly sensitive to temperature changes. By carefully controlling the temperature of the water, researchers can achieve precise and reproducible measurements. This sensitivity also makes water a useful medium for studying the temperature dependence of ultrasonic wave velocity in other materials.

2. Calibration of Equipment:

Water's well-characterized acoustic properties enable it to be used for calibrating ultrasonic interferometers. Accurate calibration is essential for ensuring the reliability and accuracy of experimental results.

Investigation of Material Properties

1. Studying Liquid Properties:

Water serves as a model liquid for studying various properties such as viscosity, density, and compressibility. By measuring the velocity and attenuation of ultrasonic waves in water, researchers can gain insights into its molecular interactions and dynamic behavior.

2. Comparative Studies:

In experiments where the properties of different liquids or solutions are compared, water often serves as a reference. This comparative approach helps in

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understanding how additives, solutes, or changes in physical conditions affect the acoustic properties of the medium.

Practical Applications

1. Industrial and Medical Uses:

Ultrasonic interferometry involving water has practical applications in industries such as food processing, pharmaceuticals, and medical diagnostics. For example, measuring the ultrasonic properties of water-based solutions can help in quality control and formulation development.

2. Environmental Monitoring:

Water is also used in environmental monitoring applications. Ultrasonic techniques can detect contaminants or changes in water quality by analyzing variations in sound velocity and attenuation, providing a non-invasive and efficient method for water quality assessment.

Glycerol

Glycerol, also known as glycerin or 1,2,3-propanetriol, is a simple polyol compound with the chemical formula $C_3H_8O_3$. It is a colorless, odorless, and viscous liquid that is sweet-tasting and non-toxic. Glycerol is a crucial compound in various industries, including pharmaceuticals, cosmetics, food, and biofuels. This research paper explores the chemical properties, production methods, applications, and potential future developments of glycerol.

Chemical Properties of Glycerol

Glycerol is a tri hydroxy alcohol, meaning it has three hydroxyl (OH) groups attached to a three-carbon backbone. These hydroxyl groups confer several important properties:

1. Hygroscopicity:

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Glycerol is highly hygroscopic, meaning it readily absorbs water from the environment. This property is useful in applications where moisture retention is desired, such as in skin care products and food preservation.

2. Solubility:

Glycerol is miscible with water and alcohols but is insoluble in oils and non-polar solvents. This makes it a versatile solvent and humectant in various formulations.

3. Boiling and Melting Points:

Glycerol has a high boiling point of 290°C (554°F) and a melting point of 17.8°C (64°F). Its high boiling point makes it stable under a wide range of temperatures, and its relatively low melting point allows it to remain liquid at room temperature.

4. Chemical Reactivity:

The hydroxyl groups in glycerol can participate in numerous chemical reactions, including esterification, oxidation, and dehydration. This reactivity allows for the synthesis of a wide range of glycerol derivatives.

Glycerol

This paper explores the significance of glycerol in ultrasonic interferometer experiments, focusing on its acoustic characteristics, experimental methodology, and practical applications.

Acoustic Properties of Glycerol

Glycerol ($C_3H_8O_3$) has several properties that make it suitable for ultrasonic studies:

1. Viscosity:

Glycerol has a relatively high viscosity compared to water and many other liquids. This high viscosity affects the attenuation and speed of ultrasonic waves, providing valuable information about the molecular interactions within the liquid.

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2. Density and Elasticity:

The density of glycerol is higher than that of water, and it exhibits unique elastic properties. These characteristics influence the propagation of ultrasonic waves and can be precisely measured using interferometry.

3. Temperature Sensitivity:

The acoustic properties of glycerol are sensitive to temperature changes, making it an excellent medium for studying the temperature dependence of ultrasonic wave velocity and attenuation.

Ultrasonic interferometry of glycerol contributes to fundamental research in acoustics and material science. It helps develop new theories and models related to molecular interactions, viscosity, and elasticity in liquids.

4. Working principle:

The principle used in the measurement of velocity (U) based on the accurate determination of the wavelength(λ) is in the medium. Ultrasonic waves of known frequency (f) are produced by quartz crystal fixed at the bottom of the cell. These waves are reflected by a movable metallic plate kept parallel to the quartz crystal. If the separation between these two plates is exactly a whole multiple of the sound wavelength, standing waves are formed in the medium. This acoustic resonance gives rise to an electrical reaction on the generator driving the quartz crystal and anode current of the generator become a maximum. If the distance is now increased or decreased and the variation is exactly one half wavelengths ($\lambda/2$) or multiple of it, anode current become maximum.

