

# Laboratory Manual

**Course code: PHY 2104**

**Course title: Heat and Thermodynamics Practical**



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### **List of Experiments:**

1. To determine the specific heat of a liquid by the method of cooling.
2. To determine the thermal conductivity of a bad conductor by Lee and Charlton's method.
3. To determine of Specific Heat of Solid with Radiation Correction.
4. To determine of coefficient of thermal conductivity of a metal using Searle's apparatus.
5. To determine of Latent heat of fusion of ice with radiation correction.
6. To calibrate of a thermocouple and determination of unknown temperature.
7. To determine of the Ratio of the Specific Heats of a Gas by Clement and Desorme's apparatus.
8. To determine the value of the mechanical equivalent of heat (J) by electrical method with radiation correction.
9. To determine of the value of J, the Mechanical equivalent of heat by Callendar and Barnes apparatus (with radiation correction)
10. To determine of temperature co-efficient of the resistance of the material of a wire.

### **Reference Books:**

1. **Practical Physics**, Dr. Giasuddin Ahmed and Md. Shahabuddin
2. **Physics-I & II**, R. Resnick, D. Halliday

**Experiment no 01:**

**Date:**

**Name of the Experiment: Determination of the specific heat of a liquid by the method of cooling**

**Theory:** Newton's law of cooling can be used to determine the specific heat of a liquid by observing the time taken by the liquid in cooling from one temperature to another.

Suppose a liquid of mass  $M_1$  and specific heat  $S_1$  is enclosed within a calorimeter of mass  $m$  and specific heat  $s$ . The thermal capacity of the system is  $(M_1S_1 + ms)$ . If the temperature of the liquid falls from  $\theta_1$  to  $\theta_2$  in time  $t_1$ , then the average rate of loss of heat is

$$(M_1S_1 + ms) \frac{(\theta_1 - \theta_2)}{t_1}$$

If now the first liquid be replaced by an equal volume of second liquid of known specific heat (say water) under similar conditions and if the time taken by the second liquid to cool through the same range of temperature from  $\theta_1$  to  $\theta_2$  be  $t_2$ , then the average rate of loss of heat is

$$(M_2S_2 + ms) \frac{(\theta_1 - \theta_2)}{t_2},$$

where  $M_2$  and  $S_2$  are the mass and specific heat of the second liquid, respectively.

Since the conditions are similar, these two rates are equal

$$(M_1S_1 + ms) \frac{(\theta_1 - \theta_2)}{t_1} = (M_2S_2 + ms) \frac{(\theta_1 - \theta_2)}{t_2}$$

or,

$$S_1 = \frac{M_2S_2t_1 + ms(t_1 - t_2)}{M_1t_2}$$

**Apparatus:** Double walled enclosure, Calorimeter, Thermometer, Heater, Stopwatch, etc.

**Brief Procedure:**

1. Clean and dry the calorimeter and measure the mass ( $m$ ) of the calorimeter and stirrer using a balance.
2. Pour water up to two-third volume of the calorimeter. Measure the total mass ( $m''$ ) of the calorimeter, water and stirrer. Calculate the mass ( $M_2$ ) of water.
3. Put the calorimeter on the heater and hold the thermometer bulb in the middle of the water and raise the temperature around  $62^\circ\text{C}$ . Keep the calorimeter into the double walled enclosure with the help of a tongs. Close the lid and fix the thermometer with holder so that its bulb is in the middle of the water.
4. Start the stopwatch when the temperature just falls to  $60^\circ\text{C}$ . Note this temperature in the table. Go on recording the temperature of water up to 20-25 minutes at an interval of one minute. Gently stir the water during the whole process.
5. Pour out the water from the calorimeter and wipe it dry. Take experimental liquid in the calorimeter as the same volume of water. Repeat steps 2, 3 and 4 for liquid.
6. On a graph paper, plot curves (both for water and liquid) by taking temperature as ordinate and time as abscissa (see Graph 1). Calculate  $t_1$  and  $t_2$  from the graph.

7. Using the given formula, determine the specific heat of the given liquid.

**Experimental data:**

**Table:** Time–temperature record for water and liquid

No. of obs.	Time (min)	Temperature of water (°C)	Temperature of liquid (°C)
1	00		
2	01		
3	02		
4	03		
5	04		
6	05		
7	06		
8	07		
9	08		
10	09		
11	10		
12	11		
13	12		
14	13		
15	14		
16	15		
17	16		
18	17		
19	18		
20	19		
21	20		
22	21		
23	22		
24	23		
25	24		
26	25		

