EXERCISE. 11 A

Question 1:
Define the term heat.
Solution 1:
The kinetic energy due to random motion of the molecules of a substance is known as its heat energy.

Question 2:
Name the S.I. unit of heat.
Solution 2:
S.I. unit of heat is joule (symbol J).

Question 3:
Define the term calorie. How is it related to joule?
Solution 3:
One calorie of heat is the heat energy required to raise the temperature of 1 g of water from $14.5^{o}C$ to $15.5\,^{o}C$.
1 calorie = 4.186 J

Question 4:
Define one kilo-calorie of heat.
Solution 4:
One kilo-calorie of heat is the heat energy required to raise the temperature of 1 kg of water from $14.5^{o}C$ to $15.5^{o}C$.

Question 5:
Define temperature and name its S.I. unit.
Solution 5:
The quantity which determines the direction of flow of heat between two bodies kept in contact is called temperature.
S.I. unit kelvin (K).

Question 6:
Differentiate between heat and temperature.

Solution 6:

Heat	Temperature
The kinetic energy due to random motion of the molecules of a substance is known as its heat energy.	The quantity which determines the direction of flow of heat between two bodies kept in contact is called temperature.
S.I. unit joule (J).	S.I. unit kelvin (K).
It is measured by the principle of calorimetry.	It is measured by a thermometer.

Question 7:
Define calorimetry

Solution 7:
The measurement of the quantity of heat is called calorimetry.

Question 8:
Define the term heat capacity and state its S.I. unit.

Solution 8:
The heat capacity of a body is the amount of heat energy required to raise its temperature by $1^{o}C$ or 1K.

S.I. unit is joule per kelvin (JK^{-1}).

Question 9:
Define the term specific heat capacity and state its S.I. unit.

Solution 9:
The specific heat capacity of a substance is the amount of heat energy required to raise the temperature of unit mass of that substance through by $1^{o}C$ (or 1K).

S.I. unit is joule per kilogram per kelvin ($Jkg^{-1}K^{-1}$).

Question 10:
How is heat capacity of a body related to specific heat capacity of its substance?

Solution 10:
Heat capacity = Mass × specific heat capacity

Question 11:
Differentiate between heat capacity and specific heat capacity.

Solution 11:
Heat capacity of the body is the amount of heat required to raise the temperature of (whole) body by 1 ℃ whereas specific heat capacity is the amount of heat required to raise the temperature of unit mass of the body by 1 ℃.

Heat capacity of a substance depends upon the material and mass of the body. Specific heat capacity of a substance does not depend on the mass of the body.

S.I. unit of heat capacity is JK^{-1} and S.I. unit of specific heat capacity is Jkg^{-1} K^{-1}.

Question 12:
Name a liquid which has the highest specific heat capacity.

Solution 12:
Water has the highest specific heat capacity.

Question 13:
Write the approximate value of specific heat capacity of water in S.I. unit.

Solution 13:
Specific heat capacity of water = 4200 J kg^{-1} K^{-1}.

Question 14:
What do you mean by the following statements:

(i) the heat capacity of a body is $50JK^{-1}$?

(ii) The specific heat capacity of copper is $0.4Jg^{-1}K^{-1}$

Solution 14:
(i) The heat capacity of a body is $50JK^{-1}$ means to increase the temperature of this body by 1K we have to supply 50 joules of energy.

(ii) The specific heat capacity of copper is $0.4 Jg^{-1}K^{-1}$ means to increase the temperature of one gram of copper by 1K we have to supply 0.4 joules of energy.

Question 15:

Name three factors on which heat energy absorbed by a body depends and state how does it depend on them.

Solution 15:

The quantity of heat energy absorbed by a body depends on three factors :
(i)Mass of the body - The amount of heat energy required is directly proportional to the mass of the substance.
(ii)Nature of material of the body - The amount of heat energy required depends on the nature on the substance and it is expressed in terms of its specific heat capacity c.
(iii)Rise in temperature of the body - The amount of heat energy required is directly proportional to the rise in temperature.