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The relation between wavelength and velocity

$$\text{Velocity} = \text{Wavelength} \times \text{Frequency}$$

$$U = \lambda \times f$$

Procedure:

1. Unscrew the knurled cap of cell and lift it away from double walled construction of the cell. In the middle position of it pour experimental liquid and screw the knurled cap. Wipe out excess liquid overflowing from the cell.
2. Insert the cell in the heavy base socket and clamp it with the help of a screw provided on its side.
3. Connect the high frequency generator with cell by coaxial cable provided with the instrument. In ultrasonic interferometer frequency selector knob should be positioned at desired frequency (same frequency as that of liquid cell chosen).
4. Move the micrometer slowly in either clockwise or anticlockwise direction till the anode current on the ammeter on the high frequency generator shows a maximum or minimum.
5. Note the reading of micrometer corresponding to the maximum or minimum (which is sharper) in micro ammeter. Take about 50 reading of consecutive maximum or minimum and tabulate them
6. Take average of all differences ($\lambda/2$).
7. Once the wavelength (λ) is known the velocity (U) in the liquid can be calculated with the help of the relation.

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5. Applications:

Ultrasonic interferometry is a precise and versatile technique used to measure the acoustic properties of materials. It has found widespread applications in various scientific and industrial fields due to its ability to provide detailed information about the mechanical properties of liquids, solids, and gases. This analysis explore the wide applications of ultrasonic interferometers, highlighting their importance in materials science, industrial processes, biomedical engineering, and environmental monitoring.

Ultrasonic waves can be categorized according to its frequency into two categories that are: (1) Low-frequency category which has frequency ranging from 20 to 1000 kHz. The applications of this category are used at high-power intensities in industrial applications, ultrasonic therapy, sono chemistry, and nanotechnology. (2)High

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frequency category which has a frequency above 1 MHz and is being used at low-power intensities for non destruc-tive quality checking.

Applications in Materials Science

1. Characterization of Liquids and Solutions:

Ultrasonic interferometry is widely used to study the acoustic properties of liquids and solutions. This includes measuring the sound velocity and attenuation to gain insights into molecular interactions, viscosity, and compressibility. Applications include the study of pure liquids, binary mixtures, and polymer solutions.

2. Analysis of Solids:

In solid materials, ultrasonic interferometry helps determine elastic constants, such as Young's modulus, shear modulus, and Poisson's ratio. These measurements are crucial for understanding the mechanical behavior of metals, ceramics, polymers, and composite materials under various conditions.

3. Phase Transitions:

Ultrasonic interferometry is valuable for studying phase transitions in materials. By monitoring changes in acoustic properties, researchers can investigate phenomena such as melting, crystallization, and glass transitions, providing insights into the fundamental physics of these processes.

Industrial Applications

1. Quality Control and Non-Destructive Testing (NDT):

In industries such as aerospace, automotive, and manufacturing, ultrasonic interferometry is employed for non-destructive testing of materials and components. It can detect flaws, cracks, and voids within materials, ensuring structural integrity and safety without damaging the tested items.

2. Process Monitoring:

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Ultrasonic interferometry is used to monitor industrial processes in real-time. For example, it can measure the concentration of solutes in solutions, monitor polymerization reactions, and control mixing processes. This helps optimize production processes, improve product quality, and reduce waste.

Biomedical Engineering

1. Medical Diagnostics:

Ultrasonic interferometry is a cornerstone of medical imaging techniques, such as ultrasound imaging. It provides detailed images of internal organs, tissues, and blood flow, aiding in the diagnosis of various medical conditions. Applications include obstetrics, cardiology, and oncology.

2. Tissue Characterization:

Ultrasonic interferometry can assess the mechanical properties of biological tissues, such as elasticity and density. This information is valuable for understanding tissue health, diagnosing diseases, and developing medical treatments and implants.

Environmental Monitoring

1. Water Quality Assessment:

Ultrasonic interferometry is used to monitor water quality in environmental studies. It can detect contaminants, measure salinity, and assess the concentration of dissolved gases and particles. This helps in managing water resources and ensuring safe drinking water.

2. Air Pollution Monitoring:

In air quality monitoring, ultrasonic interferometry can detect airborne particles and gases. By measuring the acoustic properties of air, researchers can assess pollution levels and identify sources of contamination, contributing to environmental protection efforts.

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Ultrasonic interferometer finds application in many other fields such as to measure fat layer thickness in live animals, to predict carcass traits as a livestock management part, and it has been used to improve homogenized milk quality. In addition, the ultrasonic application technology is utilized in the pest control that includes the expulsion or killing of insects

6. Results and discussion

Temperature Dependence of Ultrasonic Velocity in Water

Water is a Universal solvent and it is used as a standard calibrating liquid for most of the experimental setup. Here in this experiment, water was subjected to measure ultrasonic velocity as a function of temperature.

