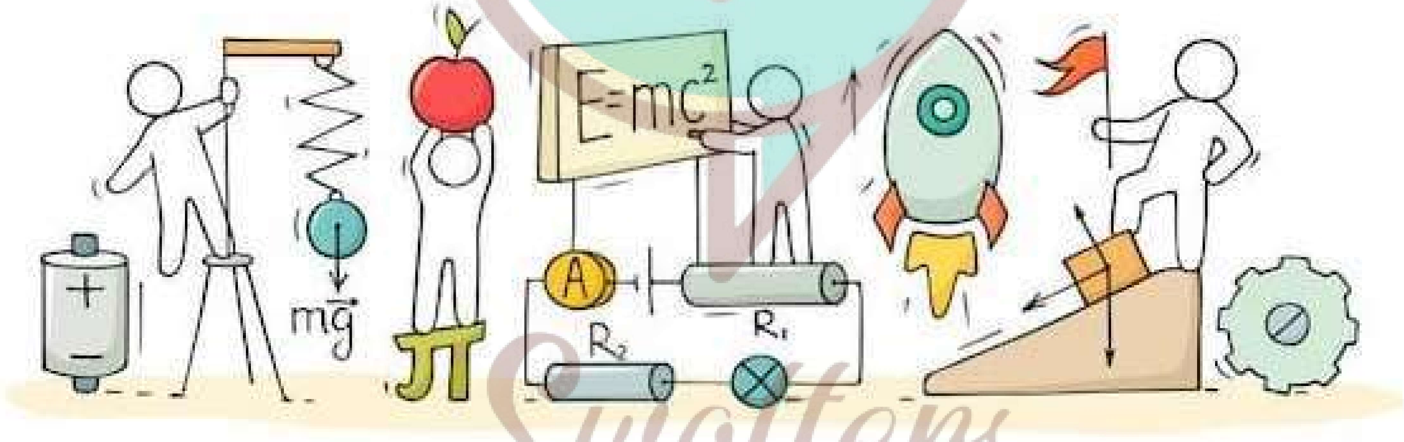
PHYSICS

Chapter 11: Thermal Properties of Matter



Important Questions

Multiple Choice questions-

Question 1. Two stars A and B radiate maximum energy at 3600°A and 3600°A respectively. Then the ratio of absolute temperatures of A and B is

(a) 256 : 81

(b) 81 : 256

(c) 3 : 4

(d) 4 : 3

Question 2. Which of the following will radiate heat to large extent?

(a) Rough surface

(b) Polished surface

(c) Black rough surface

(d) Black polished surface

Question 3. Two spheres made of same material have radii in the ratio 2 : 1. if both the spheres are at same temperature, then what is the ratio of heat radiation energy emitted per second by them?

(a) 1 : 4

(b) 4 : 1

(c) 3 : 4

(d) 4 : 3

Question 4. The earth intercepts approximately one billionth of the power radiated by the sun. if the surface temperature of the sun were to drop by a factor of 2, the average radiant energy incident on earth per second would reduce by factor of

(a) 2

(b) 4

(c) 8

(d) 16

Question 5. A bucket full of hot water is kept in a room and it cools from 75°C to 70°C in t1 minutes from 70°C to 65°C in t2 minutes and from 65°C to 60°C in t3 minutes; then

(a) t1 – t2 = t3

(b) t1 < t2 < t3

(c) t1 > t2 > t3

(d) t1 < t2 > t3

Question 6. A sphere, a cube and a thin circular plate, all made of the same material and having the same mass are initially heated to a temperature of 3000°K, which of these will cool fastest?

