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	??				

Date

Expt. No. 1 Page No. 01

To determine the surface tension of water by capillary rise

Aim: To experimentally determine surface-tension of water and to be able to explain the deviation of the experimental value from literature value.

Apparatus:
1. Capillary Tubes (of uniform bore and equal diameters)
2. Travelling Microscope
3. Thermometer
4. Glass strip.
5. Needle
6. Clamping Stand
7. Glass beaker
8. Adjustable stand.

Working Formula:

$$T = \frac{1}{2}\left[\left(h+\frac{r}{3}\right)\cdot \rho r g\right]$$

~~H~~ r is the radius of capillary tube
h is the height of water rise in the glass capillary
ρ is the density of water used
g is the value of acceleration due to gravity in lab.

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Experimental Data :

Temperature of water at the beginning $(T_b) = 26°C$

Temperature " " " " end $(T_e) = 26°C$

Mean Temperature $(T_m) = (T_b + T_e)/2 = 26°C$

Density of water at $T_m°C$ (26°C) $= \rho =$ ~~0.9965 gm/cc~~ 0.996 5162 gm/cc

Angle of contact of water $(\theta) = 0°$

LC of Travelling Microscope : ~~0.01cm~~ $(1 - \frac{49}{50}) = 0.02$

A. Determination of capillary tube diameter using Travelling Microscope :-

Tube No.	a=MSR (cm)	b=VSR×LC (cm)	$A_1 = a+b$ (cm)	Zero Corrected A_1 (cm)	a_1=MSR (cm)	b=VSR×LC (cm)	$B_1 = a+b$ (cm)
1.(1)	3.42	0.1×					
2(1)							
3(1)							
4(2)							
(2)							
(2)							
(3)							
(3)							
(3)							

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Tube No. Zero Corrected B_1 (cm) $B_1 - A_1 = AB$.

Table for measuring horizontal Diameter :-

Tube No.	a=MSR (cm)	b= ~~MSR~~ +(VSR×LC) (cm)	A_1=a+b	Zero Corrected A_1	a_1=MSR (cm)	b_1=(VSR×LC) (cm)	B_1=(a+b)	Zero Corrected B_1	B_1-A_1 =AB
	2.00	0.035	2.035		2.25	0.030	2.280		0.245
1.	1.9	0.001	0.191		1.65	0.005	0.338		0.147
	8.75	0.01	0.165		9.0	0.030	0.285		0.120
2.	0.15	~~0.003~~ 0.041	0.191		0.3	0.038	0.338		0.25
	0.2	0.030	0.230		0.05	0.020	0.070		0.160
	7	0.021	7.021		6.85	0.046	6.896		0.112
3.	0.15	0.015	0.165		0.25	0.035	0.285		0.270
	~~0.2~~ 5.05	0.007	5.057		~~0.~~4.9	0.005	4.945		0.125
	5.1	0.010	5.110		4.95	0.040	4.990		0.120

Table for Measuring the vertical Diameter :-

Tube No.	C = MSR	δ = VSR×LC	Tot. (C_1) Reading	C_1 = MSR	δ_1 = VSR×LC	Tot (D_1) Reading	$\lvert C_1 - D_1 \rvert$
	9.35	0.037	9.387	9.6	0.033	9.633	0.246
1	8.8	0.040	8.840	9.05	0.042	9.092	0.252
	9.05	0.038	9.088	8.85	0.006	8.856	0.232
2.	9.4	0.01	9.41	9.55	0.045	9.595	0.185
	8.85	0.035	8.885	9.05	0.045	9.095	0.210
	8.85	0.025	8.875	9.05	0.006	9.056	0.181
3.	9.0	0.007	9.007	8.9	0.002	8.902	0.105
	9.0	0.036	9.036	8.85	0.045	8.895	0.141
	9.0	0.04	9.040	8.9	0.001	8.901	0.139.

