LABORATORY MANUAL FOR JOULE'S CALORIMETER

Joule's Calorimeter

AIM

To measure the value of Joules's constant (J) or Mechanical Equivalent of Heat by Joule's Calorimeter.

Outcome: Understanding the principle of equality the heat energy and mechanical energy.

APPARATUS REQUIRED

1. Joule's Calorimeter
2. Sensitive Thermometer
3. Key
4. Ammeter
5. Voltmeter
6. Rheostat
7. Power supply

THEORY

According to the law of thermodynamics, the amount of work converted into heat (W) is directly proportional to the quantity of heat generated (H).

$$\text{Thus, } W = JH$$

Where J is called the mechanical equivalent of heat or Joule's constant.

$$\text{Therefore, } J = \frac{W}{H}$$

If W is measured in Joules and H is measured in calories, the unit of J will be Joule/calorie.

In this experiment, electrical energy (W) is converted into heat. If 'I' current flows in a conductor for a time 't' and 'V' is the potential difference across the conductor, then the work done in time t = V.I.t Joules (in SI units). i.e,

$$W = V.I.t \text{ ----------(1)}$$

If 'm' is the mass of calorimeter and stirrer and 'm_k' is the mass of K-oil, then the heat gained by the calorimeter and K-oil in calorie is

$$H = (m.s + m_k.s_k)\Theta \text{----------(2)}$$

Where 's' and 's_k' are the specific heat capacities of copper and K-oil respectively and 'Θ' is the rise in temperature of calorimeter and K-oil.

PROCEDURE

1. Circuit is completed as shown in the diagram.
2. The calorimeter is filled up to 2/3rd by known K-oil (volume may be measured with the help of a measuring cylinder).
3. Then, the current is adjusted (say at 1 A) with the help of a rheostat and the initial temperature of the calorimeter is noted. (current can be adjusted between 1 A to 2 A for the experiment)
4. Current is allowed to pass through the calorimeter for a measured time 't' during which the temperature of calorimeter increases by 4-5° C. Final Temperature is noted and increase in temperature is calculated.
5. Mass of the calorimeter is noted. Similarly, mass of the K-oil is calculated using its known values of density and volume (supplied in lab).
6. The circuit is disconnected and J is calculated.

Figure

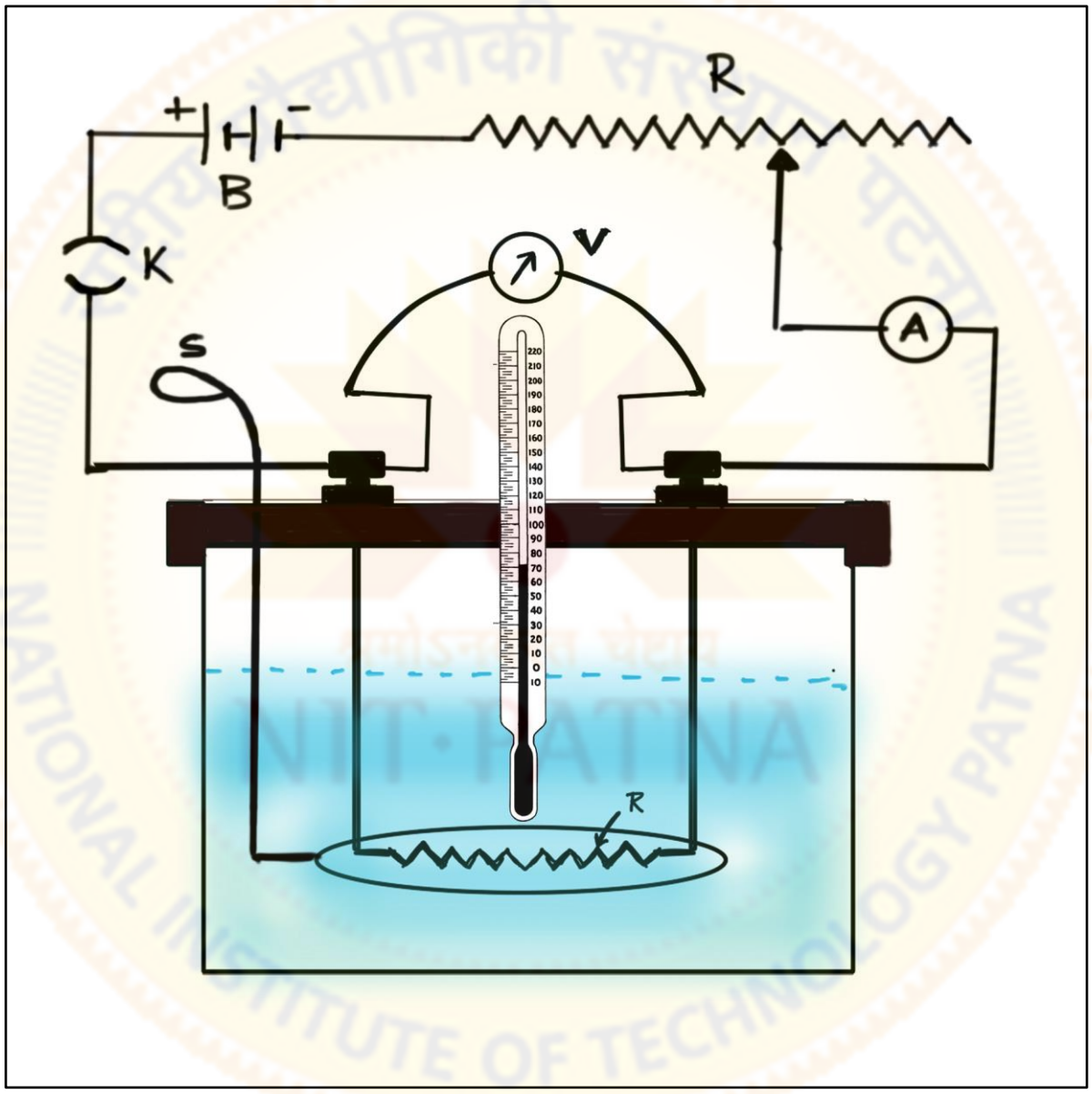

Figure: Schematic Diagram of Calorimeter

OBSERVATION

Table: Measurement of Joule's Constant

S. No	Current 'I' in Amp.	P.D. 'V' in Volt	Time (t) in sec.	Increase in temp. in '℃'	Mass of Calorimeter in gm	Mass of K-oil in gm.	J in Joule/Cal

Data sheet

Mass of Calorimeter with stirrer = 89.12 gm.

Sp. Heat of Cu = 0.094 cal / gm ℃ = 390 Joules/kg K
Sp. Heat of K-Oil = 0.51 cal / gm ℃ = 2142 Joules/kg K
Density of K-Oil = 0.8×10^3 kg/m^3
Volume of K-Oil = …. ml (will be supplied as accurate value may vary)

CALCULATION

Show all the calculations for finding J.

RESULT

∴ The value of Joules's constant (J) or Mechanical Equivalent of Heat is …… Joule/Cal.

Theoretical value of J_T = 4.18 Joules/Cal

Percentage error in the experimental value of J = ……

PRECAUTIONS

1. Before turning on the circuit all the connections should be carefully checked.
2. Measure the vol. of K-Oil using measuring cylinder before starting the experiment.
3. While taking the temperature reading avoid any parallax error.
4. Do not heat the oil more than 75 ℃.

SAMPLE VIVA QUESTIONS

1. What is meant by J?
2. What is the purpose of measuring the voltage and current at regular intervals during the course of the experiment? Briefly explain the method of determining W.
3. Why it is known as mechanical equivalent of heat.