The ultrasonic velocity was measured at temperature 30°C, 60°C and 65°C. The results show significant variation in velocity of sound with increase in temperature. The sound velocity increased with increase in temperature. The sound velocity at room temperature was 1500 m/s which is in good agreement with previously published research. With increase in temperature, the sound velocity increased to 1660 m/s. The observed results may be due to the fact that, the water density decreases with increase in temperature. This decreases the inertia of the water medium against motion of the sound waves. Therefore the ultrasonic velocity increases with increase in temperature.

Table 1. Temperature Dependence of Ultrasonic Velocity in Water

Sl.No	Temperature in(k)	No. of oscillation	Screw gauge reading		D=d1-d2 (mm)	$\lambda=\frac{2D}{n}$(mm)	V=λf
			D1(mm)	D2(mm)			
1.	30	5	16.11	15.36	0.75	0.300	1500
2.	60	5	3.04	3.80	0.76	0.304	1520
3.	65	5	11.09	11.92	0.83	0.332	1660

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Figure 1. Temperature Dependence of Ultrasonic Velocity in Water

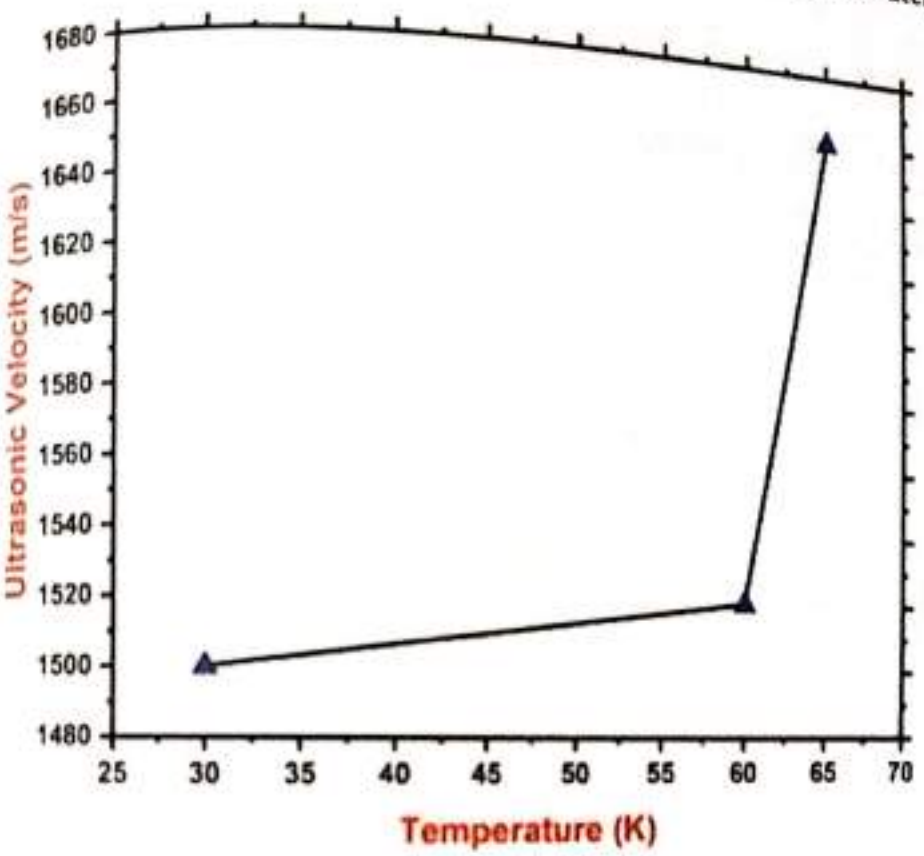

Table 2. Temperature Dependence of Ultrasonic Velocity in Glycerol

Sl.No	Temperature in °C	No. of oscillation	Screw gauge reading		D=d1-d2 (mm)	$\lambda=\frac{2D}{n}$(mm)	V=νf
			D1(mm)	D2(mm)			
1	30	5	1.49	2.48	0.99	0.396	1980
2	45	5	2.92	3.89	0.97	0.388	1940
3	50	5	4.32	5.27	0.95	0.380	1900
4	60	1	0.71	0.89	0.18	0.360	1800
5	70	1	0.28	0.12	0.16	0.320	1600
6	80	1	1.03	1.17	0.14	0.280	1400