Average vertical diameter for Tube 1 : 0.243 cm
" " " " Tube 2 : 0.192 cm
" " " " Tube 3 : 0.1283 cm

*all datas are in (cm)

Tube No.	For lower tip of the needle (Lex)			For lower meniscus of water (Lex)			Height
	*MSR	*VSR	*TR	*MSR	*VSR	*TR	
	1.6	0.018	1.618	1.95	0.043	1.993	0.375
1.	1.5	0.04	1.504	2.00	0.027	2.027	0.487
	1.55	0.019	1.569	2.00	0.04	2.04	0.471
	1.6	0.018	1.618	2.2	0.04	2.240	0.622
2.	1.5	0.04	1.54	2.25	0.005	2.255	0.715
	1.55	0.019	1.569	2.25	0.017	2.267	0.698
	1.6	0.018	1.618	2.85	0.019	2.869	1.251
3.	1.5	0.04	1.540	2.95	0.025	2.975	1.435
	1.55	0.019	1.569	2.9	0.015	2.915	1.346

☒ Calculation of Surface Tension for :

1. Tube-1 :

Average Radius $= \dfrac{\text{Horizontal Diameter} + \text{Vertical Diameter}}{2 \times 2}$

$= 0.1245$ cm.

Average height of lower meniscus of water (h)

$= 0.4443$ cm.

ρ of water $= 0.9965162$ g/cc.

$g = 980$ cm/s^2

Surface Tension $T = \frac{1}{2}\left[\left(h+\frac{r}{3}\right) r \rho g\right]$

$= \frac{1}{2}\left[0.4443 + \frac{0.1245}{3}\right] \times (0.1245) \times 980 \times (0.9965162)$

$= 29.53$ dyne/cm

$= 2.953 \times 10^{-2}$ N/m

Error Analysis :-

i) Percentage Error :-

Actual value of Surface tension $= 7.197 \times 10^{-2}$ N/m.

calculated value $= 3.31192 \times 10^{-2}$ N/m

[Experimental]

$$\% \text{ error} = \left(\frac{7.197 \times 10^{-2} - 3.31192 \times 10^{-2}}{7.197 \times 10^{-2}} \times 100\right)\%$$

$= 53.981\%$.

2. Tube 2:

Averge Radius $= \frac{0.144+0.192}{4} = 0.084$ cm.

h(capillary rise) $= 0.6783$ cm.

$\rho = 0.9965162$ g/cc.

$g = 980$ cm/s^2

Surface Tension (T) $= \frac{1}{2}[r/3 + h] r\rho g$

$= \frac{1}{2}\left[\frac{0.084}{3} + 0.6783\right] \times 0.084 \times 0.9965162 \times 980$

$= 28.97$ dyne/cm

$= 2.897 \times 10^{-2}$ N/m.

3. Tube 3: $r = 0.061325$ cm, $h = 1.344$ cm

$\rho = 0.9965162$ g/cc. $g = 980$ cm/s^2.

$T = \frac{1}{2}[(\frac{r}{3}+h) r\rho g] = 40.8576$ dyne/cm

$= 4.08576 \times 10^{-2}$ N/m,

Average value of Surface Tension

$= 3.31192 \times 10^{-2}$ N/m.

- Discussion of Error :

The sources of high error :-

i) The levelling device was faulty

ii) Difficulty in focusing

* iii) The contact angle wasn't zero.

iv) Impurities in Tap water changes density.

v) Human Errors.

- Conclusion:

Experimental value of $T = 3.31192 \times 10^{-2}$ N/m

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Date 10.04.23

Expt. No. 2

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Dynamical viscosity of a liquid & Stokes' law

Aim: To determine the co-efficient of viscosity of a liquid using a falling ball viscometer (using stokes law), finding possible source of error.

Apparatus:-

1) Falling ball viscometer
2) Balls of different radius.
3) Screw gauge
4) Scale.

