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## Physics 211

**Experiment No. 9**

 **Thermal conductivity**

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* **Abstract:**

1) The objects of the experiment:

a. To familiarize oneself with some of the thermal properties of insulating materials.

b. To determine the thermal conductivity of ebonite and glass .

c. To describe and understand the thermal properties of the material .

2) The method used:

By using Lee’s Disk method .

3) The main results are:

K= 0.027±0.3 cal/ (sec.m.C)

**Theory:**

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**\***The medium have conductivity K Is placed between two heat reservoirs with one at a temperature (T2) that is higher than the other (T1) the we heat the transferred acoording this equation

dq/dt= -KA dT/dt …….(1)

\*A is the cross sectional area of the thermal conductor .

\*dx is the thickness of the thermal conductor .

\*dT is the difference across its ends.

dQ/dt=-MC dT/dt

\*C is called the specific heat and dT/dt is the rate of change of the object temperature .

**The procedure :**

* The Initial temperature was noted before the heating(T1 and T2) which shown in the fig\*.
* The Lee’s disk apparatus was suspended horizontaly.
* The water container was started heated ,and the temperature of T1 and T2 was started to rise as the steam passes.
* The temperature T1 and T2 was reading from the thermometer when the temperature stop changing(the stady state).
* The A disk was removed and the disk C was heated slab directly by the burner to 10 C° higher than its steady state(T2+10 C°).
* When the temperature is rises 10 C° the heated was stoped ,and it was cooled down.
* The measure of the temperature was taken every min.

**The Data:**

 T1=68 C° T2=54 C°

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Time(min) | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 |
| Temp(C°) | 64 | 62.5 | 61 | 60 | 59 | 57.5 | 56 | 55 | 54 | 53 | 52 | 51 | 50 |
| Time(min) | 13 | 14 | 15 |  |  |  |  |  |  |  |  |  |  |
| Temp(C°) | 49 | 48 | 47 |  |  |  |  |  |  |  |  |  |  |

 d=2.1± 0.01mm

D=11± 0.1 cm

M= 986 ± 5g

C=0.092 cal/g

K : the thermal conductivity of ebonite

A : the area of ebonite disk

D : the diameter of ebonite disk

d : the thickness of ebonite disk

$T\_{1},T\_{2}:$ the steady state temperatures

C : the specific heat of copper

$\left(\frac{dT}{dt}\right)\_{T\_{2}}$: the rate of change of the temperature at T2

M : the mass of the copper disk

**The Calculation:**

$$\frac{dQ}{dt}=kA \frac{T\_{1}-T\_{2}}{d}=MC \left(\frac{dT}{dt}\right)\_{T\_{2}}$$

$$k= \frac{4 M C d (\frac{dT}{dt})\_{T\_{2}}}{πD^{2}(T\_{1}-T\_{2})}$$

Slope = -0.0186 ± 0.000328 C°/sec

Y intercept= 63.30882 ± 0.173484 C°

$$\left(\frac{dT}{dt}\right)\_{T\_{2}}=-0.0186 \pm 0.000328 C°/sec$$

K= 0.027 cal/ (sec.m.C)

$$\frac{∆k}{k}=\frac{∆M}{M}+\frac{∆d}{d}+\frac{∆slope}{slope}+ 2\frac{∆D}{D}+\frac{∆T1+∆T2}{T1-T2}$$

$\frac{∆k}{k}=\frac{5}{986}+\frac{0.01}{2.10}+\frac{0.000328}{0.0186}+2\frac{0.1}{11}+ \frac{2+2}{14}+$

=0.3 cal/ (sec.m.C)

**The result and conclusion:**

**K**theo=0.0406$\frac{cal}{sec.m.C}$

**Discrepancy =**0.0406-0.0273/0.0406)\*100%

=32%

=0.327>2\*dK

My result is not accepted

There were many sources of error in this experiment

* The ebonite disk is not exactly cylindrical so using the diameter is not that accurate in calculations
* There was an air layer between the ebonite disk and the copper disk which affected the heat transfer between the disks .
* The weighing scale that used was not accurate.

The temperatures were not the exact steady state ones we had to wait more time

References:

\*physics 211 introductory laboratory.

\*<https://thermtest.com/thermal-resources/build-your-own/lees-disc>.

\*<https://scholar.google.com/scholar?hl=en&as_sdt=0%2C5&as_vis=1&q=less+disk&btnG=>

\*<https://www.youtube.com/results?search_query=thermal+conductivity+of+a+bad+conductor+by+lee%27s+disc+method+calculation+>

\*some reports from another student.