



# EXPERIMENT

## AIM

To determine specific heat of a given solid (i.e., lead shots) by method of mixtures.

## MATERIAL REQUIRED

Lead shots, copper calorimeter, copper stirrer, calorimeter insulated container and lid, hypsometer, tripod stand, burner, wire gauge, two thermometers, physical balance, weight box and fractional weights.

## THEORY

Consider a dry calorimeter which has been filled with water. The given substance is heated and placed in calorimeters. Specific heat capacity of copper material =  $s_1$

Temperature of water in calorimeter =  $\theta_1$

Temperature of solid when kept in calorimeter =  $\theta_2$

Specific heat capacity of water = 1 cal. /g °C

Mass of calorimeter (dry) =  $m_1$

Mass of calorimeter (filled with water) =  $m_2$

Mass of calorimeter with solid and water =  $m_3$

Now, mass of water filled in calorimeter =  $m_2 - m_1$

Mass of solid kept in calorimeter =  $m_3 - m_2$

If final temperature attained by calorimeter =  $\theta$ , then heat lost by solid =  $(m_3 - m_2)(\theta_2 - \theta)$

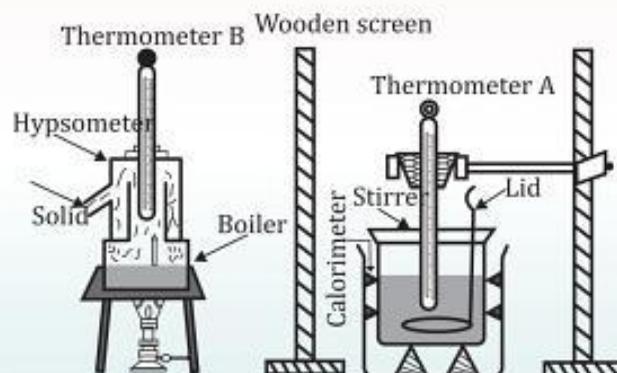
Heat gained by calorimeter and stirrer =  $m_1 s_1 (\theta - \theta_1)$

Heat gained by water in calorimeter =  $(m_2 - m_1) \times S_2 \times (\theta - \theta_1)$  [ $S_2 = 1 \text{ cal/g } ^\circ\text{C}$  for water]  
=  $(m_2 - m_1)(\theta - \theta_1)$

Heat lost by heated solid =  $(m_3 - m_2)(\theta_2 - \theta)$

Since Total heat gained = Total heat lost

$$m_1 s_1 (\theta - \theta_1) + (m_2 - m_1)(\theta - \theta_1) = (m_3 - m_2)(\theta_2 - \theta) \text{ or } s = \frac{m_1 s_1 + (m_2 - m_1)(\theta - \theta_1)}{(m_3 - m_2)(\theta_2 - \theta)}$$



Determination of specific heat of solid by method of mixture

## PROCEDURE

Label the thermometers as A and B. Read the room temperature in both, If the readings vary, label thermometer A as standard and find the correction in reading thermometer B. Record this correction to be performed while taking readings of the system using thermometer B.

1. Fill about half of the copper test tube provided in hypsometer with lead shots. Fill in the hypsometer to approximately  $\frac{2}{3}$  rd of its total length. Now place the test tube in the hypsometer.
2. Pass the thermometer A through a rubber cork and fit on the mouth of the test tube.
3. Now place the burner under tripod stand and place wire gauge over the stand. Put the hypsometer upon the wire gauge and light up the burner.
4. Now set the physical balance and check if it is in proper working condition.
5. Take the calorimeter and find its mass when dry and empty (with stirrer) and record its mass ( $m$ ).
6. Fill the calorimeter up to half of its vertical height with water and find its mass again.
7. Place the calorimeter inside its insulated chamber and insert thermometer in the provided in the lid of chamber. Record its initial temperature ( $\theta_1$ ).
8. Simultaneously with this process, keep track of reading of thermometer A, by reading after every 1 minute, till the temperature becomes steady.
9. Quickly open the rubber cork of the test tube and invert its contents into the calorimeter. Close the lid of calorimeter again.
10. Keep stirring the water in calorimeter with the help of stirrer till it attains a constant temperature ( $\theta$ ).
11. Take the calorimeter out of its chamber and weigh it again ( $m_3$ ).

## OBSERVATIONS

### Room temperature

Thermometer A = \_\_\_\_\_ °C

Correction =  $T_A - T_B =$  \_\_\_\_\_ °C

### Calorimeter masses

Load and eter + Stirrer =  $m_1 =$  \_\_\_\_\_ g.

Calorimeter + Stirrer + water =  $m_2 =$  \_\_\_\_\_ g.

Calorimeter + Stirrer + water + solid =  $m_3 =$  \_\_\_\_\_ g.

Initial temperature of water =  $\theta_1 =$  \_\_\_\_\_ °C.

Temperature of solid in hypsometer on being heated =  $\theta_2 =$  \_\_\_\_\_ °C.

Final temperature after mixing =  $\theta = \theta_2 - \theta_1 =$  \_\_\_\_\_ °C.

Specific heat of copper,  $S_1 =$  \_\_\_\_\_ cal/g°C.

## CALCULATIONS

Specific heat of solid,

$$s = \frac{m_1 s_1 + (m_2 - m_1) (\theta - \theta_1)}{(m_3 - m_2) (\theta_2 - \theta)} = \text{_____ cal. /g } ^\circ\text{C} = \text{_____ J/kg } ^\circ\text{C}$$

## RESULT

Specific heat of solid as calculated by experiment = \_\_\_\_\_ J/kg °C

## PRECAUTIONS



1. The calorimeter should be dry while taking the initial mass on physical balance.
2. The correction of temperature in thermometer B should be carefully taken.
3. Bulb of thermometer should be completely immersed in be carefully taken. case.
4. Solid should be heated in hypsometer till its temperature remains steady for a few minutes.
5. While transferring the solid to calorimeter water should not spill over.
6. The solid must be immediately transferred to the calorimeter after reading the final temperature so that heat is not lost to the surroundings.
7. Mixture should be slowly and steadily stirred to maintain temperature of the mixture constant throughout.

Physical balance should be carefully used by following all the necessary precautions.

## VIVA VOCE

**Q1. What is calorimetry?**

**Ans.** The science of measuring heat energy and its allied terms is called calorimetry.

**Q2. Relate calorie and joule.**

**Ans.** 1 calorie = 4.186 joule.

**Q3. Relate thermal capacity and specific heat capacity.**

**Ans.** Thermal capacity = mass  $\times$  specific heat capacity

**Q4. Why is calorimeter made of copper selected for experiment?**

**Ans.** Copper has a small value of specific heat capacity. So, for a given change in temperature, its temperature changes significantly and hence easily detected.

**Q5. State law of mixtures.**

**Ans.** When two substances at different temperatures are mixed, one of them loses heat and the other gains heat so that loss of heat by one is equal to gain in heat by the other.

**Q6. Give SI unit of specific heat capacity.**

**Ans.** J/kg °C.

**Q7. Why do we keep calorimeters in a wooden chamber?**

**Ans.** We keep a calorimeter in a wooden chamber so that it gets insulated from the surroundings.

**Q8. What is heat?**

**Ans.** It is the energy which produces the sensation of warmth.

**Q9. State the principle of calorimeter.**

**Ans.** Whenever substances at different temperature are mixed, there occurs an exchange the heat.

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

**Q10. Is heat gained always equal to heat lost?**

**Ans.** No, it is only correct if there is no chemical reaction that takes place between its components.