Working Formula:

$$\eta = \frac{2}{9} \frac{r^2(\rho-\sigma)g}{v_t\left(1+2.4\frac{r}{R}\right)}$$

η = dynamic viscosity.
r = radius of the ball
ρ = density of ball
v_t = terminal velocity.
R = radius of liq. cylinder.

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Calculations :-

I. Calculation for Least count of Screw Gauge :-

for a full rotation ; MSR = 0.5mm

i.e, for 50 marks = 0.5mm

So, 1 mark of CS = 0.01 mm

So, L.C = 0.01mm.

Zero Error of Screw Gauge:

Negative Zero Error.

Reading = − 0.2mm.

Experimental Data :-

Table: Measure radius and density of steel balls.

Table No.

Ball NO.	MSR (mm)	CSR X LC Z (mm)	Total Reading (mm)	Zero corrected Reading (mm)
1(a)	3	0	3.00	3.20
1(b)	3	40 X 0.01	3.40	3.60
1(c)	3	38 X 0.01	3.38	3.58
1(d)	3	36 X 0.01	3.36	3.56
1(e)	3	43 X 0.01	3.43	3.63
1(f)	3	36 X 0.01	3.36	3.56
2(a)	3.5	21 X 0.01	3.71	3.91
2(b)	3.5	26 X 0.01	3.76	3.96
2(c)	3.5	18 X 0.01	3.68	3.88
2(d)	3.5	15 X 0.01	3.65	3.85
2(e)	3.5	22 X 0.01	3.72	3.92

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Ball No.	MSR(mm)	CSR X LC (mm)	Total Reading(mm)	Zero Corrected Reading (mm)
2(f)	3.5	27 X 0.01	3.77	3.97
3(a)	4.5	45 X 0.01	4.95	5.15
3(b)	4.5	48 X 0.01	4.98	5.18
3(c)	4.5	44 X 0.01	4.94	5.14
3(d)	4.5	43 X 0.01	4.93	5.13
3(e)	4.5	45 X 0.01	4.96	5.16
3(f)	4.5	46 X 0.01	4.96	5.16

Mass

Weight of Ball No.(1) [6 balls] = 0.77g
" " " " (2) [6 "] = 1.54g
" " " " (3) [6 Balls] = 2.65g.

So, 1 ball (Ball No. 1) weights = 0.128g
(Ball NO. 2) " = 0.257g
(Ball NO. 3) " = 0.442g

Average radius of Ball no (1) = (3.522/2) mm = 1.761 mm.
Ball " (2) = (3.915/2) = 1.9575 mm
" " (3) = 2.577 mm

Ball NO.	radius (mm)	volume (mm^3)	Total vol. (mm^3)	Total Mass (g)	Density (g/mm^3)
1(a)	1.6	17.164			
1(b)	1.8	24.438			
1(c)	1.79	24.033	137.958	0.~~778~~	~~0.00093~~
1(d)	1.78	23.633			0.00558
1(e)	1.815	25.054			
1(f)	1.78	23.633			

Ball No.	radius (mm)	vol (mm³)	Total vol (mm³)	Total Weight (g)	Density (g/mm³)
2(a)	1.955	31.3114			
2(b)	1.98	32.5281			
2(c)	1.94	30.5962	188.655	1.54	0.00816
2(d)	1.925	29.8920			
2(e)	1.96	31.5523			
2(f)	1.985	32.7751			
3(a)	2.575	71.5476			
3(b)	2.59	72.8052			
3(c)	2.57	71.1316	430.132	2.65	0.00616
3(d)	2.565	70.7172			
3(e)	2.58	71.9651			
3(f)	2.58	71.9651			