Question 16:

Write the expression for the heat energy Q received by the substance when m kg of substance of specific heat capacity c $J\ kg^{-1}\ k^{-1}$ is heated through $\Delta t°$ C.

Solution 16:

The expression for the heat energy Q
Q= mc Δ t (in joule)

Question 17:

(a) Same amount of heat is supplied to two liquid A and B. The liquid A and B. The liquid A shows a greater rise in temperature. What can you say about the heat capacity of A as compared to that of B?
(b) Two metallic blocks P and Q of masses in ratio 2 : 1 are given same amount of heat. If their temperature rise by same amount, compare their specific heat capacities.

Solution 17:

(a) Heat capacity of liquid A is less than that of B.

As the substance with low heat capacity shows greater rise in temperature.

(b)

Let C_P and C_q be the specific heat capacities of blocks P and Q respectively,

We know that,

$$c = \frac{Q}{m \times \Delta t}$$

$$\therefore \left(\frac{C_P}{C_Q}\right) = \left(\frac{\frac{Q}{2m \times \Delta t}}{\frac{Q}{m \times \Delta T}}\right) = \frac{1}{2}$$

Hence, the required ratio is 1 : 2

Question 18:

Why do the farmers fill their fields with water on a cold winter night?

Solution 18:

In the absence of water, if on a cold winter night the atmospheric temperature falls below 0^oC, the water in the fine capillaries of plant will freeze, so the veins will burst due to the increase in the volume of water on freezing. As a result, plants will die and the crop will be destroyed. In order to save the crop on such cold nights, farmers fill their fields with water because water has high specific heat capacity, so it does not allow the temperature in the surrounding area of plants to fall up to 0^oC.

Question 19:

Discuss the role of high specific heat capacity of water with reference to climate in coastal areas.

Solution 19:

The specific heat capacity of water is very high. It is about five times as high as that of sand. Hence the heat energy required for the same rise in temperature by a certain mass of water will be nearly five times than that required by the same mass of sand. Similarly, a certain mass of water will give out nearly five times more heat energy than that given by sand of the same mass for the same fall in temperature. As such, sand gets heated or cooled more rapidly as compared to water under the similar conditions. Thus a large difference in temperature is developed between the land and the sea due to which land and sea breezes are formed. These breezes make the climate near the sea shore moderate.

Question 20:

Water is used in hot water bottles for fomentation give a reason.

Solution 20:

The reason is that water does not cool quickly due to its large specific heat capacity, so a hot water bottle provides heat energy for fomentation for a long time.

Question 21:
Water is used as an effective coolant. Give reason.

Solution 21:
By allowing water to flow in pipes around the heated parts of a machine, heat energy from such part is removed. Water in pipes extracts more heat from surrounding without much rise in its temperature because of its large specific heat capacity. So, Water is used as an effective coolant.

Question 22:
Give one example each where high specific heat capacity of water is used (i) as coolant, (ii) as heat reservoir.

Solution 22:
(1) Radiator in car.
(2) To avoid freezing of wine and juice bottles.

Question 23:
What is a calorimeter? Name the material of which it is made of. Give two reasons for using the material stated by you.

Solution 23:
A calorimeter is a cylindrical vessel which is used to measure the amount of heat gained or lost by a body when it is mixed with other body.
It is made up of thin copper sheet because:
(i) Copper is a good conductor of heat, so the vessel soon acquires the temperature of its contents.
(ii)Copper has low specific heat capacity so the heat capacity of calorimeter is low and the amount of heat energy taken by the calorimeter from its contents to acquire the temperature of its contents is negligible.

Question 24:
Why is the base of a cooking pan made thick and heavy.

Solution 24:
By making the base of a cooking pan thick, its thermal capacity becomes large and it imparts sufficient heat energy at a low temperature to the food for its proper cooking. Further it keeps the food warm for a long time, after cooking.

