BANGLADESH SCHOOL & COLLEGE, SAHAM

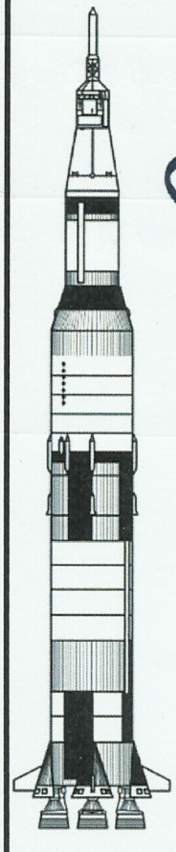
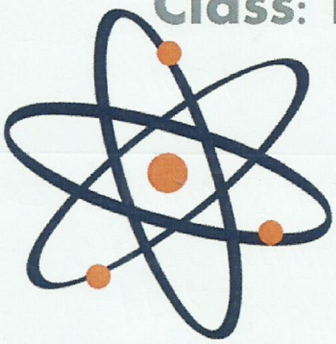
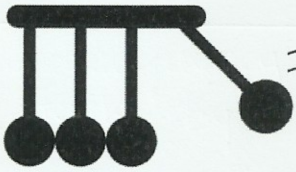
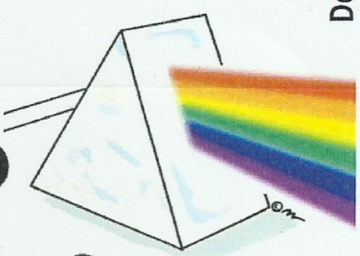
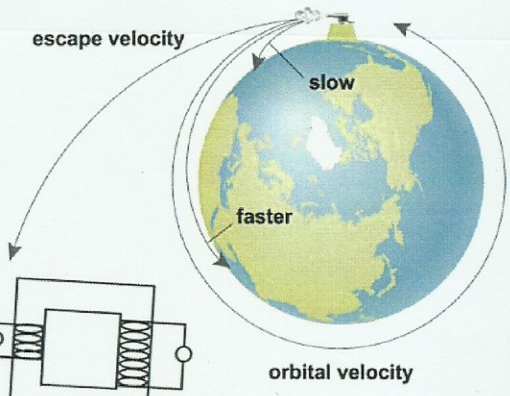
Sultanate of Oman

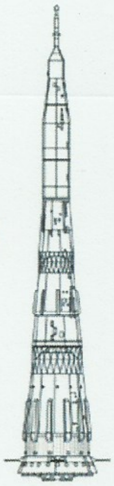
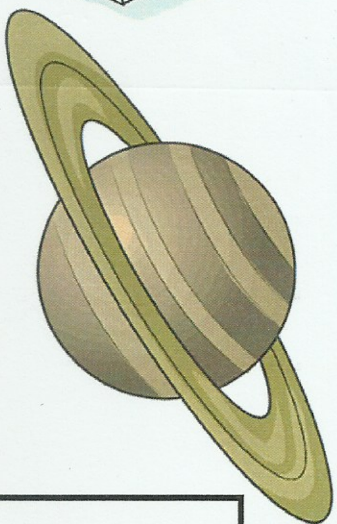
Physics 1st Paper

Practical Notebook

Designed by W4H1D

Class: Eleven - Twelve

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Roll no.		Reg. no.	
Session	2020 - 2021		
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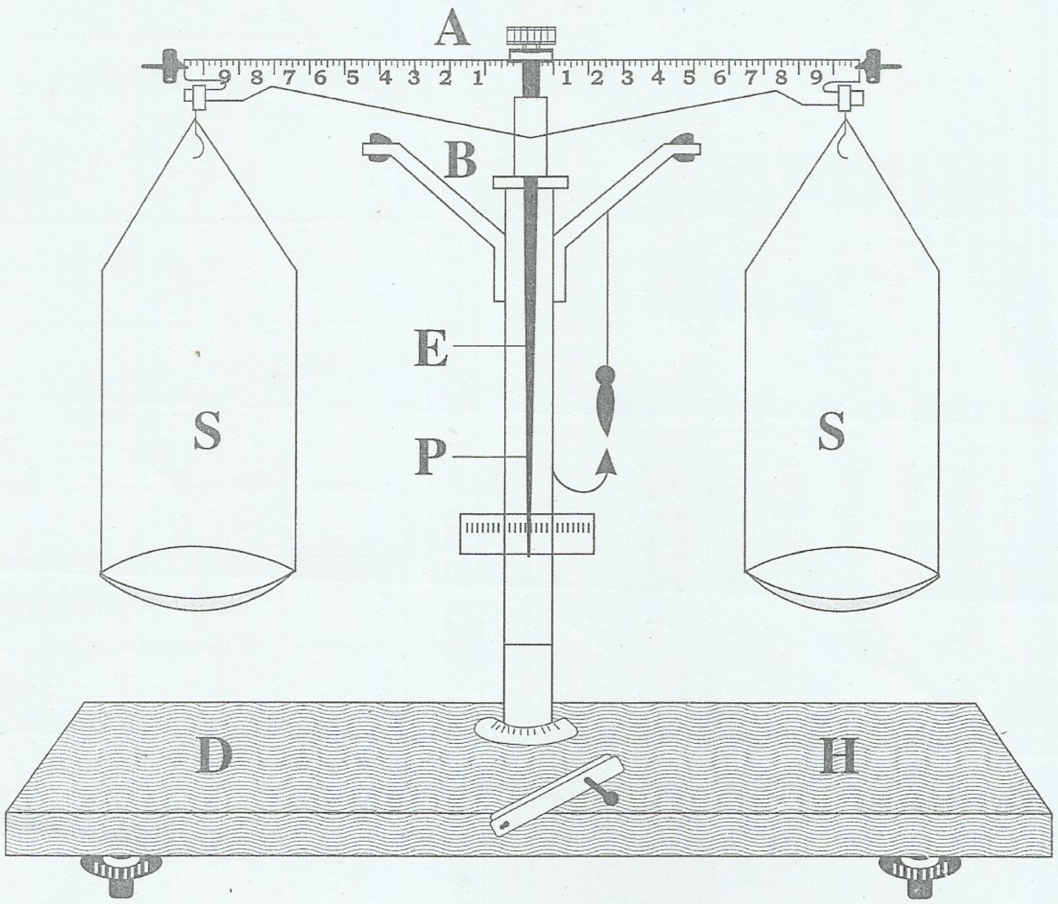
W4H1D

2554

BALANCE



A= METALLING BEAM
D= WOODEN FRAME
H= HANDLE

B= MOVABLE ROD
E= POINTER
P= PILLER, S= BALANCE PANS

NAME : Najmul Huda
SCHOOL/ COLLEGE : Bangladesh School & College, Saham
SUBJECT : Physics 1st Paper
ROLL NO. : SESSION : 2020-2021
REGISTRATION NO. :

USEFUL DATA FOR PHYSICS

SI NO	NAME OF ELEMENTS	SPECIFIC GRAVITY	SPECIFIC RESISTANCE	SPECIFIC HEAT		LATENT HEAT		THERMAL CONDUCTIVITY	VALOCITY OF SOUND m/sec		REFRACTIVE		CRITICAL ANGLE	BREAKING STRESS	MODULLUS OF RIGIDITY	YOUNGS MODULLUS	CO-EFFICIENT EXPANSION	
		GM.C.C.	x 10-60HA -CM	SOLID Gm/ Cal	LIQUID Gm/Cal	FUSION L.CALS Gm	VAPORI SATION	CAL.Cm SEC/^{0}c	SOLID	LIQUID	SOLID	LIQUID	/oc	KILOS/Sq cm	DYNES/CM^2	'y' dynes/Cm^2	LINE Ar /^{0}C	VOLUME /OC
1	COPPER	8.93	1.78	0.091-0.094	-	50.6	-	0.920	3600.3970	-	-	-	-	30.000	3.9-40X10^{11}	12.4-12.9X10^{11}	0.0000167	-
2	BRASS	8.6	4.1-66	0.088-0.092	-	-	-	-.260	3600	-	-	-	-	34.000	3.5X10^{11}	9.9-10.2X10^{11}	0.0000189	-
3	IRON (OUS)	7.2	13.19-18.80	0.119	-	65.0	-	0.14	5000	-	-	-	-	6.000	7.7-8.3X10^{11}	10-13X10^{11}	0.0000102	-
4	IRON (IC)	7.86	12.0-16.80	-	-	-	-	-	-	-	-	-	-	-	7.9-8.9X10^{11}	19.9-20X10^{11}	-	-
5	STEEL	-	19.9-25-60	-	-	-	-	0.10800	5200	-	-	-	-	8.000	-	19.5-20.6X10^{11}	-	-
6	ALUMINIUM	26.27	3.21	0.21	-	93.0	-	0.480	-	-	-	-	-	-	-	70.5X10^{11}	0.000023	-
7	ZINC	7.1	6.10	0.033	-	24.1	-	0.265	-	-	-	-	-	-	-	-	0.0000258	-
8	LEAD	11.4	20.80	0.109	-	5.4	-	0.083	-	-	-	-	-	-	-	-	0.0000291	-
9	NICKEL	8.9	-	0.056	-	-	-	0.14200	4900	-	-	-	-	-	-	-	0.0000128	-
10	SILVER	-	1.63	0.033	- -	21.0	-	-	-	-	-	-	-	-	-	-	-	-
11	GOLD	19.3	-	-	0.033	0.16		-	-	-	-	-	-	-	-	-	-	-
12	PLATINUM	21.5	1.63	0.055	-	-	2.8	-	-	-	-	-	-	-	-	-	0.000089	-
13	MERCURY	-	-	1.12	-	-	-	0.02000	-	-	-	-	-	-	-	-	-	18.2X10^{-5}
14	TIN	2.29	11.00	0.16	-	14.0	-	-	5000-5300	-	-	-	41.25	-	--	--	0.0000214	-
15	GLASS (FUNT)	2.9-5.9	-	-	0.42	-	-	0.002	-	-	1.53-1.960	-	41.45	-			-	-
16	GLASS (CROWN)	2.4-2.8	11.30	-	1.51	-	-	-	-	1370.0	1.48-16.10	1.47	43.15	-	-	-	-	-
17	TARPINTINE OIL	0.87	-	-	1.00	-	-	-	-	1260.0	-	1.362	-	-	-	-	-	97.3X10^{-5}
18	ALCOHOL (ETHYL)	0.79	-	-	-	-	5.37	-	-	1410	-	1.33	48.5	-	-	-	-	-
19	WATER	-	-	0.502	0.58	-	-	-	-	-	-	-	-	-	-	-	-	-
20	ICE	0.92	-	-	0.64	80.0	-	-	-	-	131	1.47	-	-	-	-	-	-
21	GLYCERINE	1.28	-	-	-	-	-	-	-	-	-	1.44	-	-	-	-	-	50.5X10^{-5}
22	KEROSINE OIL	0.08	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
23	RUBBER	0.9-13	-	-	-	-	-	0.0045	30-40	-	-	-	-	-	-	-	-	-