Distance between P & Q = 70cm

Ball No.	Average Time Taken (s)	V_t (cm/s)	Average V_t (cm/s)
1(a)	14.63	4.7846	
1(b)	14.47	4.8375	
1(c)	14.47	4.8375	4.83557
1(d)	14.40	4.8611	
1(e)	14.35	4.8780	
1(f)	14.54	4.8143	
2(a)	9.69	7.2239	
2(b)	9.75	7.1794	7.2217
2(c)	9.69	7.2239	
2(d)	9.66	7.2463	
2(e)	9.58	7.3068	
2(f)	9.79	7.1501	

Ball No.	Time Taken(s)	v_t (cm/s)	Average v_t (cm/s)
3(a)	7.03	9.9573	
3(b)	7.03	9.9573	
3(c)	7.07	9.9009	9.96576
3(d)	6.90	10.1449	
3(e)	7.16	9.7765	
3(f)	6.96	10.057	

Calculation for η :

1. For ball 1 :– $\rho = 0.00558\ g/mm^3$

$r = 1.761\ mm$ $R = 46.07\ mm$.

$\sigma = 0.961\ g/cm^3$

$v_t = 4.83557\ cm/s$.

$$\eta = \cancel{20}\ \frac{\frac{2}{9}\left(\frac{r^2}{100}\right)(1000 \times \rho - \sigma)g}{v_t\left(1+2.4\frac{r}{R}\right)}$$

$= 5.90973$ cgs-unit

$= 0.590973$ Pa.s.

2. For ball 2 :– $\rho = 0.00816$

$r = 1.9575\,mm$

$\sigma = 0.961\ g/cm^3$ $R = 46.07\ mm$

$v_t = 7.2217\ cm/s$.

$$\eta = \frac{\frac{2}{9}\left(\frac{1.9575^2}{100}\right)(1000 \times 0.00816 - 0.961) \times 980}{7.2217\left(1+2.4 \times \frac{1.9575}{46.07}\right)} = 7.551875\ cgs.$$

$= 0.7551875$ Pa.s.

For ball 3 :-

$\rho = 0.00616 g/cm^3$

$r = 2.577 mm$

$\sigma = 0.961 g/cm^3$ $R = 46.07 mm$

$V_t = 9.96576$ cm/s.

$$\eta = \frac{\frac{2}{9}\left(\frac{2.577}{100}\right)^2 (1000 \times 0.00616 - 0.961) \times 980}{9.96576 \times \left(1 + 2.4 \times \frac{2.577}{46.07}\right)}$$

unit in each step

$= \cancel{9.965762}$ 6.65139 cgs-unit.

$= \cancel{0.0996576}$ ~~pa.s.~~ 0.665139 pa.s.

Average dynamic viscosity =

$\eta_{experimental} = 0.67043374$ pa.s

Error Analysis :-

$\eta_{theoretical} = 0.650$ pa.s.

$\eta_{experimental} = 0.67043374$ pa.s

$$\text{Relative Error} = \left(\frac{0.67043374 - 0.650}{0.650}\right) \times 100\%$$

$= 3.14\%$.

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[I] Standard deviation of η = 0.0822 (Experimental)

Standard deviation in ~~each~~ measurement of diameter of balls.

Ball 1 : 0.159

Ball 2 : 0.0459

Ball 3 : 0.0175

Standard deviation in measurement of time taken to travel 70 cm (distance b/w P & Q) :

Ball 1 : 0.09953

Ball 2 : 0.07284

Ball 3 : 0.89610

Error Propagation :-

$$\frac{\partial \eta}{\partial v_t} = \left(-\frac{1}{v_{mean}}\right)^2 \left(\frac{2}{9} r^2 \left(\frac{M}{4/3 \pi r^3} - \sigma\right) g\right) \frac{1}{\left(1+2.4\frac{r}{R}\right)}$$

$= 1.222137$

$\sigma_{v_t} = 0.331845$

$\frac{\partial \eta}{\partial r} \sigma_r = 4.1734528$

$$So, \quad \sigma_\eta = \sqrt{\left(\frac{\partial \eta}{\partial r}\sigma_r\right)^2 + \left(\frac{\partial \eta}{\partial v_t}\sigma_{v_t}\right)^2} = \sqrt{17.41985} = \cancel{1.703885} = 4.1736500$$

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no. of Measurements = 6.