(a) Sphere

(b) Cube

(c) Plate

(d) None

Question 7.A perfectly black body emits radiation at temperature T^1K. if it sis to radiate 16 times this power, its temperature T^2. will be

(a) $T^2 = 16 T^1$

(b) $T^2 = 8 T^1$

(c) $T^1 = 4 T^1$

(d) $T^2 = 2 T^1$

Question 8. Unit of Stefans constant is given by

(a) $W/ m K^2$

(b) $W/ m^2 K^2$

(c) $W^2/ m^2 K^4$

(d) W/ mK

Question 9. The good absorber of heat are

(a) Non-emitter

(b) Poor-emitter

(c) Good-emitter

(d) Highly polished

Question 10.A black body is at a temperature of 500K. it emits energy at a rate which is proportional to

(a) 500

(b) (500)2

(c) (500)3

(d) (500)4

Very Short:

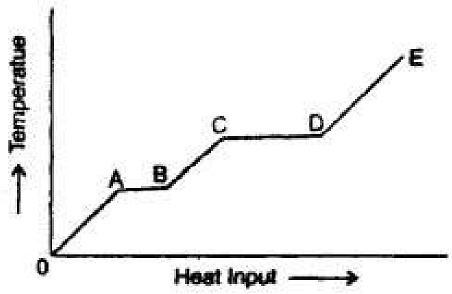
1. The fact that the triple point of a substance is unique is used in modern thermometry. How?
2. Is it possible for a body to have a negative temperature on the Kelvin scale? Why?
3. (a) Why telephone wires are often given snag?

   (b) The temperature of a gas is increased by 8°C. What is the corresponding change on the Kelvin scale?
4. There is a hole in a metal disc. What happens to the size of the hole if the metal disc is heated?
5. Milk is poured into a cup of tea and is mixed with a spoon. Is this an example of a reversible process? Why?
6. The top of a lake is frozen. Air ¡n contact with it is at -15°C. What do you expect the maximum temperature of water in contact with the lower surface ice? What do you expect the maximum temperature of water at the bottom of the lake?
7. How does the heat energy from the sun reaches Earth?
8. Why does not the Earth become as hot as the Sun although it has been receiving heat from the Sun for ages?
9. Why felt rather than air is employed for thermal insulation?
10. What are the three modes of transmission of heat energy from one point to another point?
11. Why a thick glass tumbler cracks when boiling liquid is poured into it?
12. What is the basic principle of a thermometer?
13. Out of mass, radius and volume of a metal ball, which one suffers maximum and minimum expansion on heating? Why?
14. The higher and lower fixed points on a thermometer are separated by 160 mm. If the length of the mercury thread above the lower point is 40 mm, then what is the temperature reading?
15. Two thermometers are constructed in the same way except that one has a spherical bulb and the other an elongated cylindrical bulb. Which of the two will respond quickly to temperature changes.

Short Questions:

1. Why gas thermometers are more sensitive than mercury thermometers?
2. Why the brake drum of an automobile gets heated up when the automobile moves down a hill at constant speed?

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?

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

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

(d) What conclusion would you draw from the fact that the slope of OA is greater than the slope of BC?

4. Define:

(a) Thermal conduction.

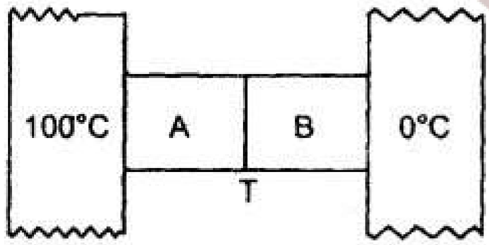
(b) Coefficient of thermal conductivity of a material.

5. On what factors does the amount of heat flowing from the hot face to the cold face depend? How?
6. State Newton's law of cooling and define the cooling curve. What is its importance?
7. Explain why heat is generated continuously in an electric heater but its temperature becomes constant after some time?
8. A woollen blanket keeps our body warm. The same blanket if wrapped around ice would keep ice cold. How do you explain this apparent paradox?
9. A liquid is generally heated from below. Why?
10. If a drop of waterfalls on a very hot iron, it does not evaporate fora long time. Why?
11. On a hot day, a car is left in sunlight with all the windows closed. After some time, it is found that the inside of the car is considerably warmer than the air outside. Explain why?
12. It takes longer to boil water with a flame in a satellite in gravitational field-free space, why? How it will be heated?
13. Find γ for polyatomic gas and hence determine its value for a triatomic gas in which the molecules are linearly arranged.
14. Food in a hot case remains warm for a long time during winter, how?

15. You might have seen beggars sleeping on footpaths or in open in winter with their hands and knees pulled inside. Similarly dogs too curl while sleeping in winter. How does such action help anybody?

