كلية التربية

نموذج إجابة مادة حرارة

الفرقة الأولي كيمياء (تخلف)

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1. Describe the principle, construction and working of a thermo electric thermometer..

---------- **Solution** ----------

Thermoelectric Thermometer

The principle underlying a thermoelectric thermometer is that when one junction of two different metals such as iron and copper is heated keeping the other cold an emf is generated and a current flows through the circuit, see Fig. (6). This is known as ***Seebeck effect***. The magnitude of the emf generated is proportional to the temperature of the hot junction if that of the cold junction is kept constant. Variation of thermo emf with temperature is given from the expression:

$$E = \alpha T + \beta T^2$$

where T is the temperature of the hot junction, α and β are constants. It has been found that for temperature up to $300^{o}C$, copper constantan and iron constantan are good as they give thermo emf of the order of 40 to 60 microvolt per degree temperature difference between junctions.

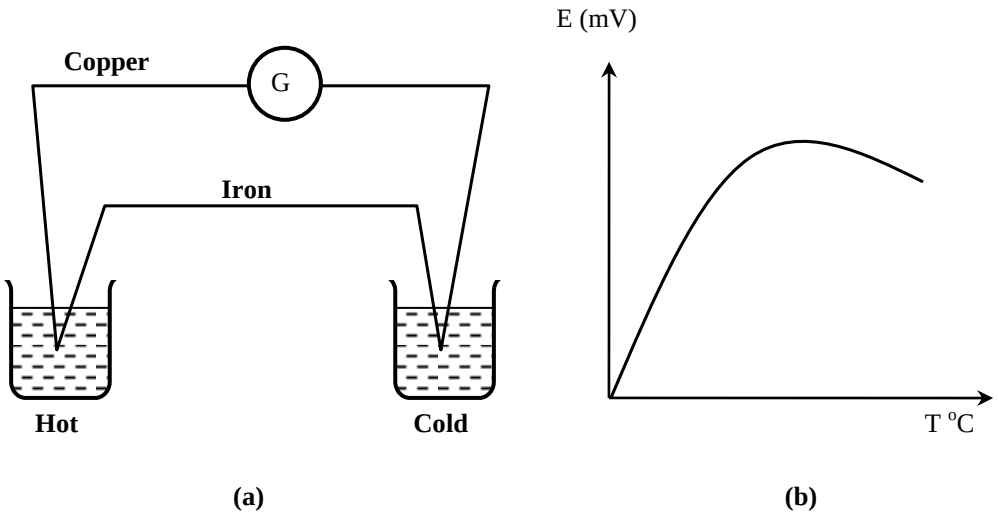

Fig. (6): (a) Thermocouple thermometer. (b) Thermocouple characteristic

The construction details of a simple thermocouple thermometer (or thermoelectric thermometer) are shown in Fig. (7). It consists of a tube B made of silica. Inside the tube a junction A obtained by electrical welding the two wire is kept. The junction A is called the hot junction as it will measure the unknown temperature. The portion of the wires near the hot junction A are insulated with capillary tubes C of hard glass.

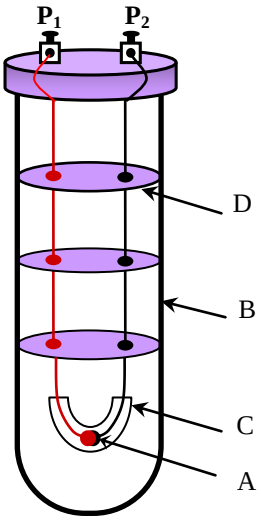

Fig. (7): Thermocouple thermometer

These two wires are then passed through mica disks D closely fitted in the tube B and attached to terminals P_1, P_2 fixed on the cap closing the mouth of tube. To these terminals long wire of the same metals are also

connected to form a cold junction being immersed in melting ice at $0^{o}C$ at a fairly distance place from hot junction.

In order to measure the temperature of a system following method is used. Firstly, a calibration curve of thermometer is drawn between temperature and emf. This is obtained by putting cold junction at ice point and increasing the temperature of hot junction and recording the corresponding thermo emf. Then the hot junction is kept in contact with the system whose temperature is measured and cold junction is again kept at ice point. The thermo emf is noted and the corresponding temperature is read from the calibration curve.