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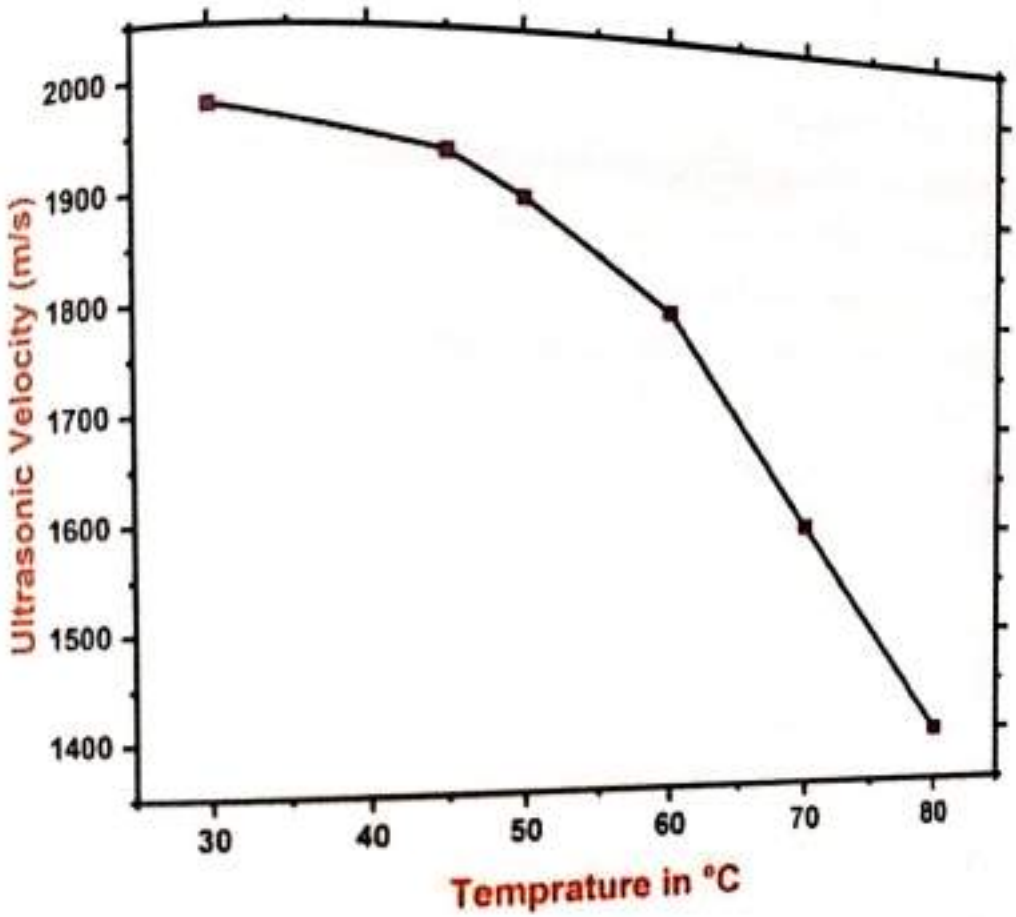
Figure 2. Temperature Dependence of Ultrasonic Velocity in Glycerol



Temperature Dependence of Ultrasonic Velocity in Glycerol

Glycerol ($C_3H_8O_3$) is a polyol compound with three hydroxyl groups, contributing to extensive hydrogen bonding. Since glycerol is a viscous liquid with exceptional properties, it is extensively studied in the research field.

The variation of sound velocity in experimental liquid glycerol is studied under temperature range 30°C to 80°C. The sound velocity was decreased with rise in temperature. The sound velocity at 30 °C was found to be 1980, which is in close agreement with the available standard data. The sound velocity reached to a minimum value of 1400 m/s at 80°C. This significant decrease in sound velocity is due to breaking of hydrogen bonds in the glycerol structure, which lead to more disordernes in

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the glycerol medium. Because of this sound velocity decreases with increase in temperature.

6. Conclusion

The variation of ultrasonic velocity depends on various parameter of the sample liquid. The results shows sound velocity in water is increasing with increase in temperature. This decreases the inertia of the water medium against motion of the sound waves. Therefore the ultrasonic velocity increases with increase in temperature. In the case of Glycerol opposite trend was observed, that is the sound velocity was decreased with rise in temperature in the case of glycerol and reached to a minimum value of 1400 m/s at 80°C. This significant decrease in sound velocity is due to breaking of hydrogen bonds in the glycerol structure, which lead to more disordernes in the glycerol medium. Because of this sound velocity decreases with increase in temperature.

7. References

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Nature Loves Symmetry

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S.D.V.S. Sangh's
S.S. Arts College & T.P. Science Institute, Sankeshwar

Report of Field Visit/Study Trip to NPO, Sankeshwar

Date of the activity	15.02.2024
Organizing Department	Sociology
Name of the Chief Guest	----
Name of the President	----
No. of teachers participated	02
No. of students participated	25
Collaborating Agency	----
Impact of the activity (Outcome)	Visiting an orphanage exposes sociology students to the lives of vulnerable children. It helps them understand the challenges faced by these children and the role of social institutions. Such visits can foster empathy, inspire social action, and provide valuable insights for future research.