Long Questions:

1. Calculate the increase in the temperature of the water which falls from a height of 100 m. Assume that 90% of the energy due to fall is converted into heat and is retained by water. J = 4.2 J cal^{-1}.
2. A clock with a steel pendulum has a time period of 2s at 20°C. If the temperature of the clock rises to 30°C, what will be the gain or loss per day? The coefficient of linear expansion of steel is 1.2×10^{-5} C^{-1}
3. The thermal conductivity of brick is 1.7 W m^{-1} K^{-1} and that – of cement is 2.9 W m^{-1} K^{-1}. What thickness of cement will have the same insulation as the brick of thickness 20 cm.
4. Two metal cubes A and B of the same size are arranged as shown in the figure. The extreme ends of the combination are maintained at the indicated temperatures. The arrangement is thermally insulated. The coefficient of thermal conductivity of A and B are 300 W/m°C and 200 W/m°C respectively. After a steady-state is reached, what will be the temperature of the interface?



5. The heat of combustion of ethane gas is 373 Kcal per mole. Assuming that 50% of heat is lost, how many litres of ethane measured at STP must be burnt to convert 50 kg of water at 10°G to steam at 100°C? One mole of gas occupies 22.4 litres at S.T.P. Latent heat (L) of steam = 2.25 × 106 JK^{-1}.

Assertion Reason Questions:

1. **Directions:** Each of these questions contain two statements, Assertion and Reason. Each of these questions also has four alternative choices, only one of which is the correct answer. You have to select one of the codes (a), (b), (c) and (d) given below.

   (a) If both assertion and reason are true and the reason is the correct explanation of the assertion.
   (b) If both assertion and reason are true but reason is not the correct explanation of the assertion.

(c) If assertion is true but reason is false.
(d) If the assertion and reason both are false.

Assertion: Specific heat capacity is the cause of formation of land and sea breeze.
Reason: The specific heat of water is more than land.

2. **Directions:** Each of these questions contain two statements, Assertion and Reason. Each of these questions also has four alternative choices, only one of which is the correct answer. You have to select one of the codes (a), (b), (c) and (d) given below.

   (a) If both assertion and reason are true and the reason is the correct explanation of the assertion.
   (b) If both assertion and reason are true but reason is not the correct explanation of the assertion.
   (c) If assertion is true but reason is false.
   (d) If the assertion and reason both are false.

Assertion: A brass disc is just fitted in a hole in a steel plate. The system must be cooled to loosen the disc from the hole.
Reason: The coefficient of linear expansion for brass is greater than the coefficient of linear expansion for steel.

✓ Answer Key:

Multiple Choice Answers-

1. Answer: (d) 4 : 3
2. Answer: (c) Black rough surface
3. Answer: (b) 4 : 1
4. Answer: (d) 16
5. Answer: (b) t1 < t2 < t3
6. Answer: (c) Plate
7. Answer: (d) $T^2 = 2$ T1
8. Answer: (b) W/ m^2 K^2
9. Answer: (c) Good-emitter
10. Answer: (d) (500)4

Very Short Answers:

1. Answer: In modern thermometry, the triple point of water is a standard fixed point.
2. Answer: No. Because absolute zero of temperature is the minimum possible temperature on the Kelvin scale.

3. Answer: (a) It is done to allow for safe contraction in winter.

   (b) 8 K.
4. Answer: The size of the hole increases on heating the metal disc.
5. Answer: No. When milk is poured into tea, some work is done which is not recoverable. So the process is not reversible.
6. Answer: 0°C, 4°C.
7. Answer: It reaches by radiation.
8. Answer: Earth loses heat by convection and radiation.
9. Answer: In the air, loss of heat by convection is possible. But convection currents cannot be set up in felt.
10. Answer: Conduction, Convection and Radiation.
11. Answer: Its inner and outer surfaces undergo uneven expansion due to the poor conductivity of glass, hence it cracks.
12. Answer: The variation of some physical property of a substance with temperature constitutes the basic principle of the thermometer.
13. Answer: Volume and radius suffer maximum and minimum expansions respectively as $\gamma = 3\alpha$.
14. Answer: The temperature reading = $\frac{100\times40}{160} = 25$.
15. Answer: The thermometer with a cylindrical bulb will respond quickly as the area of the cylindrical bulb is greater than the area of the spherical bulb.

