CLASS – 11

WORKSHEET- THERMAL PROPERTIES OF MATTER

A. HEAT AND CALORIMETRY

(1 Mark Questions)

1. What is heat?

2. What are the SI and CGS units of heat? How are they related?

(2 Marks Questions)

3. 0.15kg of ice at 0°C is mixed with a 0.30kg of water at 50°C in a container. Find the resultant temperature. Given the Latent heat of fusion of ice = 3.35×10^5 J/kg and c_{water} = 4200 j kg^{-1} K^{-1}.

(3 Marks Questions)

4. A brass wire 1.8m long at 27°C is held taut with little tension between two rigid supports. If the wire is cooled to a temperature of – 39°C, what is the tension developed in the wire, if its diameter is 2.0mm? Coefficient of linear expansion of brass = 2.0×10^{-5} K^{-1}, Young's modulus of brass = 0.91×10^{11} Pa.

5. A copper block of mass 2.5kg is heated in a furnace to a temperature of 500°C and then placed on a large ice block. What is the maximum amount of ice that can melt? (Specific heat of copper = 0.39 J g^{-1} $°C^{-1}$, heat of fusion of water = 335 Jg^{-1}).

6. 2 kg of ice at – 20°C is mixed with 5kg of water at 20°C in an insulating vessel having a negligible heat capacity. Calculate the final mass of water remaining in the container. It is given that the specific heats of water and the ice are 1 kcal/kg°C and 0.5 kcal/kg°C while the latent heat of fusion of ice is 80 kcal/kg.

7. A child running a temperature of 101°F is given an antipyrin (i.e. a medicine that lowers fever) which causes an increase in the rate of evaporation of sweat from his body. If the fever is brought down to 98°F in 20 min, what is the average rate of extra evaporation caused by the drug? Assume the evaporation mechanism to be the only way by which heat is lost. The mass of the child is 30kg. The specific heat of human body is approximately the same as that of water, and latent heat of evaporation of water at that temperature is about 580 cal g^{-1}. [Ans. 4.31 g min^{-1}]

B. TEMPERATURE AND THERMAL EXPANSION

(1 Mark Questions)

1. What is thermometry?

2. Define temperature.

3. State the principles of thermometer.

4. What is temperature of the triple point of water on an absolute scale whose unit interval size is equal to that of the Fahrenheit scale?

5. There is a hole in the middle of a copper plate. When heating the plate, diameter of hole would
   (a) always increase (b) always decrease
   (c) remains same (d) none of these

6. If α, β and γ are coefficients of linear, superficial and volume expansion respectively, then:
   (a) $\frac{\beta}{\alpha}=\frac{1}{2}$ (b) $\frac{\beta}{\gamma}=\frac{2}{3}$ (c) $\frac{\gamma}{\alpha}=\frac{3}{2}$ (d) $\frac{\beta}{\alpha}=\frac{\gamma}{\beta}$

7. Why iron rims are heated red hot before being put on cart wheels?

8. Two identical rectangular strips one of copper and other of steel, are riverted to form a bimetallic strip. What will happen on heating?

(2 Marks Questions)

9. Distinguish clearly between heat and temperature.

10. Why is mercury used in thermometer?

11. An object has a temperature of 50°E. What is the temperature in degrees Celsius and in Kelvin?

12. What do you mean by triple point of water? Why is it unique?

13. Two absolute scales A and B have triple point of water defined to be 200A and 350B. What is the relation between T_A and T_B?

14. A thin rod having L_0 of 0°C and coefficient of linear expansion α has its two ends maintained at temperatures θ_1 and θ_2 respectively. Find its new length.

15. A large steel wheel is to be fitted on to a shaft of the same material. At 27°C, the outer diameter of the shaft is 8.70cm and the diameter of the central hole in the wheel is 8.69cm. The shaft is cooled using ;dry ice'. At what temperature of the shaft does the wheel slip on the shaft? Assume coefficient of linear expansion of the steel to be constant over the required temperature range: α_{steel}: 1.20×10^{-5} K^{-1}.

16. Show that the coefficient of area expansions, $(\Delta A/A)/\Delta T$, of a rectangular sheet of the solid is twice its linear expansivity, α_1.

17. A steel tape 1m long is correctly calibrated for a temperature of 27.0°C. The length of a steel rod measured by this tape is found to be 63.0 cm on a hot day when the temperature is 45.0°C. What is the actual length of the steel rod on that day? What is the length of the same steel rod on a day when the temperature is 27.0°C? Coefficient of linear expansion of steel = 1.20×10^{-5}°/C? [Ans. 63.0136 m]

(3 Marks Questions)

18. In an isotropic solid, has coefficients of linear expansions, α_x, α_y and α_z for three mutually perpendicular directions in the solid, what is the coefficient of volume expansion for the solid?

19. Find out the increase in moment of inertia I of a uniform rod (coefficient of linear expansion α) about its perpendicular bisector when its temperature is slightly increased by ΔT.

