IMPORTANT QUESTIONS CLASS – 11 PHYSICS CHAPTER – 10 THERMAL PROPERTIES OF MATTER

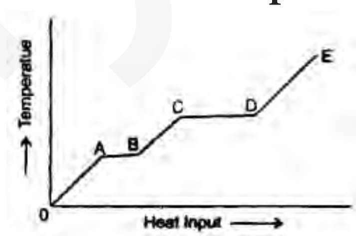
Question 1.
Why gas thermometers are more sensitive than mercury thermometers?

Answer:
This is because the coefficient of expansion of a gas is very large as compared to the coefficient of expansion of mercury. For the same temperature change, the gas would undergo a much larger change in volume as compared to mercury.

Question 2.
Why the brake drum of an automobile gets heated up when the automobile moves down a hill at constant speed?

Answer:
Since the speed is constant so there is no change of kinetic energy. The loss in gravitational potential energy is partially the gain in the heat energy of the brake drum.

Question 3.
A solid is heated at a constant rate. The variation of temperature with heat input is shown in the figure here:



(a) What is represented by AB and CD?

Answer:
The portions AB and CD represent a change of state. This is because the supplied heat is unable to change the temperature. While AB represents a change of state from solid to liquid, the CD represents a change of state from liquid to vapour state.

(b) What conclusion would you draw1 if CD = 2AB?

Answer:
It indicates that the latent heat of vaporization is twice the latent heat of fusion.

(c) What is represented by the slope of DE?

Answer:
Slope of DE represents the reciprocal of the thermal or heat capacity of the substance in vapour state i.e. slope of DE = dTdQ=1mC(∴ dQ = mCΔT).

(d) What conclusion would you draw from the fact that the slope of OA is greater than the slope of BC?
Answer:
Specific heat of the substance in the liquid state is greater than that in the solid-state as the slope of OA is more than that of BC i.e. 1mC1 > 1mC2 where C_1, C_2 are specific heats mC_1 mC_2 of the material in solid and liquid state respectively.

Question 4.
Define:
(a) Thermal conduction.

Answer:
It h defined as the process of the transfer of heat energy from one part of a solid. to another part at a lower temperature without the actual motion of the molecules. It is also called the conduction of heat.

(b) Coefficient of thermal conductivity of a material.

Answer:
It is defined as the quantity of heat flowing per second across the opposite faces of a unit cube made of that material when the opposite faces are maintained at a temperature difference of 1K or 1°C.

Question 5.
On what factors does the amount of heat flowing from the hot face to the cold face depend? How?

Answer:
If Q is the amount of heat flowing from hot to the cold face, then it is found to be:

1. directly proportional to the cross-sectional area (A) of the face
   i. e. Q ∝ A ...(1)
2. directly proportional to the temperature difference between the two faces, i.e. Q ∝ Δθ ....(2)
3. directly proportional to the time t for which the heat flows i.e. Q ∝ t .... (3)
4. inversely proportional to the distance 'd' between the two faces
   i.e. Q ∝ 1Δx ...(4)

Combining factors (1) to (4), we get

$Q \propto A\Delta\theta\Delta xt$

or

$Q \propto K\,A\,\Delta\theta\Delta xt$

where K is the proportionality constant known as the coefficient – of thermal conductivity.

Question 6.

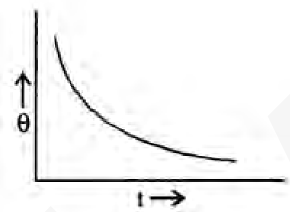
State Newton's law of cooling and define the cooling curve. What is its importance?

Answer:

Newton's law of cooling: States that the rate of loss of heat per unit surface area of a body is directly proportional to the temperature difference between the body and the surroundings provided the difference is not too large.

Cooling Curve: It is defined as a graph between the temperature of a body and the time. It is as shown in the figure here.

The slope of the tangent to the curve at any point gives the rate of fall of temperature.



Question 7.