Question 25:
What is the principle of method of mixture (or principle of calorimetry)? Name the law on which this principle is based.

Solution 25:
The principle of method of mixture:
Heat energy lost by the hot body = Heat energy gained by the cold body.
This principle is based on law of conservation of energy.

Question 26:
A mass m_1 of a substance of specific heat capacity c_1 at temperature t_1 is mixed with a mass m_2 of other substance of specific heat capacity c_2 at a lower temperature t_2. Deduce the expression for the temperature of the mixture. State the assumption made, if any.

Solution 26:
A mass m_1 of a substance A of specific heat capacity c_1 at temperature T_1 is mixed with a mass m_2 of other substance B of specific heat capacity c_2 at a lower temperature T_2 and final temperature of the mixture becomes T.
Fall in temperature of substance A = $T_1 – T$
Rise in temperature of substance B = $T – T_2$
Heat energy lost by A = $m_1 \times c_1 \times$ fall in temperature
$= m_1c_1 (T_1 – T)$
Heat energy gained by B = $m_2 \times c_2 \times$ rise in temperature
$= m_2c_2 (T – T_2)$
If no energy lost in the surrounding, then by the principle of mixtures,
Heat energy lost by A = Heat energy gained by B
$m_1c_1(T_1 - T) = m_2c_2(T – T_2)$
After rearranging this equation, we get

$$T = \frac{m_1c_1T_1 + m_2c_2T_2}{m_1c_1 + m_2c_2}$$

Here we have assumed that there is no loss of heat energy.

Question 27:
Describe a method to determine the specific heat capacity of a solid, like a piece of copper.

Solution 27:
We can do a simple experiment as follows:
1) The given solid in the form of a small piece, is first weighed and is then heated by suspending it by a thread in a beaker containing boiling water.

2) While the solid is getting heated, the empty dry calorimeter with the stirrer is weighed. The calorimeter is then filled nearly one third with water and is weighed again. The difference in the two reading gives the mass of water taken.
3) The initial temperature of water in the calorimeter is noted with a thermometer.
4) When the solid has attained the steady temperature, its temperature is recorded by the thermometer kept in boiling water.
5) The solid is then gently dropped into the calorimeter carefully without splashing out the water.
6) The contents of the calorimeter are well stirred and the final highest temperature reached is noted.

Then specific heat capacity of solid can be calculated by the formula:

$$c = \frac{\left[(m_2 - m_1)c_w + m_1 c_c\right](T - T_1)}{m(T_2 - T)} JKg^{-1}K^{-1}$$

where, Mass of solid = m kg
Mass of calorimeter = m_1 kg
Mass of calorimeter + water = m_2 Kg
Initial temperature of water = T_1 °C
Temperature of heated solid = T_2°C
Temperature of mixture = T° C
c is the specific heat capacity of solid
c_c is the specific heat capacity of material of the calorimeter
c_w is the specific heat capacity of water

Question 28:

How will you determine the specific heat capacity of a liquid like olive oil by the method of mixtures?

Solution 28:

In this case we take a solid of known specific heat capacity. Then follow this procedure:
(1)The solid in the form of small piece, is first weighed and is then heated by suspending it by a thread in a beaker containing boiling water.
(2)While the solid is getting heated, the empty dry calorimeter with the stirrer is weighed. The calorimeter is then filled nearly one third with olive oil and is weighed again. The difference in the two reading gives the mass of olive oil taken.
(3)The initial temperature of olive oil in the calorimeter is noted with a thermometer.
(4)When the solid has attained the steady temperature, its temperature is recorded by the thermometer kept in boiling water.
(5)The solid is then gently dropped into the calorimeter carefully without splashing out the olive oil.