CLASSIFICATION OF ELEMENTS ACCORDING TO THEIR VALENCY

Mono valent	Divalent	Trivalent	Tatravalent	Panta Valent	Hexavalent
Hydrogen Fluorine Chlorine Bromine Iodine	Oxygen Sulphur	Boron Nitrogen Phosphorus	Carbon Sillicon Sulphur	Nitrogen Phosphours	Sulpher
Potassium Sodium Mercury (ous) Copper (-ous) Silver	Calcium Strontium Barium Zinc Megnesium Copper (ic) Mercury (-ic) Iron (-ous) tin (-ous) Lead (-ous)	Aluminium Gold (ic) Bismuth Iron (ic) Antimony (-ous)	Tin (-ic) Platinum Lead	Arsenic Antimony (ic)	

PRACTICAL

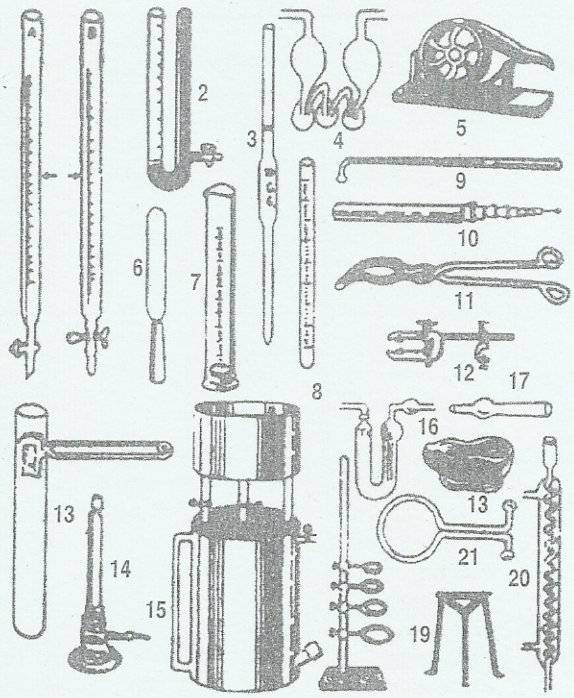
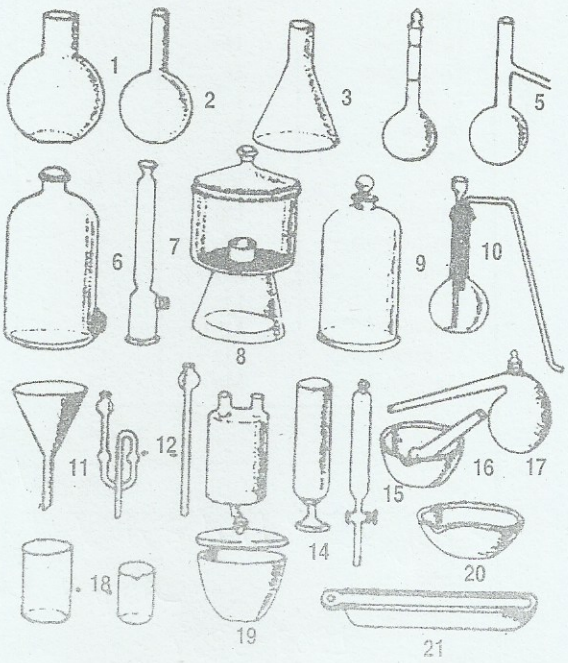


PLATE NO.1

1. BURETTE
2. EUDIOMETER
3. PIPETTE
4. POTASH BULES
5. CORK SQUEEZER
6. SPATULA
7. MEASURING CYLINDER
8. MEASURING TUBE
9. BLW PIPE
10. CORK BORER
11. TONGS
12. CLAMP
13. TEST TUBE WITH HOLDER
14. BUNSEN BUENER
15. GAS HOLDER
16 & 17. Ca C12-TUBE
18. MERCURY TROUGH
19. TRIPOD STAND
20. CONDENSER
21. CLIP
22. RETORT STAND

PLATE NO. 2

1. FLAT BOTTOM FLASK
2. ROUND BOTTOM FLASK
3. CONICAL FLASK
4. MEASURING FLASK
5. DISTILLING FLASK
6. ASPIRATOR
7. TOWER
8. DESICCATOR
9. BELL JAR
10. FLASK WITH THISTLE FUNNEL & DELIVERY TUBE
11. FUNNEL
12. THIST LE FUNNELS
13. WOULFE'S BOTTLE
14. TEST GLASS
15. SEPARATING FUNNEL
16. MORTAR & PESTLE
17. BETORT
18. BEAKERS
19. CRUCIBLE
20. BASIN
21. BOAT

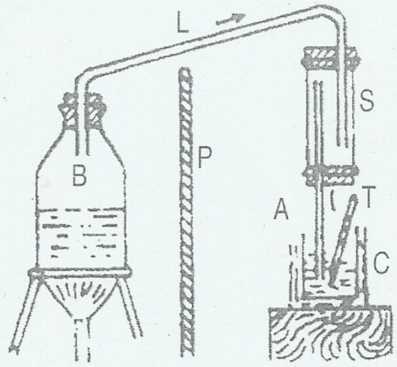


ATOMIC NUMBERS AND ATOMIC WEIGHTS WITH THEIR SYMBOLS

Name of the Element	Symbol	Atomic Number	Atomic Weight	Name of the Element	Symbol	Atomic Number	Atomic Weight
Actinium	Ac	89	227	Mercury	Hg	80	200.5
Aluminium	Al	13	6.97	Molybdenum	Mo	42	95.9
Amcricium	Am	95	243	Neodymium	Nd	60	144.2
Antimony	Sb	51	121.7	Neon	Ne	10	20.17
Arogon	Ar	18	39.94	Nickel	Ni	28	58.7
Arsenic	As	33	74.9216	Niobium	Nb	41	92.9064
Astatine	At	85	210	Nitrogen	N	7	14.0067
Barium	Ba	56	137.3	Osmium	Os	76	190.2
Berkelium	Bk	97	249	Oxygen	O	8	15.999
Beryllium	Be	56	137.36	Palladium	Pd	46	106.4
Bismuth	Bi	4	9.02	Phosphorus	P	15	30.97376
Boron	B	83	209.00	Platinum	Pt	78	195.0
Bromine	Br	5	10.82	Potassium	K	19	39.09
Cadnium	Cd	35	80	Praseodymium	Pr	59	140.9077
Calcium	Ca	48	11.24	Prtotactinium	Pa	91	231.0359
Carbon	C	20	40	Radium	Ra	88	226.0254
Cerium	Ce	6	12	Radom	Rn	86	222
Caesium	Cs	58	140.12	Rhenium	Re	75	186.2
Chlorine	C1	55	132.91	Rhodium	Rh	45	102.9055
Chromium	Cr	17	35.476	Ruthenium	Ru	44	101.75
Copper	Cu	29	63.5	Rubinium	Rb	37	85.43
Dysprocium	Dy	66	162.46	Samarium	Sun	62	150.4
Erbrium	Er	68	167.67	Seandium	Sc	21	44.9559
Europium	Eu	63	152.0	Sclenium	So	34	78.09
Fluorne	F	9	19.00	Sillcon	Si	14	28.08
Franeium	Fr	87	223	Silver	Ag	47	107.868
Gadolinium	Gd	64	156.9	Sodium	Na	11	22.98977
Gaflium	Ga	31	62.72	Stontlum	Sr	38	87.62
Germanium	Ge	32	72.62	Sulphur	S	16	32.06
Gold	Au	79	797.2	Tuntalum	Ta	73	180.947
Hafnium	Hf	72	178.6	Tellurim	Te	52	127.6
Helium	He	2	4.002	Terbium	Th	65	159
Hokmium	Ho	67	163.5	Thallium	Ti	81	20.39
Hydrogen	H	1	1.007	Thorium	Th	90	232.12
Indium	I	53	126.92	Thulium	Tm	69	169.04
Iodine	Ir	77	193.1	Tin	Sm	50	119
Iridium	Fe	26	55.84	Titanium	Ti	22	47.90
Iron	Kr	36	83.7	Tungstem	W	74	184.0
Krypton	La	57	138.9	Uranium	U	92	238.07
Ianthenum	Ph	82	207.22	Vonadium	V	28	50.95
Lead	Lm	3	6.940	Xenon	Xe	54	131.3
Lithium	Li	3	6.94	Ytterubim	Yb	70	178.0
Lutecium	Lu	71	174.97	Yttrium	Y	39	88.9059
Magnecium	Mg	12	24.305	Zunc	Zn	30	65.38
Manganese	Mn	25	54.9380	Zircontum	Zr	40	91.22