Short Questions Answers:

1. 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.
2. 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.
3. Answer: (a) 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) It indicates that the latent heat of vaporisation is twice the latent heat of fusion.

   (c) Slope of DE represents the reciprocal of the thermal or heat capacity of the substance in vapour state i.e. slope 0f DE $= \frac{dT}{dQ} = \frac{1}{mC} (\because\ dQ = mC\Delta T)$.

   (d) 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. $\frac{1}{mC_1} > \frac{1}{mC_2}$ where C_1, C_2 are specific heats mC_1 mC_2 of the material in solid and liquid state respectively.

4. Answer: (a) 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) 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.

5. 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. $Q \propto A$ ...(1)
   2. directly proportional to the temperature difference between the two faces, i.e. $Q \propto \Delta\theta$ ....(2)
   3. directly proportional to the time t for which the heat flows i.e. $Q \propto t$ .... (3)
   4. inversely proportional to the distance 'd' between the two faces.

      i.e. $Q \propto \frac{1}{\Delta x}$ ...(4)

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

   $$Q \propto \frac{A\Delta\theta}{\Delta x} t$$

   or

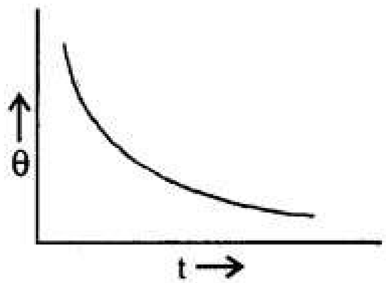
   $$Q \propto K A \frac{\Delta\theta}{\Delta x} t$$

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

6. 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.



7. 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.
8. Answer: Wool is a bad conductor of heat. Moreover wool encloses air in it which is a bad conductor. There can also be no loss of heat by convection. The woollen blanket keeps us warm by preventing the heat of the human body to flow outside and hence our body remains warm.
9. Answer: When a liquid is heated, it becomes rarer due to a decrease in density and it rises up. Liquid from the upper part of the vessel comes down to take its place and thus convection currents are formed. If the liquid is heated at the top, no such convection currents will be formed and only the liquid in the upper part of the vessel will become hot. However, the temperature in the lower part of the vessel will rise slightly due to a small amount of heat conducted by the hot liquid in the upper part of the vessel.
10. Answer: When a drop of waterfalls on a very hot iron, it gets insulated from the hot iron due to the formation of a thin layer of water vapour, which is a bad conductor in nature. It takes quite a long to evaporate as heat is conducted from hot iron to the drop through the layer of water vapour very slowly.

    On the other hand, if a drop of waterfalls on an iron which is not very hot, then it comes in direct contact with the iron and evaporates immediately.
11. Answer: Glass possesses the property of selective absorption of heat radiation. It also transmits about 50% of heat radiation coming from a hot source like the sun and is more or less opaque to the radiation from moderately hot bodies (at about 100°C or so). Due to this, when a car is left in the sun, heat radiation from the sun gets into the car but as the temperature inside the car is moderate, it cannot escape through its windows. Thus glass windows of the car trap the sun rays and because of this, the inside of the car becomes considerably warmer.
12. Answer: Water boils with flame by the process of convection. Hot lighter particles raise up and heavier particles move down under gravity. In. a gravity-free space in the satellite, the particles cannot move down hence, water can't be heated by convection.

    It will be heated by conduction.
13. Answer: The energy of a polyatomic gas having n degrees of freedom is given by

$$E = n \times \frac{1}{2}kT \times N = \frac{n}{2}RT$$

$$\therefore \quad C_V = \frac{dE}{dT} = \frac{n}{2}R$$

$$\therefore \quad C_P = C_V + R = \frac{n}{2}R + R$$

$$= \left(\frac{n}{2}+1\right)R$$

$$\therefore \quad \gamma = \frac{C_P}{C_V} = \frac{\frac{n}{2}+1}{\frac{n}{2}} = 1 + \frac{2}{n}$$

In case of a triatomic gas, n = 7

$$\therefore \gamma = 1 + \frac{2}{7} = \frac{9}{7}.$$

14. Answer: The hot case is a double-walled vessel. The space between the walls is evacuated in a good hot case. The food container placed inside the hot case is made of crowning steel, thus neither the outside low-temperature air can enter the container nor the heat from inside can escape through the hot case by conduction or convection. The highly polished shining surface of the food container helps in stopping loss of heat due to radiation. Thus, the heat of the food is preserved for a long time and food remains hot in winter.