So, standard error = $\frac{\sqrt{17.41935308}}{\sqrt{6}}$ = 1.70388
= 0.170388 (SI in)

So, value of η_{exp} = ~~0.67043374 ± 0.170388~~

η_1 = 0.590973 ± 0.170388

Source of Error:-

1) Standard deviation is way to high in measurement of radius for different balls.

2) Error in measurement of time due to reaction threshold for human reflex.

3) ~~Air~~ Upper air-gap in the fluid tube (air resistance).

4) Mechanical, Instrument faults. (if any).

Conclusion:

The value of η_{exp} = 0.67043374 Pa.s.

Discussion - What you learnt?

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Heat Capacity of Solids :-

Aim: a) To determine specific heat capacity of different metals.
b) To estimate molar heat capacity of those metals and hence to verify Dulong-Petit law.

Apparatus: a) Calorimeter
b) Digital Thermometer
c) Electronic Balance
d) Heater
e) waterboiling container.
f) Stand.
g) 3 blocks of same material (3 set)

Working Formula:

$$c = \frac{(C + c_w m_w)(T_e - T_w)}{m_1 \cdot (T_1 - T_e)}$$

m_1 = known mass (Blocks)
c_w = specific heat capacity of water $\approx$ 4.19 J/g°C
C = heat capacity of calorimeter $\approx$ 80 J/°C
m_w = Mass of water in calorimeter.
T_e = Equilibrium Temperature.
T_w = known Temp. of calorimeter at first.
T_1 = known Temp. of the metal blocks at first.

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Experimental Data:-

Table 1:- Mass measurement of the blocks with nylon thread

1. Iron	0.182 Kg
2. Brass	0.180 Kg
3. Aluminium	0.179 Kg

Table 2: Measurement of Temperatures*.

	T_1 (°C)	T_w (°C)	T_e (°C)	$T_e - T_w$ (°C)	$T_1 - T_e$ (°C)	m_w (g)
Iron	100.1	30.6	34.5	3.9	69.5	182g
	100.6	34.5	38.3	3.8	66.1	
	100.6	34.8	38.9	4.1	65.8	
Brass	100.3	31.8	34.4	2.6	68.5	180g
	100.1	28.6	31.4	2.8	71.5	
	100.3	33.6	36.5	2.9	66.7	
Aluminium	100.6	33.7	41.8	8.1	66.9	179g
	100.1	32.2	41.2	9	68	
	100.1	32.1	39.8	7.7	67.9	

* T_1 = Temperature of the solid after heating.
T_w = Temperature of calorimeter + water (initial)
T_e = Temperature of the equilibrium state (thermal)

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Formula: $\dfrac{(C + c_w m_w)(T_e - T_w)}{m_1 \cdot (T_1 - T_e)} = c$

Calculations :-

Sl.no.

3. $c = \dfrac{5214.3\ J}{(182g \times (69.5)^\circ C)} = \cancel{0.29087}$ 0.41223 $J/g^\circ C$

2. $c = \dfrac{1337\ J/^\circ C \times 8.1^\circ C}{179g \times 66.9^\circ C} = 0.90435\ J/g^\circ C.$

1. $c = \dfrac{1337\ J/^\circ C \times 2.8^\circ C}{180g \times 71.5^\circ C} = 0.29087\ J/g^\circ C$

4. $c = \dfrac{1337\ J/^\circ C \times 38^\circ C}{182g \times 66.1^\circ C} = 0.42232\ J/g^\circ C$

5. $c = \dfrac{1337\ J/^\circ C \times 2.6^\circ C}{180g \times 68.5^\circ C} = 0.28193\ J/g^\circ C$