Mass of the calorimeter + stirrer,  $m =$  \_\_\_\_\_ g

Mass of the calorimeter + stirrer + liquid,  $m' =$  \_\_\_\_\_ g

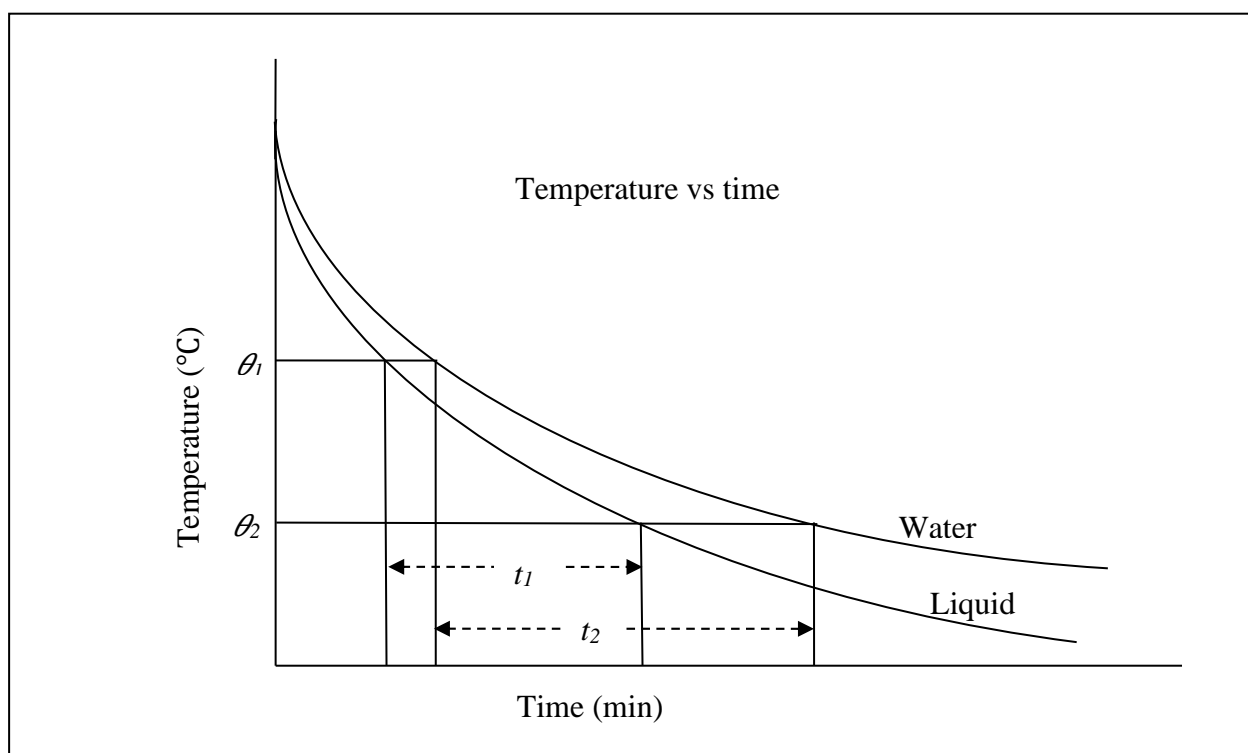
Mass of the liquid,  $M_1 = m' - m =$  \_\_\_\_\_ g

Mass of the calorimeter + stirrer + water,  $m'' =$  \_\_\_\_\_ g

Mass of the water,  $M_2 = m'' - m =$  \_\_\_\_\_ g

Specific heat of the water,  $S_2 = 1.00 \text{ Cal g}^{-1}\text{C}^{-1}$

Specific heat of the material of the calorimeter (Aluminum),  $s = 0.2096 \text{ Cal g}^{-1}\text{C}^{-1}$   
(Copper),  $s = 0.0909 \text{ Cal g}^{-1}\text{C}^{-1}$



Graph 1: Variation of temperature with time

**Calculations:**

Time taken by water to cool from  $\theta_1 =$  \_\_\_\_\_ °C to  $\theta_2 =$  \_\_\_\_\_ °C as obtained from the graph 1,  $t_2 =$  \_\_\_\_\_ min

Time taken by the liquid to cool from  $\theta_1 =$  \_\_\_\_\_ °C to  $\theta_2 =$  \_\_\_\_\_ °C as obtained from the graph 1,  $t_1 =$  \_\_\_\_\_ min

Specific heat of the liquid,

$$S_1 = \frac{M_2 S_2 t_1 + ms(t_1 - t_2)}{M_1 t_2}$$

**Error Calculation:**

Standard value of the specific heat of turpentine is  $0.42 \text{ Cal g}^{-1}\text{C}^{-1}$ .

$$\text{Percentage error} = \frac{\text{Standard value} - \text{Experimental value}}{\text{Standard value}} \times 100 \%$$

**Result:**

**Discussions:**

**Experiment no 02:**

**Date:**

**Name of the Experiment: Determination of the thermal conductivity of a bad conductor by Lee and Charlton's method.**

**Theory:** Consider a thin layer of slab of a bad conductor,  $S$  (such as glass or ebonite).  $A$  and  $B$  are the thick discs of brass or copper, one on either side of  $S$ .  $B$  is a steam chamber from which heat passes to  $S$  and  $A$  (Fig. 8.1). When steam is passed through  $B$ ,  $A$  is warmed up by the heat conducted through  $S$ . After some time, a steady state will be reached when the rate of flow of heat through  $S$  equals the heat lost from  $A$  by radiation and conduction.