Field Visit to NPO

S.S. Arts College & T.P. Science Institute
SANKESHWAR
591313

Collecting Information

List of the students

Reg. No.	Name of the Student	Signature
U15CH21A0005	AKASH VINAYAK NAIK	A.V. Naik.
U15CH21A0008	ANAND CHANDRAKANT SARAPURE	
U15CH21A0016	BHAIRU SHRIMANT SANADI	
U15CH21A0018	BALAPPA BEERAPPA GUGGARI	
U15CH21A0021	BASAVARAJ PARUSHARAM KAMBLE	B.P. KAMBLE
U15CH21A0032	NIKITA KARISHETTI	
U15CH21A0034	DIKSHA BHUSAGOL	
U15CH21A0042	PRAVEEN SURESH KUMBAR	
U15CH21A0050	SACHIN BABU KADALAGI	
U15CH21A0053	MALLIKARJUNA SURESHA KHODI	
U15CH21A0054	MANOHAR HANAMANT MATHAD	
U15CH21A0055	SAMIKSHA JAYAKAR	Samiksha Jayakar.
U15CH21A0062	SEVANTA DUNDAPPA KALAYI	Sevanta. D. KALAYi
U15CH21A0083	SHRIDHAR CHIDANAND GANGAIGOL	S.S. Gangaigol
U15CH21A0086	SHRISHAIL RAMAPPA WALAKI	Walaki

U15CH21A0096	UMESH M DHARMATTI	
U15CH21A0097	SWAPNIL MAHADEV MALAGI	Swapnil. M. Ma
U15CH21A0111	VISHAL VIRUPAKSHI MATHADAVAR	V.V.M.
U15CH21A0120	SUSHMITA SUBHASH NAIK	SSN
U15CH21A0121	YUVARAJ RAJU GHORPADE	YRG
U15CH21A0127	GOURI RAJU YAMAGARNI	G.R. Yamagarni
U15CH21A0132	MARUTI S JADHAV	MSJ
U15CH21A0133	SACHIN A PATIL	
U15CH21A0064	MALLAPPA BEERAPPA HEGADE	
U15CH21A0122	SUSHANT SANJEEV KAMAT	

S. S. Arts College & T. P. Science Institute BANKESHWAR 591313

H. O. D.
Department of Sociology.

PRINCIPAL.
S.S. Arts College & T.P. Science Institute
BANKESHWAR

S.D.V.S. Sangh's
S.S. Arts College & T.P. Science Institute, Sankeshwar

Report of Field Visit/Study Trip to Dandeli

Date of the activity	03.02.2024
Organizing Department	Sociology
Name of the Chief Guest	----
Name of the President	----
No. of teachers participated	02
No. of students participated	23
Collaborating Agency	----
Impact of the activity (Outcome)	Sociology students visit Siddi tribal community to learn about their culture, traditions, and problems. They talk to people, observe their way of life, and understand their challenges. This helps students learn and become more aware of different cultures and social issues.

Field Visit to Siddi Community of Gardadolli, Dandeli

College & T. P. Science Institute
SANKESHWAR
591313
B. S. Arts

Collecting Information

Anganawadi

Department of Sociology

Field Work Attendance

Sl. No.	Reg. No.	Name of the Student	Signature
1	U15CH21A0005	AKASH VINAYAK NAIK	
2	U15CH21A0008	ANAND CHANDRAKANT SARAPURE	
3	U15CH21A0016	BHAIRU SHRIMANT SANADI	
4	U15CH21A0018	BALAPPA BEERAPPA GUGGARI	
5	U15CH21A0021	BASAVARAJ PARUSHARAM KAMBLE	
6	U15CH21A0030	HALAPPA BEERAPPA HEGADE	
7	U15CH21A0032	NIKITA KARISHETTI	
8	U15CH21A0034	DIKSHA BHUSAGOL	
9	U15CH21A0039	Premakumar parashuram asode	
10	U15CH21A0042	PRAVEEN SURESH KUMBAR	
11	U15CH21A0050	SACHIN BABU KA LAGI	
12	U15CH21A0053	MALLIKARJUNA S ESHA KHODI	
13	U15CH21A0054	MANOHAR HANA NT MATHAD	
14	U15CH21A0055	SAMIKSHA JAYAK	
15	U15CH21A0062	SEVANTA DUNDA LAYI	
16	U15CH21A0064	MALLAPPA BEER EGADE	
17	U15CH21A0083	SHRIDHAR CHIDA ND GANGAIGOL	
18	U15CH21A0086	SHRISHAIL RAM	
19	U15CH21A0096	UMESH M DHAR	
20	U15CH21A0097	SWAPNIL MAHA LAGI	
21	U15CH21A0109	VIRESH SATYA	
22	U15CH21A0111	VISHAL VIRU AVAR	
23	U15CH21A0113	VEERABHADR CHOUGALA	
24	U15CH21A0120	SUSHMITA S	
25	U15CH21A0121	YUVARAJ R	
26	U15CH21A0127	GOURI RAJ	
27	U15CH21A0132	MARUTI S J	
28	U15CH21A0133	SACHIN A P	
29	U15CH21A0122	Sushant. Kamat	