(6)The contents of the calorimeter are well stirred and the final highest temperature reached is noted.
Then specific heat capacity of olive oil (c_L) can be calculated by the formula:

$$c_L = \frac{mc(T_2 - T) - m_1c_c(T - T_1)}{(m_2 - m_1)(T - T_1)} JKg^{-1}K^{-1}$$

where, mass of solid = m kg.
Mass of calorimeter = m_1 kg.
Mass of calorimeter + olive oil = m_2 Kg
Initial temperature of olive oil = T_1°C
Temperature of heated solid = T_2°C
Temperature of mixture = T°C
c is the specific heat capacity of solid
c_c is the specific heat capacity of material of the calorimeter

Question 29:

In an experiment to determine the specific heat capacity of a solid following operations were made:
Mass of calorimeter + stirrer = x kg
Mass of water = y kg
Initial temperature of water t_1℃
Mass of solid = z kg
Temperature of solid = t_2 ℃
Temperature of mixture = t ℃
Specific heat capacity of calorimeter and water are c1 and c_2 respectively. Express the specific heat capacity c of the solid in terms of the above data.

Solution 29:

The specific heat capacity c of the solid in terms of the above data is:

$$c = \frac{(xc_1 + yc_2)(T - T_1)}{z(T_2 - T)}$$

Question 30:

A heater of power P watt raises the temperature of m kg of a liquid by Δt K in time t s. Express the specific heat capacity of liquid in terms of above data.

Solution 30:

The specific heat capacity of liquid in terms of the above data is:

$$c = \frac{P\ t}{m \vartriangle T}$$

MUTIPLE CHOICE QUESTIONS:

Question 1:

The S.I. unit of heat capacity is:

(a) J kg^{-1} (b) J K^{-1}

(c) J kg^{-1} K^{-1} (d) cal $°C^{-1}$

Solution 1:

JK^{-1}

Question 2:

The S.I. unit of specific heat capacity is:

(a) J kg^{-1} (b) J K^{-1}

(c) J kg^{-1} K^{-1} (d) kilocal kg^{-1} $°C^{-1}$

Solution 2:

J kg^{-1} K^{-1}

Question 3:

The specific heat capacity of water is:

(a) 4200 J kg^{-1} K^{-1} (b) 420 J g^{-1} K^{-1}

(b) 0.42 J g^{-1} K^{-1} (d) 4.2 J kg^{-1} K^{-1}

Solution 3:

4200 J kg^{-1} K^{-1}

NUMERCIALS:

Question 1:

By imparting heat to a body its temperature rises by 15° C. what is the corresponding rise in temperature on kelvin scale?

Solution 1:

The size of 1 degree on the Kelvin scale is the same as the size of 1 degree on the Celsius scale. Thus, the difference (or change) in temperature is the same on both the Celsius and Kelvin scales. Therefore, the corresponding rise in temperature on the Kelvin scale will be 15K.

Question 2:

(a) Calculate the heat capacity of a copper vessel of mass 150g if the specific heat capacity of copper is 410 J kg^{-1} K^{-1}

(b) How much heat energy will be required to increase the temperature of the vessel in part (a) from 25°C to 35°C?

Solution 2:

(i) Mass of copper vessel = 150 g
= 0.15 kg

The specific heat capacity of copper = 410 J kg^{-1} K^{-1}.

Heat capacity = Mass × specific heat capacity
= 0.15 kg × 410J$kg^{-1}K^{-1}$
= 61.5JK^{-1}

Change in temperature= (35 − 25)°C = 10°C = 10K

(ii) Energy required to increase the temperature of vessel

$\Delta Q = mc\Delta T$
$= 0.15 \times 410 \times 10$
$= 615$ J

Question 3:

A piece of iron of mass 2.0 kg has a thermal capacity of 966 J K^{-1}. Find : (i) heat energy needed to warm it by 15°C and (ii) its specific heat capacity in S.I. unit.

Solution 3:

(i)We know that heat energy needed to raise the temperature by 15° is = heat capacity × change in temperature.