If  $\theta_1$  and  $\theta_2$  be the temperatures of  $B$  and  $A$  in steady state, respectively, then the quantity of heat conducted per second through the slab  $S$  is

$$Q_1 = \frac{K\alpha(\theta_1 - \theta_2)}{d},$$

where  $K$  is the thermal conductivity of the slab  $S$  and  $\alpha$  and  $d$  are the area of cross-section and thickness of  $S$ , respectively.

If  $\frac{d\theta}{dt}$  be the rate of cooling of disc  $A$ , the heat lost (radiated) per second is

$$Q_2 = ms \frac{d\theta}{dt},$$

where  $m$  and  $s$  be the mass and specific heat of  $A$ .

In the steady state,  $Q_1 = Q_2$ .

$$\text{or, } \frac{K\alpha(\theta_1 - \theta_2)}{d} = ms \frac{d\theta}{dt}$$

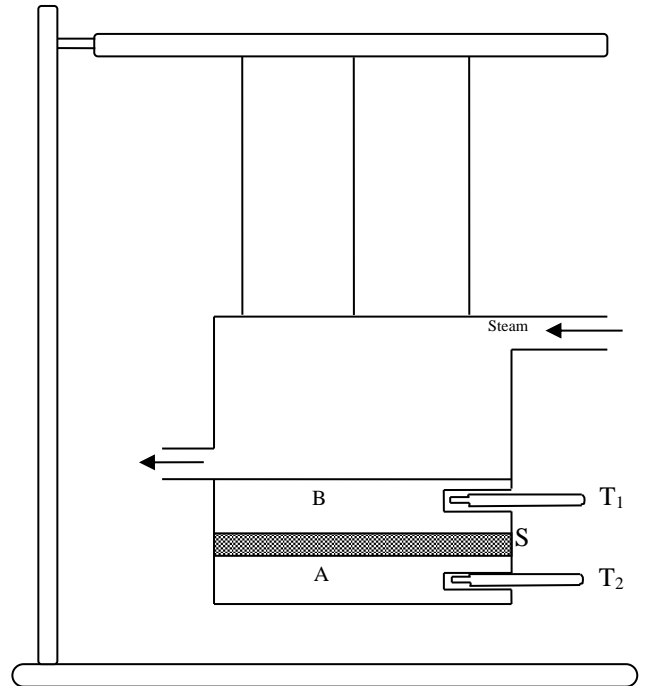
$$\text{or, } K = \frac{ms \frac{d\theta}{dt} d}{\alpha(\theta_1 - \theta_2)}$$

**Apparatus:**

Lee and Charlton's apparatus, Slide callipers, Screw gauge, Thermometers, etc.

**Brief Procedure:**

1. Start heating the boiler apart from the bad conductor slab.
2. Measure the diameter of the bad conductor slab by using slide callipers.
3. Measure the thickness of the bad conductor slab by using screw gauge.
4. Put the slab between  $A$  and  $B$ .



**Fig. 2.1:** Lee and Charlton's apparatus

5. When the steam starts to come from the outlet, start taking data from both the thermometers  $T_1$  and  $T_2$  at an interval of every 5 minutes until they show steady readings ( $\theta_1$  and  $\theta_2$ ). Steady readings mean that they remain constant for at least 3 consecutive intervals, i. e. for 20 or 25 minutes.
6. After reaching the steady temperature  $\theta_2$  in thermometer  $T_2$ , stop the supply of steam and remove  $B$ . Place  $A$  with the slab still on the top of it on the heater and heat it till its temperature rises to  $(\theta_2+10)^\circ\text{C}$ .
7. Remove  $A$  with the slab still on top of it from the heater and allow it to cool. Note the temperature at an interval of every half minute until the temperature falls from  $(\theta_2+10)$  to  $(\theta_2-10)^\circ\text{C}$ .
8. Plot a graph of temperature vs. time from cooling data. Draw a tangent at steady temperature ( $\theta_2$ ). Calculate the slope of the tangent.
9. Determine the thermal conductivity of the bad conductor using the given formula.

