20TDCS122 Rushik Rathod

EXPT. NO.	NAME 20DCS103	M T W T F S S Page No.: Date:	YOUVA

* Experiment 1 : Understanding Errors and Uncertainties in the measurements.

→ Objectives :-

1). Combining and reporting uncertainties in measurements.
2). Estimation of uncertainty in an averaged measurements.

→ Apparatus :-

Vernier caliper, Micrometer screw gauge, Objective pieces.

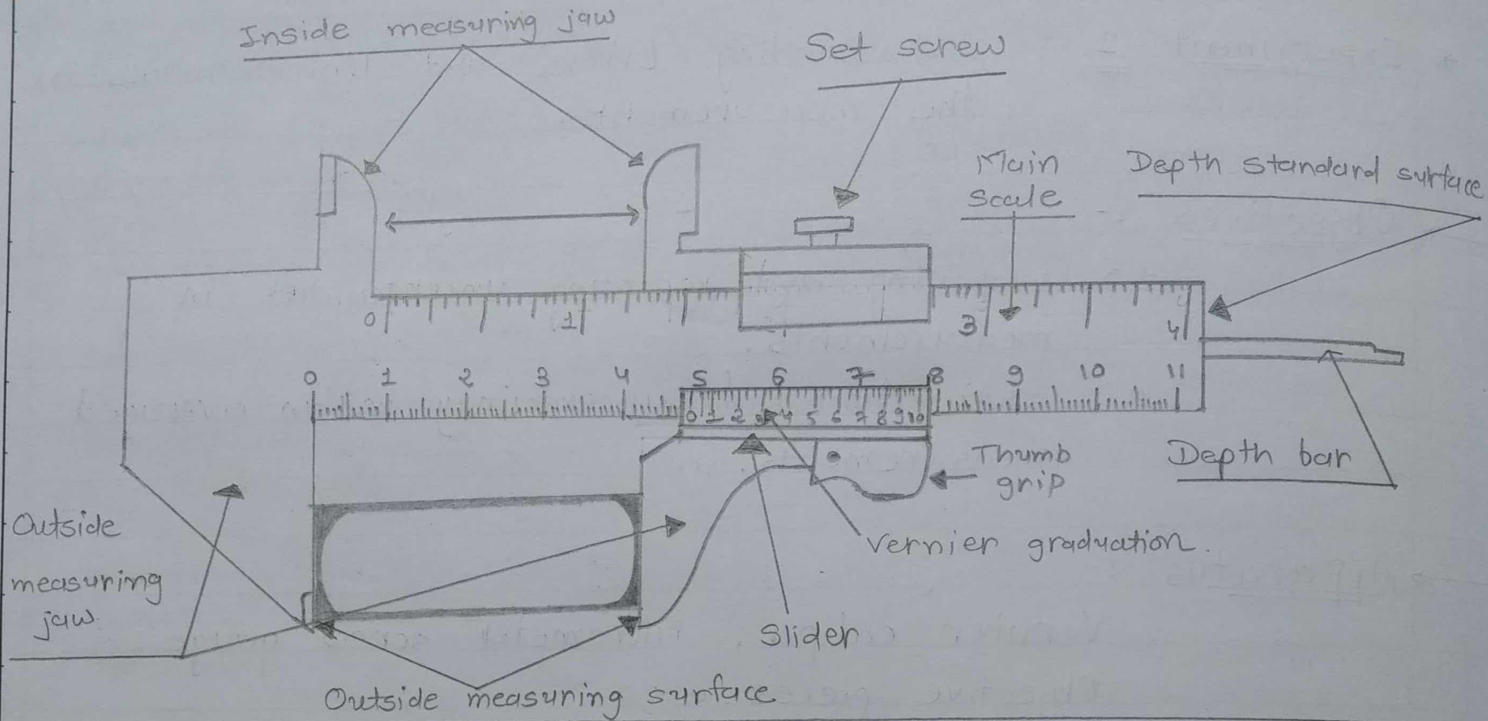
→ Procedure :-

1). Clean the workpiece and instruments.
2). Check the vernier caliper for errors like play in the jaw, zero error if any.
3). If any error is present, correct it.
4). Calculate the least count of the instrument.
5). Hold the workpiece in the measuring jaws.
6). Note down the readings of main scale and vernier scale.
7). Complete the observation table.
8). All the calculations are required to be done in accordance with error analysis.

Teacher's Signature:

20TDCS122 Rushik . Rathod.

→ Vernier caliper and objective pieces:



Sr. No.	Inner diameter (D) cm	Absolute error in the measurement of diameter $\Delta D = \lvert D_{mean} - D \rvert$ cm	Length of cylinder (L) cm	Absolute error in the measurement of length $\Delta L = \lvert L_{mean} - L \rvert$ cm	Inner volume $V = \pi r^2 L$ cm^3	Absolute error in the measurement of inner volume. $\Delta V = \lvert V_{mean} - V \rvert$ cm^3
1	1.73	0	3.52	0.01	8.26	0.01
2	1.72	0.01	3.53	0	8.19	0.08
3	1.73	0	3.54	0.01	8.31	0.04
4	1.71	0.02	3.53	0	8.10	0.~~0~~13
5	1.71	0.02	3.56	0.03	8.17	0.1
6	1.75	0.02	3.53	0	8.48	0.21
7	1.74	0.01	3.51	0.02	8.34	0.07
8	1.73	0	3.53	0	8.29	0.02
9	1.73	0	3.54	0.01	8.31	0.04
10	1.72	0.01	3.55	0.02	8.24	0.03
	Dmean = 1.79 cm	ΔDmean = 0.009 cm	Lmean = 3.53 cm	ΔLmean = 0.007 cm	Vmean = 8.27 cm^3	ΔVmean = 0.62 cm^3

20TDCS122 Rushik. Rathod.

EXPT. NO. NAME

M T W T F S S Page No.: Date: YOUVA

→ Calculation - 1

Error in volume.

1). Relative error, $= \frac{\Delta x_{mean}}{x_{mean}}$

$= \frac{0.009}{1.73}$ $\boxed{= 0.0052 \text{ cm}}$

2). Percentage error $= \frac{\Delta x_{mean}}{x_{mean}} \times 100$

$= 0.0052 \times 100$ $\boxed{= 0.52 \%}$

3). Standard deviation, $\sigma = \sqrt{\left(\frac{1}{N-1} \sum_{i=1}^{N} (x_i - \bar{x})^2 \right.}$

$$= \left(\frac{1}{10-1} \right)^{\frac{1}{2}} \left[\sum_{i=1}^{N} (V_i - V_{mean})^2 \right]^{\frac{1}{2}}$$

$$= \left(\frac{1}{9} \right)^{\frac{1}{2}} \left[\begin{array}{l} (0.01)^2 + (0.08)^2 + (0.04)^2 + (0.19)^2 + (0.1)^2 + \\ (0.2)^2 + (0.07)^2 + (0.02)^2 + (0.04)^2 + (0.03)^2 \end{array} \right]^{\frac{1}{2}}$$

$$= \frac{1}{3} \left[0.0869 \right]^{\frac{1}{2}}$$

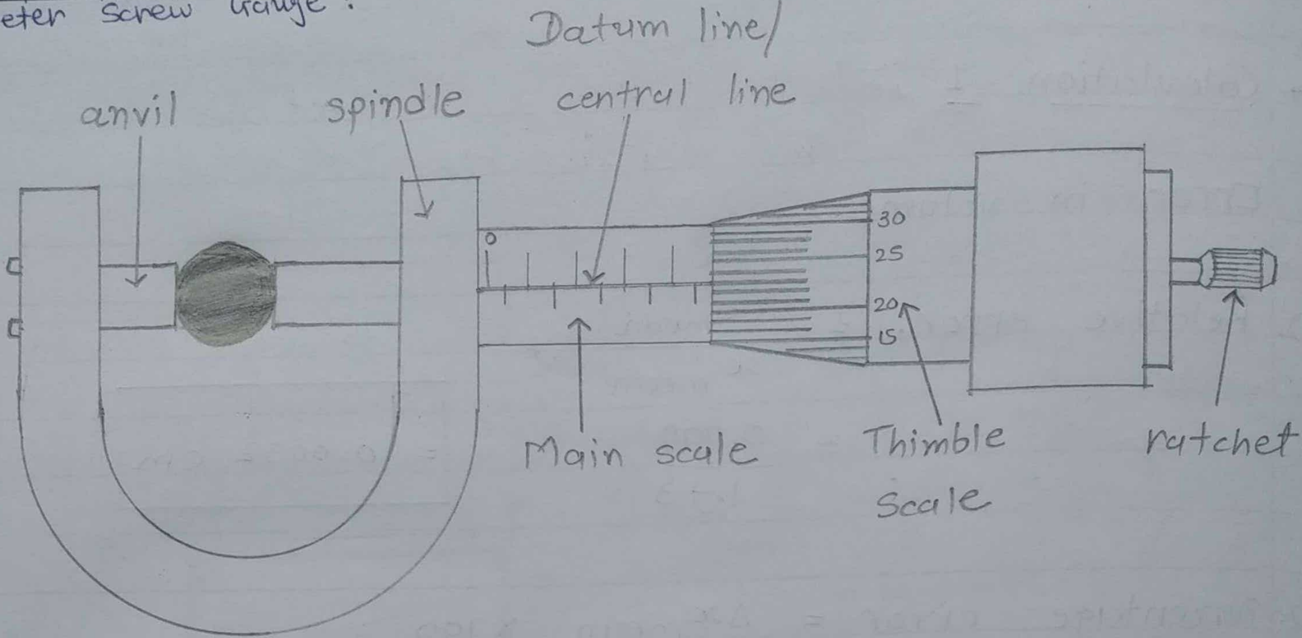
$= \frac{0.294}{3}$ $\boxed{= 0.098 \text{ cm}^3}$

4). Standard error. $= \frac{\sigma}{\sqrt{N}} = \frac{0.098}{\sqrt{10}}$ $\boxed{= 0.91 \text{ cm}^3}$

Teacher's Signature:

20TDCS122 Rushik. Rathod.

