جامعة بيرزيت

BIRZEIT UNIVERSITY

Physics Lab 211

Experiment No. 9

The Thermal Conductivity

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Data Sheet:

$T_1 = (68 \pm 2)\ C^o$

$T_2 = (38 \pm 2)\ C^o$

$M = (985 \pm 5)\ g$

$Thickness\ (d) = (3.89 \pm 0.01) \times 10^{-3}\ m$

$Diameter(D) = (0.115 \pm 0.001)\ m$

$\boldsymbol{Temperature\ (C^o)}$	$\boldsymbol{time\ (s)}$
52	0
50	142
48	322
46	527
44	774
42	1095
40	1393
38	1682
36	2141
34	2786
32	3709
30	4590

Calculations:

From the (Temperature vs. Time) graph, we found $\frac{dT}{dt} = 6.2 \times 10^{-3}\ C^o/s$

$$K = \frac{4MCd\left(\frac{dT}{dt}\right)_{T_2}}{\pi D^2 (T_2 - T_1)}$$

$$K = \frac{4 \times 985(\boldsymbol{g}) \times 0.092\left(\frac{\boldsymbol{cal}}{\boldsymbol{g}.\boldsymbol{C^o}}\right) \times 3.89 \times 10^{-3}(\boldsymbol{m}) \times 6.2 \times 10^{-3}(\boldsymbol{C^o/s})}{\pi(0.115)^2(\boldsymbol{m^2})(68-38)(\boldsymbol{K})}$$

$$K \approx 0.007\ \frac{cal}{m.K.s} \rightarrow 0.007 \times 4.184 = 0.03\ \frac{watt}{m.K}$$

$$\frac{\Delta K}{K} = \frac{\Delta M}{M} + \frac{\Delta d}{d} + \frac{\Delta\left(\frac{dT}{dt}\right)}{\frac{dT}{dt}} + \frac{2\Delta D}{D} + \frac{\Delta(T_2 - T_1)}{T_2 - T_1}$$

$$\Delta\left(\frac{dT}{dt}\right) = \frac{\Delta slope}{slope} = \frac{\Delta T}{T_{avg}} + \frac{\Delta t}{t_{avg}} = \frac{2}{41} + \frac{1}{1597} = 0.05$$

$$\frac{\Delta K}{0.007} = \frac{5}{985} + \frac{0.01}{3.89} + 0.05 + 2 \times \frac{0.001}{0.115} + \frac{4}{68-38}$$

$$\Delta K = 0.0015\frac{cal}{m.K.s}$$

$$\boldsymbol{K = (0.007 \pm 0.0015)\frac{cal}{m.K.s}}$$

Result & Conclusion:

$$\boldsymbol{K = (0.007 \pm 0.0015)\frac{cal}{m.K.s}}$$

The theoretical value of the thermal conductivity "K" for ebonite is $0.043\frac{cal}{m.K.s}$

$$Discrepancy = \left|K_{theo} - K_{exp}\right| = |0.043 - 0.007| = 0.036\frac{cal}{m.K.s}$$

$2 \times \Delta K >? D$

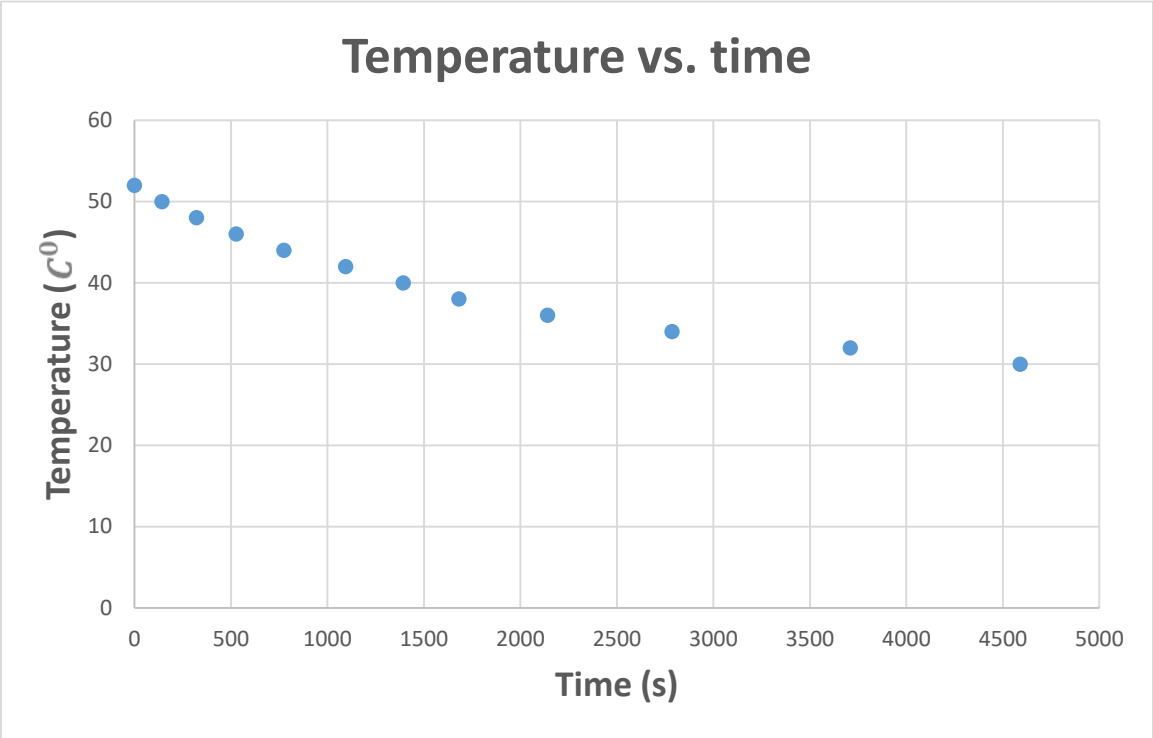
$2 \times 0.0015 >? 0.036$

$0.003 < 0.036$

Thus, our obtained value is not acceptable.

The unaccepted value is due to many reasons. The steady state might had a random error if there was a problem with the apparatus. There is obviously random errors in measuring the time in the cooling process. Also, we calculated the diameter by measuring the circumference of the ebonite plate and diving by π which was not precise. After all, the room temperature and the pressure affect the experiment significantly. I believe it would have given better results in cooler environments.

GRAPH



	Slope	y-intercept
	-0.004711655	48.52333469
error	0.000457696	0.972174108