**Experimental Data:**

Vernier Constant (V.C.) of the slide callipers

$$V. C. = \frac{\text{The value of one smallest division of the main scale}}{\text{Total number of divisions in the vernier scale}}$$

**Table-1:** Table for the radius of the disc  $S$

No. of obs.	Main scale reading, $x$ (cm)	Vernier scale division, $\phi$	Vernier constant, $V_c$ (cm)	Vernier scale reading, $y = V_c \times \phi$ (cm)	Diameter, $D = x + y$ (cm)	Mean diameter, $D$ (cm)	Instrumental error $\pm e$ (cm)	Corrected diameter, $D - (\pm e)$ (cm)	Radius, $r = D/2$ (cm)
1									
2									
3									
4									



Least Count (*L.C.*) of the Screw Gauge

$$L. C. = \frac{\text{Pitch}}{\text{Total number of divisions in the circular scale}}$$

**Table-2:** Table for the thickness of the disc *S*

No. of obs.	Linear scale reading, <i>x</i> (cm)	Circular scale division, $\beta$	Least count, $L_c$ (cm)	Circular scale reading, $y = \beta \times L_c$ (cm)	Thickness, $d = x + y$ (cm)	Mean thickness, $d$ (cm)	Instrumental error $\pm e$ (cm)	Corrected thickness, $d - (\pm e)$ (cm)
1								
2								
3								
4								

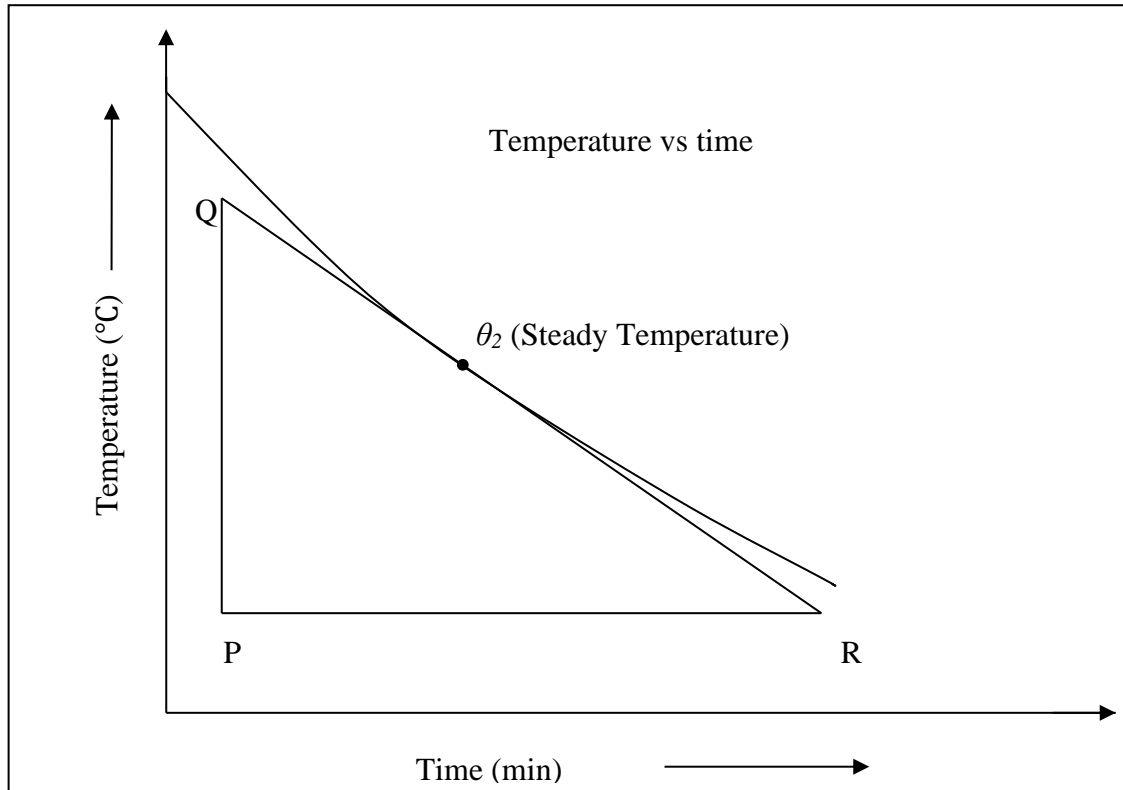
**Table-3:** Time- temperature records of *B* and *A*.