15. Answer: The heat radiated or emitted from a body at a given temperature depends on

    1. the temperature difference between the body and the surrounding,
    2. area of the body in contact with the surroundings and
    3. the nature of the body.

    For man and animals in winter (1) and (2) factors remain what they are. So, in order to preserve, their body heat they curl up to reduce the surface area in contact with cold air.

Long Questions Answers:

1. Answer: Here, h = 100 m

   Let m (kg) = mass of water

   ∴ Its P.E. at a height h = mgh

   Energy of fall retained by water i.e. useful work done is given by,

   W = 90% of mgh

   $$= \frac{900}{100}mgh$$

$= \frac{90}{100} \text{m} \times 9.8 \times 100$

$= 882 \text{ m J.}$

∴ Heat retained, $Q = WJ = \frac{m \times 882J}{4.2J\ cal^{-1}}$

= m × 210 cal ...(i)

Specific heat of water C = 10 cal kg^{-1} $°C^{-1}$

Let Δθ (°C) be the rise in the temperature of water.

∴ Heat gained, Q = mCΔθ

.= m × 10^3 × Δθ

= m × Δθ × 10^3 cal …. (ii)

∴ From (1) and (ii), we get

m × 210 = m × Δθ × 10^3

or

$\Delta\theta = \frac{210}{10^3} = 0.21°\text{C.}$

2. Answer: Here α = 1.2 × 10^{-1} $°C^{-1}$

Δt = 30 – 20= 10°C

T = 2s.

Using the relation, Δl = l α Δt, we get

$\frac{\Delta l}{l} = \alpha \Delta t$

= 1.2 × 10^{-5} × 10 = 1.2 × 10^{-4} …. (i)

$\therefore\ T = 2\pi\sqrt{\frac{l}{g}} \ldots (ii)$

If T' be the time period of the pendulum, when l increases by Δl, then

$$T' = 2\pi\sqrt{\frac{l+\Delta l}{g}}$$

$$= 2\pi\sqrt{\frac{l}{g}\left(1+\frac{\Delta l}{l}\right)} \quad \text{.... }(iii)$$

$\frac{(iii)}{(ii)}$ gives $\frac{T'}{T} = \sqrt{1+\frac{\Delta l}{l}} = \sqrt{1+1.2\times10^{-4}}$

∴ loss in time in one oscillation T' – T

Hence loss in time in one day is given by

$$= \frac{T'-T}{T} \times 24 \times 3600 \text{ s}$$

$$= \left(\frac{T'}{T}-1\right) \times 24 \times 3600 \text{ s}$$

$$= \left[\sqrt{1+1.2\times10^{-4}}-1\right] \times 24 \times 3600\text{s}$$

$$= \left[1+\frac{1}{2}\times1.2\times10^{-4}-1\right]\times24\times3600\text{s}$$

$$= \frac{1.2\times10^{-4}\times24\times3600}{2}\text{s}$$

$$= 5.18 \text{ s.}$$

3. Answer: Here, KB = 1.7 W m^{-1} K^{-1}

   KC = 2.9 W m^{-1} K^{-1}

   dB = 20 cm

   dc = ?