H. O. D.
Department of Sociology.

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SANKESHWAR

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DEPARTMENT OF ZOOLOGY

REPORT

ON

A study Tour on Biodiversity and ecology

FOR

For B.Sc 6th SEM students

2023-24

PRINCIPAL
S.S.Arts College & T P Science Institute
SANKESHWAR

REPORT

A Field visit to Stavanidi a jain Basadi (Shippur) –a sacred grove near Nippani town. The department of Zoology, SDVS Sangh's S.S Arts and T.P Science Institute, Sankeshwar organised an ecological and biodiversity study visit to Stavanidi , a ghat section and a jain basadi near Nippani town which can be considered as a sacred grove, a religioua place which is visited by many people. The one day study visit to said place is organised for the students of VI sem Zoology as a part of their curriculum of the course "ecology and conservation biology". The ecology is a study of ecosystems, an ecosystem as a geographical area in which there ia an interaction between the biotic-biotic and biotic-abiotic components. The forest is an terrestrial ecosystem which encompasses many different types of plants including herbs, shrubs, undershrubs, trees and climbers which interact among themselves for their existence and also support the faunal diversity such as insects , rodents, herbivores, carnivores etc. The conservation biology deals with the conservation aspects. There are mainly two stratergies of insitu and exsitu. The sacred groves is a type of insitu conservation- conserving biological diversity at its natural habitat. Since Stavanidhi is a religious place of Jainism. Disturbances to the diversity is considerably less because of the religious value. In view of the above the students were brought to this place to study ecological interactions, ecological values and functioning of an ecosystem. The visit was organised on 27th august 2023.All the students of B.Sc IV and VI semester Zoology and faculties of Botany and Zoology department attended the study visit. A short treck in the forest area was undertaken to study the diversity of plants and associated faunal diversity at the area. The species of tree, shrubs, herbs and climbers were identified in the field with knowledge of taxonomic identification that they learnt in taxonomy. The inter relationship among the different plant forms and also associated animals and insects were also observed. The visit provided an overall insight of ecology and conservation.

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SDVS SANGH'S
S.S ARTS AND T.P SCIENCE COLLEGE, SANKESHWAR

Department of Zoology

Report on: "A Study Tour on Biodiversity & Ecology"

Student Attendence List

Class – B.Sc VI Sem **Date:27/08/2023**

Sl No.	Reg no.	Name of the student	Signature
1.	S2022405	AIMAN TAHASILDAR	
2.	S2022410	AKASH SHIVANAND BALOJI	
3.	S2022415	AMISHA SURYAVANSHI	
4.	S2022421	ANJALI SHIVAPPA PUJARI	
5.	S2022422	ANKITA KARYAGOL	
6	S2022440	DIVYA SURESH SAVITRIGOL	
7	S2022443	GAYATRI KALAPPA BADIGER	
8	S2022458	KEERTI RAJU BORAGALLI	
9	S2022459	KEERTI SANJAY KOLI	K. S. Koli
10	S2022465	LAXMI MALAGI	L. A. malagi
11	S2022469	LAXMI SANJEEVKUMAR HIREMATH	
12	S2022489	NIRANJAN SHANKAR MAGADUM	
13	S2022493	POORNIMA BASAVARAJ HOLIMATH	
14	S2022494	POORNIMA KADAPPA PATIL	P.K. Patil
15	S2022501	PRIYA RAVASAHEB VANI	
16	S2022512	SAHANA RAJU HATROTI	
17	S2022520	SHANTA MAHESH KAMATE	
18	S2022521	SHARADA SURESH BUSARI	Sharada
19	S2022525	SHEETAL BHARAT SURYAVANSHI	
20	S2022526	SHILPA NAIK	
21	S2022528	SHIVANAND HORATTI	
22	S2022533	SHREYA APPASAHEB JODATTI	
23	S2022534	SHREYA RAJU SHETTENNAVAR	
24	S2022541	SNEHA MALAGI	Smalagi
25	S2022539	SNEHA ASHOK DODAMANI	
26	S2022545	SOUMYA ADIVEPPA HANCHINAL	
27	S2022555	TAISEEN GULAB MULLA	
28	S2022558	VAISHNAVI NARASANNAVAR	

Rukamale
HEAD
DEPARTMENT OF ZOOLOGY

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DEPARTMENT OF BOTANY

REPORT

ON

A study on nursery techniques

TO

ANJALI HI-TECH NURSERY KAMATNUR

FOR

STUDENTS OF B.Sc I and V SEM BOTANY

S. Arts College & T. P. Science Institute SANKESHWAR 591313

2023-24

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Arts College & T. P. Science Institute SANKESHWAR 591313