6. $c = \dfrac{1337\ J/^\circ C \times 7.7^\circ C}{179g \times 68^\circ C} = 0.84579\ J/g^\circ C$

7. $c = \dfrac{1337\ J/^\circ C \times 4.1^\circ C}{182g \times 65.8^\circ C} = 0.45773\ J/g^\circ C$

8. $c = \dfrac{1337\ J/^\circ C \times 2.9^\circ C}{180g \times 66.7^\circ C} = 0.32294\ J/g^\circ C$

9. $c = \dfrac{1337\ J/^\circ C \times 9^\circ C}{179g \times 67.9^\circ C} = 0.99003\ J/g^\circ C$

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Table 3:-

Table for caculating value of specific heat capacity (c)

units: C+CwMw(J/°c) ; c(J/g°c)

Sl.no.	Set-I:	value of C+CwMw	value of (C+CwMw)(Te-Tw)	value of c	std. deviation
	~~Iron~~				
1.	Brass	1337	~~5214.3~~ 7466.6	0.29087	
2.	Aluminium	1337	10829.7	0.90435	
3.	Iron	1337	5214.3	0.41223	

	Set II:	val. of C+CwMw	value of c (J/g°c)
4.	Iron	1337	0.42232
5.	Brass	1337	0.28193
6.	Aluminium	1337	0.84579

	Set III:	val. of C+CwMw	val. of (C+CwMw)(Te-Tw)	value of c
7.	Iron	1337	5481.7	0.45773
8.	Brass	1337	3877.3	0.32294
9.	Aluminium	1337	12033	0.99003

~~H~~ standard deviation in value of c(J/g°c)

Iron = 0.023900

Brass = 0.0215608

Aluminium = 0.0725490

Table 4: Calculation of Average heat Capacity & Molar heat capacity

Metal	Specific heat capacity (J/g°c) Measured	Specific heat capacity (J/g°c) Literature	Molar Mass (g/mol)	Molar Heat capacity (J/mol°c)
Iron	0.430763	0.452	55.85	24.05795
Brass.	0.298585	0.385	64.28	19.19304
Aluminium	0.9133910	0.896	26.98	24.64329

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Error Analysis :-

Maximum possible error (relative) in c

$$\frac{\delta c}{c} = \frac{\delta m_w}{m_w} + \frac{\delta m_1}{m_1} + \frac{\delta T_e + \delta T_w}{T_e - T_w} + \frac{\delta T_1 + \delta T_e}{T_1 - T_e}$$

$\delta m_w, \delta m_1, \delta T_1, \delta T_w, \delta T_e$ are maximum possible error in m_w, m_1, T, T_w & T_e.

$\delta T_e = \delta T_w = \delta T_1$ = least count for thermometer we've used.

= 0.1°C

least count for weighing machine = 0.001 Kg.

= 1g.

1. For iron-

Avg of $(T_e - T_w) = 3.933°C$ Avg val. of $c = 0.430763$ J/g°C

Avg of $(T_1 - T_e) = 67.133°C$

So, $\frac{\delta c}{0.430763\ J/g°C} = \left(\frac{1}{300} + \frac{1}{182} + \frac{0.2}{3.933} + \frac{0.2}{67.133}\right)$

$\delta c = 0.026990$ ~~cal/g°C~~ J/g°C

2. For Brass-

Avg of $(T_e - T_w) = 2.7667°C$ Avg of $c = 0.29859$ J/g°C

Avg of $(T_1 - T_e) = 68.9°C$

$\delta c = 0.29859\ J/g°C \left(\frac{1}{300} + \frac{1}{180} + \frac{0.2}{2.7667} + \frac{0.2}{68.9}\right) = 0.02451$ J/g°C

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For Aluminium :-

Avg $(T_e - T_w) = 8.2667°C$ Avg val. of $c = 0.91339$ J/g°C
Avg $(T_1 - T_e) = 67.6°C$