Heat energy required = 966 J K^{-1} × 15 K = 14490 J.

(ii)We know that specific heat capacity is = heat capacity/ mass of substance

So specific heat capacity is = 966 / 2 = 483 J kg^{-1} K^{-1}.

Question 4:

Calculate the amount of heat energy required to raise the temperature of 100 g of copper from 20°C to 70°C. specific heat capacity of copper = 390 J kg^{-1} K^{-1}.

Solution 4:

Mass of copper m = 100 g = 0.1 kg

Change of temperature $\Delta t = (70 - 20)^\circ C$

Specific heat of capacity of copper = 390 J kg^{-1} K^{-1}

Amount of heat required to raise the temperature of 0.1 kg of copper is

$Q = m \times \Delta t \times c$
$= 0.1 \times 50 \times 390$
$= 1950$ J

Question 5:

1300 J of heat energy is supplied to raise the temperature of 0.5 kg of lead from 20° C to 40°C. Calculate the specific heat capacity of lead

Solution 5:

Heat energy supplied = 1300 J
Mass of lead = 0.5 kg
Change in temperature = (40-20)°C = 20 °C (or 20 K)
Specific heat capacity of lead

$$c = \frac{\Delta Q}{m\Delta T}$$

$$c = \frac{1300}{0.5 \times 20}$$

$c = 130\ J\ kg^{-1}\ K^{-1}$

Question 6:

Find the time taken by a 500 W heater to raise the temperature of 50 kg of material of specific heat capacity 960 J kg^{-1} K^{-1}, from 18°C to 38° C. assume that all the heat energy supplied by the heater is given to the material.

Solution 6:

Specific heat capacity of material c = 960 J kg^{-1} K^{-1}
Change in temperature $\Delta T = (38 - 18)^{o}C = 20^{o}C$ (or 20 K)
Power of heater P = 500 W

$\Delta Q = mc\Delta T$

$\Delta Q = 50 \times 960 \times 20$

Time taken by a heater to raise the temperature of material

$$t = \frac{\Delta Q}{P}$$

$$t = \frac{50 \times 960 \times 20}{500}$$

t = 1920 seconds
t = 32 min

Question 7:

An electric heater of power 600 W raises the temperature of 4.0 kg of a liquid from 10.0 ℃ to 15.0 ℃ I 100 s. Calculate: (i) the heat capacity of 4.0 kg of liquid, (ii) the specific heat capacity of the liquid.

Solution 7:

Power of heater P = 600 W
Mass of liquid m = 4.0 kg
Change in temperature of liquid = (15 − 10)^{o}C = 5^{o}C(or 5 K)
Time taken to raise its temperature = 100s
Heat energy required to heat the liquid

$\Delta Q = mc\Delta T$

And

$\Delta Q = P \times t = 600 \times 100 = 60000J$

$$c = \frac{\Delta Q}{m\Delta T} = \frac{60000}{4 \times 5} = 3000\,Jkg^{-1}K^{-1}$$

Heat capacity = c × m
Heat capacity = 4 × 3000JKg^{-1} K^{-1} = 1.2 × 10^4 J/K

Question 8:

0.5 kg of lemon squash at 30° C is placed in a refrigerator which can remove heat at an average rate of 30 J s^{-1}. How long will it take to cool the lemon squash to 5°C? Specific heat capacity of squash = 4200 J kg^{-1} K^{-1}

Solution 8:

Change in temperature= 30 − 5 = 25 K.