* Micrometer Screw Gauge :



Sr. No.	Outer diameter (D) cm	Absolute error in the measurement of diameter $\Delta D = \lvert D_{mean} - D \rvert$ cm	Inner Volume $v = \frac{4}{3}\pi r^3$ cm^3	Absolute error in the measurement of inner volume $\Delta V = \lvert V_{mean} - V \rvert$ cm^3
1	2.754	0	10.94	0
2	2.753	0.001	10.92	0
3	2.760	0.006	11.01	0.02
4	2.754	0	10.94	0
5	2.751	0.003	10.9	0.04
6	2.754	0	10.94	0
7	2.753	0.001	10.92	0.02
8	2.755	0.001	10.95	0.01
9	2.754	0	10.94	0
10	2.752	0.002	10.91	0.03
	D_{mean} = 2.754 cm	ΔD_{mean} = 0.0014 cm	V_{mean} = 10.94 cm^3	ΔV_{mean} = 0.012 cm^3

20TDCS122 Rushik Rathod.

EXPT. NO. NAME

M T W T F S S

Page No.: Date: YOUVA

Calculation - 2

Error in volume

1). Relative error $= \frac{\Delta x_{mean}}{x_{mean}}$

$= \frac{0.0014}{2.754}$

$\boxed{= 0.00051 \text{ cm}}$

2). Percentage error $= \frac{\Delta x_{mean}}{x_{mean}} \times 100$

$= 0.00051 \times 100$

$\boxed{= 0.051 \%}$

3). Standard deviation, $\sigma = \sqrt{\frac{1}{N-1} \sum_{i=1}^{N} (v_i - v_{mean})^2}$

$= \left(\frac{1}{10-1}\right)^{\frac{1}{2}} \left[0 + 0 + (0.02)^2 + 0 + (0.04)^2 + 0 + (0.02)^2 + (0.01)^2 + 0 + (0.03)^2\right]^{\frac{1}{2}}$

$= \left(\frac{1}{9}\right)^{1/2} \left[0.0034\right]^{1/2}$

$= \frac{1}{3} \left[0.0034\right]^{1/2}$

$= \frac{0.058}{3}$

$\boxed{= 0.019 \text{ cm}^3}$

4). Standard errors $= \frac{\sigma}{\sqrt{N}} = \frac{0.019}{\sqrt{10}}$

$\boxed{= 0.006 \text{ cm}^3}$

Teacher's Signature:

20TDCS122 Rushik. Rathod.

EXPT. NO. NAME

M T W T F S S
Page No.:
Date:
YOUVA

→ Conclusions :-

Apparatus : 1 Vernier caliper

→ Relative error in the measurement of diameter = 0.0052 cm

→ Percentage error in the measurement of diameter = 0.52 %.

→ Standard deviation, σ = 0.098 cm^3

→ Standard error = 0.91 cm^3

Apparatus : 2 Micrometer screw gauge.

→ Relative error in the measurement of diameter = 0.00051 cm

→ Percentage error in the measurement of diameter = 0.051 %.

→ Standard deviation, σ = 0.019 cm^3

→ Standard error = 0.006 cm^3

Teacher's Signature:

20DCS103 Rushik . Rathod . - 20TDCS122

M	T	W	T	F	S	S

EXPT. NO. | NAME | Page No.: | Date: | YOUVA

* Experiment 2 : Understanding errors and uncertainties in the measurements and to verify the Hook's law.

→ Objectives :-

To verify the Hook's law.

→ Apparatus :-

Hook's law apparatus [mirror scale, spring, slotted weights with hanger and pointer, complete tripod stand], Digital stop watch.

→ Procedure :-

1. Arrange a spring AB, a pointer P and a vertical scale as shown in Fig. 1.
2. Attach the weights on the hanger gradually and note down the scale reading correspondingly in Table - 1.
3. Plot the graph between extension (scale readings) versus load for the spring. By taking extension on X- axis and load on Y-axis.
4. The graph of these data is expected to be linear as shown in Fig. 2.
5. Deduce the force constant k from the relation k = Load / Extension.
6. Now determine the period of oscillation T with the help of Digital Stop Clock when different loads are attached on the hanger in Table - 2. Let m be the

Teacher's Signature:

mass of the load. Using this relation, compute k for the different m versus T data. Check if k comes out constant, and check if its value agrees with that obtained from equation -1. For low m values, there may be a serious departure.

7. In case the spring deviates from hook's laws but is elastic the k deduced in step 6 should match the corresponding k deduced in step 5, assuming small amplitude oscillations are used to get T.

→ Precautions :-

1. Do not stretch the spring by hand.
2. It is advisable to stretch a wire on the scale (parallel to its markings) and to let the pointer and move between this wire and the markings.
3. Apply only small oscillations.
4. If experiment is over, remove the extra load from the hanger.

→ Calculations :-

→ Spring is 0.4 m long.

→ $F = mg$

→ $k = F/x$

20DCS103 Rushik . Rathod - 20TDCS122

EXPT. NO.	NAME	Page No.: Date:	YOUVA

1). $F_1 = m_1 \cdot g = 0.05 \times 9.8 = \boxed{0.49 \ N}$

$\rightarrow k_1 = \frac{F_1}{x_1} = \frac{0.49}{0.12} = \boxed{4.083 \ N/m}$

2). $F_2 = m_2 g = \cancel{\frac{0.01}{0.24}} \ 0.1 \times 9.8 = \boxed{0.98 \ N}$

$\rightarrow k_2 = \frac{F_2}{x_2} = \frac{0.98}{0.24} = \boxed{4.083 \ N/m}$

3). $F_3 = m_3 g = 0.15 \times 9.8 = \boxed{1.47 \ N}$

$\rightarrow k_3 = \frac{F_3}{x_3} = \frac{1.47}{0.36} = \boxed{4.083 \ N/m}$

4) $F_4 = m_4 g = 0.2 \times 9.8 = \boxed{1.96 \ N}$

$\rightarrow k_4 = \frac{F_4}{x_4} = \frac{1.96}{0.48} = \boxed{4.083 \ N/m}$

5) $F_5 = m_5 g = 0.25 \times 9.8 = \boxed{2.45 \ N}$

$\rightarrow k_5 = \frac{F_5}{x_5} = \frac{2.45}{0.6} = \boxed{4.083 \ N/m}$

6). $F_6 = m_6 g = 0.3 \times 9.8 = \boxed{2.94 \ N}$

$\rightarrow k_6 = \frac{F_6}{x_6} = \frac{2.94}{0.72} = \boxed{4.083 \ N/m}$

Teacher's Signature:

20DCS103 Rushik. Rathod. - 20TDCS122

EXPT. NO.	NAME	Page No.: / Date:	YOUVA

7) $F_7 = m_7 g = 0.35 \times 9.8 = \boxed{3.43\ N}$

→ $k_7 = \frac{F_7}{x_7} = \frac{3.43}{0.84} = \boxed{4.083\ N/m}$

→ Graph :-

$k = \text{slope} = \frac{y_2 - y_1}{x_2 - x_1}$

$= \frac{1.47 - 0.98}{0.36 - 0.24}$

$= \frac{0.49}{0.12}$ $\boxed{= 4.083\ N/m}$

→ Conclusions :-

→ Practical value of k = $\boxed{4.083\ N/m}$

→ Graphical value of k = $\boxed{4.083\ N/m}$

Teacher's Signature:

20DCS103 . Rushik. Rathod. - 20TDCS 122

* Diagram :- (Hook's law set up)

