Al- mustaqbal University College
Anesthesia Techniques Department
First stage /medical physics
Third lecture by Asst. Lecturer Fatema Sattar

Measurement of Specific Heat

Objective:

To determine the specific heat of a solid sample.

Apparatus:

Calorimeter, stirrer, centigrade thermometer, boiler with heater, balance, metal sample, water.

Theory:

Heat is defined as the flow of thermal energy, and as such, has S.I. units of Joules. A quantity of heat cannot be measured directly; a measurement for the amount of

thermal energy in transit (heat) can be made by determining its effects on matter. When a substance gains heat, its total internal energy is increased, the total internal energy of a substance being defined as the sum of the potential and kinetic energies of all the molecules in the substance. Temperature is a measure of the average kinetic energy of the molecules in a substance, and the two are directly proportional. The greater the average kinetic energy of the molecules (i.e. the faster the molecules move), the greater the temperature of the substance. Thus, heat transferred to a substance increases its total internal energy, and the result is increases the average kinetic energy and temperature of its molecules.

Specific heat is the amount of heat that is required for the temperature of one unit of body mass to change by one degree Celsius, which is symbolized by (Cp), and it is measured in (joules/kg.Kelvin), and therefore specific heat varies according to different substances.

$$Cp = \Delta Q / M \Delta T \qquad \ldots\ldots 1$$

Δ=change in a variable

M= mass of the sample

Q= amount of heat

T= temperature of the substance

Cp= Specific heat

From The first law of thermodynamics tells us that thermal energy is conserved. In other words, the same amount of heat flows out of the warmer object as flows into the cooler object, or

heat lost = heat gained

In the case of the experiment, this hot object is the ball that we will heat to the degree T_2 (the one that will lose heat energy) and then we put it in a calorimeter which is simply a container that isolates substances from their environment in order to minimize any heat flow of the surroundings into or out of the system its containing a quantity of water degree, Their temperature is T_1 (since the calorimeter is isolated, only the water and the calorimeter together will gain the energy that lost by the ball) as the temperature of the ball gradually decreases and the temperature of the calorimeter and water rises until we reach the thermal equilibrium temperature. Then we can apply the principle of equilibrium as follows:

$$Q_{ball} = Q_{water} + Q_{calorimeter} \qquad \text{.....2}$$

From equation (1), equation (2) can be rewritten as follows:

$$m_b C_b (T_f - T_2) = m_w C_w (T_f - T_1) + m_c C_c (T_f - T) \qquad \text{.....3}$$

$$C_b = \frac{\mathbf{mw\ Cw\ (Tf - T1) + mc\ Cc\ (Tf - T)}}{\mathbf{mb\ (Tf - T2)}}$$

m_w: mass of water (Kg.)

C_w: the specific heat of water (J/Kg. °c)

m_c: calorimeter mass (Kg.)

C_c: the specific heat of the calorimeter (J/Kg. °c)

m_b: the mass of the ball (Kg.)