PHYSICS PRACTICAL SHEETS

Date: 16th Feb 2023 | K.U. CAMPUS | Experiment No. 7
Class: CE | | Group: I
Roll No.: 25 | | Sub.: Physics
Shift: Morning | | Set:

Object of the Experiment (Block Letter)

DETERMINATION OF THE COEFFICIENT OF THERMAL CONDUCTIVITY OF A BAD CONDUCTOR BY LEE'S METHOD

Apparatus Required:

i) Lee's disc apparatus
ii) Two $1/10°C$ thermometers
iii) Circular disc of the specimen of a bad conductor
iv) Stop watch
v) Vernier calipers and micrometer screw gauge.

Theory:

On passing steam through a cylindrical vessel (C) a steady state is reached soon. In this condition, the rate at which heat is conducted across the specimen disc (D) is equal to the rate at which heat is emitted through the exposed surface of the lower metallic disc (M). If 'K' is the coefficient of thermal conductivity of the material, d its thickness and r its radius; θ_1 and θ_2 the constant reading of the thermometers T_1 and T_2 in the steady state, then rate at which heated is conducted across the specimen disc

$$Q = K\frac{\pi r^2(\theta_1 - \theta_2)}{d}$$

If 'M' is the mass of the metallic disc, 's' the specific heat of its material, then rate of cooling at θ_2 is equal to

$$Ms\frac{d\theta}{dt}$$

Here, $d\theta/dt$ is fall of temp. at θ_2.

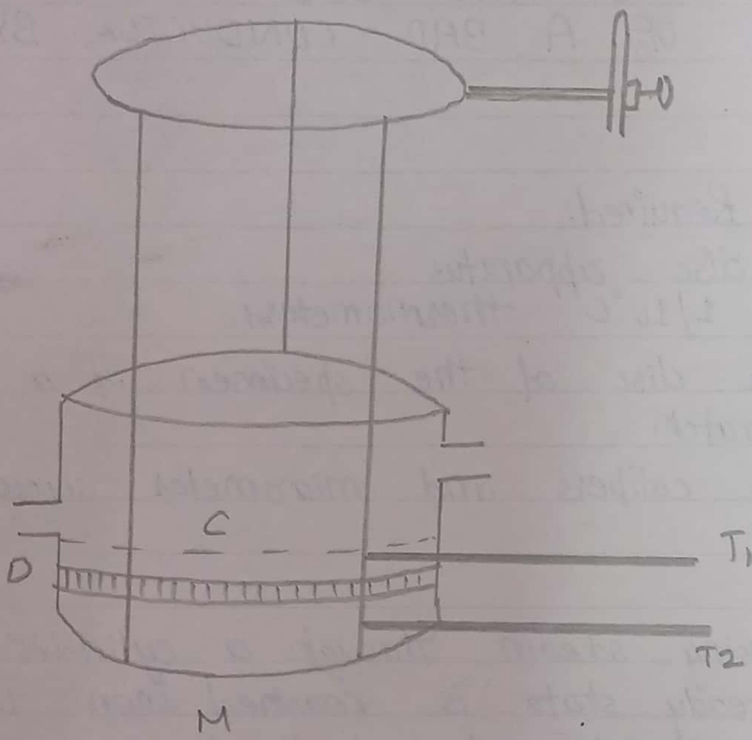

Fig: Lee's Apparatus

fig?

Therefore,

$$K \frac{\pi r^2 (\theta_1 - \theta_2)}{d} = Ms \frac{d\theta}{dt}$$

$$\therefore K = \frac{Msd}{\pi r^2 (\theta_1 - \theta_2)} \frac{d\theta}{dt}$$

The rate of cooling is found by heating the metallic disc to a temperature about 10°C above the steady temperature θ_2, it is then allowed to cool and temperature is noted after 30 seconds till the temperature falls to about 10°C below θ_2. A graph is then plotted between the temperature and time. A tangent is drawn at a point P corresponding to θ_2. The slope of the tangent gives the value of $d\theta/dt$ corresponding to θ_2.

Observations and Calculations:

Mass of metallic disk (M) = 860 gm
Specific heat of metal (s) = 0.093 cal/gm °C.
Diameter of the disc (Ø D) = 11.06 cm
Radius of the disc (r) = 5.53 cm
Thickness of the disc (d) = 0.7 cm
Steady temperature of T_1 (θ_1) = 86 °C
Steady temperature of T_2 (θ_2) = 58 °C

Table for Cooling Curve:

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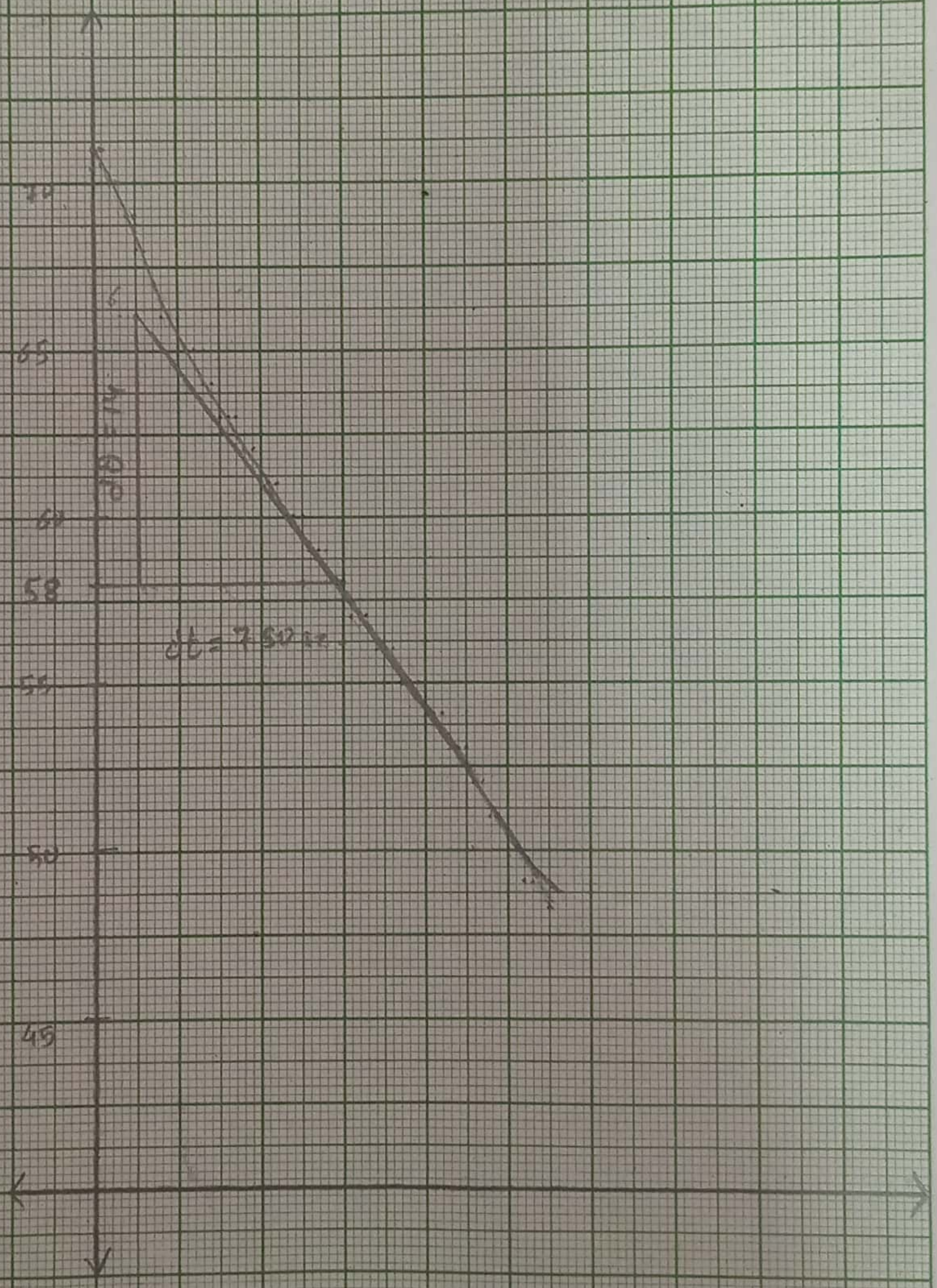
Scale: Along x-axis
1 small division = 30 sec
Along y-axis
4 small division = 1°C



No. of obs	Time in sec	Temp of disc	No. of obs	Time in sec	Temp disc	No. of obs	Time in sec	Temp in disc	No. of obs	Time in sec	Temp in disc
1	0	71	15	420	64	29	840	59	43	1260	54
2	30	71	16	450	64	30	870	59	44	1290	54
3	60	70	17	480	63	31	900	58	45	1320	53
4	90	70	18	510	63	32	930	58	46	1350	53
5	120	69	19	540	63	33	960	57	47	1380	53
6	150	69	20	570	62	34	990	57	48	1410	52
7	180	68	21	600	62	35	1020	57	49	1440	52
8	210	68	22	630	61	36	1050	56	50	1470	51
9	240	67	23	660	61	37	1080	56	51	1500	51
10	270	66	24	690	62	38	~~1100~~ 1110	56	52	1530	50
11	300	66	25	720	60	39	1140	55	53	1560	50
12	330	66	26	750	60	40	1170	55	54	1590	49
13	360	65	27	780	60	41	1200	55	55	1620	49
14	390	65	28	810	59	42	1230	54	56	1650	48

Rate of cooling $(d\theta/dt)$ from graph corresponding to θ_2

$= 14/750 = 0.018$ °C/sec.

Hence, $$k = \frac{M \cdot s \cdot d}{\pi r^2 (\theta_1 - \theta_2)} \times \frac{d\theta}{dt} = 3.885 \times 10^{-4} \text{ cal/cm/sec/°C}$$

Precautions:

i) Thickness 'd' of the specimen disc should be measured at a numbes of places on its surface.

ii) The diameter of the specimen disc should be equal to that of cylindrical vessel and the metallic disc and must be taken in two ⊥r directions.

(iii) The thermometer should be placed close to the face of the specimen disc.

(iv) There should be good thermal conduct between the specimen disc and the lower surface of cylindrical vessel and upper surface of metallic disc.

(v): The steady state temperature should be recorded after the temperature stays ideal for 5 minutes.