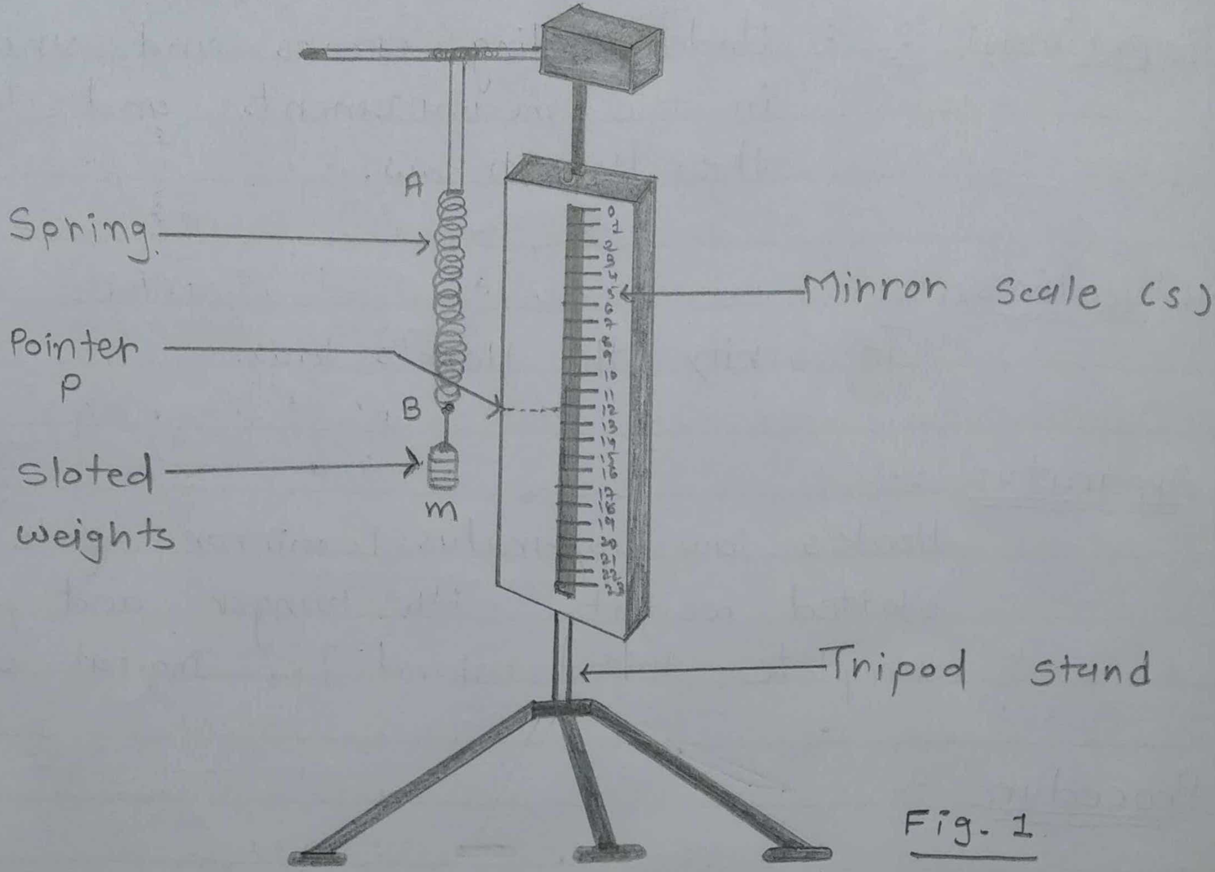


Fig. 1

* Observations :-

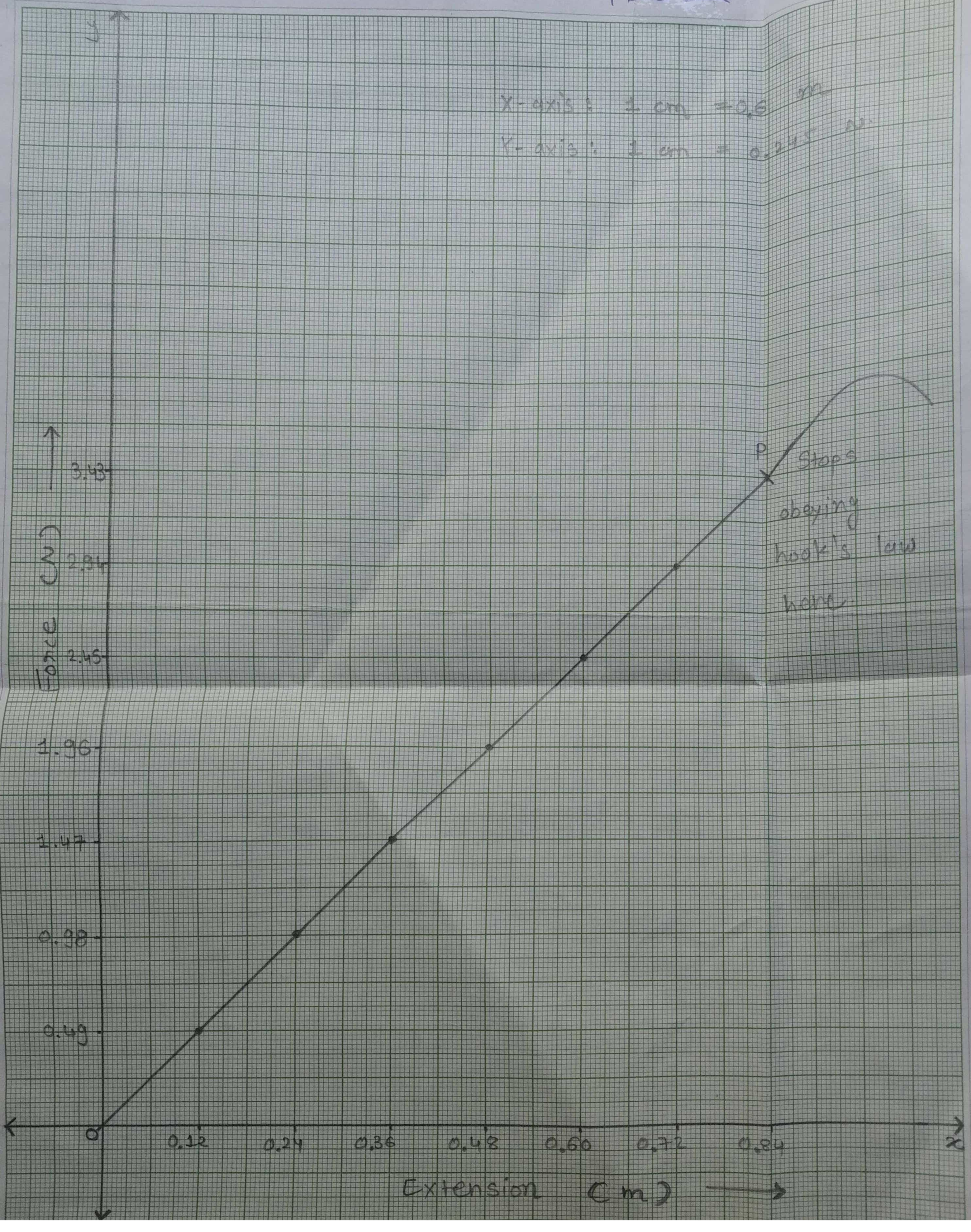
Table :- 1

Sr. No.	Load (m) (in gm) 1	2	Mean	Extension (x) (in cm)
1	50	50	50	12
2	100	100	100	24
3	150	150	150	36
4	200	200	200	48
5	250	250	250	60
6	300	300	300	72
7	350	350	350	84

→ Gravitational acceleration of earth (g) = 9.8 m/s^2

20DCS103 Rushik Rathod - 20DCS122

1 mm Graph



* Experiment 3 : Determination of Young's modulus by bending of beam.

→ **Objectives :→** To determine Young's modulus of elasticity of the material of a given wire.

→ **Apparatus :→** Young's modulus set up, Galvanometer, Metal bar, 1 kg hanger.

→ **Procedure :-**

1. Measure the length of the given bar with a meter scale and place the centre of the bar at the middle point of the two supports fixed to the table.
2. Place rectangular hook cum hanger at the centre of the scale. Place the spherometer such that screw of spherometer is on top of the rectangular hook cum hanger.
3. Make the electrical connections as shown in the figure - 1 by connecting power supply, spherometer and galvanometer.
4. Switch on the power supply, adjust the circular scale such that screw of spherometer(S) touches rectangular hook, indicating deflection in the Galvanometer (G).
5. Take the initial reading on the spherometer.
6. Hang a weight to the hook and then you notice

that galvanometer reading come back to zero (why?). Again adjust the spherometer such that screw touches the hook and galvanometer deflects. Take the depression of the bar reading corresponding the weight hanged.

7. Continue the same procedure for all the weights. Avoid back lash error while using spherometer.
8. Repeat the experiment once again with all the weights.