So, $\frac{\delta c}{0.91339 \text{ J/g°C}} = \left(\frac{1}{300} + \frac{1}{179} + \frac{0.2}{8.2667} + \frac{0.2}{67.6}\right)$

$\delta c = 0.03295$ J/g°C

- Maximum possible error in c —

Iron = 0.026990 J/g°C
Brass = 0.0251 J/g°C
Aluminium = 0.03295 J/g°C

⇒ Deviation from literature value :-

	Literature value of c	Measured value of c	Relative Error
Iron	0.43076 J/g°C	0.452 J/g°C	4.699 %
Brass	0.29858 J/g°C	0.385 J/g°C	22.447 %
Aluminium	0.91339 J/g°C	0.896 J/g°C	2.166 %

⊞ Discussion of Error :-

1) Two potential sources of error – bias error (zero being shifted by some degrees) and linearity error. These are also called as caliberation error.

2) Poor thermal contact can cause a reading less than

its actual value.

3) The composition of brass metal we used can be different from our literature one giving more relative error.

4) A small fraction of heat can be lost by radiation while transfering the blocks from heating pot to calorimeter.

Conclusion:–

~~The~~ ~~so~~ We learnt the process of calculating the heat capacity by the experimental procedure.

The molar heat capacity of a solid (in temperature range of Room Temp → Melting Pt) is $3R = 24.9433$ J/mol °C according to Dulong Petit law and our experimental data (ie $C_{Iron} = 24.05795$ J/g°C; $C_{Brass} = 19.19304$ J/g°C; $C_{Al} = 24.64329$ J/g°C) supports the fact.

Study of resonance phenomena in Series LCR AC Circuit :

Aim: To be able to draw resonance curve and to obtain quality factor from resonance curve for two different values of R

Apparatus: I) LCR test set
II) Digital Oscilloscope.
III) Crocodile to BNC cable.
IV) Wires.

Working Formula :

$$i = \frac{V_R}{R}$$

i = current passing through the system
V_R = voltage across resistor
R = value of R

$$f_0 = \frac{1}{(2\pi\sqrt{LC})}$$

f_0 = resonance frequency
L = inductance.
C = capacitance.

$$Q = \frac{f_0}{\Delta f}$$

f_0 = resonance freq.
Δf = full width of resonance curve.

$$= \frac{\sqrt{L}}{R\sqrt{C}}$$

L = Inductance
R = resistance
C = capacitance.

▣ Experimental Data :- R = 220Ω

L = 40mH ; Capacitance = (0.1 microF)

1. Table 1 : Data of Freq (KHz) with corresponding voltage across resistance and calculated current (I) (mA)

Sl.No.	Frequency (KHz)	Voltage across resistance (V)	Current (I) (mA)
1	0.1152	0.144	0.6545
2	0.53	0.624	2.8363
3	0.893	0.203	0.92272
4	1.25	1.72	7.8181
5	1.626	2.4	10.9091
6	2	3	13.6364
7	2.415	3.32	15.09091
8	2.611	3.3	15
9.	2.809	3.24	14.7273
10.	3.026	3.12	14.18182
11.	3.226	2.96	13.4546
12	3.636	2.68	12.1819
13	4.024	2.48	11.2728
14	4.405	2.32	10.5455
15	4.831	2.12	9.6364
16	5.208	2.04	9.2728
17	5.65	1.92	8.7273
18	6.02	1.8	7.6364
19	6.41	1.68	7.4546
20	6.826	1.64	7.0901
21	7.246	1.56	6.5455
22	7.874	1.44	6.3637
23	8.264	1.44	6.1819
24	8.621	1.4	6.1819
25	9.091	1.36	5.81819
26	9.434	1.36	5.81819
27	9.901	1.28	

Teacher's Signature

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~~Loss~~ R = 470 Ω

Table 2: Data for Freq (KHz) vs Voltage across resistance (V) and calculated current (mA).