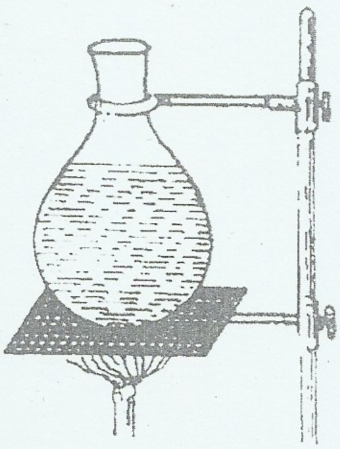
তড়িৎ কোষের বৈদ্যুতিক চাপ (E.M.F of Cells)

কোষের নাম	বৈদ্যুতিক চাপ ভোল্ট	কোষের নাম	বৈদ্যুতিক চাপ ভোল্ট
ড্যানিয়েল	1.07-1.08	ড্যানিয়েল	2.0000
বুনসেন	1.08-1.90	বুনসেন	1.8-1.9000
লেকল্যান্স	1.45	লেকল্যান্স	1.433
শুষ্ক	1.50	শুষ্ক	1.01830
সেকেন্ডারী		সেকেন্ডারী	
সীসা এডিস (সঞ্চয়ী)	1.9-2.20	সীসা এডিস (সঞ্চয়ী)	1.1-1.4000

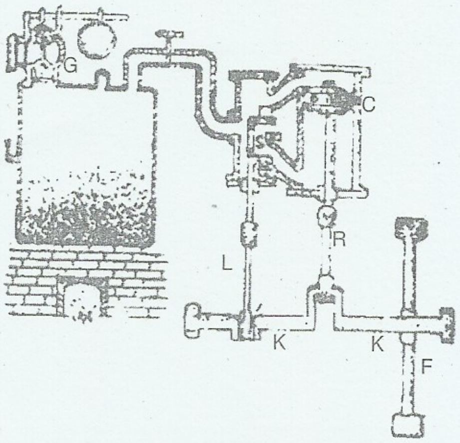


B- Water vessel
S- Steam trap
P- A screen
C- Calorimeter
T-Thermometer
A-Exit tube

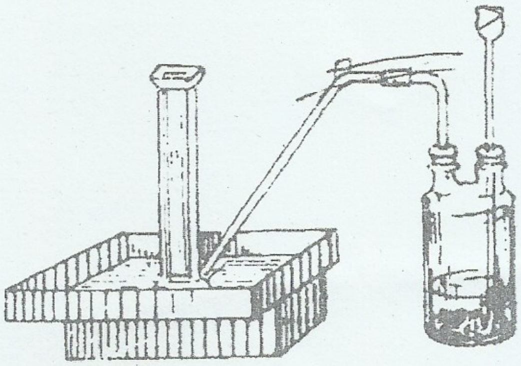
DETERMINATION OF LATENT HEAT
OF VAPORISATION OF WATER



TRANSMISSION OF HEAT



SECTIONAL DIAGRAM OF COMPLETE
STEAM OF ENGINS



LABORATORY METHOD PREP
OF HYDROGEN

Index

Index

Sl. No.	Date	Name of the Experiment	Page No.	Initials	Remarks

This is to Certify that Mr./Miss ....

A Student of ....Class Roll No. .... Has Performed the Required

Number of Experiments in Physics/Chemistry Laboratory of ....

School/College/University as per Syllabus During the Session ....

Head of the Department
Physics/Chemistry

NAME OF THE EXPERIMENT Determination of radius of curvature of spherical surface using spherometer.

DATE 17/04/2022

PAGE NO. 01

EXPT. NO. 01

Theory:

It is the geometrical radius of the sphere of which the given surface is a part.

The radius of curvature of a spherical surface is the geometrical radius of the sphere.

The radius of curvature of a given surface, $R = \frac{d^2}{6h} + \frac{h}{2}$, where d = mean distance between the fixed legs of spherometer and h = vertical height through which the central leg has to be raised or lowered in order that it may touch the given surface.

$$\text{Least Count } (L.C) = \frac{\text{Pitch } (P)}{\text{total number of circular scale divisions } (n)}$$

Pitch is the distance through which the spherometer screw moves for one complete rotation of the circular scale.

The height of the spherical surface, $h = M + (N \times L.C)$

M = number of complete rotation of the circular scale

N = additional circular divisions required for lowering the central leg from its point of contact on the test to its point of the contact on the glass plate.

Apparatus:

The spherometer, the spherical surface (concave or convex mirror or lens), thick glass plate, scale, pencil, paper etc.

FIGURE NO. 01

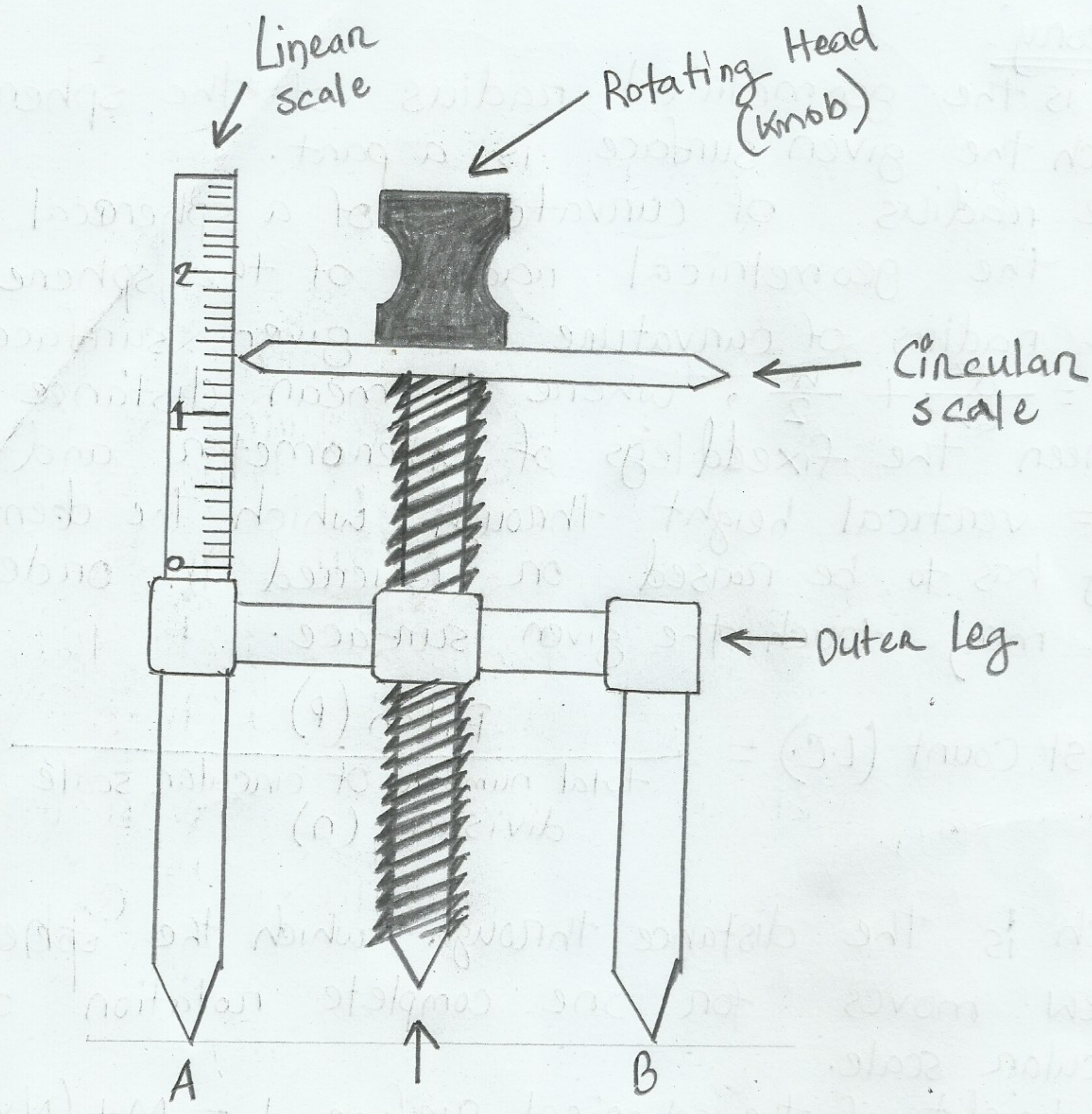


Figure-01 (Exp-01): Determination of Radius of curvature of a spherical surface by spherometer.

Procedure:

1) At first, the pitch i.e. distance through which the spherometer screw moves for one complete rotation of the circular scale was determined. Value of 1 small division of vertical (linear) scale was determined and number of divisions of the circular scale was determined and then dividing the pitch by total number of divisions of the circular scale, the least count of the spherometer were determined.