No. of observation	Time (minutes)	Temperature, $\theta_1$ (°C)	Temperature, $\theta_2$ (°C)
1	0		
2	5		
3	10		
4	15		

No. of observation	Time (minutes)	Temperature, $\theta_1$ ( $^{\circ}\text{C}$ )	Temperature, $\theta_2$ ( $^{\circ}\text{C}$ )
		$\theta_1 =$	$\theta_2 =$

**Table-4:** Time-temperature record of A during its cooling.

No. of obs.	Time, $t$ (minutes)	Temperature, ( $^{\circ}\text{C}$ )	No. of obs.	Time, $t$ (minutes)	Temperature, ( $^{\circ}\text{C}$ )
1	0	$\theta_2 + 10$	15	7.0	
2	0.5		16	7.5	
3	1.0		17	8.0	
4	1.5		18	8.5	
5	2.0				
6	2.5				
7	3.0				
8	3.5				
9	4.0				
10	4.5				
11	5.0				
12	5.5				
13	6.0				
14	6.5				$\theta_2 - 10$



Graph 1

**Calculations:**

Mass of the disc A,  $m =$  g

Specific heat of the material of A,  $s = 0.0909 \text{ Cal g}^{-1}\text{°C}^{-1}$

Radius of the specimen disc S,  $r =$  cm

Area of cross-section,  $\alpha = \pi r^2 =$   
 $=$  cm<sup>2</sup>

From the graph 1, the slope of the tangent at  $\theta_2 =$  °C,

$$\frac{d\theta}{dt} = \frac{PQ}{PR} \text{ °C min}^{-1} = \frac{PQ}{PR \times 60} \text{ °C s}^{-1} =$$

**Thermal conductivity,**

$$K = \frac{ms \frac{d\theta}{dt} d}{\alpha(\theta_1 - \theta_2)}$$

**Error Calculation:**

The thermal conductivity of ebonite is  $4.2 \times 10^{-4} \text{ Cal cm}^{-1} \text{ s}^{-1} \text{ }^\circ\text{C}^{-1}$ .

$$\text{Percentage error} = \frac{\text{Standard value} \sim \text{Experimental value}}{\text{Standard value}} \times 100 \%$$

**Result:**

**Discussions:**

**Experiment no 03:**

**Date:**

**Name of the Experiment: Determination of specific heat of solid with radiation correction.**

**Theory:** Let a solid body of mass  $M$  of specific  $S$  be heated to a temperature  $T_2$  °C and then dropped into water of mass  $W$  gm, contained in a calorimeter whose mass and specific heat are  $W_1$  and  $S_1$  respectively. The water and the calorimeter were both at the room temperature  $T_1$  °C before the solid was dropped. But after the solid has been dropped, (the calorimeter and its contents gain heat while the solid loses heat and after a while mixture attains a final temperature, after radiation correction be  $T$  °C.

Then the heat lost by the solid  $=MS(T_2 - T)$  and the heat and the heat gained by the calorimeter and its contents

$$=W(T - T_1) + W_1S_1((T - T_1) = (W + W_1S_1)(T - T_1)$$

Since, heat lost= heat gained

$$MS(T_2 - T) = (W + W_1S_1)(T - T_1)$$

$$\text{or, } S = \frac{(W+W_1S_1)(T-T_1)}{M(T_2-T)}$$

**Apparatus:** Regnault's apparatus, Balance, two thermometers, steam boiler, pieces of solid, stopwatch.

**Experimental data:**

Mass of the solid,  $M =$  gm

Wight of the calorimeter + stirrer,  $W_1 =$  gm

Wight of the calorimeter + stirrer + water,  $W_2 =$  gm

Wight of water,  $W = W_2 - W_1 =$  gm

Specific heat of the material of the calorimeter + stirrer,  $S_1 =$

Temperature of the hot solid,  $T_2 =$  °C

Initial temperature of water + calorimeter,  $T_1 =$  °C

Final temperature of the mixture after applying radiation correction,  $T =$  °C

**Calculations:**

Specific heat of the material of the given solid is

$$S = \frac{(W + W_1 S_1)(T - T_1)}{M(T_2 - T)}$$

**Error Calculation:**

$$\text{Percentage error} = \frac{\text{Standard value} - \text{Experimental value}}{\text{Standard value}} \times 100 \%$$

**Result:**

**Discussions:**

**Experiment no 04:**

**Date:**

**Name of the Experiment: Determination of coefficient of thermal conductivity of a metal using Searle's apparatus.**

**Theory:** If two points of a material of length  $d$  and area of cross section  $A$  are maintained at temperatures  $\theta_1$  and  $\theta_2$  where  $\theta_1$  is greater than  $\theta_2$ , then the amount of heat flowing from the hotter to the colder point in  $t$  sec is given by

$$Q = KA \frac{(\theta_1 - \theta_2)t}{d}$$

Where  $K$  is the thermal conductivity of the material.