NURSERY VISIT REPORT

As mentioned in the syllabus of B.Sc. II & VI semester Botany provided by the affiliating Ranichennamma University, Belagavi. A nursery visit was arranged to the Anjali Hi-tech Nursery at Kamatnur which is 6km from Sankeshwar. The students of B.Sc. II & VI semester were brought to the nursery on 1st February 2024. The students were informed to assemble in the institution campus at 12:00 pm. The students along with the faculty members left the institution at 12:00pm in a school vehicle and reached the Nursery at 12:30pm. A total of 40 students and 3 faculties of the department along with an attender participated in the visit. The owner of the nursery guided the team during the study. He explained the procedures of pruning, budding, grafting and layering which are the artificial methods of plant (vegetative) propagation. He also explained the students about the preparation of the potting mixture for the various kinds of plants. Students observed different sections in the nursery like vegetables, fruits, hybrid Roses and different varieties of mangoes and guava, amla, lemon etc. The main objective of the activity was to familiarize the students about pruning, budding, grafting and other methods of propagating plants at the nursery.

List of the faculty members attending the Nursery visit

1. Dr. Smt. I B Gokak (HOD)
2. Miss. S M Kamble (Staff)
3. Miss. V R Kolakar (Staff)
4. Mr. Jotirmay Dhudum (Attender)

From

Date: 30/01/2024

Dr. Smt. Irawwa B Gokak
S.S. Arts College & T.P. Science Institute
Sankeshwar .

To

The principal
S.S. Arts College & T.P. Science Institute
Sankeshwar .

Respected Sir,

Sub: Requisition to provide School Bus facility for visit to Nursery at Kamatnur

With respect to the above subject, we would like to bring it to your kind notice that, as per the BSc I. and V. semester students need to visit Nursery/horticulture as a part of syllabus. In this regard, we have planned to visit the Anjali H-Tech Nursery at Kamatnur on 1st of Febrauary . There will be 40 students and 3 staff members and 1 attender joining us..Hence, we kindly request you to provide the School Bus facility for one day for the same and oblige.

Thanking you,

Yours sincerely

(Dr. I. B. Gokak)
HEAD
DEPARTMENT OF BOTANY

Place: Sankeshwar.

Time:- 12:00pm - Departure
2:00pm - Arrival.

Respectfully Forwarded
To
The Secretary
SDVS Sangh
Sankeshwar

PRINCIPAL
S.S.Arts College & T.P.Science Institut
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List of students

Sl No.	Name	Sign
1.	Sumitra santagol	
2.	Santosh khatagalli	
3.	Pramodini akkiwate	
4.	Tejashree bandekar	
5.	Ishwari mraje	
6.	Priya maradi	
7.	Balesh lolasuri	
8.	Lekha sadalagi	
9.	Sneha ontigadad	
10.	Dastageer rajesab multani	
11.	Ganga rudragouda patil	
12.	Sachin suresh bhosale	
13.	Basavaraj vinod ghabe	
14.	Chandrakant dundappa hosamani	
15.	Soumya chandrakant patil	
16.	Shivani manjunath raikar	
17.	Soumya avinash patil	
18.	Umesh kadappa munnoli	
19.	Susmita chandrappa malakannavar	
20.	Laxmi babu kurbet	
21.	Veena veerabadra halasi	
22.	Sarswati ravindra kamble	
23.	Shilpa mallappa bisirotti	
24.	Aruna mahadev naik	
25.	Ravi rajendra khanapuri	
26.	Tanzeela aqeel nadaf	
27.	Rakshita madhukar kumbar	
28.	Saratajabi jahangeerbeg inamadar	
29.	Srusti b patil	
30.	Pankaja suresh jain	
31.	Sudarshan ravindra mankale	
32.	Priyanka balappa kamble	
33.	Kartik inamdar	
34.	Swastik sanjeev kaggudi	
35.	Amruta achyut patil	
36.	AKSHATA R HIREMATH	
37.	Soujanya goravagol	

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38.	Manjula ashok nerli	
39.	Priyanka vijay gavani	
40.	Megha mahadev rabakavi	

List of staff and attender

1 Dr. I.B Gokak
2 Miss S M Kamble
3 Miss V R Kolkar
4. Miss R V Kamate

Attender- J M Dhudam

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SANKESHWAR

SDVS SANGH'S

S.S.ARTS AND T.P.SCIENCE INSTITUTE SANKESHWAR

Affiliated to Rani Channamma University, Belagavi, Karnataka, India

DEPARTMNENT OF BOTANY

REPORT

ON

A TAXONOMIC FIELD WORK IN THE CAMPUS TO STUDY THE DIVERSITY OF ANGIOSPERMS CONDUCTED FOR THE STUDENTS OF Vth SEMESTER BOTANY

