(HT1-6) Electrical Equivalet of Heat, Joule's Experiment

Aim of experiment

Determination of the specific heat of a liquid by electric method

Apparatus

D.C Power Supply – Ammeter – Voltmeter - Calorimeter – Water – Coil – Thermometer – Stop Watch.

Theory of experiment

When a resistor of resistance R has a current I at voltage V, the power absorbed in the resistor is

$$P=I^2R=V^2/R=VI \qquad (1).$$

Power is energy per unit time, and if it is constant, the energy U delivered in time t is given by

$$U=Pt=Vit \qquad (2)$$

When a resistor absorbs electrical energy, it dissipates this energy in the form of heat Q. If the resistor is placed in the calorimeter, the amount of heat produced can be measured when it is absorbed in the calorimeter. Consider the experimental arrangement shown in Figure 1, which a resistor coil (also called and "immersion heater") is immersed in the water in a calorimeter.

The heat Q produced in the resister is absorbed by the water, calorimeter cup, and the resistor coil itself. This heat Q produces a rise in temperature ΔT. The heat Q is related to ΔT by:

$$Q=(m_wc_w+m_cc_c+m_rc_r)\Delta T \qquad (3)$$

The mc's are the masses and specific heats of the water, the calorimeter, and the resistor. Let mc stand for the sum of the product of the masses and the specific heats for the three objects that absorb the heat. In those terms the heat Q is given by the following:

$$Q=mc\Delta T \qquad (4)$$

The electrical energy absorbed in the resistor is completely converted to heat. The equality of those two energies is expressed as

$$U\,(J)=J\,(J/cal)\,Q\,(cal) \qquad (5)$$

J represents the conversion factor from joules to calories. Using the expression for U and Q from equations (2) and (4) in equation (5) leads to

$$VIt(J)=J(J/cal)\,.mc\Delta T(cal) \qquad (6)$$

Procedures

1. Arrange the circuit as shown in *figure 1.*
2. Find the mass of the calorimeter m_c, fill it with water to cover the heating coil and reweigh to obtain the mass of water mw in the calorimeter.
3. Immerse the coil in the calorimeter with the thermometer, and place the calorimeter in heat-insulating supports inside a larger calorimeter and take the reading of the thermometer T_1.
4. Adjust a suitably large current through the coil ≈ 0.5 A at a voltage of about 10 V, and let the stop watch simultaneously started.
5. Record the values of V, I, and T at different times, t, in a table
6. Draw the relation between Q and U *at different times* and determine its slope= J *(J/cal)*

Results

Specific heat of the copper calorimeter c_c = 0.092 4 cal/g °C
Mass of the calorimeter m_c = g
Specific heat of water cw = 1 cal/g °C
Mass of water m_w = g
$m_c = m_wc_w + m_cc_c$ = (cal/ °C)
The initial temperature Ti = °C

t(s)	V (V)	I(A)	U=VIt (J)	T(°C)	ΔT(°C)	Q cal
0						
60						
120						
180						
240						
300						
360						
420						
480						
540						
600						

$J_{av}(J/cal)$ =

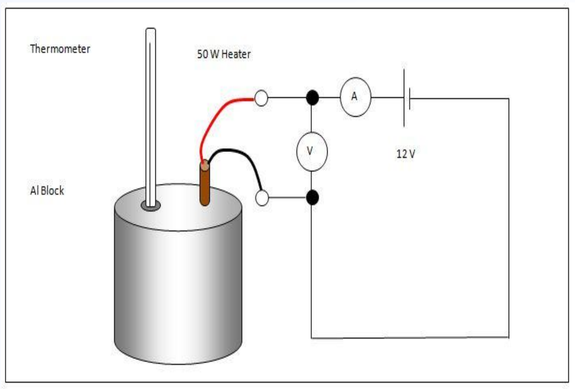

Figure 1. A schematic diagram of Joule experiment

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