   We know that the heat flow is given by

   Q = KA $\frac{\Delta\theta}{d}t$

   For the same insulation by the brick and the cement, Q, A, Δθ and t don't change

   Thus $\frac{K}{d}$ should be a constant.

$$i.e. \quad \frac{K_B}{d_B} = \frac{K_C}{d_C}$$

$$\text{or} \quad d_C = \frac{K_C}{K_B} \times d_B$$

$$= \frac{2.9}{1.7} \times 20 = 34.12 \text{ cm.}$$

4. Answer: Let T (°C) be the temperature of the interface =?

   Here, $K_1 = 300$ Wm^{-1} $°C^{-1}$ for A

   $K_2 = 200$ Wm^{-1} $°C^{-1}$ for B

   ∴ $\Delta\theta_1 = 100 - T$ for A

   $\Delta\theta_2 = T - 0$ for B .

   x = size of each cube A and B

   ∴ $x_1 = x_2 = x$

   Let a = area of cross-section of the faces between which there is the flow of heat

   If $\left(\frac{\Delta Q_1}{\Delta t}\right)_A$ and $\left(\frac{\Delta Q_2}{\Delta t}\right)_B$ be the rate of low of heat for A and B respectively, then in steady state,

$$\left(\frac{\Delta Q_1}{\Delta t}\right)_A = \left(\frac{\Delta Q_2}{\Delta t}\right)_B$$

$$\text{or} \quad \frac{K_1 a \Delta\theta_1}{x} = \frac{K_1 a \Delta\theta_2}{x} \quad \left(\because \Delta Q = K\frac{\Delta\theta}{d} at\right)$$

$$\text{or} \quad K_1\Delta\theta_1 = K_2\Delta\theta_2$$

$$\text{or} \quad 300(100 - T) = 200(T - 0)$$

$$\text{or} \quad (300 + 200)T = 30000$$

$$\text{or} \quad T = \frac{300 \times 100}{500}$$

$$\therefore \quad T = 60°C.$$

5. Answer: Here

   L = 2.25 × 106 JK^{-1}

   $= \frac{2.25}{4.2} \times 106$ cal$°C^{-1}$

   Q = Heat of Combustion

   = 373 × 103 Cal/mole

   C = 103 J Kg^{-1} $°C^{-1}$

   m = 50 kg

$\Delta\theta = 100 - 10 = 90°C$

V = 22.4 litres

If Q_1 = Total heat energy required to convert 50 kg of water at 10°C to steam at 100°C

$Q_1 = mC\Delta\theta + mL$

$= 5.0 \times 1000 \times 90 + 50 \times \frac{2.25\times10^6}{4.2}$

= 4.5 × 106 + 26.79 × 106

= 31.29 × 106 cal

As 50% of heat is lost,

∴ total heat produced $= \frac{100}{50} \times 3.129 \times 106$

Let n = no. of moles of ethane to be burnt, then

$n = \frac{2\times31.29\times10^6}{373\times10^3}$ mole

∴ Volume of ethane = nV

$$= \frac{2\times31.29\times10^6}{373\times10^3} \times 22.4 \text{ litres}$$

= 3758.2 litres.

Assertion Reason Answer:

1. (a) If both assertion and reason are true and the reason is the correct explanation of the assertion.
2. (a) If both assertion and reason are true and the reason is the correct explanation of the assertion.

Case Study Questions-

1. we can say that heat is the form of energy transferred between two (or more) systems or a system and its surroundings by virtue of temperature difference. The SI unit of heat energy transferred is expressed in joule (J) while SI unit of temperature is Kelvin (K), and degree Celsius (^{0}C) is a commonly used unit of temperature. When an object is heated, many changes may take place. Its temperature may rise; it may expand or change state. A measure of temperature is obtained using a thermometer. Many physical properties of materials change sufficiently with temperature. Some such properties are used as the basis for constructing thermometers. The two familiar temperature scales are the Fahrenheit temperature scale and the Celsius temperature scale. The ice and steam point have values 32 °F and 212 °F, respectively, on the Fahrenheit scale and 0 °C and 100 °C on the Celsius scale. On the Fahrenheit scale, there are 180 equal intervals between two reference points, and on the Celsius scale, there are 100. A relationship for converting between the two scales may be obtained from a graph of Fahrenheit