2) The spherical surface (concave or convex) was placed on the base plate (which is usually thick glass plate) and the spherometer then was placed on the spherical surface in such a way that the central leg and three other legs touch the spherical surface. The circular scale reading was taken.

3) Now the spherical surface was removed and slowly turned the central leg down until it touches the base plate. Each full turn was counted. Next the reading of the circular scale was noted and the height of the spherical surface was calculated.

4) The spherometer was placed on plane white paper and the impression of the three outer legs (A, B, C) was taken by pressing the spherometer. Then the distance between the fixed legs of spherometer was calculated.

FIGURE NO. 01

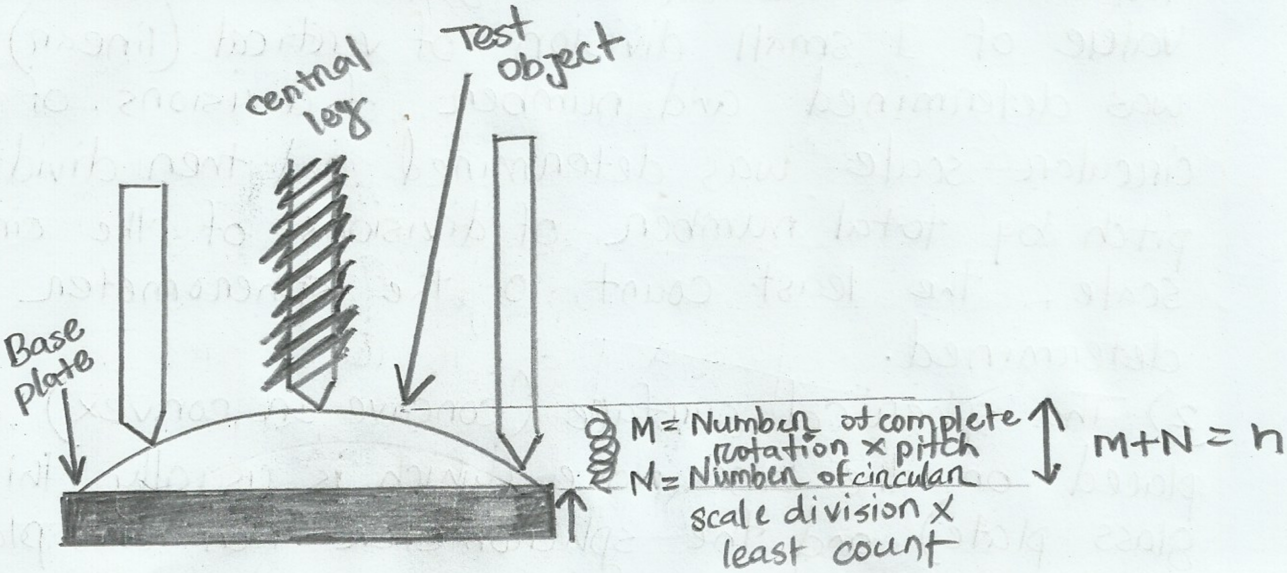


Figure - 2 (Exp-01): Determination of height (h) by spherometer.

NAME OF THE EXPERIMENT Determination of radius of curvation of spherical surface using spherometer.

DATE 17/04/2022

PAGE NO. 03

EXPT. NO. 01

Data and Table:-

Value of 1 small division of vertical (linear) scale = 1 mm.

Pitch of the instrument = 1 mm = 0.1 cm

Number of divisions of the circular scale (n) = 100

$\therefore$ Least count (L.C.) $= \frac{P}{n} = \frac{1\text{ mm}}{100} = 0.01\text{ mm}$
$= 0.001\text{ cm}$

Mean value of d $= \frac{d_1 + d_2 + d_3}{3}$

$= \frac{(3.2 + 3.1 + 3.3)\text{ cm}}{3}$

$= 3.2\text{ cm}$

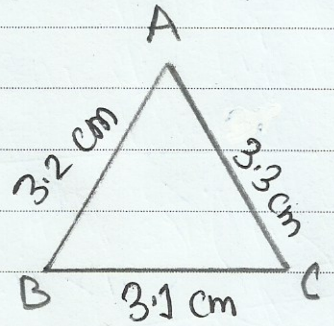


Table:- Determination of Vertical Height (h):

No. of observation	Circular scale reading on the test plate	Number of Complete	Value of complete rotation M'×Pitch =M	Circular scale reading on the base plate after complete rotation	Number of additional circular scale reading	L.C.	Value of N = a−b × L.C.	Total M+N = h	Mean
1	21	1	0.1	95	26		0.026	0.126	
2	23	1	0.1	95	28	0.001	0.028	0.128	0.127
3	24	1	0.1	97	27		6.027	0.127	

NAME OF THE EXPERIMENT Determination of radius of curvation of spherical surface using spherometer.

DATE 17/04/2022

PAGE NO. 04

EXPT. NO. 01

Calculations:-

Radius of curvature of spherical (Concave or Convex) surface,
$$R = \frac{d^2}{6h} + \frac{h}{2} = \frac{(3.2)^2}{6 \times 0.127} + \frac{0.127}{2}$$
$$= 13.44 + 0.0635 = 13.5035 \text{ cm}$$
$$= 13.5035 \times 10^{-2} \text{ m}$$
$$= 0.135035 \text{ m}$$
$$\therefore R = 13.5035 \text{ cm} = 0.135035 \text{ m}.$$

Result with Explanation:

Radius of curvature of spherical surface, R = 13.50 cm = 0.135035 m.

If the plane surface and the spherical surface are not uniform, then error may come. To avoid backlash error, screw should always move in one direction. Care also should be taken so that central leg and three other legs just touch the spherical surface. To minimize error, 'd' should be measured very care-fully.

Precautions:

1) Pitch and least count should be determined very carefully
2) Care should be taken to determine 'd'.
3) Backlash error should be avoided.
4) Care should be taken to observe whether the central leg has just touches the test or base plate.
5) All the readings should be taken very carefully.

NAME OF THE EXPERIMENT Detenmination of radius of curvation of spherical surface using sphenometer.

DATE 17/04/2022

PAGE NO. 05

EXPT. NO. 01

Discussions:

1) The spherical surface was not smooth, so the result was not satisfactory.

2) The sphenometer was very old, so the readings were not perfect.

NAME OF THE EXPERIMENT Determination of the moment of inertia of a fly wheel.

DATE 18/04/2022

PAGE NO. 06

EXPT. NO. 02

Theory:

Let M be the mass of the suspended weight, I be the moment of inertia of the fly wheel and r is the radius of the axle. When the mass M falls through a vertical height h, it loses potential energy (P.E.). This energy is converted into ~~or~~ kinetic energy (K.E.) and stored in the fly wheel and work done against the friction at the axle of the wheel. Now, if the body falls through height h and acquired the angular velocity ω and work done for each rotation be W, the lost of potential energy at fall of the vertical height, h is expended to produce.

(i) Kinetic energy of the body $= \frac{1}{2}Mv^2$

(ii) Rotational kinetic energy of the wheel $= \frac{1}{2}I\omega^2$

(iii) Work done against friction $= W$

$$\therefore Mgh = \frac{1}{2}Mv^2 + \frac{1}{2}I\omega^2 + n_1 W \quad \text{------ (1)}$$

Here, I = moment of inertia of the wheel

n_1 = Number of revolution while M fall through vertical height h (from A to B).

n_2 = Further revolutions of flywheel before it comes to rest

The work done during this n_2 revolutions in overcoming friction

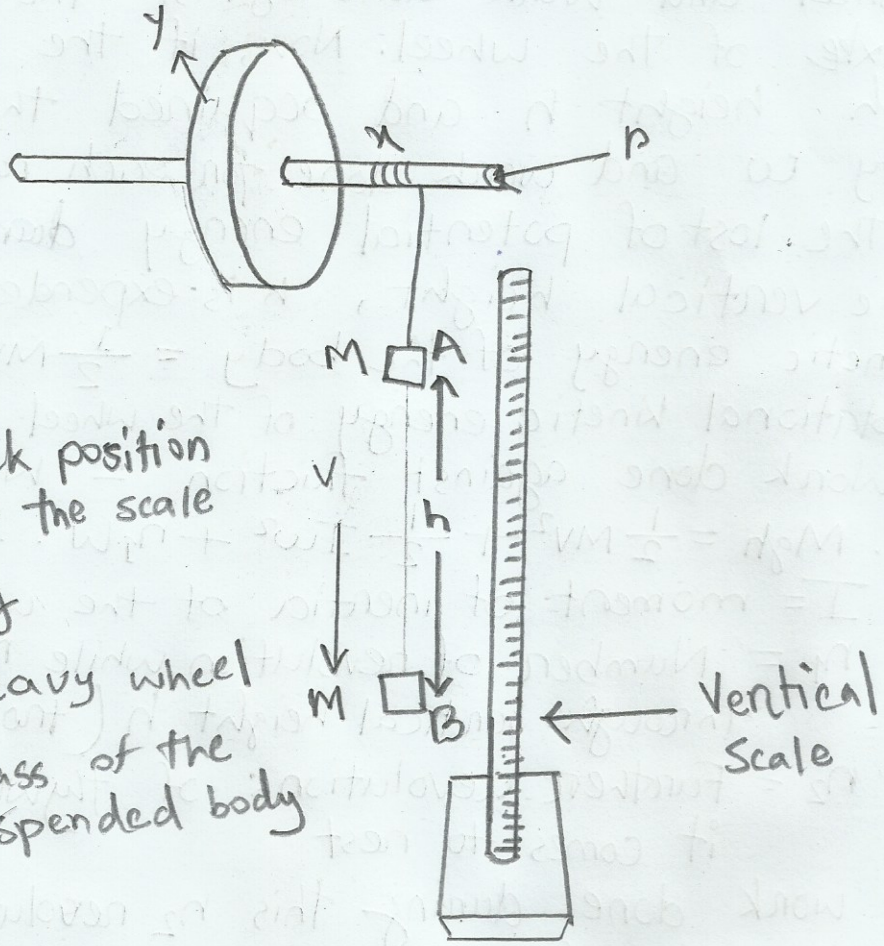
$$\therefore n_2 W = \frac{1}{2}I\omega^2$$