To measure  $Q$ , cold water is made to circulate round the colder ends through a coil of tube in contact with this end so that the quantity of heat  $Q$  raises the temperature from  $\theta_3$  to  $\theta_4$  of  $m$  gm of water flowing in sec, then

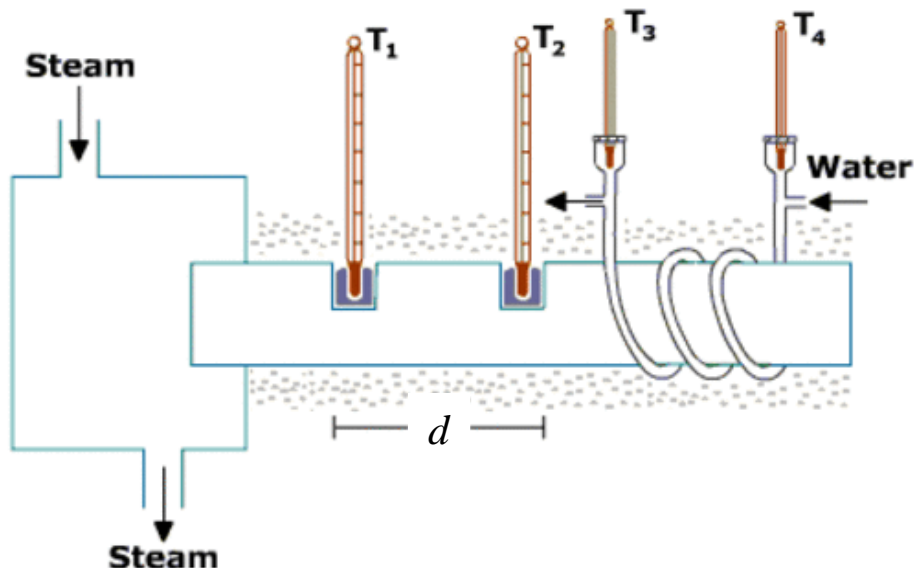
$$Q = m \times 1(\theta_4 - \theta_3) = m(\theta_4 - \theta_3)$$

with the specific heat of water be unity. Combining the above equations, we have

$$KA \frac{(\theta_1 - \theta_2)t}{d} = m(\theta_4 - \theta_3)$$

or,

$$K = \frac{md(\theta_4 - \theta_3)}{At(\theta_1 - \theta_2)}$$



**Apparatus:** Searle's thermal conductivity apparatus, steam generator, four thermometers, a beaker, stopwatch, slide callipers and constant pressure head apparatus

**Experimental data:**

Diameter of the cylinder = cm  
Radius of the cylinder,  $r =$  cm  
Area of cross-section of the cylinder,  $A = \pi r^2 =$   
= cm<sup>2</sup>  
Distance between the holes,  $d =$  cm  
Mass of water collected,  $m =$  gm  
Time of collection,  $t =$  s

**Table:** Thermometer reading

No. of obs.	Time (min)	$\theta_1$ (°C)	$\theta_2$ (°C)	$\theta_3$ (°C)	$\theta_4$ (°C)
	0				
	5				
	10				
	15				
	20				

**Calculations:**

Coefficient of thermal conductivity of the given material is

$$K = \frac{md(\theta_3 - \theta_4)}{At(\theta_1 - \theta_2)}$$



**Error Calculation:**

$$\text{Percentage error} = \frac{\text{Standard value} - \text{Experimental value}}{\text{Standard value}} \times 100 \%$$

**Result:**

**Discussions:**

**Experiment no 05:****Date:**

**Name of the Experiment: Determination of Latent heat of fusion of ice with radiation correction.**

**Theory:** Latent heat of fusion of ice is defined as the quantity of heat required to melt one gram of ice at 0 °C into water at 0 °C. Let an amount of ice of mass  $M$  be added to a mass  $m$  of water contained in a calorimeter of mass  $w$  and specific heat  $s$ . Let  $t_1$  °C be the temperature of the calorimeter and its content before the addition of ice and  $t_2$  °C be the final temperature ,after making due allowance for the gain of heat from the surrounding ,of the mixture after addition and complete melting of ice. Then the heat lost by the calorimeter and water is

$$m(t_1 - t_2) + ws(t_1 - t_2).$$

The heat required to melt the ice is  $ML$  where  $L$  is the latent heat of fusion of and the heat required to raise the temperature of the water , formed as a result of melting of ice, from 0 °C to  $t_2$  °C is  $Mt_2$ . Therefore, the total heat gained in the experiment is

$$ML + Mt_2 = M(L + t_2)$$

According to the law of calorimetry heat gained is equal to heat lost. So,

$$M(L + t_2) = (m + ws)(t_1 - t_2)$$

or,

$$L = \frac{(m + ws)(t_1 - t_2) - Mt_2}{M}$$

**Apparatus:** Calorimeter with stirrer, thermometer, blotting paper, stopwatch, ice, balance, etc.

**Experimental data:**

Mass of calorimeter + stirrer, $w =$	gm
Specific heat of the calorimeter material, $s =$	Cal g <sup>-1</sup> °C <sup>-1</sup>
Mass of calorimeter + stirrer + water, $w_1 =$	gm
Mass of water, $m = w_1 - w =$	gm
Mass of calorimeter + stirrer + water + molten ice, $w_2 =$	gm
Mass of ice added, $M = w_2 - w_1 =$	gm
Initial temperature of water, $t_1 =$	°C
Final temperature of the mixture, $t_2 =$	°C