→ Calculations :-

→ Mean value of table : 3 :-

1). $\frac{0.0234 + 0.0235}{2} = \frac{0.0469}{2} = \boxed{0.02345 \text{ cm}}$

2). $\frac{0.0222 + 0.0232}{2} = \frac{0.0454}{2} = \boxed{0.0227 \text{ cm}}$

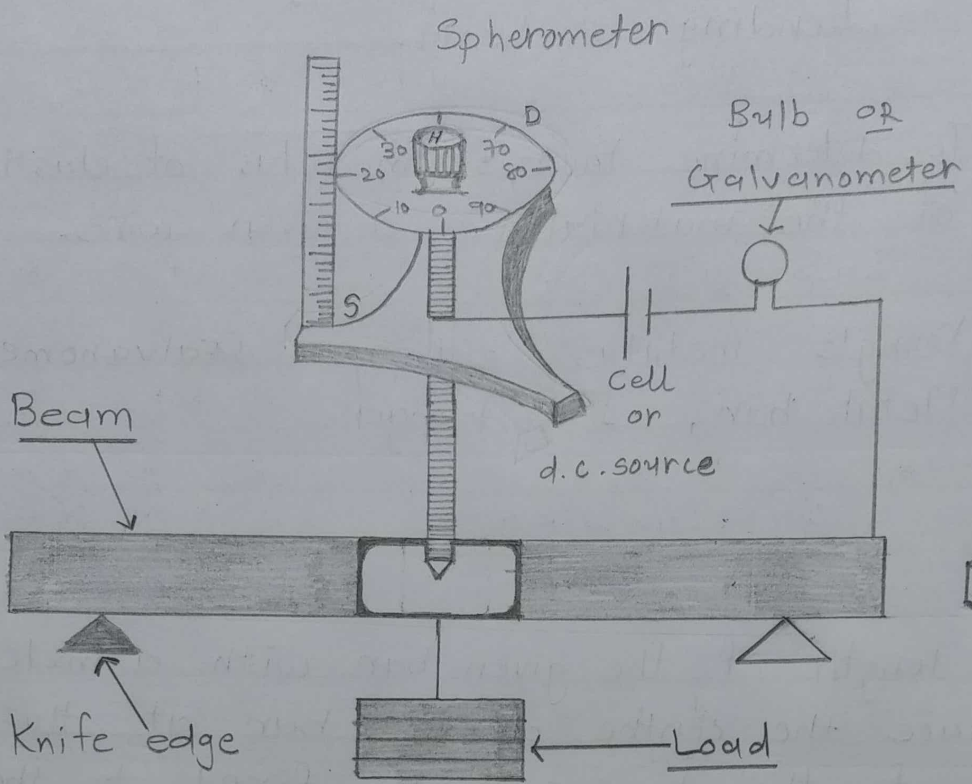
3). $\frac{0.02187 + 0.0216}{2} = \frac{0.04347}{2} = \boxed{0.02173 \text{ cm}}$

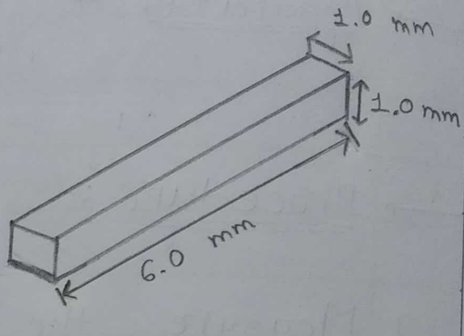
4). $\frac{0.0216 + 0.0215}{2} = \frac{0.0431}{2} = \boxed{0.02155 \text{ cm}}$

5). $\frac{0.0213 + 0.0214}{2} = \frac{0.0427}{2} = \boxed{0.02135 \text{ cm}}$

20DCS103 Rushik. Rathod - 20TDCS122

* Diagram :-





* Observations:

1). Length of beam between knife edges $(l) = 60$ cm

2). Least count of screw gauge $= \dfrac{\text{pitch}}{\text{Number of divisions on circular scale}} = 0.001$ cm

3). Zero error in screw gauge = 0 gm

4). Table for thickness (d) of beam :

Sr no.	M.S. (cm)	C.S. (div)	un-corrected diameter $T = MS + CS \times LC$ (cm)	mean un-corrected diameter (T : cm)	corrected diameter $d = T \pm$ zero error (cm)
1	0.5	0.081	0.581	$T = \dfrac{0.581 + 0.588 + 0.504 + 0.509}{4}$ $= 0.546$	d = 0.546 cm
2	0.5	0.088	0.588		
3	0.5	0.09	0.509		
4	0.5	0.09	0.509		

(Table : 1)

20DCS103 Rushik. Rathod - 20DCS122

5). Least count of Vernier calipers = $\dfrac{\text{value of one division on main scale}}{\text{Number of divisions on vernier scale}}$

= 0.01 cm

6). Zero errors in vernier calipers = 0 cm

7). Table for breadth of beam :

Sr. no.	M.S. (cm)	V.S. (div)	un-corrected breadth T = MS + VS x LC (cm)	Mean un-corrected breadth (d : cm)	corrected breadth b = T ± zero error (cm)
1	2.35	0.11	2.46	$d = \dfrac{2.46+2.45+2.51+2.36}{4}$ = 2.445	b = 2.445 cm
2	2.35	0.10	2.45		
3	2.4	0.11	2.51		
4	2.3	0.06	2.36		

(Table : 2)

No of obs.	Load in (kg)	Spherometer reading load (cm) - first measurement			Spherometer reading for increasing load (cm) - second measurement			Mean reading (cm)	Depression l (cm)
		Main scale	circular	Total	Main scale	circular	Total		
1	0	0.023	0.0004	0.0234	0.023	0.0005	0.0235	0.02345 (a)	0
2	0.5	0.022	0.0002	0.0222	0.023	0.0002	0.0232	0.0227 (b)	0.00075
3	1	0.0215	0.0003	0.0218	0.0215	0.0001	0.0216	0.0217 (c)	0.001
4	1.5	0.021	0.0006	0.0216	0.021	0.0005	0.0215	0.02155 (d)	0.00015
5	2	0.0205	0.0008	0.0213	0.0205	0.0009	0.0214	0.02135 (e)	0.002

(Table : 3)

20DCS103 Rushik. Rathod. - 20TDCS122

EXPT. NO. NAME Page No.: Date: YOUVA

→ Depression :-

1) $a - a = 0$

2) $b - a = 0.0227 - 0.02345 = 0.00075$ cm

3) $c - b = 0.0217 - 0.0227 = 0.001$ cm

4) $d - c = 0.02155 - 0.0217 = 0.00015$ cm

5) $e - d = 0.02135 - 0.02155 = 0.0002$ cm.

→ Mean of all depressions,

$$l = \frac{0 + 0.00075 + 0.001 + 0.00015 + 0.0002}{5}$$

$$\boxed{l = 0.00042 \text{ cm}}$$

* Young's Modulus :-

$$Y = \frac{gL^3}{4bd^3}\frac{m}{l}$$

$$= \frac{9.8 \times (60 \times 10^{-2})^3}{4 \times 2.445 \times 10^{-2} \times (0.546 \times 10^{-2})^3} \times \frac{50 \times 10^{-3}}{0.0042 \times 10^{-2}}$$

$$= \frac{0.10584}{0.0006685 \times 10^{-10}}$$

$$= 158.32 \times 10^{10}$$

$$\therefore \boxed{Y = 1.58 \times 10^{12} \ N/m^2}$$

→ Young's Modulus by bending of beam is $\boxed{1.58 \times 10^{12} \ N/m^2}$

Teacher's Signature:

20DCS103 Rushik. Rathod

EXPT. NO. NAME

M T W T F S S
Page No.:
Date:
YOUVA

* Experiment 4 : Study of small Oscillations using a bar Pendulum.

→ Objective :→ To determine the value of acceleration due to gravity and radius of gyration using bar pendulum.

→ Apparatus :→ A bar pendulum with holes for hanging, Wall support for hanging, stop clock, meter scale, knife edge for measuring the center of mass of the bar.

→ Procedure :→

1. The compound bar pendulum AB is suspended by passing a knife edge through the first hole at the end A. The pendulum is pulled aside through a small angle and released, whereupon it oscillates in a vertical plane with small amplitude. The time for 10 oscillations is measured. From this the period T of oscillation of the pendulum is determined.

2. In a similar manner, periods of oscillation are determined by suspending the pendulum through the remaining holes on the same side of the centre of mass G of the bar. The bar is then inverted and periods of oscillation are determined

Teacher's Signature:

by suspending the pendulum through all the holes on the opposite side of G. The distances d of the top edges of different holes from the end A of the bar are measured for each hole. The position of the centre of mass of the bar is found by balancing the bar horizontally on a knife edge. The mass M of the pendulum is determined by weighning the bar with an accurate scale ~~for~~ or balance.

3. A graph is drawn with the distance d of the various holes from the end A along X-axis and the period T of the pendulum at these holes along the Y-axis. The graph has two branches, which are symmetrical about G. To determine the length of the equivalent simple pendulum corresponding to any period, a straight line is drawn parallel to the X-axis from a given period T on the Y-axis, cutting the graph at four points A, B, C, D. The distances AC and BD, determined from the graph, are equal to the corresponding length l. The average length $l = (AC+BD)/2$ and l/T^2 are calculated. In a similar way, l/T^2 is calculated for different periods by drawing lines parallel to the X-axis from the corresponding values of T along the Y-axis. l/T^2 should be constant over all

20DCS103 Rushik. Rathod

EXPT. NO.	NAME	M T W T F S S Page No.: Date:	YOUVA

periods T, so the average over all suspension point is taken. Finally, the acceleration due to gravity is calculated from the equation $g = 4\pi^2 (l/T^2)$.