$$\text{or, } W = \frac{1}{2n_2}I\omega^2 \quad \text{------ (2)}$$

Putting the value of W in equation-(1), we get,

$$Mgh = \frac{1}{2}Mv^2 + \frac{1}{2}I\omega^2 + \frac{n_1 I\omega^2}{2n_2}$$

FIGURE NO. 02



A, B = Mark position along the scale

x = Peg

Y = Heavy wheel

M = Mass of the suspended body

Figure – 02 (Exp – 02): Determination of the moment of inertia of a fly wheel.

or, $Mgh = \frac{1}{2} Mp^2 \omega^2 + \frac{1}{2} I\omega^2 \left(1 + \frac{n_1}{n_2}\right)$ [$\because v = \omega r$ and r = radius of the axle

$$\text{or, } I = \frac{2Mgh - Mr^2\omega^2}{\omega^2\left(1 + \frac{n_1}{n_2}\right)}$$

$$= \frac{Mn_2(2gh - r^2\omega^2)}{\omega^2(n_1 + n_2)} \quad \text{.........} (3)$$

Again, since the wheel revolves with ω uniform angular velocity and after n_2 revolutions come to rest, so average angular velocity $= \frac{\omega + 0}{2}$

$$= \frac{\omega}{2}$$

$$= \frac{2\pi n_2}{t}$$

$\because$ angular velocity $\omega = \left(\frac{2\pi n_2}{t}\right)$

$$\therefore \omega = \frac{4\pi n_2}{t} \quad \text{........} (4)$$

$$I = \frac{Mn_2 \left\{2gh - r^2\left(\frac{4\pi n_2}{t}\right)^2\right\}}{n_1 + n_2}$$

$$= \frac{Mn_2}{n_1 + n_2}\left[\frac{2ght^2 - 16\pi^2 n_2^2 r^2}{16\pi^2 n_2^2}\right]$$

$$\text{or, } I = \frac{M}{n_1 + n_2}\left[\frac{8ht^2}{8\pi^2 n_2^2} - n_2 r^2\right]$$

Apparatus:

A fly wheel with axle, cotton rope/strings, meter scale, slide calipers, weight box, stop watch etc.

Procedures:

1) A mass (M) of about 200 gm was tied to the cotton string and the other end was fixed to the peg on the axle, the string was winded several times round the axle by rotating the wheel with the hand until the mass is near the rim, that is, at A. The position of A on the side of the scale was marked.
2) Now the mass M, was allowed to fall through a measured distance h to near the ground & at the time t of fall was noted with the stop watch. The number of revolutions, n_1 of the wheel during time t was noted by observing a mark was made on the rim of the fly wheel.
3) The string was rewinded till the mass is again at A and the mass was allowed to fall. As soon as the mass was detached, a stop watch was stared and the number of revolutions n_2 made by the wheel before coming to rest (B) was noted.
4) Procedure (2) was repeated taking the mass 240 gm.

5) The experiment may be repeated taking several masses.
6) The vertical height AB = h can be also measured by a meter scale.
7) The diameter, d of the axle was measured by a slide calipers and dividing this diameter by 2, radius (r) was obtained.
8) Now, putting the value of n_1, n_2, t, r, M, h and g, moment of inertia (I) was determined.

Experimental Data & Table:

i) Determination of radius of the axle:-

Vernier constant $= \frac{s}{n} = \frac{1 mm}{10} = 0.1 mm = 0.01$ cm

s = value of 1 small division of linear scale
n = Number of total division of linear scale.

No. of Observations	Main scale Reading a cm	Vernier scale Reading v	Vernier Constant c cm	Value of Vernier scale Reading $b = v \times c$ cm	Total apparent reading $d' = a + b$ cm	Instrumental error $\pm e$ cm	Correct Reading (diameter) $d = d' - (\pm e)$ cm	Average Diameter d cm
01	2.3	2	0.01	0.02	2.32	0	2.32	
02	2.3	3	0.01	0.03	2.33	0	2.33	2.33
03	2.3	4	0.01	0.04	2.34	0	2.34	

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Radiu of axle, $r = \frac{d}{2} = \frac{2.33}{2} = 1.165$ cm

ii) Table of detenmining n_1, n_2, h and t :-

No. of observation	Weight of the body M gm	Height h cm	No. of nevolutions of the wheel n_1	Average n_1	No of revolutions of the wheel n_2	Average n_2	Time for n_2 nevolutions t sec	Average t sec	Radius of the axle r cm	Moment of inentia of the wheel I gm-cm²	Avera-age I gm-cm²
01	200	60	8		29		22.6				
02	200	60	8	8	29	29	22.4	22.5	1.165	70053	
03	200	60	8		29		22.5			·77	77167
01	240	60	8		34		26.1				·66
02	240	60	8	8	34	34	25.9	26	1.165	84281	
03	240	60	8		34		26			·54	

Calculations:

1) $$I = \frac{M}{n_1+n_2}\left[\frac{ght^2}{8\pi^2 n_2} - n_2 r^2\right]$$

$$= \frac{200}{8+29}\left[\frac{980 \times 60 \times (22.5)^2}{8 \times (3.1416)^2 \times 29} - 29 \times (1.165)^2\right]$$

$$= \frac{200}{37}\left[\frac{29767500}{2289.76} - 39.35\right]$$

$$= 5.405 \times [13000.27 - 39.35] = 5.405 \times 12960.92$$

$$= 70053.77 \text{ gm cm}^2 = 7.005377 \times 10^{-3} \text{ Kgm}^2$$

2) $$I = \frac{M}{n_1+n_2}\left[\frac{ght^2}{8\pi^2 n_2} - n_2 r^2\right]$$

$$= \frac{240}{8+34}\left[\frac{980\times 60\times (26)^2}{8\times (3.1416)^2\times 34} - 34\times(1.165)^2\right]$$

$$= \frac{240}{42}\left[\frac{39748800}{2684.55} - 46.16\right]$$

$$= 5.71\times(14806.5 - 46.16)$$

$$= 5.71\times 14760.34 = 84281.54 \text{ gm cm}^2$$

$$= 8.428154\times 10^{-3} \text{ kgm}^2$$

Results with Explanation:-

Moment of inertia of fly wheel, $I = 7.716766\times10^{-3}$ kgm². Moment of inertia, $I = \sum mr^2$, since mass m and distance r are constant, so we have the correct value of I.

Precautions:-

1) Time and number of revolution must be counted very carefully.
2) When the fly wheel makes less than 100 revolutions before coming to rest, there is a considerable frictional loss and the axle should be oiled.
3) The string should be of small diameter compared to that of the axle.

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4) Readings along mutually perpendicular direction must be taken while measuring the diameter of the axle.
5) Height (h) should also be measured very carefully.
6) n_1 and n_2 should be measured carefully.

Discussions:

1) The slide caliper was old, so the result was not correct.
2) The stop watch was disturbing, so it was not possible to count correct time.
3) The cotton thread was not swing less, so the result was not satisfactory.

First Method

Theory:

Potential energy is defined as the energy possessed by it by virtue of its position or configuration. This potential energy is equal to work done in moving against the force of gravity.

The stretched spring has potential energy equal to the work done against the molecular force in spring.

$\therefore$ Potential energy = work done.

We know,

In case of spring, within elastic limit, force $\propto$ extension (which is Hooke's law).

$\therefore F \propto y$.

or, $F = ky$, where k is the spring constant.

Now, work done by external force to expand the spring from position y_1 to y_2 is,

$$W = \int_{y_1}^{y_2} F\,dy = \int_{y_1}^{y_2} ky\,dy = k\int_{y_1}^{y_2} y\,dy = k\left[\frac{y^2}{2}\right]_{y_1}^{y_2}$$

$$= \frac{k}{2}\left(y_2^2 - y_1^2\right) \quad \ldots\ldots (i)$$

This work is positive work which remains in the spring as potential energy.

Let, $y_1 = 0$ and $y_2 = y$.