Freq (K.Hz)	Voltage across resistance (V)	Current (I) (mA)
0.143	0.38	0.80851
0.513	1.3	2.7659
0.982	2.52	5.36170
1.421	3.6	7.65957
1.805	4.32	9.191489
2.208	4.8	10.21276
2.625	4.8	10.21276
3.017	4.48	9.531914
3.436	4.32	8.68085
3.802	4.08	8.510638
4.228	4	7.82978
4.619	3.68	7.65957
5.013	3.6	7.310148
5.415	3.44	6.978723
5.814	3.28	6.63829
6.211	3.12	6.468085
6.608	3.04	6.29787
7.018	2.96	6.127659
7.407	2.88	5.78723
7.812	2.72	5.65957
8.22	2.66	5.53914
8.613	2.6	5.404255
9.05	2.54	5.23404
9.432	2.46	5.10638
9.911	2.4	

Teacher's Signature ______

Calculation:-

$$f_0 = \frac{1}{2\pi\sqrt{LC}} \qquad Q = \frac{\sqrt{L}}{(R\sqrt{C})}$$

I) $L = 40\,mH$ & capacitance (C) $= 0.1\,\mu F$

$$f_{0_I} = \frac{1}{2\pi\sqrt{40\times10^{-3}\times0.1\times10^{-6}}} = 2.51646\ kHz$$

$Q_I = 2.8748$

II) $L =$ & $C =$

$f_{0_{II}} =$

$Q_{II} =$

Data from graph-fitting ⇒

Experimental

$f_{0_I} = 2.7894$ Standard Error $= 0.09809$

$f_{0_{II}} = 2.72465$ Standard Error $= 0.06099$

$Q_I = 0.87752$ Standard Error $= 0.07245$

$Q_{II} = 0.5501$ " " $=$ ~~0.0724~~ 0.02452

Error Calculation:-

For $R = 220\Omega$;

Q_I (Theoretical) $= 2.8748$

Q_I (Exp) $= 0.87752$

Relative Error $= \frac{|2.8748 - 0.87752|}{(2.8748)} \times 100\%$

$= 69.47544\%$.

f_{0I} (Theoretical) $= 2.51646$ KHz

f_{0I} (Experimental) $= 2.7894$ KHz

Relative Error $= \frac{|2.7894 - 2.51646|}{2.51646} \times 100\%$

$= 10.846\%$.

For $R = 470\Omega$

Q_{II} (Theoretical) $= 1.34565$

Q_{II} (Experimental) $= 0.550$

Relative Error $= \frac{|1.34565 - 0.550|}{1.34565} \times 100\%$.

$=$ ~~7.64%~~ 59.12%

f_{0II} (Theoretical) $= 2.72465$ KHz

f_{0II} (Experimental) $= 2.51646$ ~~KHz~~

Relative Error $=$ 7.64%

☐ observation:-

for f_{01} & f_{02} Q_1 for $R = 220\Omega$
and f_{02} & Q_2 for $R = 470\Omega$

comparing the experimental values we found-
$f_{01} > f_{02}$
and
$Q_1 > Q_2$

☐ Discussion of Error:-

i) The intrinsic properties of the circuit were not considered, for example internal resistance wasn't considered.

ii) The grounding wasn't done properly

iii) the oscilloscope was fluctuating it did not give a fixed value. So we took the mean.

iv) Due to these conditions the experimental error was very high.

Complete this

III Conclusion:

Our findings in the experiment can be summerised as follows:

A series circuit composed of Resistance 220Ω capacitance 0.1μF and 40mH Inductance has a Quality factor 0.87752 (69% error).

An increase in the resistance 470Ω the Q factor decreases to 0.5501 (59% error) and as Q factor infers the sharpness of resistance.

We conclude decreasing resistance increases the sharpness of resonance, as the quality factor increases.