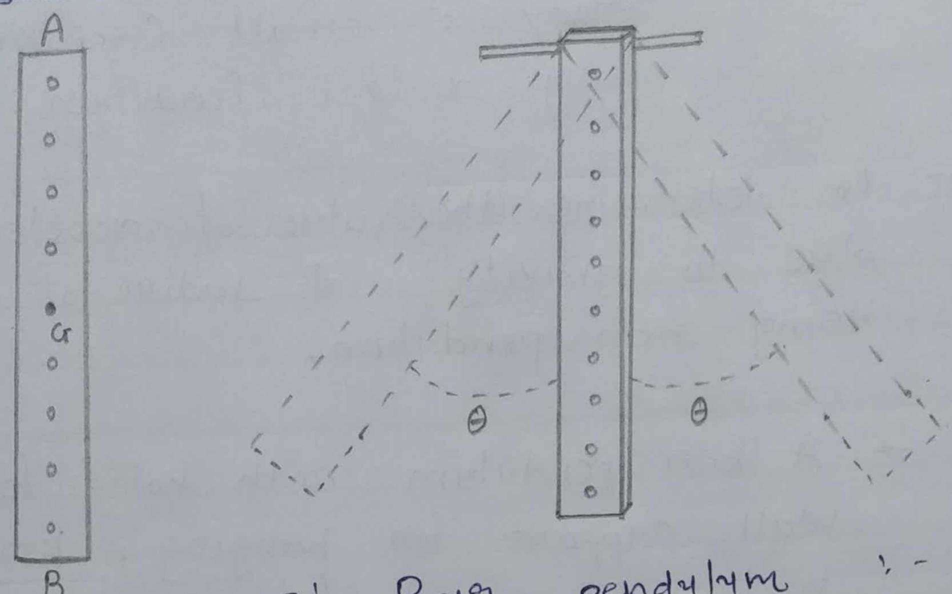
4. Tmin is where the tangent EF to the two branches of the graph crosses the Y-axis. At Tmin, the distance EF $= l = 2k_G$ can be determined, which gives us k_G, the radius of gyration of the pendulum about its centre of mass, and one more value of g, from $g = 4\pi^2 \left(\frac{2k_G}{T_{min}^2} \right)$.

5. k_G can also be determined as follows. A line is drawn parallel to the Y-axis from the point G corresponding to the centre of mass on the X-axis, crossing the line ABCD at P. The distance $AP = PD = AD/2 = h$ and $BP = PC = BC/2 = h'$ are obtained from the graph. The radius of gyration k_G about the centre of mass of the bar is then determined by $k_G = (hh')^{1/2}$.

Teacher's Signature:

20DCS103 Rushik. Rathod

* Diagram :-



-: Bar pendulum :-

* Formula :-

1). The general formula of time period for bar pendulum,

$$T = 2\pi\sqrt{\frac{\frac{K^2}{l}+l}{g}} = 2\pi\sqrt{\frac{l_1+l_2}{g}}$$

=> where, $l_1+l_2 = L$.

2) $T_{min} = 2\pi\sqrt{\frac{2k}{g}}$

and radius of gyration $K^2 = \frac{l^2+b^2}{12}$

and $g = 4\pi^2\left(L/T^2\right)$

20DCS103 Rushik. Rathod

* Observation Table :- 1 :-

Side	Sr. No.	Distance from CG (cm)	Time for 20 oscillations (s)			Time Period T (s)
			t_1	t_2	Mean	
A	1	45	33	32	32.5	1.625
	2	40	31	31	31	1.55
	3	35	30.5	30.5	30.5	1.525
	4	30	30	30	30	1.5
	5	25	29	29	29	1.45
	6	20	32	32	32	1.6
	7	15	33.5	33.75	33.65	1.6825
	8	10	38	39	38.5	1.925
	9	5	52	53	52.5	2.625
B	1	45	32	32	32	1.6
	2	40	31.5	31.5	31.5	1.575
	3	35	31	30.5	30.75	1.537
	4	30	30	30	30	1.5
	5	25	29.5	29.5	29.5	1.475
	6	20	32	32	32	1.6
	7	15	34	34	34	1.7
	8	10	39	38	38.5	1.925
	9	5	55	54	54.5	2.725

* Observation Table :- 2 :-

→ To calculate the value of 'g' :-

SI No.	Length of equivalent simple pendulum (cm)			Time period T (s)	g (cm/s²)
	AC (cm)	BD (cm)	Mean l		
1.	57	55	56	1.5	9.8
2.	56	56	56	1.5	9.8
3.	57	55	56	1.52	9.77

* To find the radius of gyration and the acceleration of gravity :-

1) Radius of gyration about the centre of mass,

$$k_G = \frac{EF}{2} = \frac{50}{2} = 25 \text{ cm}$$

2) Acceleration of gravity, $g = 4\pi^2 \left(\frac{2 k_G}{T_{min}^2} \right)$

$$= 9.8 \text{ m/s}^2$$

* Observation Table :- 3 :-

→ To find the radius of gyration :-

Sr. No.	$h = AD/2$	$h' = BC/2$	$K_G = (hh')^{1/2}$
1.	35	20	26.45
2.	36.9	19	26.48
3.	35	20	26.45.

* Calculations :-

1). Least count of the measuring scale used
= 0.1 cm

2). Least count of the stop watch used = 0.1 sec.

3). Tmin from the graph = 1.5 sec at d = 0.56 m

At Tmin, d = K = 0.56 m

4). $T_{min} = 2\pi\sqrt{\frac{2k}{g}}$ so $g = 9.8$ m/s².

* Results :-

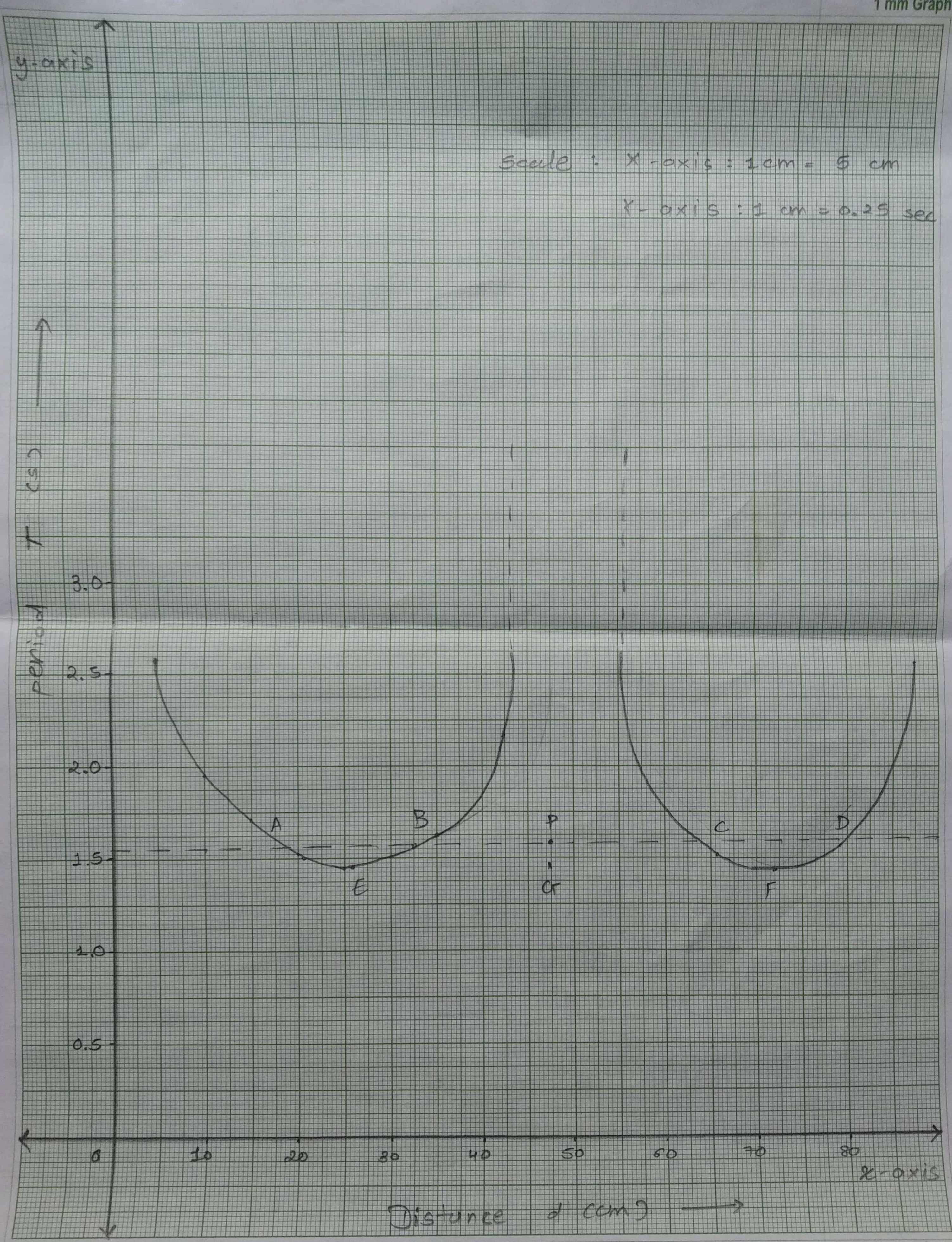
1). Average acceleration of gravity,

$g = 4\pi^2(l/T^2) = 9.8$ m/s².