$\therefore$ From (i), we get,

$$w = \frac{1}{2}ky^2 \quad \ldots\ldots (ii)$$

FIGURE NO. 03

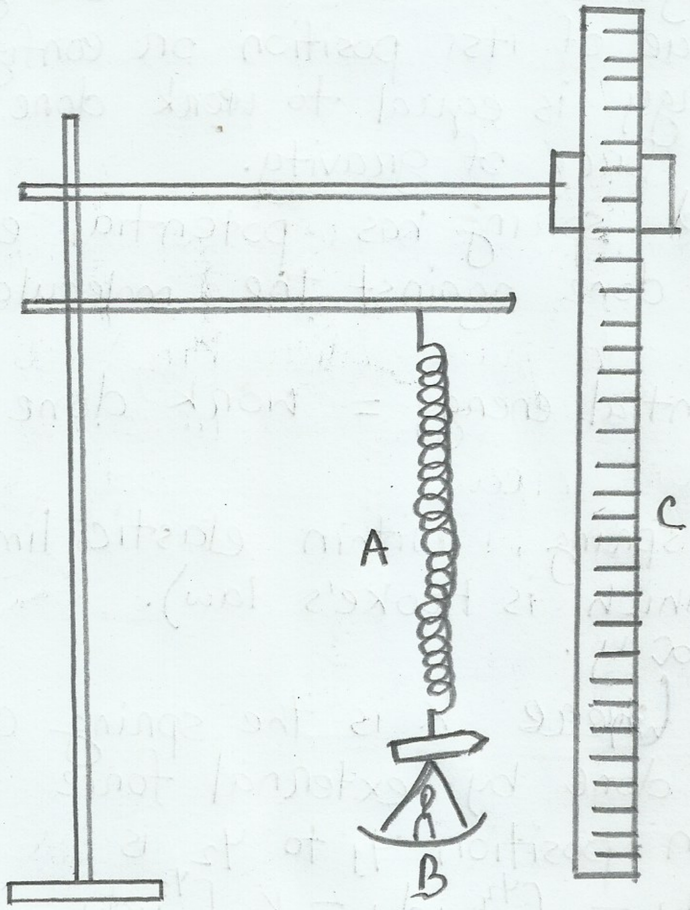

Figure-03 (Exp-03): Measuring the potential energy of a spring.

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Measuring potential energy of a spring.

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Apparatus:

A spiral spring A, scale pan B, meter scale C, two clamps and stands, two boxes of weight, light pointed P for spring etc.

Procedure:

1) The spring from the clamp was suspended and the light pointer P was attached to the spring. A vertical meter scale C was fixed beside the spring A.
2) The scale pan, B was attached to the lower end of the spring and then suitable load was added and the reading of the pointer P was noted and extension (y) for each load was noted.
3) Procedure (2) was repeated several times with the same load and average of y was taken.

Table :- Determination of extension (y) :-

No. of observations	Initial reading of the pointer y_1 (cm)	Load on scale pan m (gm)	Reading of the pointer after loading y_2 (cm)	Extension of the spring $y=y_2-y_1$ cm	Average extension of the spring y (cm)	Potential energy of the spring $=\frac{1}{2}ky^2$ (J)
01	30·3	100	40·7	10·4	10·5	0·05
02	30·3	100	40·8	10·5		
03	30·3	100	40·8	10·5		
04	30·3	100	40·9	10·6		

Calculations:

Potential energy, E_p (or U or P.E) $= \frac{1}{2} k y^2$

$= \frac{1}{2} \times 9.33 \times (0.105)^2$

$= 0.05$ Joule

$\because y = 10.5\ cm = 0.105\ m$

$\because K = \frac{F}{y} = \frac{0.1 \times 9.8}{0.105} = 9.33\ Nm^{-1}$

$m = 100\ g = 0.1\ kg$

Result with Explanation:-

Potential energy, $U = 0.05$ Joule.

The potential energy [Ep] depends on mass, acceleration due to gravity and extension of the spring. Since at a place, g is constant. So, Ep depends on mass (m) and extension of spring (y). So, mass (m) and extension of spring (y) should be measured very carefully. Load on the pan (m) should not be more than half of breaking stress of force. By this process if we can measure extension (y) of spring, then it is possible to measure Ep correctly.

Precautions:

1) The load should not be more than half of the breaking stress or force.
2) The diameter or radius should be measured very carefully as in the formula there is a square.
3) Load should be applied very carefully also.

4) Length of coil should be taken only.
5) At the time of vibration of string, length should not be measured.

Discussions:

1) The apparatus was very old, so the correct reading did not come.
2) The weight was not correct.

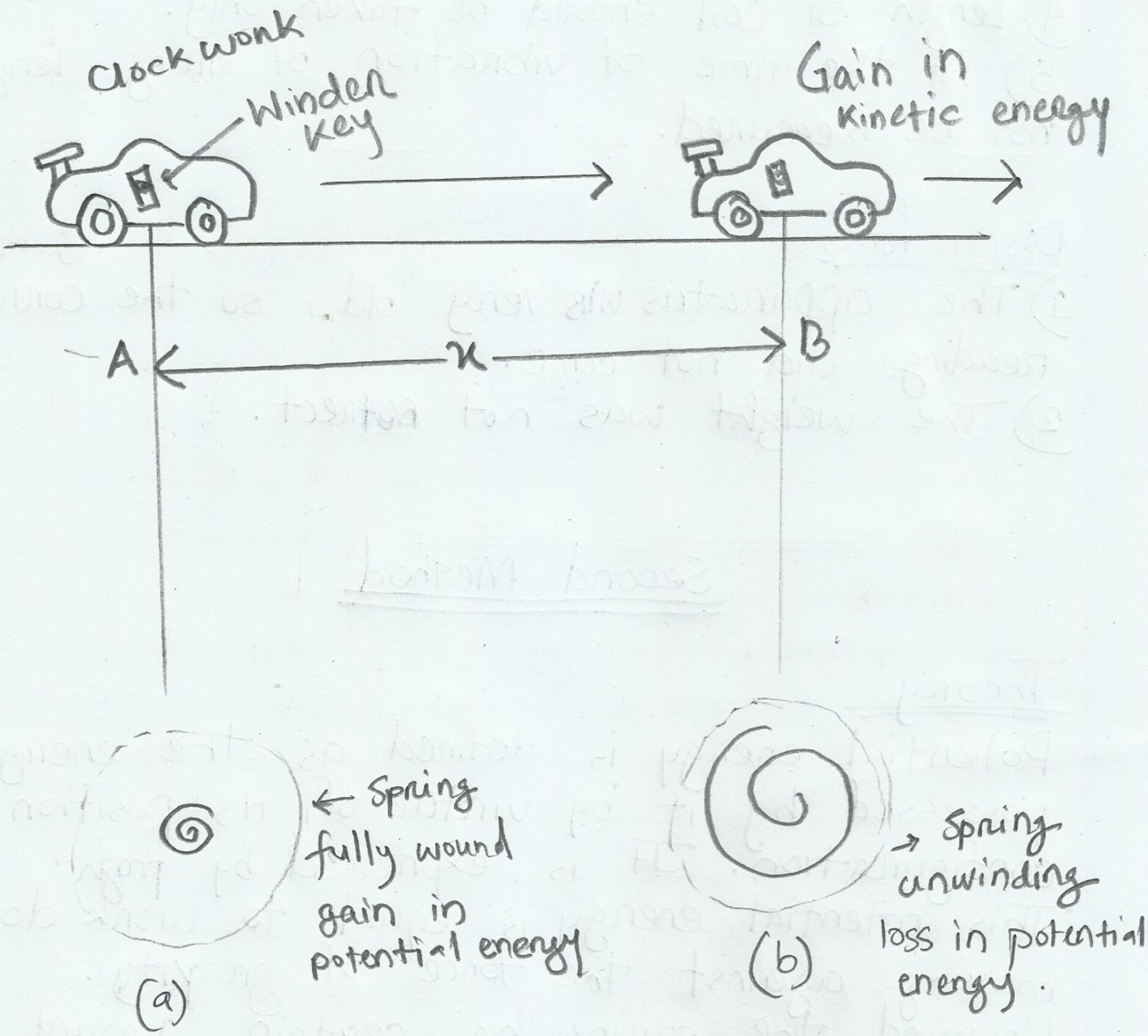
Second Method

Theory:

Potential energy is defined as the energy possessed by it by virtue of its position or configuration. It is expressed by mgh.
This potential energy is equal to work done in moving against the force of gravity.
Unwound, the spring has certain amount of potential energy. When it is coiled, it has greater amount of potential energy.
The stretched elastic or spring of a toy car has potential energy equal to the work done against the molecular force in elastic or spring.

$\therefore$ Potential energy = Kinetic energy = work done $= \frac{1}{2}mv^2$; where m = mass of the car and v = velocity of the car.

FIGURE NO. 03



Clock wonk
Winden key
Gain in Kinetic energy
A
x
B
Spring fully wound
gain in potential energy
(a)
Spring unwinding
loss in potential energy
(b)

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EXPT. NO. 03

Materials :-

Spring (which can be wound), clockwork car (say, toy car), scale, stop watch etc.

Procedure:

1) A spring was fully wound up and was connected with the winder key of clockwork car (or toy car).
2) Now, the car was released from A and the spring ~~was~~ released it's potential energy and the car will move until there is stored of potential energy.
3) As soon as the spring was released, a stop-watch was started and when the car was stopped at B, the time (t) was noted and the distance (s) between A and B was measured.
4) The mass (m) of the car was measured and finding the velocity of the car $v = \frac{s}{t}$, the kinetic energy $= \left(\frac{1}{2}mv^2\right)$ of the car was calculated which was equal to the potential energy of the spring.
5) The whole procedure (1-4) was repeated several times.

Calculations:

Mass of the car, $m = \frac{1}{2}$ kg.

Distance travelled, $s = 1.5$ m.

Time taken, $t = 3s$.