temperature (t_F) versus Celsius temperature (t_C) in a straight line. When temperature is held constant, the pressure and volume of a quantity of gas are related as PV = constant. This relationship is known as Boyle's law. When the pressure is held constant, the volume of a quantity of the gas is related to the temperature as V/T = constant. This relationship is known as Charles' law. Low-density gases obey these laws, which may be combined into a single relationship. PV = μRT where, μ is the number of moles in the sample of gas and R is called universal gas constant: R = 8.31 J mol^{-1} K^{-1} we have learnt that the pressure and volume are directly proportional to temperature: PVαT. This relationship allows a gas to be used to measure temperature in a constant volume gas thermometer. The absolute minimum temperature for an ideal gas at which pressure becomes zero is found to be – 273.15°C and is designated as absolute zero. Absolute zero is the foundation of the Kelvin temperature scale or absolute scale temperature. The size of unit in Kelvin and Celsius temperature scales is the same. So, temperature on these scales are related by $T = t_c + 273.15$

i. The SI unit of heat energy transferred is expressed in
   a. Joule (J)
   b. Kelvin (K)
   c. Newton (N)
   d. None of these
ii. Temperature is measured using
   a. Thermometer
   b. Barometer
   c. Tachometer
   d. None of these
iii. Relation between Kelvin (T) and Celsius temperature (t_c) scale is given by
   a. $T = t_c + 273.15$
   b. $T = t_c – 273.15$
   c. $T = t_c$
   d. None of these
iv. What is heat energy
v. What is absolute zero temperature

2. A system is said to be isolated if no exchange or transfer of heat occurs between the system and its surroundings. When different parts of an isolated system are at different temperature a quantity of heat transfers from the part at higher temperature to the part at lower temperature. The heat lost by the part at higher temperature is equal to the heat gained by the part at lower temperature. Calorimetry means measurement of heat. When a body at higher temperature is

brought in contact with another body at lower temperature, the heat lost by the hot body is equal to the heat gained by the colder body, provided no heat is allowed to escape to the surroundings. A device in which heat measurement can be done is called a calorimeter. It consists of a metallic vessel and stirrer of the same material, like copper or aluminium. The vessel is kept inside a wooden jacket, which contains heat insulating material. Matter normally exists in three states: solid, liquid and gas. A transition from one of these states to another is called a change of state. Two common changes of states are solid to liquid and liquid to gas (and, vice versa). These changes can occur when the exchange of heat takes place between the substance and its surroundings. The change of state from solid to liquid is called melting and from liquid to solid is called fusion. It is observed that the temperature remains constant until the entire amount of the solid substance melts. That is, both the solid and the liquid states of the substance coexist in thermal equilibrium during the change of states from solid to liquid. The temperature at which the solid and the liquid states of the substance is in thermal equilibrium with each other is called its melting point. The change of state from liquid to vapour (or gas) is called vaporisation. It is observed that the temperature remains constant until the entire amount of the liquid is converted into vapour. That is, both the liquid and vapour states of the substance coexist in thermal equilibrium, during the change of state from liquid to vapour. The temperature at which the liquid and the vapour states of the substance coexist is called its boiling point. The change from solid state to vapour state without passing through the liquid state is called sublimation, and the substance is said to sublime. Dry ice (solid CO2) sublimes, so also iodine. During sublimation both the solid and vapour states of a substance coexist in thermal equilibrium.

i. Device used for measurement of heat is
   a. Calorimeter
   b. Thermometer
   c. Both a and b
   d. No one of these
ii. The change of state from solid to liquid is called
   a. Melting
   b. Vaporization
   c. Sublimation
   d. None of these
iii. Define melting point and boiling point
iv. What is sublimation?
v. Define fusion process

Case Study Answer-

1. Answer

i. (a) Joule (J)

ii. (a) Thermometer

iii. (a) $T = t_c + 273.15$

iv. Heat energy is the form of energy transferred between two or more systems or its surroundings due to temperature difference from higher temperature to lower temperature. The SI unit of heat energy transferred is expressed in joule (J).

v. The absolute minimum temperature for an ideal gas at which pressure becomes zero is found to be – 273.15 °C and is designated as absolute zero temperature. This is lowest temperature possible for ideal gas.

2. Answer

i. (a) Calorimeter

ii. (a) Melting

iii. The change of state from solid to liquid is called melting process and temperature at which conversion of solid into liquid happens is called as melting point.
The temperature at which the liquid and the vapour states of the substance coexist is called its boiling point.

iv. The change from solid state directly into vapour state without passing through the liquid state is called sublimation, and the substance is said to sublime.

v. The change of state from liquid state to solid state is called as fusion process.