**Calculations:**

Latent heat of fusion of ice is

$$L = \frac{(m + ws)(t_1 - t_2) - Mt_2}{M}$$

**Error Calculation:**

$$\text{Percentage error} = \frac{\text{Standard value} - \text{Experimental value}}{\text{Standard value}} \times 100 \%$$

**Result:**

**Discussions:**

**Experiment no 08:**

**Date:**

**Name of the Experiment: Determination of the value of the mechanical equivalent of heat (J) by electrical method**

**Theory:** The mechanical equivalent of heat  $J$  is the amount of electrical energy required to generate one calorie of heat. If  $E$  volt be the potential difference across a conducting coil (Fig. 8.1) and  $i$  ampere be the current flowing through the coil for  $t$  seconds, then the electrical energy in the coil is  $Eit$ . If this energy is converted into heat  $H$  (calories) then the mechanical equivalent of heat  $J$  is

$$J = \frac{Eit}{H} \text{ Joules/Calorie} \quad (1)$$

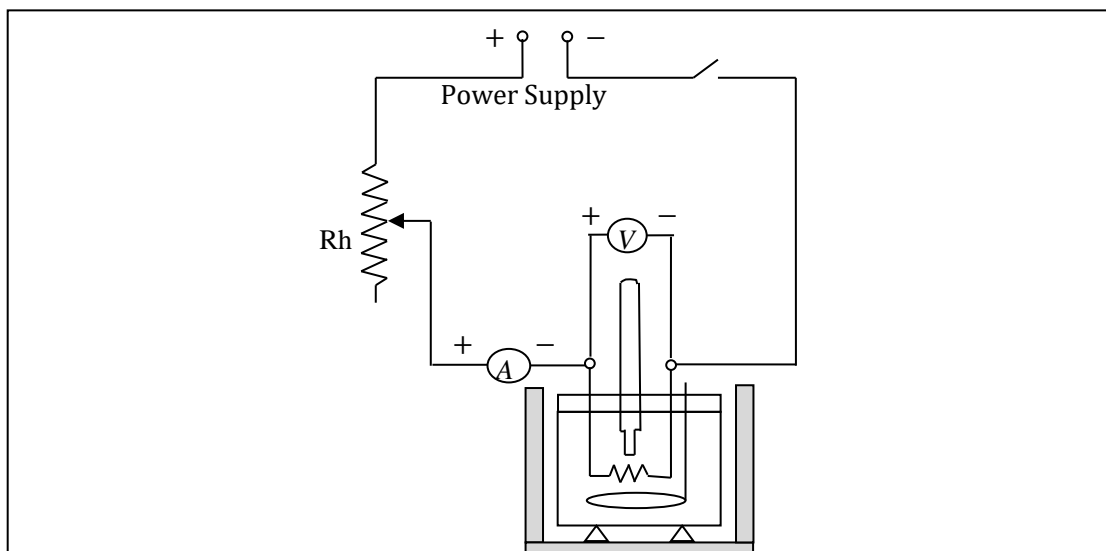
If  $H$  is measured by means of a calorimeter with its contents where the temperature raises from  $\theta_1^\circ$  C to  $\theta_2^\circ$  C then

$$H = (Ms + W)(\theta_2 - \theta_1), \quad (2)$$

where  $M$  is the mass of the water in the calorimeter,  $s$  is the specific heat of water and  $W$  is the water equivalent of the calorimeter and stirrer.  $W$  can be calculated from the mass and specific heat of the calorimeter and stirrer.

From equations (1) and (2), we get

$$J = \frac{Eit}{(Ms + W)(\theta_2 - \theta_1)} \text{ Joules/Calories}$$



**Fig. 8.1:** Experimental setup for measuring the mechanical equivalent of heat

### **Apparatus:**

Joule's calorimeter set, Ammeter, Voltmeter, Stopwatch, Thermometer, Balance, Power Supply, Rheostat, Key, etc.

### **Brief Procedure:**

1. Measure the mass ( $m_1$ ) of the calorimeter and stirrer using a balance.
2. Pour water into the calorimeter which is just enough to dip the heating coil and the bulb of the thermometer. Then measure the total mass ( $m_2$ ) of the calorimeter, stirrer and water. Calculate the mass ( $M$ ) of water.
3. Place the heating coil into the calorimeter. Keep the calorimeter with heating coil into its insulating box. Fix the thermometer with holder so that its bulb is in the middle of the water but never touching the coil and the calorimeter.
4. Complete the circuit as shown in Fig.8.1. Switch on the circuit temporarily and adjust the control knob of the power supply until the current is about 2 amperes. Then switch off the circuit and stir the water until a steady temperature is shown by the thermometer. Record this temperature as initial temperature.
5. Switch on the circuit and start the stopwatch simultaneously. Then start recording the temperature, current and voltage in the table at an interval of every 1 minute. Keeping the current supply and stopwatch on, record these values for 10 minutes. Then switch off the circuit but allow the stopwatch to run on and record the temperature for further 10 minutes in the same manner. Stir the water gently during the whole process.
6. Find the maximum and final temperatures. Use them to calculate the radiation correction.
7. Calculate the water equivalent of the calorimeter.
8. Using the given formula, determine the value of the mechanical equivalent of heat.