The thermocouple thermometer has the advantage of its suitability for measuring the rapidly varying temperatures as it has small thermal capacity. It has a wide range from $-200^{o}C$ to $1000^{o}C$.

2. Describe a method to determine the specific heat of a liquid by Joule method

---------- **Solution** ----------

Specific Heat of Liquids (Joule's Method)

The method is applied to liquids. The apparatus consists of a calorimeter, in which a heater coil of resistance R is enclosed. The ends of the coil are connected to the terminals by two binding screws on the top of the lid. The calorimeter is enclosed in a wooden box as in Fig. (7). A sensitive thermometer and a stirrer S can be introduced into the calorimeter through holes in the lid. The heater coil is connected in series with a battery B, an ammeter A, a rheostat and a tap key K. A voltmeter V is connected in parallel with the heater coil to measure the potential difference between its ends.

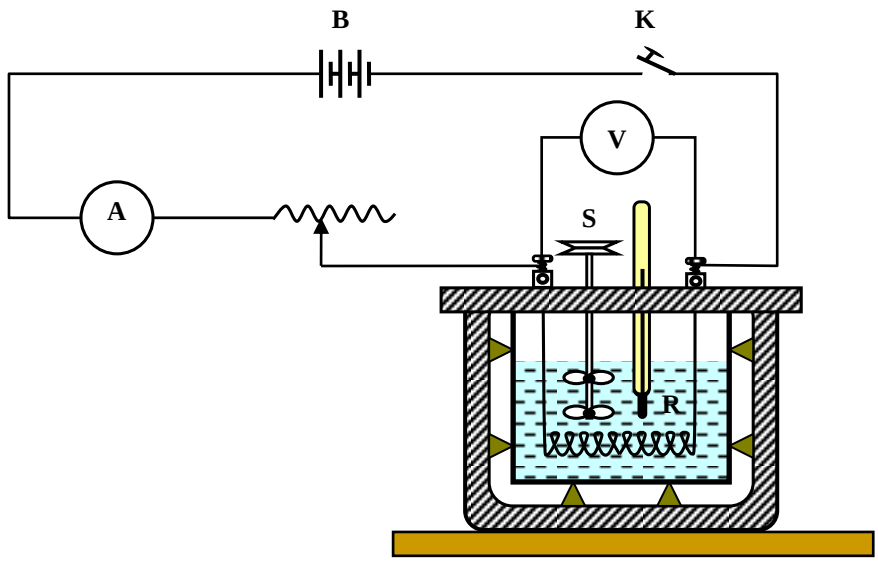

Fig. (7): Determination of specific heat of a liquid by electrical method

The liquid, whose specific heat is to be determined, is poured into the calorimeter until the coil is completely immersed in it. The mass m of the liquid taken is known by weighting the calorimeter first empty and then with the liquid.

Closing the electric circuit, the rheostat is adjusted in order to have a pretty slow rate of rise of temperature (about $\frac{1}{2}\,^{o}C$ per min.) in the calorimeter. The current is cut of and after stirring well the contents of the calorimeter, its initial temperature is noted accurately. Let it be T_1. The tap key is closed and current allowed to pass through the coil for a known time t, until there is a rise of temperature of about $5^{o}C$ the key is then released. During the current flows through the coil, the ammeter and voltmeter readings are taken every minute and the averages taken if there is any variation. Let these be I amperes and V volts.

Let T_2 be the final temperature. The electrical heat produced in calories is $\frac{IVt}{4.2}$ and the heat gained by the liquid and calorimeter is $(m_1c_1 + m_2c_2)(T_2 - T_1)$. From the conservation of energy law

$$\text{Heat produced} = \text{Heat gained}$$

$$(m_1c_1 + m_2c_2)(T_2 - T_1) = \frac{IVt}{4.2}$$

Hence the specific heat of the liquid can be calculated as

$$c_1 = \frac{IVt}{4.2m_1(T_2 - T_1)} - \frac{m_2c_2}{m_1} \qquad (10)$$

where

m_1, c_1	are the mass and the specific heat of the liquid
m_2, c_2	are the mass and the specific heat of the calorimeter.
T_1	is the initial temperature of the liquid
T_2	is the final temperature of the liquid
I	is the current flowing
V	is the potential difference across the resistance R
t	is the time in second

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