2). Average radius of gyration of the pendulum about its centre of mass,

$k_G = 25.725$ m.

20DCS103 Rushik. Rathod



20DCS103 Rushik. Rathod

M T W T F S S

EXPT. NO.	NAME	Page No.: Date:	YOUVA

* **Experiment 5 :- To determine g by Kater's pendulum.**

→ **Objective :-** To determine the value of g by using kater's pendulum.

→ **Apparatus :-** Kater's pendulum, Stopwatch, meter scale.

→ **Procedure :-**

1. Fix the weights as shown in the figure.
{ One end → M → k_1 → m → w → k_2 → w other end }.

2. Make sure that the distances from big masses to ends and big masses to knife edges should be symmetrical.

3. Balance the pendulum on a sharp wedge such that the smaller weights are at symmetrical distant from CG. Now mark the position of its ~~corner~~ center of gravity and measure that distances of the knife-edges k_1 and k_2 CG. This will give you value of l_1 and l_2.

Teacher's Signature:

20DCS103 Rushik. Rathod.

4. Suspend the pendulum with the knife edge K_1 and set it to oscillate with small amplitude. Note that the times for 15, 20 and 25 oscillations respectively.

5. Now, suspend the pendulum with the knife-edge K_2 and set it to oscillate with small amplitude. Note the times for 15, 20 and 25 oscillations respectively.

6. The oscillations should be seen with the help of a telescope for accuracy.

* Calculations :-

→ Mean of $T_1 = \frac{1.748 + 1.752 + 1.752}{3} = 1.751$ s

→ Mean of $T_2 = \frac{1.731 + 1.752 + 1.771}{3} = 1.751$ s

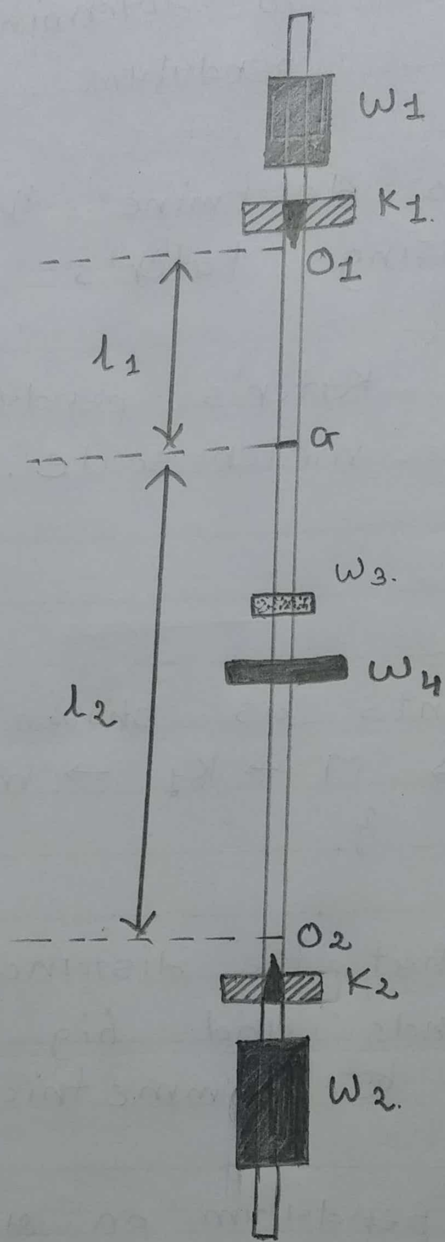
→ For 'g' :-

Length $l_1 + l_2 = 0.77$ m

Teacher's Signature:

20DCS103 Rushik . Rathod

* Diagram :-



:- Kater's pendulum :-

20DCS103 Rushik. Rathod

* Observation Table :- 1 :-

→ Table for time period T_1 (oscillation about k_1):

Sr. No.	Number of oscillations	Time of oscillations t_1 sec	Time period $T_1 = t_1/n$	Mean T_1 (sec)
1.	5	8.78 8.91 8.53	1.756 1.782 1.706	1.748
2.	10	17.56 17.52 17.48	1.756 1.752 1.754	1.752
3.	15.	26.28 26.27 26.32	1.752 1.752 1.754	1.752.

* Observation Table :- 2 :-

→ Table for time period T_2 (oscillation about k_2) :-

Sr. No.	Number of oscillations	Time of oscillations t_2 sec	Time period $T_2 = t_2/n$	Mean T_2 (sec)
1.	5	8.72 8.77 8.48	1.768 1.750 1.738	1.731
2.	10	17.68 17.50 17.38	1.744 1.754 1.696	1.752
3.	15	26.53 26.44 26.78.	1.769 1.762 1.785.	1.771

20DCS103 Rushik. Rathod

EXPT. NO.	NAME	Page No.: Date:	YOUVA

→ $g = \dfrac{8\pi^2}{\dfrac{T_1^2 + T_2^2}{l_1 + l_2}} = \dfrac{8\,(3.14)^2}{\dfrac{(1.751)^2 + (1.751)^2}{(0.77)}}$

$= \dfrac{78.88}{7.964} = \underline{9.9 \ m/s^2}$

* Conclusions :-

→ Accelerations due to gravity,

$g = \underline{9.9 \ m/s^2}$

→ Standard value of gravity,

$g = \underline{9.8 \ m/s^2}$

→ Percentage error $= \dfrac{\Delta g}{g} \times 100 \ \%$

$= \dfrac{(9.9 - 9.8)}{9.8} \times 100 \ \%$

$= \dfrac{0.1}{9.8} \times 100 \ \%$

$= 1.02 \ \%$

Teacher's Signature:

20DCS103 Rushik. Rathod

EXPT. NO.	NAME	Page No.: Date:	YOUVA

* **Experiment 6 :- Specific heat of the metals**

→ **Objective :-** To determine the specific heat of two different metals. and to compare results with the accepted values of these metals.

→ **Apparatus :-** Metal sample, hot plate, weight machine, thermometer, beaker, thread.

→ **Procedure :-**

1. Measure 100 ml (exactly) of room temperature water in the volumetric cylinder. Use the known density of water to determine the mass of this water. Pour the water into the plastic cup. Record the temperature of this water at room temperature. This is your starting temperature for the water.

2. Choose one of the metal cubes. Record what type of metal it is (copper, iron, brass, aluminum or anyother). And determine its weight.

3. Place the metal cube carefully in the bottom of the glass beaker. Don't break the beaker.

Teacher's Signature:

20DCS103 Rushik. Rathod

EXPT. NO.	NAME	Page No.: / Date:	YOUVA

Fill the beaker with enough tap water to cover the metal cube. Heat the beaker and its contents on the hot plate, until it approaches boiling.

4. Just before taking the metal cube out of the boiling water, measure the temperature of the hot water. You can treat this measurement as the starting temperature of the metal block, since you have no other means to measure the internal temperature of a solid block.

5. Take the metal cube out of the hot water, and transfer it immediately to the plastic cup. Stir the water around the metal cube in the plastic cup with the thermometer until the thermometer reading becomes stable. You can treat this measurement as the final temperature of both the water and the final temperature of the metal block.

6. Calculate the change in temperature of the water in the plastic cup. Show your work. Label this $\Delta T (H_2O)$.

Teacher's Signature:

20DCS103 Rushik. Rathod

EXPT. NO.	NAME	Page No.: Date:	YOUVA

7. Calculate the heat absorbed by the water in the foam cup. Use the equation $q = m \Delta T C_p$. All variables must apply to the water in the cup. Label the solution to this equation "q (water)."

8. Based on the heat absorbed by the water, how much heat was emitted by the metal cube? Label this value "q (metal)."

9. Calculate the change in temperature of the metal block label this ΔT (metal).

10. Now solve for the specific heat of the metal. Again use the equation, $q = m \cdot \Delta T C_p$. but this time make sure all the variables apply to the metal. You took the mass of the metal, calculated the change in temperature of the metal and calculate the heat absorbed by the metal. The only unknown to solve for is C_p, the specific heat of the metal.