### **Experimental data:**

Mass of the calorimeter + stirrer,  $m_1 =$  g

Mass of the calorimeter + stirrer + water,  $m_2 =$  g

Mass of the water,  $M = m_2 - m_1 =$  g

Specific heat of the water,  $s = 1 \text{ Cal g}^{-1}\text{C}^{-1}$

Specific heat of the material of the calorimeter (Aluminum),  $s_1 = 0.2096 \text{ Cal g}^{-1}\text{C}^{-1}$   
(Copper),  $s_1 = 0.0909 \text{ Cal g}^{-1}\text{C}^{-1}$

**Table 1:** Table for current, voltage and temperature

No of observations	Times (min)	Current, $i$ (amp.)	Voltage, $E$ (Volt)	Temperature, $T$ ( $^{\circ}\text{C}$ )
1	00	0	0	$\theta_i =$
2	01			
3	02			
4	03			
5	04			
6	05			
7	06			
8	07			
9	08			
10	09			
11	10			
<b>Current Stopped</b>				
12	11	0	0	
13	12	0	0	
14	13	0	0	
15	14	0	0	
16	15	0	0	
17	16	0	0	
18	17	0	0	
19	18	0	0	
20	19	0	0	
21	20	0	0	$\theta_f =$

### Calculations:

Water equivalent of the calorimeter, $W = m_{1S1} =$	g
Initial temperature of the calorimeter + contents, $\theta_i =$	°C
Maximum temperature of the calorimeter + contents, $\theta_m =$	°C
Final temperature of the calorimeter + contents, $\theta_f =$	°C
Rise of temperature, $\theta = (\theta_m - \theta_i)$	°C
Radiation correction, $\theta_r = (\theta_m - \theta_f) / 2 =$	°C
Corrected rise of temperature $(\theta_2 - \theta_1) = (\theta + \theta_r) =$	°C
Time during which the current is passed, $t =$	sec
Mean current during the interval $t$ , $i =$	amp.
Mean voltage during the interval $t$ , $E =$	volt
Mechanical equivalent of heat,	

$$J = \frac{Eit}{(Ms + W)(\theta_2 - \theta_1)} \text{ Joules/Calories}$$

### **Error Calculation:**

Standard value of the mechanical equivalent of heat,  $J$  is 4.2 Joules/Calories

$$\text{Percentage error} = \frac{\text{Standard value} - \text{Experimental value}}{\text{Standard value}} \times 100 \%$$

### Result:

### Discussions:

**Experiment no 10:****Date:****Name of the Experiment: Determination of temperature co-efficient of the resistance of the material of a wire.****Theory:** The temperature co-efficient of the resistance of the material of a wire may be defined as the change in resistance per unit resistance per degree rise in temperature.If  $R_2$  and  $R_1$  are the resistances of a coil at temperatures  $t_2^\circ\text{C}$  and  $t_1^\circ\text{C}$  respectively, then

$$R_2 = R_1(1 + \alpha t)$$

Where  $\alpha$ , the mean temperature co-efficient between the temperature  $t_2$  and  $t_1$ , is given by

$$\alpha = \frac{(R_2 - R_1)}{R_1(t_2 - t_1)} \text{ } ^\circ\text{C}^{-1}$$

**Apparatus:**

Metre bridge, dc power supply, rheostat, commutator, galvanometer, hypsometer etc.

**Experimental data:**Table: Reading for  $R_1$  and  $R_2$ 

Temperature	No. of obs.	Resistance (ohm)		Null points (cm)		Mean null point (cm)	Unknown resistance (ohm)	Mean Resistance (ohm)
		Left gap	Right gap	Direct current	Reverse current			
$t_1 =$	1							
	2							
	3							
	4							
	5							
	6							



Temperature	No. of obs.	Resistance (ohm)		Null points (cm)		Mean null point (cm)	Unknown resistance (ohm)	Mean Resistance (ohm)
		Left gap	Right gap	Direct current	Reverse current			
$t_2 =$	1							
	2							
	3							
	4							
	5							
	6							

**Calculations:**

$$\alpha = \frac{(R_2 - R_1)}{R_1(t_2 - t_1)} \text{ } ^\circ\text{C}^{-1}$$

**Result:**

**Discussions:**