20XC18 - APPLIED PHYSICS LAB

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EXP 3 : DETERMINATION OF THERMAL CONDUCTIVITY OF BAD CONDUCTOR.

AIM:

To determine the thermal conductivity, K of wood disk.

APPARATUS:

Boiler, thermometer, brass disk, brass chamber, stand, vernier calliper, stop watch.

FORMULA:

$$K = \frac{M_c \cdot dT/dt}{\pi r^2 (T_1 - T_2)} \times \frac{(r + 2h)\, d}{2(r + h)}$$

where,

K = Coefficient of thermal conductivity

M_c = Mass of metallic disk

dT/dt = Rate of cooling of metal disk at T_2

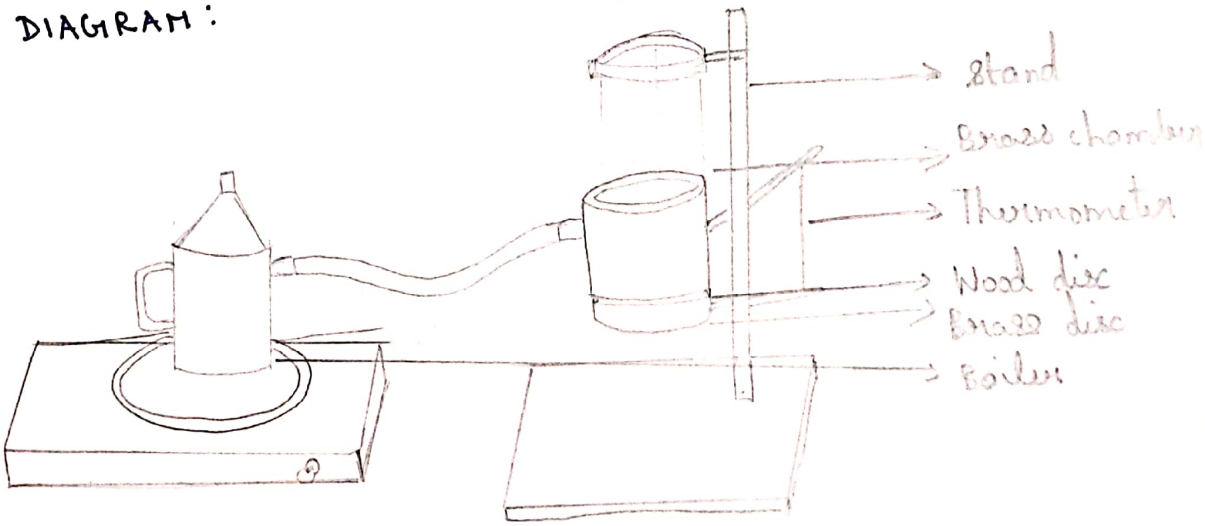
r = Radius of wooden disc

$T_1 - T_2$ = Temperature difference across sample's thickness.

h = Thickness of metallic disc.

d = Thickness of given sample.

DIAGRAM:



PROCEDURE:

Take a brass disc and hang it on a stand. Now place a cardboard followed by a brass chamber such that the cardboard is in between the brass chamber and brass disc Insert a thermometer inside both cavities of brass disc and brass chamber. Take a boiler and turn it on. Connect it to the brass chamber using a rubber tube.

Once the vapour from boiler starts filling the brass chamber check temperature in both thermometers. The thermometers will show constant temperature in each a few minutes after the vapour starts filling in. Note down both steady temperatures

Once noted, remove the card board and thermometer from the chamber. Wait until temperature of the brass disc reaches 5 degrees above noted reading.

Remove brass chamber along with rubber tube once required temperature is obtained. Now, using a stopwatch, note down time taken for drop in every degree till it reaches 5 degrees below noted temperature.

For measurements required to calculate the thermal conductivity, at the start of the experiment, measure:

- Thickness of brass disc using screw guage.
- Thickness of given sample using screw guage
- Diameter of given sample using vernier callipers.

at 5 different positions and find the mean.

TABULATION:

1. Thickness Of Brass Disc:

LC = 0.01 mm

S.NO	PSR (mm)	HSC (div)	HSR (HSC x LC) (mm)	TR = PSR + HSR (mm)
1.	10	4	0.04	10.04
2.	10	48	0.48	10.48
3.	10	7	0.07	10.07
4.	10	18	0.18	10.18
5.	10	44	0.44	10.44

Mean = 10.24 mm $\Rightarrow h = 10.24 \times 10^{-3}$ m

2. Thickness Of The Cardboard:

S.NO	PSR (mm)	HSC (div)	HSR (HSC x LC) (mm)	TR = PSR + HSR (mm)
1.	1	6	0.06	1.06
2.	1	4	0.04	1.04
3.	1	2	0.02	1.02
4.	1	7	0.07	1.07
5.	1	3	0.03	1.03

Mean = 1.04 mm $\Rightarrow d = 1.04 \times 10^{-3}$ m

3. Diameter of the cardboard:

LC = 0.02 mm

S.NO	HSR (mm)	VSC (div)	VSR (VSC x LC) (mm)	TR = HSR + VSR) (mm)
1.	113	18	0.36	113.36
2.	113	6	0.12	113.12
3.	113	7	0.14	113.14
4.	113	10	0.2	113.02
5.	113	24	0.48	113.48

Mean = 113.26 mm $\Rightarrow$ $r = d/2 = 56.63$ mm $= 56.63 \times 10^{-3}$ m

4. Fall in Temperature Data:

Temperature (°C)	Time (s)
90	0
89	27
88	54
87	81
86	124
85	141
84	184
83	187
82	204
81	253
80	306
79	317

CALCULATIONS:

TABLE 1 : Mean = $(10.04 + 10.48 + 10.07 + 10.18 + 10.44)/5$

$= 51.21/5$

$= 10.24$ mm

TABLE 2 : Mean = $(1.06 + 1.04 + 1.02 + 1.07 + 1.03)/5$

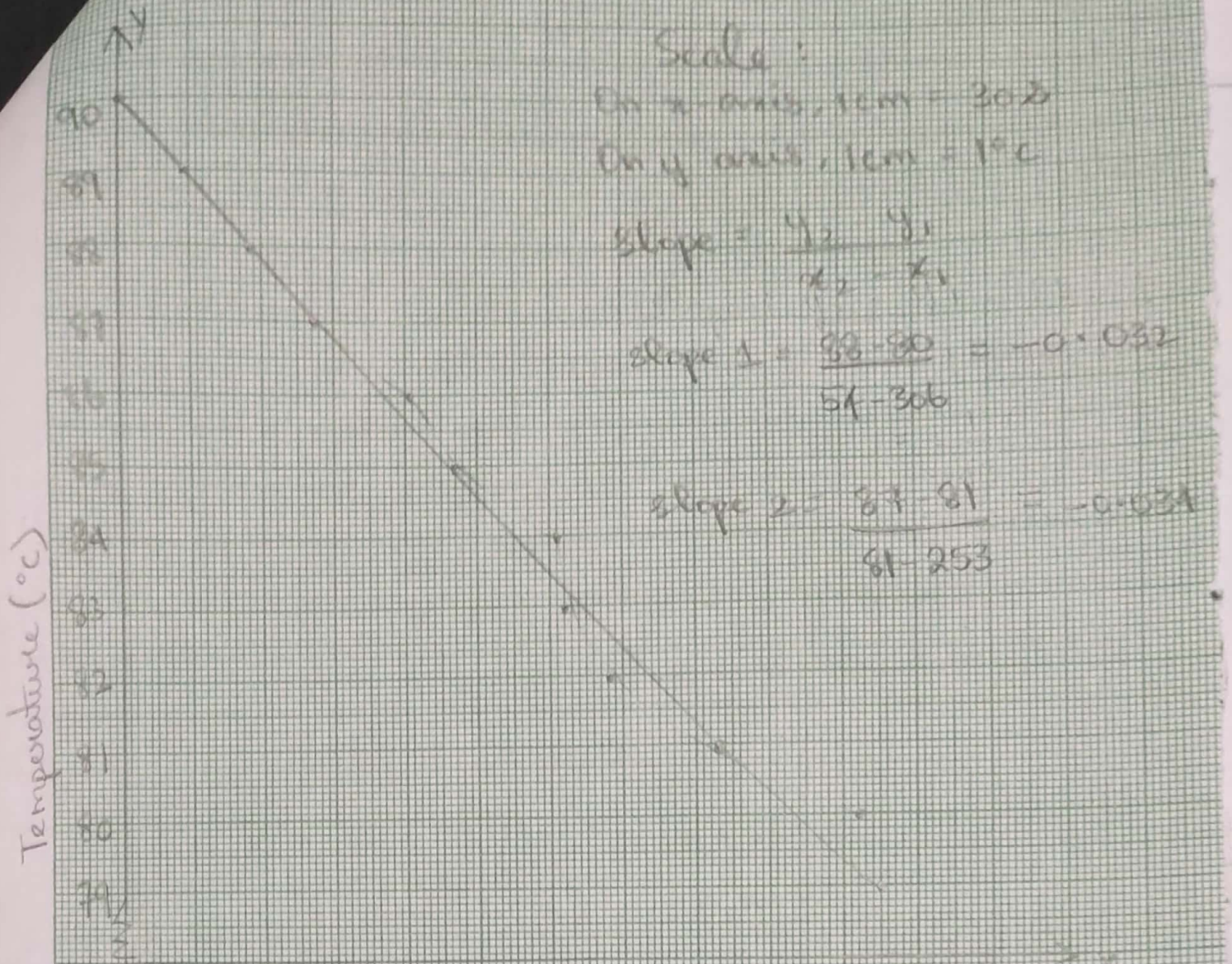
$= 5.22/5$

$= 1.04$ mm

TABLE 3 : Mean = $(113.36 + 113.12 + 113.14 + 113.20 + 113.48)/5$

$= 566.3/5$

$= 113.26$ mm.



Scale:

On x-axis, 1cm = 30s

On y-axis, 1cm = 1°C

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

$$\text{slope 1} = \frac{33 - 30}{51 - 306} = -0.032$$

$$\text{slope 2} = \frac{87 - 81}{81 - 253} = -0.034$$

$$\text{slope 3} = \frac{86 - 82}{121 - 347} = -0.017$$

$$\text{slope 4} = \frac{85 - 73}{121 - 187} = -0.048$$

Mean slope = 0.039 R/s

For thermal conductivity:

$H = 800g = 0.8kg$.

$c = 370\ J/kg\ K$

$r = 56.63 \times 10^{-3} m = 0.05663\ m$.

$T_1 = 96°C$

$T_2 = 84°C$

$T_1 - T_2 = 12K$.

$h = 10.24 \times 10^{-3} m = 0.01024 m$

$d = 1.04 \times 10^{-3} m = 0.00104 m$.

$dT/dt = 0.023$

$$K = \frac{Hc \cdot dT/dt}{\pi r^2 (T_1 - T_2)} \times \frac{(r+2h)\,d}{2(r+h)}$$

$$= \frac{6.808}{0.12} \times \frac{8.019 \times 10^{-5}}{0.134}$$

$$= 56.73 \times 5.984 \times 10^{-4}$$

$$= 0.0339\ Wm^{-1}k^{-1}$$

RESULT:

The thermal conductivity of cardboard = $0.0339\ Wm^{-1}k^{-1}$