20. The coefficient of volume expansion of glycerine is 49×10^{-5}°C^{-1}. What is the fractional change in its density for a 30°C rise in temperature?

21. A brass wire 1.8m long at 27°C is held taut with little tension between two rigid supports. If the wire is cooled to a temperature of – 39°C, what is the tension developed in the wire, if its diameter is 2.0mm? Coefficient of linear expansion of brass = 2.0×10^{-5}°C^{-1}, Young's modulus of brass = 0.91×10^{11} Pa. [Ans. 3.77×10^2 N]

22. What is meant by coefficient of linear expansion and coefficient of cubical expansion? Derive relationship between them.

C. HEAT TRANSFER

(1 Mark Questions)

1. For a perfectly black body, its absorptive power is
   (a) 1 (b) 0.5 (c) 0 (d) infinity

2. The unit of Stefan's constant in SI system will be
   (a) Joule/m^2s (b) Joule/m^2sK^4 (c) Joule/msK^4 (d) Joule/m^2K^4

3. Animals curl into a ball, when they feel very cold why?

4. If the temperature of a blackbody is increased from 500K to 1000K, by what factor the rate of emission of energy from it changes?

5. Pieces of copper and glass are heated to the same temperature. Why does the piece of copper feel hotter on touching?

6. Why it is much hotter above a fire than by its side?

7. How can one determined the surface temperature of the stars?

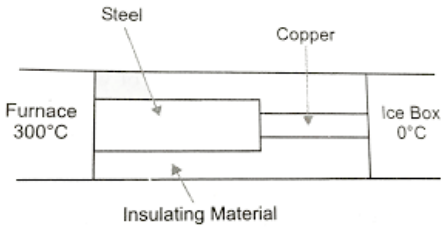
8. What are the basic requirements of a cooking utensils in respect of specific heat, thermal conductivity?

(2 Marks Questions)

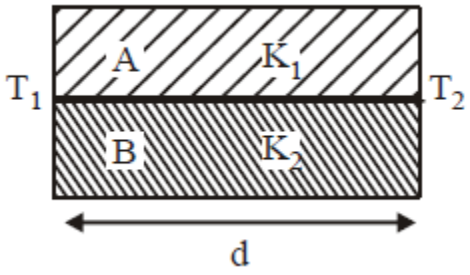
9. Draw experimental curves between wavelength λ and intensity of radiation $E\lambda$ emitted by a black body maintained at different constant temperatures.

10. What is the temperature of the steel-copper junction in the steady state of the system shown in the figure. Length of the steel rod = 15.0cm, length of the copper rod = 10.0cm, temperature of the furnace = 300°C, temperature of the other end = 0°C. The area of

cross section of the steel rod is twice that of the copper rod. (Thermal conductivity of steel = 50.2 Js^{-1} m^{-1} K^{-1} and of copper = 385Js^{-1} m^{-1} K^{-1})



11. Two rods A and B of different materials are welded together as shown in the figure. Their thermal conductivities are K_1 and K_2. Find the thermal conductivity of the composite rod.



(3 Marks Questions)

12. Explain briefly the anomalous expansion of water. How the fishes can survive in extreme winter when lake ponds are frozen?

13. A pan filled with hot food cools from 94°C to 86°C in 2 minutes, when the room temperature is 20°C, How long will it take to cool from 70°C to 69°C?

14. A body cools in 7 minutes from 60°C to 40°C. What will be the temperature of the body after next 7 minutes? The temperature of the surroundings is 10°C. Assume that Newton's law of cooling holds good throughout the process.

15. A 'thermocole' carbicoal icebox of side 30cm has a thickness of 5.0cm. If 4.0 kg of ice are put in the box, estimate the amount of ice remaining after 6h. The outside temperature is 45°C and coefficient of thermal conductivity of thermocle = 0.01 Js^{-1} m^{-1}° C^{-1}. Given heat of fusion of water = 335×10^3 Jkg^{-1}. [Ans. 3.687 kg]

16. A brass boiler has a base area of 0.15 m^2 and thickness 1.0cm.It boils water at a\the rate of 6.0 kg min^{-1}, when placed on a glass stove. Estimate the temperature of the part of the

flame in contact with the boiler. Thermal conductivity of brass = 109 Js^{-1} m^{-1} C^{-1} and heat of vaporization of water = 2256 Jg^{-1}. [Ans. 238°C]

(5 Marks Questions)

17. State Newton's law of cooling. Derive mathematical expression for it.

18. In an experiment on the specific heat of a metal, a 0.20kg of the metal at 150°C is dropped in a copper calorimeter (of water equivalent 0.025 kg) containing 150 cm^3 of water at 27°C. The final temperature is 40↑8C. Compute the specific heat of the metal.
[Ans. 0.1 cal g^{-1} C° C^{-1}]