التجربة الخامسة

اسم التجربة:- مكافئ جول

Joule equivalent

The purpose of the experiment:-

Determination the thermomechanical equivalent value (Joule equivalent) using the electrical method

Used equipment's :-

Calorimeter, suitable resistance, heat insulation sleeve, DC source, rheostat, thermometer, weigher, voltmeter, ammeter, and stopwatch.

Theory :-

When the voltage difference (V) is applied to both ends of a resistance (R), an electric current (I) passes through the resistance. If this is for a period of time (t), then the electrical work done on the wire is given by the following relation .

$$W = I^2 R\, t = I\, V t \cdots\cdots\cdots (1)$$

Because of this work, the temperature of the wire will rise, which will lead to heat transfer from it to the water and the calorimeter. When finding the ratio between the electrical work and the amount of heat that entered the water and the calorimeter, it is found to be equal to a constant called the Joule constant.

$$J = \frac{W}{Q} \ldots\ldots\ldots\ldots (2)$$

If we put the resistance (R) in a calorimeter containing water and pass a current through this resistance, then by applying the law of conservation of energy, the amount of heat lost by the resistance is equal to the amount of heat gained by the water and the calorimeter

If we symbolize the amount of heat gained by water (Q_W), then:-

$$Q_W = M_W C_W \Delta T \ldots\ldots (3)$$

where (M_W) is the mass of water, (C_W) is the specific heat of water, (ΔT) is the change in temperature of water.

The amount of heat gained by the calorimeter (Q_C) is:-

$$Q_C = M_C C_C \Delta T \ldots\ldots\ldots (4)$$

Where (M_C) is the mass of the calorimeter, and (C_C) is the specific heat of the calorimeter.

From equations (3) and (4) we find that the acquired energy is given by the relation:-

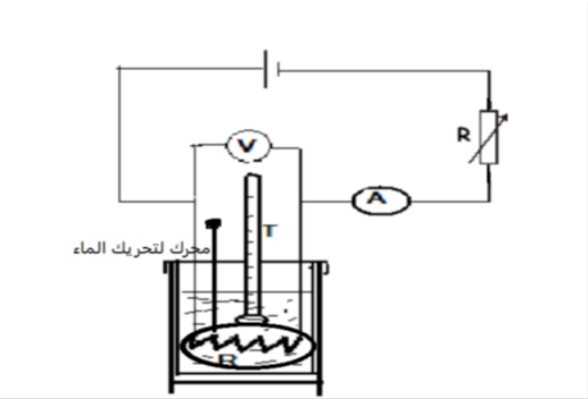
$$Q = (T_2 - T_1)(M_C C_C + M_W C_W) \ldots\ldots\ldots (5)$$

Since (T_1 and T_2) are the initial and final temperatures, respectively, of water and calorimeter, and by substituting equation (1) and (5) in (2), we find that:-

$$J = \frac{IVt}{(T_2 - T_1)(M_C C_C + M_W C_W)} \ldots\ldots\ldots\ldots (6)$$

Work steps :-

1- Clean and dry the calorimeter, then determine its weight while it is empty and let it be (M_c).
2- Connect the circle as shown in the following figure



3- Put a quantity of water in the calorimeter until the resistance is immersed in the water, then record the total weight of the calorimeter with water, let it be (M_{C+W}).
4- Find the mass of water (M_W).
5- Adjust the voltage source to the appropriate voltage.
6- Turn on the power supply and record the initial temperature.
7- When the system temperature rises to five degrees above the initial temperature, record the final temperature, close the current source, and record the time reading (t).
8- Substitute for the measured values in relation (6) and find the value of (J).