11. Choose a second metal cube, and repeat the lab.

* **Result** :- Specific heat of cadmium = 0.2885 J/g °C

Teacher's Signature:

* Observations :-

1). The specific heat of water = 4186 J/kg °C

2). Mass of calorimeter cup = 0.05 kg

3). Mass of the calorimeter cup plus water

= 0.15 kg

* Observation Table :-

→ To measure the change in temperature and heat energy :-

Sr. No.	Sample	Initial T_i (°c)	Final T_f (°c)	Mass (g)	Q (J)	ΔT (°c)
1.	Calorimeter water	22° c	25° c	100 g	1255.2	3 °c
2.	Metal - cadmium	100° c	25° c	58 g	1.2552×10^3	|-75°c|

20DCS103 Rushik. Rathod

→ Here, Mass of Metal = 58 g

Initial temperature of Metal = 100 °C

Mass of water = 100 g

Initial temperature of water = 22 °C

Final temperature of water = 25 °C

Specific heat of water = 4.184 J/g °C

→ Now, $q_{water} = M_w \cdot C_w \cdot \Delta T_w$.

and $q_{metal} = M_m \cdot C_m \cdot \Delta T_m$.

$\therefore q_{water} = q_{metal}$

$\therefore M_w \cdot C_w \cdot \Delta T_w = M_m \cdot C_m \cdot \Delta T_m$

$$\therefore C_m = \frac{M_w \cdot C_w \cdot \Delta T_w}{M_m \cdot \Delta T_m}$$

$$\therefore C_m = \frac{100 \times 4.184 \times 3}{58 \times 75}$$

$\therefore C_m = 0.2885$ J/g °C.

→ Thus, $q_{metal} = M_m \cdot C_m \cdot \Delta T_m = 58 \times 0.2885 \times 75$

$= 1255.2$ J

and $q_{water} = M_w \cdot C_w \cdot \Delta T_w = 100 \times 4.184 \times 3$

$= 1255.2$ J

20DCS103 Rushik. Rathod

EXPT. NO.	NAME	Page No.: Date:	YOUVA

* Experiment 8 :- Newton's law of cooling.

→ Objectives :- Verification of newton's law of cooling by drawing a cooling curve for the liquid.

→ Apparatus :- Newton's law of cooling apparatus, Battery eliminator, Digital stop clock, Omega type DSC-602, Thermometer.

→ Procedure :-

1. Find the least count of thermometers T_1 and T_2. Take some water in a beaker and measure its temperature (at room temperature °c) with one (say T_1) of the thermometers.

2. Examine the working of the stop-watch and find its least count.

3. Pour water into the double-walled container (enclosure) at room temperature. Insert the other thermometer T_2 in water contained in it, with the help of the clamp stand.

Teacher's Signature:

20DCS103 Rushik. Rathod

EXPT. NO.	NAME	Page No.: Date:	YOUVA

4. Heat some water separately to a temperature of about 40 °c above the room temperature T_0. Pour hot water in calorimeter up to its top.

5. Put the calorimeter, with hot water, back in the enclosure and cover it with the lid having holes. Insert the thermometer T_1 and the stirrer in the calorimeter through the holes provided in the lid, as shown in the figure.

6. Note the initial temperature of the water between enclousure of double wall with the thermometer T_2, when the difference of readings of two thermometers T_1 and T_2 is about 30 °c. Note the initial reading of the thermometer T_1.

7. Keep on stirring the water gently and constantly. Note the reading of thermometer T_1, first after about every half a minute, then after about one minute and finally after two minutes durations or so.

8. Keep on simultaneously noting the reading of the stop-watch and that of the thermometer T_1, while stirring water gently and constantly.

Teacher's Signature:

20DCS103 Rushik Rathod.

M	T	W	T	F	S	S

Page No.: YOUVA
Date:
NAME
EXPT. NO.

till the themperature of water in the calorimeter falls to a temperature of about 5 °c above that of the enclosure. Note the temperature of the enclosure, by the thermometer T_2.

9. Record observations in tabular form. Find the excess of temperature $(T - T_0)$ and also $\log_{10}(T - T_0)$ for each reading, using logarithmic tables. Record these values in the corresponding columns in the table.

10. Plot the graph between time t, taken along x-axis and $\log_{10}(T - T_0)$ taken along y-axis. Interpret the graph.

* Calculations :-

1. $T_1 - T_0 = 70 - 27 = 43\ ^\circ C$

2. $T_2 - T_0 = 66 - 27 = 39\ ^\circ C$

3. $T_3 - T_0 = 63 - 27 = 36\ ^\circ C$

4. $T_4 - T_0 = 61 - 27 = 34\ ^\circ C$

5. $T_5 - T_0 = 58.5 - 27 = 31.5\ ^\circ C$

Teacher's Signature:

20DCS103 Rushik. Rathod,

EXPT. NO.	NAME	Page No.: Date:

6. $T_6 - T_0 = 57 - 27 = 30\ ^\circ C$

7. $T_7 - T_0 = 55 - 27 = 28\ ^\circ C$

8. $T_8 - T_0 = 53 - 27 = 26\ ^\circ C$

9. $T_9 - T_0 = 51.5 - 27 = 24.5\ ^\circ C$

10. $T_{10} - T_0 = 50 - 27 = 23\ ^\circ C$.

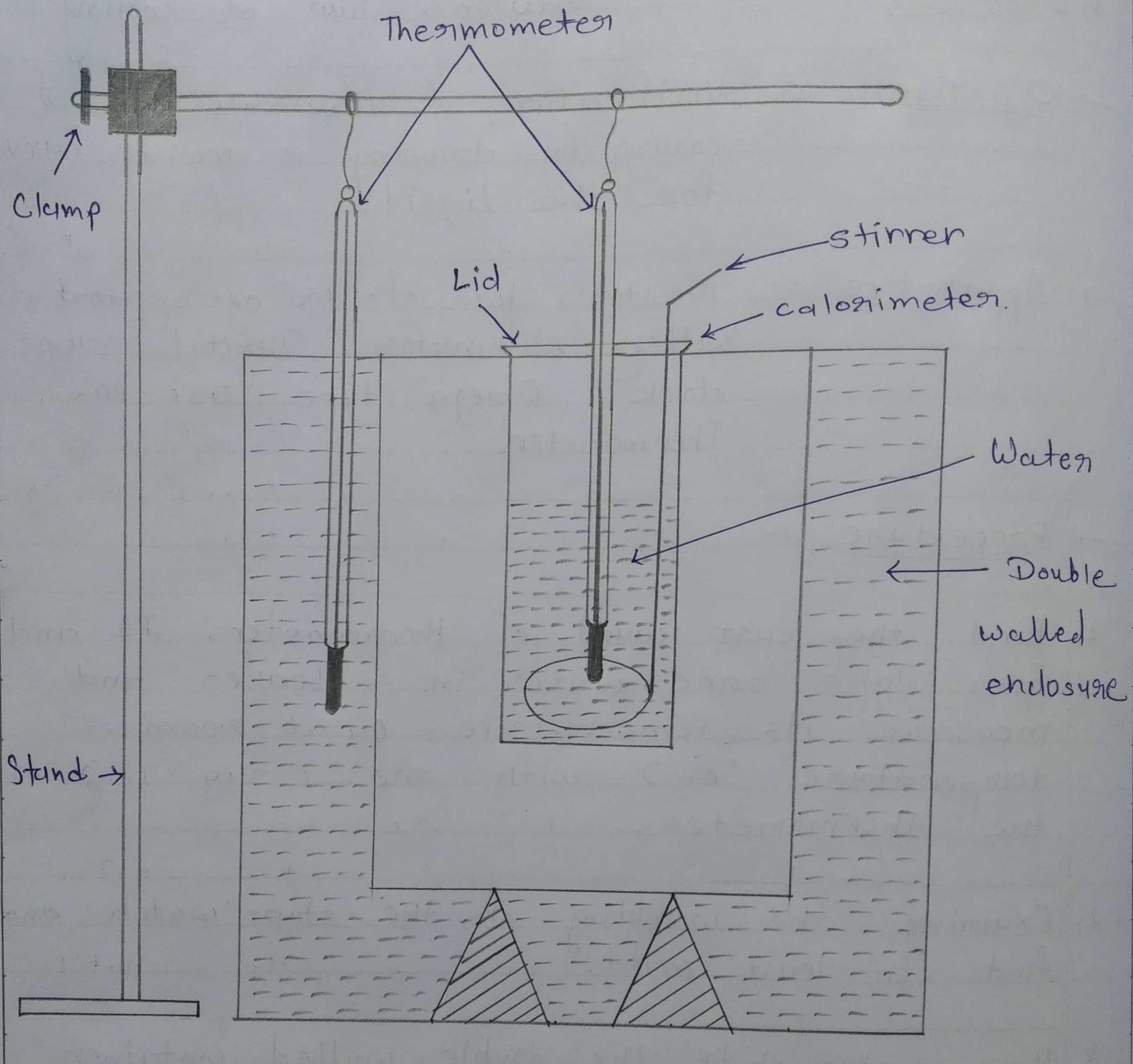
* Result :-

→ The cooling curve is an exponential decay curve. It is observed from the graph that the logarithm of the excess of temperature of hot body over that of its surroundigs varies linearly with time as the body cools.