$\therefore$ Velocity of the car, $v = \frac{s}{t} = \frac{1.5}{3} = 0.5$ m/s

$\therefore$ Kinetic energy, $E_k = \frac{1}{2}mv^2 = \frac{1}{2} \times \frac{1}{2} \times (0.5)^2$ Joule

$= 0.0625$ Joule = Potential energy of

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Result with Explanation:

There is no fixed potential energy of spring as there are different springs.

Here, potential energy = 0·0625 J.

Potential energy = kinetic energy depends on the mass (m) of the car and velocity of the car. So, if we can measure m and v correctly then we can get correct value of the potential energy.

Precautions:

1) Time must be measured very cautiously.
2) Distance should be measured carefully too.
3) The spring should be wound up completely.

Discussions:

1) At the time of wound up the spring, it was disturbing
2) Stop-watch disturbing to record time.

Theory:

We know, in case of spring, within elastic limit, force $\propto$ extension (which is Hooke's law).

$\therefore F \propto y$ or $F = ky$ or $-ky$ where k is the spring constant.

$$\therefore k = \frac{F}{y} \text{ Nm}^{-1} \quad \text{.........} (1)$$

Apparatus:-

A spiral spring A, scale pan B, meter scale C, two clamps and stands, two boxes of weight, light pointer P for spring etc.

Procedure:-

1) The spring from the clamp was suspended and the light pointer P was attached to the spring. A vertical meter scale C was fixed beside the spring A.
2) The scale pan, B was attached to the lower end of the spring and then suitable load was added and the reading of the pointer P was noted and extension (y) for each load was noted.
3) Procedure (2) was repeated several times increasing load gradually.
4) A graph of load (m) vs extension (y) was drawn and from the graph $\frac{1}{slope}$ was found out and ~~the~~ from equation (1), spring constant was determined.

FIGURE NO. 04

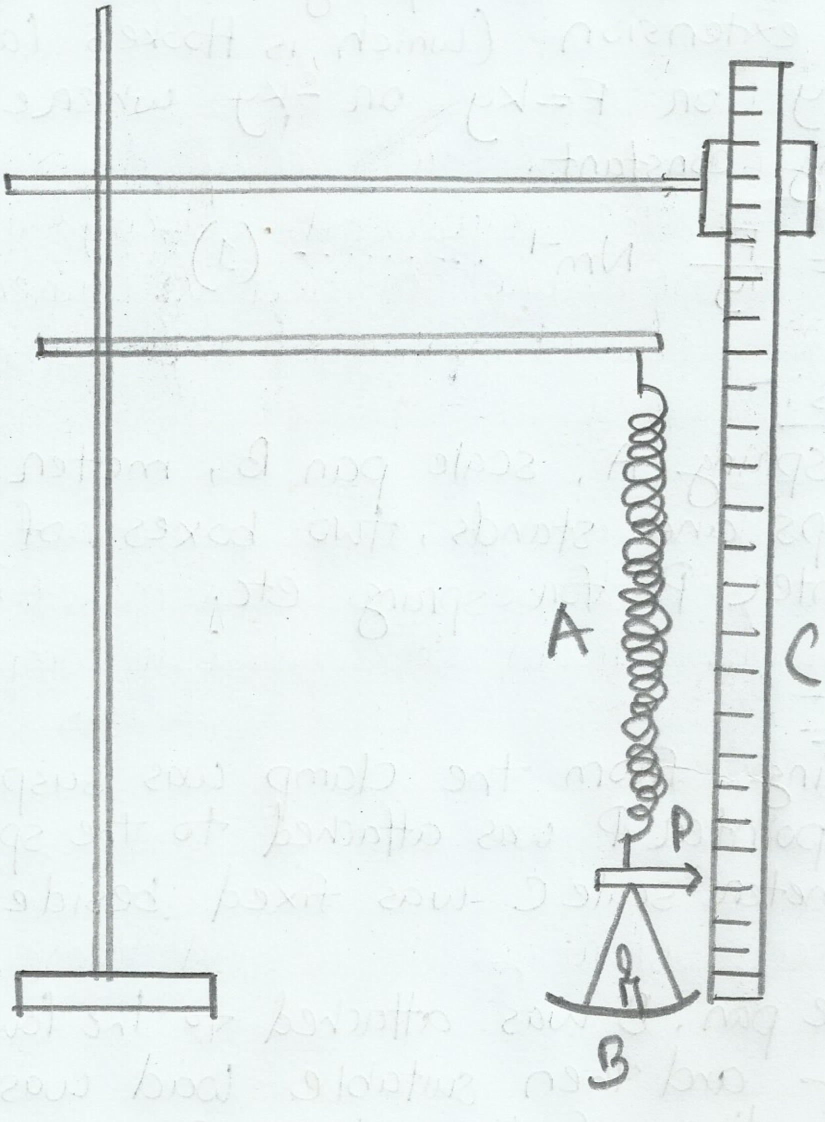

Figure - 04 (Exp- 04): Determination of spring constant of a spring.

Table :- Determination of extension :-

No. of observations	Mass of scale pan m_0 gm	Load on scale pan gm	Reading of pointer cm	Extension of spring y cm
01		0	13·5	0
02		50	18·3	4·8
03	50	100	21·5	8
04		150	23·65	10·15
05		200	28·6	15·1
06		250	33·5	20

[To get the extension initial pointer reading (13·5 cm) should be subtracted each time from the obtained reading when loaded the pan].

Calculations:

From graph, we get, slope $= \frac{16-4}{200-50}$ cm/gm

$= \frac{12}{150}$ cm/gm

$\therefore \frac{1}{\text{slope}} = K = \frac{150}{12}$ gm/cm $= 12·5$ gm/cm

$= \frac{12·5 \text{ gm}}{1 \text{ cm}} = \frac{\frac{12·5}{1000} \text{ kg}}{\frac{1}{100} \text{ m}}$

$= \frac{12·5}{10\cancel{00}} \times \frac{1\cancel{00}}{1}$ kg/m

$= 1·25$ kg/m $= (1·25 \times 9·8)$ Nm^{-1}

$= 12·25$ Nm^{-1}

FIGURE NO. 03

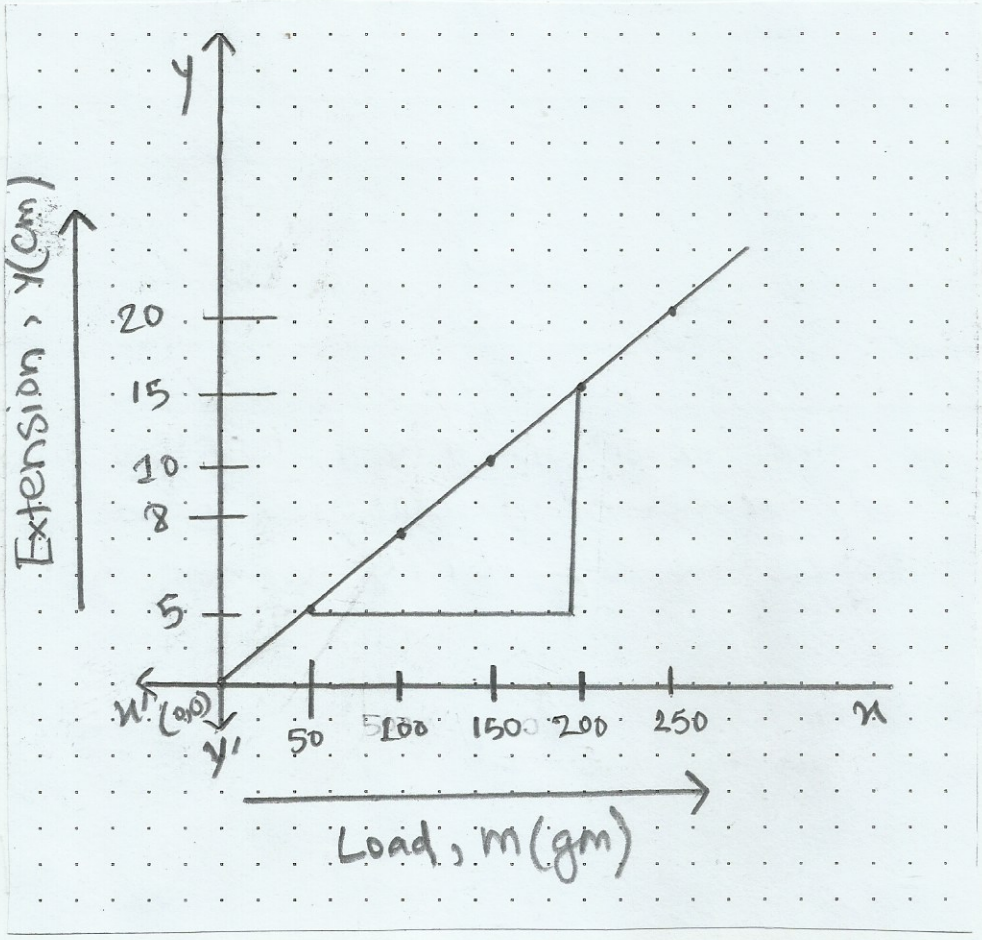

Figure - 04 [Exp-04): Load (m) vs extension (y) graph.

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Result with Explanation:

Spring constant, $K = 12.25 \ Nm^{-1}$.

Here, load (m) and extention were available, we have taken different of them. Since the graph is straight line and passes through origin, so our measurement of m and l are correct. Hence our result of K is correct. So, we can say our experiment is correctly done.

Precautions:

1) Reading of pointer should be taken avoiding parallex error.
2) Load should be added within elastic limit.
3) Avoiding jerking, load should be given - should not be more than half of the breaking stress.
4) Expansion of spring should be measured carefully.