Explain why heat is generated continuously in an electric heater but its temperature becomes constant after some time?

Answer:

When the electric heater is switched on, a stage is quickly reached when the rate at which heat is generated by an electric current becomes equal to the rate at which heat is lost by conduction, convection and radiation and hence a thermal equilibrium is established. Thus temperature becomes constant.

Question 8.

Specific heats of argon at constant pressure and volume are 0.125 cal g^{-1} and 0.075 cal g^{-1} respectively. Calculate the density of argon at N.T.P. (J = 4.18 × 10^7 ergs/cal and normal pressure = 1.01 × 10^6 dynes cm^{-2}.)

Answer:

Here, CP = 0.125 cal g^{-1}

Cv = 0.075 cal g^{-1} J

J = 4.18 × 107 ergs cal^{-1}

P = 1.01 × 106 dyne cm^{-2}

d = density at NTP = ?
m = 1 g
T = 273 K

Using the relation,
$C_p - C_v$ = rJ=PVTJ=PmdTJ (∵ V = md)
d = Pm TJ(Cr−Cv)

$$= \frac{1.01\times10^6\times1}{273\times4.18\times10^7\times(0.125-0.075)}$$
$$= \frac{1.01\times10^6}{273\times4.18\times10^7\times0.050}$$
$$= 0.00177\ g/cc = 1.77\ g\ litre^{-1}.$$

Question 9.
A piece of metal weighs 46 g in air. When it is immersed in a liquid of specific gravity 124 at 27°C, it weighs 30g. When the temperature of the liquid is raised to42°C, the metal piece weighs 30.5 g. The specific gravity of the liquid at 42°C is 1.20. Calculate the coefficient of linear expansion of the metal.

Answer:
Here, the Weight of the metal piece at 27°C in air 46 g
Weight of metal piece at 27°C in liquid =30 g
Weight of metal piece at 42°C in liquid = 30.5 g
α =?
Loss in weight of the metal = weight of liqiid displaced = 46 – 30
= 16 g.

The volume of metal at 27°C = Volume of liquid displaced at 27°C
or
V1 = 16g specific gravity of liquid
= 16 g1.24gcm−3
= 12.903 cm3

Similarly volume of metal piece at 42°C = V_2 = (46−30.5)1.2gcm−3
= 12.917 cm^3

∴ Coefficient of cubical expansion of the metal $$\gamma = \frac{V_2 - V_1}{V_1(\theta_2 - \theta_1)}$$

$$= \frac{(12.917 - 12.903)cm^3}{12.903\times(42-27)cm^3\,^\circ C}$$
$$= 7.23\times10^{5}\,^\circ C^{-1}$$

Since γ = 3α
∴ α = 13 γ = 13 × 2.41 × 10^5 $°C^{-1}$
= 0.803 × 10^5 $°C^{-1}$

Question 10.
In an industrial process, 10 kg of water per hour is to be heated from 20°C to 80°C. To do so, steam at 150°C is passed from a boiler into a copper coil immersed in water. The steam condenses in the coil and is returned to the boiler as water at 90°C. How many kg of steam is required per hour? Specific heat of steam = 1 Kcal kg^{-1} $°C^{-1}$ and latent heat of steam = 540 Kcal kg^{-1}.

Answer:
C = sp. heat of steam
= 1 Kcal kg^{-1} $°c^{-1}$

L = latent heat of steam
= 540 Kcal kg^{-1}

Let m (kg) = mass of steam required per hour.

Heat is given by steam first from 150°C to steam at 100°C = $mC\Delta\theta$
= m × (150 – 100)Kcal = 50 m Kcal.

Then steam changes from steam at 100°C to water at 100°C and gives out heat = mL = 540 m Kcal.

After this water at 100°C gives heat is going to temperature 90°C = m (100 – 90) = 10m Kcal.

Total amount of heat given by the steam = 50 m + 540 m + 10 m = 600 m Kcal.
∴ 600 m K cal = 600 K cal
∴ m = 1 kilogram.