S.S. Arts College & T. P. Science Institute SANKESHWAR 591317

2023-24

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REPORT

The Department of Botany SDVS Sangh's, S S Arts and T P Science Institute Sankeshwar conducted a taxonomic field work to study the diversity of angiosperms in the campus. The field study is a part of curriculum of the V semester Botany course. A field visit was organized on 12-02-2024, Prof. Pradeep Sangappagol, Assistant Professor in Botany, KLE Society's Jagadguru Tontadarya College, Gadag was invited as an expert for the field work as he is specialized in the Angiosperm taxonomy and Environmental Biology. The expert guided the students during the field work regarding the Diagnostic characteristics of the plant species, their families and also economic and ecological importance of the species such as medicinal properties, religious values, ecological indications and edibility etc. The practical session was conducted after the field visit in the laboratory where the expert taught the students about the use of flora, monographs and manuals in identifying the plants. Use of artificial keys provided in the flora in field and laboratory identification was demonstrated to the students. Students identified few angiosperms of the campus using artificial key under the guidance of the expert. All the students participated actively and got benefited.

The following angiosperms of the campus were identified and studied by the students during the field work.

List of the species studied

Sl.No.	*Species name*	Family
1	*Ocimum tenuiflorum*	Lamiaceae
2	*Ocimum sanctum*	Lamiaceae
3	*Nyctantes arbor-tristis*	Oleaceae
4	*Aloe vera*	Liliaceae
5	*Chrysanthemum procumbens*	Asteraceae
6	*Tridax procumbens*	Asteraceae

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7	*Euphorbia hirta*	Euphorbiaceae
8	*Euphorbia heterophylla*	Euphorbiaceae
9	*Amaranthus spinosus*	Amarathaceae
10	*Royalstonia regia*	Aracaceae
11	*Hibiscus rosa-sinesis*	Malvaceae
12	*Eucalyptus globulus*	Myrtaceae
13	*Acacia nilotica*	Mimosaceae
14	*Acacia auriculiformis*	Mimosaceae
15	*Prosopis julifera*	Mimosaceae
16	*Datura stramonium*	Solanaceae
17	*Duranta repens*	Verbenaceae
18	*Achyranthes aspera*	Amaranthaceae
19	*Lantana camera*	Verbenaceae
20	*Mimosa pudica*	Mimosaceae
21	*Acalypha hispida*	Euphorbiaceae
22	*Morus alba*	Moraceae
23	*Acalypha indica*	Euphorbiaceae
24	*Dalbergia latifolia*	Dalberginaceae
25	*Delonix regia*	Caesalpinaceae
26	*Tectona grandis*	Verbinaceae

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Students list

Reg. No.	Name of the students	Signature
U15CH21S0001	DASTAGEER RAJESAB MULTANI	
U15CH21S0005	GANGA RUDRAGOUDA PATIL	
U15CH21S0007	SACHIN SURESH BHOSALE	
U15CH21S0011	BASAVARAJ VINOD GHABE	
U15CH21S0013	CHANDRAKANT DUNDAPPA HOSAMANI	—
U15CH21S0016	SOUMYA CHANDRAKANT PATIL	
U15CH21S0024	SHIVANI MANJUNATH RAIKAR	
U15CH21S0026	SOUMYA AVINASH PATIL	
U15CH21S0031	UMESH KADAPPA MUNNOLI	
U15CH21S0038	SUSMITA CHANDRAPPA MALAKANNAVAR	
U15CH21S0044	LAXMI BABU KURBET	
U15CH21S0053	VEENA VEERABADRA HALASI	
U15CH21S0055	SARSWATI RAVINDRA KAMBLE	
U15CH21S0056	SHILPA MALLAPPA BISIROTTI	
U15CH21S0064	ARUNA MAHADEV NAIK	
U15CH21S0067	RAVI RAJENDRA KHANAPURI	—
U15CH21S0068	TANZEELA AQEEL NADAF	
U15CH21S0073	RAKSHITA MADHUKAR KUMBAR	
U15CH21S0075	SARATAJABI JAHANGEERBEG INAMADAR	
U15CH21S0078	SRUSTI B PATIL	
U15CH21S0081	PANKAJA SURESH JAIN	
U15CH21S0087	SUDARSHAN RAVINDRA MANKALE	
U15CH21S0091	PRIYANKA BALAPPA KAMBLE	
U15CH21S0093	KARTIK INAMDAR	
U15CH21S0094	SWASTIK SANJEEV KAGGUDI	
U15CH21S0097	AMRUTA ACHYUT PATIL	
U15CH21S0101	AKSHATA R HIREMATH	

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