Discussions:

1) The spring was not good. So, it was very difficult to take reading.
2) Meter scale and pointer was not in a good condition; so, the result was not so good.

Theory:

In Melde's experiment, stationary waves are produced in a uniform thread or string one end of which is fixed and other end is fastened to the prongs of a tuning fork.

Now, when the tuning fork is vibrated, then the velocity of the vibration, $v = \sqrt{\frac{T}{M}}$;

where, T = Tension of string, m = mass per unit length.

But $v = n\lambda$; where λ = wavelength of the wave and n = frequency of the tuning fork.

$$\therefore v = n\lambda = \sqrt{\frac{T}{M}}$$

$$\text{or, } n = \frac{1}{\lambda}\sqrt{\frac{T}{M}} \quad \ldots\ldots (1)$$

From vibrating tuning fork waves are produced in two ways:

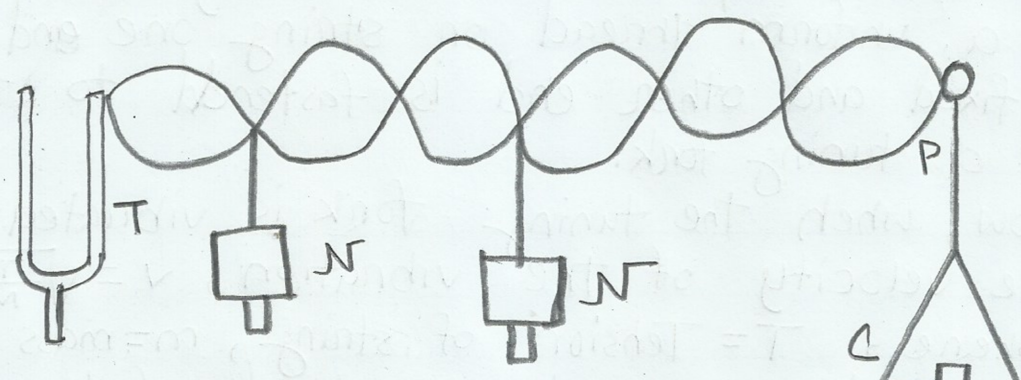
i) Vibration of the prongs of the tuning fork is along the resonant vibration of the string, which is called longitudinal vibration.

ii) Vibration of the prongs of the tuning fork is in perpendicular of the resonant vibration of the string, which is called transverse vibration.

In case of longitudinal vibration, it can be shown that, the frequency of the tuning fork (f) is twice of the vibration of the string (n), that is $f = 2n$.

$$\therefore f = 2n = \frac{2}{\lambda}\sqrt{\frac{T}{M}} \quad \ldots\ldots (2) \quad [\text{From} \ldots (1)]$$

FIGURE NO. 05



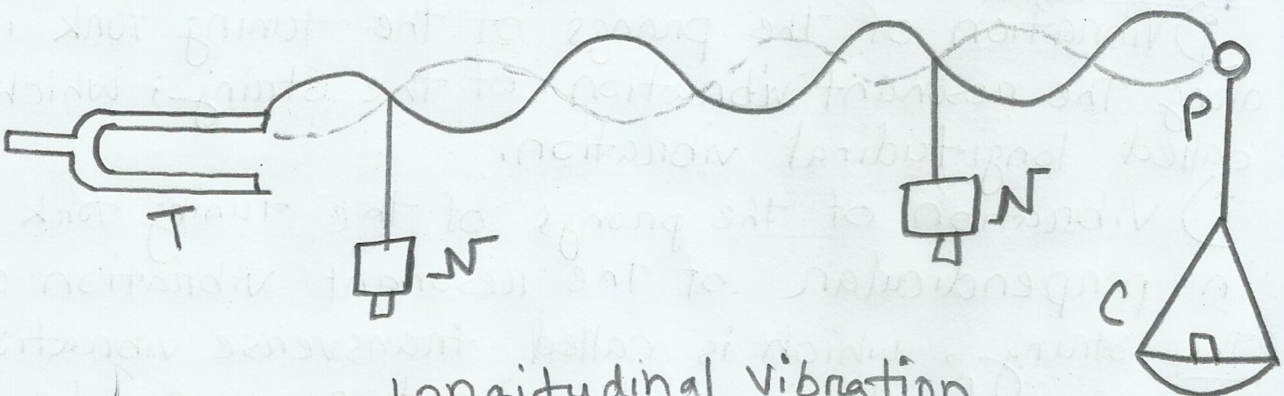
Transverse Vibration

T = Tuning fork

P = Pulley

N = Pin/Pointer

C = Pan



Longitudinal Vibration

Figure-05 (Exp-05): Determining frequency of a tuning fork.

Again, in case of transverse vibration, it is shown that the frequency of tuning fork (f) is equal to the vibration of the string (n), that is, $f = n$.

$$\therefore f = n = \frac{1}{\lambda}\sqrt{\frac{T}{M}} \;\ldots\ldots (3) \quad [\text{From} \ldots (1)]$$

Apparatus:

Melde's apparatus, thread, meter scale, balance, weight box, fine string etc.

Procedure:

1) The scale pan was weighed and one prong of a tuning fork is fastened with one end of the string and the other end of the string over the pulley mounted at the edge of the table and was attached with the scale pan to it.
The given tuning fork on a massive wooden base was firmly clamped in such a way that the line of vibration of the prong is —
   i) along the resonance vibration of the string
   ii) in perpendicular to the resonance vibration of the string.
2) Some load (4 gm to 10 gm) was placed on the scale pan and it was stretched slightly.
3) Now the fork was set into transverse vibration by a stroke of the bow. The length of the string was adjusted properly until the string vibration in a number of segments and loops are clearly

defined. Two vertical points (N, N) were set by clamps against the extreme nodal points. The distance (d) between the two points (N, N) and the number of loops (s) between the two points (N, N) were determined.
Now, from $\lambda = \frac{2d}{s}$, λ was determined. The procedure was repeated several times.
4) Now the tuning fork was turned and it was fixed to the string such a way that the line of vibration of the prongs of the fork is along the length of the string and as per .... (3) d and s were determined. Now from $\lambda = \frac{d}{s}$, λ was determined.
5) Last of all, the mass per unit length of the string was determined measuring the total mass and the length of the string. Mass per unit length,
$$m = \frac{\text{Total mass}}{\text{Total length}}.$$
6) All the data was placed in the table and from equation 2 and 3, the frequency (f) of the tuning fork was determined.

Table 1:- Determination of f (for transverse vibration):-

No. of observations	Weight of the pan W_1 gm	Load on the pan W_2 gm	Total weight $W = W_1 + W_2$ gm	Tension $T = mg$ dyn	No. of loop s	Distance among loops d cm	Wave length $\lambda = \frac{2d}{s}$ cm	Mass per unit length m gm/cm	$f = n = \frac{1}{\lambda}\sqrt{\frac{T}{M}}$ vib/s or Hertz	Average f vib/s or Hz

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01	7.9	4.1	12	11760	7	66	18.86		177.45	
02	7.9	8.2	16.1	15778	5	54.75	21.9	0.00105	177	177.71
03	7.[illegible]	12.3	20.2	19796	3	36.45	24.3		178.68	

Calculations:

1) $T = wg = 12 \times 980 = 11760$ dyn

$\lambda = \frac{2d}{s} = \frac{2 \times 66}{7} = 18.86$ cm

$f = \frac{1}{\lambda}\sqrt{\frac{T}{m}} = \frac{1}{18.86} \times \sqrt{\frac{11760}{0.00105}} = 177.45$ Hz.

Table 2 :- Determination of f (for longitudinal vibration):-

No. of obser-vations	Weight of the pan W_1 gm	Load on the pan W_2 gm	Total weight $W = W_1 + W_2$ gm	Tension $T = mg$ dyn	No. of Loop s	Distance among loop d cm	Wavelength $\lambda = \frac{d}{s}$ cm	Mass per unit length m gm/cm	$f = n = \frac{1}{\lambda}\sqrt{\frac{T}{M}}$ vib/s or Hz	Mean f vib/s or Hz
01	7.9	4	11.9	11662	3	112.2	37.4		178.2	
02	7.9	8.1	16	15680	2	87.72	43.86	0.00105	177	178.4
03	7.9	12.1	20	19600	1	48	48		180	

Calculations:

2) $T = wg = 11.9 \times 980 = 11662$ dyn

$\lambda = \frac{d}{s} = \frac{112.2}{3} = 37.4$ cm

$f = 2n = \frac{2}{\lambda}\sqrt{\frac{T}{m}} = \frac{2}{37.4} \times \sqrt{\frac{11662}{0.00105}} = 178.2$ Hz

Mean freancy, $f = \frac{177.71 + 178.4}{2} = 178.055$ vib/s or Hz.

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Result with Explanation:-

Both for transverse and longitudinal vibration, frequency of a tuning fork is 177.71 Hz and 178.4 Hz which are almost same. So, the performance of experiment is correct.

Precaution:

1) The tuning fork should be firmly fixed to the wooden clamp.
2) A uniform light and fine thread should be taken.
3) The loops should be carefully counted.
4) The ~~fork~~ should be set into vibration each time with only a single stroke of the hammer.
5) The adjustment of the weight should be made carefully.

Discussions:

1) It was not possible to fix the tuning fork tightly.
2) Very uniform and narrow string was not obtained.
3) The weights were not so good.