Teacher's Signature:

20DCS103 Rushik. Rathod

* Diagram :-



-: Newton's law of cooling apparatus :-

20DCS103 Rushik. Rathod

* Observations :-

1). Least count of both identical thermometer = 0.2°C

2). Least count of stop watch/clock = 1 sec

3). Intial temperature of water in the enclosure T_1 = 27 °C

4). Final temperature of water in the enclosure T_2 = 70 °C

5). Mean temperature of the water in the enclosure,

$$T = \frac{T_1 + T_2}{2}$$

$$= \frac{27 + 70}{2}$$

$$= \frac{97}{2}$$

$$T = 48.5 \text{ °C}$$

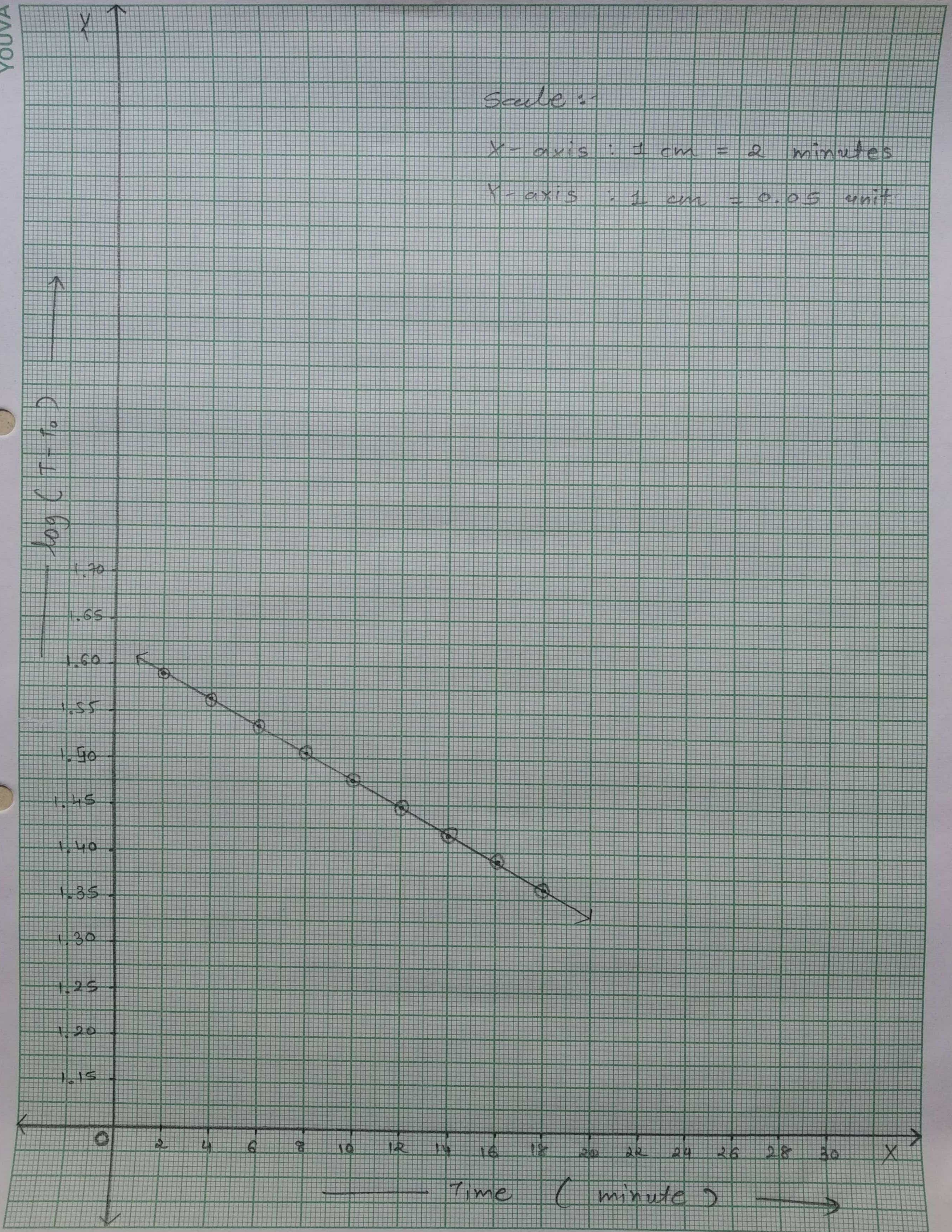
20DCS103 Rushik. Rathod

* **Observation Table :-**

→ To measure the change in temperature in a particular time,

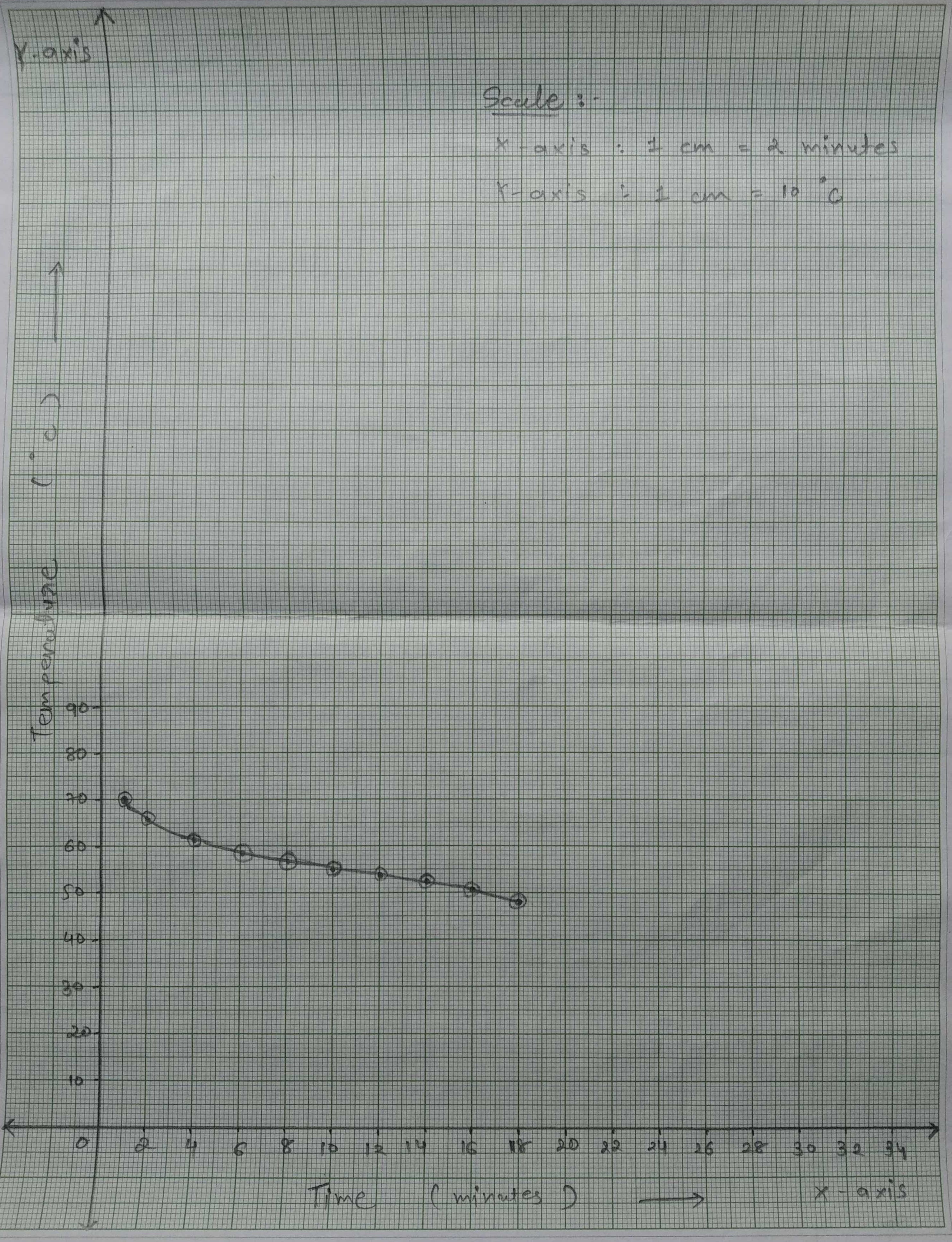
Obs. No.	Time (min)	Temperature (°c)	Excess Temp. of hot water $(T_0 - T_0)$ (°c)	$\log_{10}(T - T_0)$
1	1	70	43	1.63
2	2	66	39	1.591
3	4	63	36	1.556
4	6	61	34	1.4983
5	8	58.5	31.5	1.498
6	10	57	30	1.497
7	12	55	28	1.447
8	14	53	26	1.415
9	16	51.5	24.5	1.389
10.	18	50.	23	1.362.

20DCS103 Rushik. Rathod.



20DCS103 Rushik. Rathod.

1 mm Graph



20DCS 103 Rushik. Rathod.