$\Delta Q = mc\Delta T$

$\Delta Q = 0.5 \times 4200 \times 25 = 52500J$

$$t = \frac{\Delta Q}{P} = \frac{52500}{30} = 1750s$$

t = 29 min 10 sec

Question 9:

200 g mass of certain metal of 83°C is immersed in 300 g of water at 30°C the final temperature is 33°C. Calculate the specific heat capacity of the metal Assume that the specific heat capacity of water is 4.2 J g^{-1} K^{-1}

Solution 9:

Mass of certain metal(m_1) = 200 g
Temperature (T_1) = 83^{o}C
Mass of water(m_2) = 300 g
Temperature of water (T_2) = 30^{o}C
Final temperature (T) = 33^{o}C

Specific heat capacity of water c_2 = 4.2 J/g/K
The specific heat capacity of the metal c_1 is given by this formula

$$m_1c_1(T_1 - T) = m_2c_2(T - T_2)$$

$$\frac{(T - T_2)m_2c_2}{m_1(T_1 - T)} = c_1$$

$$c_1 = \frac{(33-30)\times 300\times 4.2}{200\times(83-33)}$$

$$c_1 = 0.378 JK^{-1}$$

Question 10:

45 g of water at 50°C in a beaker is cooled when 50 g of copper at 18° C is added to it. The contents are stirred till a final constant temperature is reached. Calculate this final temperature. The specific heat capacity of copper is 0.39 J g^{-1} K^{-1} and that of water is 4.2 J g^{-1} K^{-1} State the assumption used.

Solution 10:

Mass of water (m_1) = 45 g
Temperature of water (T_1) = 50°C
Mass of copper (m_2) = 50 g
temperature of copper(T_2) = 18°C
Final temperature (T) = ?
The specific heat capacity of the copper c_2 = 0.39 J/g/K
The specific heat capacity of water c_1 = 4.2 J/g/K

$$m_1c_1(T_1 - T) = m_2c_2(T - T_2)$$

$$T = \frac{m_1c_1T_1 + m_2c_2T_2}{m_2c_2 + m_1c_1}$$

$$T = \frac{45\times 4.2\times 50 + 50\times 0.39\times 18}{45\times 4.2 + 50\times 0.39} = \frac{9801}{208.5} = 47^{\circ} c$$

$$T = 47^{\circ} C$$

Question 11:

200 g of hot water at 80°C is added to 300 g of cold water at 10°C. Neglecting the heat taken by the container, calculate the final temperature of the mixture of water. Specific heat capacity of water = 4200 J kg^{-1} K^{-1}

Solution 11:

Mass of hot water (m_1) = 200g
Temperature of hot water (T_1) = 80°C
Mass of cold water (m_2) = 300g
Temperature of cold water (T_2) =10°C
Final temperature (T) = ?

$$m_1c_1(T_1 - T) = m_2c_2(T - T_2)$$

$c_1 = c_2$

$$T = \frac{m_1T_1 + m_2T_2}{m_2 + m_1}$$

$$T = \frac{200 \times 80 + 300 \times 10}{500}$$

T = 38°C.

Question 12:

The temperature of 600 g of cold water rises by 15° C when 300 g of hot water at 50° C is added to it. What was the initial temperature of the cold water?

Solution 12:

Mass of hot water (m_1) = 300 g
Temperature (T_1) = 50°C
Mass of cold water (m_2) = 600 g
Change in temperature of cold water ($T - T_2$) = 15°C
Final temperature = T°C
The specific heat capacity of water is c.

$$m_1c_1(T_1 - T) = m_2c_2(T - T_2)$$

300(50 – T) = 600 (15)
T = 20°C.
Final temperature = 20° c
Change in temperature = 15°C
Initial temperature of cold water = 20°C − 15°C = 5°C.

Question 13:
1.0 kg of water is container in a 1.25 kW kettle Calculate the time taken for the temperature of water to rise from 25° C to its boiling point 100°C. Specific heat capacity of water = 4.2 J $g^{-1} K^{-1}$

Solution 13:
Mass of water = 1000 g.
Change in temperature=100°C − 25 °C = 75 °C (or 75K)
Amount of heat energy required to raise temperature = 1000 × 4.2 × 75 = 315000 J.
Time taken to raise the temperature, T = 4 min 12 seconds.

EXERCISE. 11 B

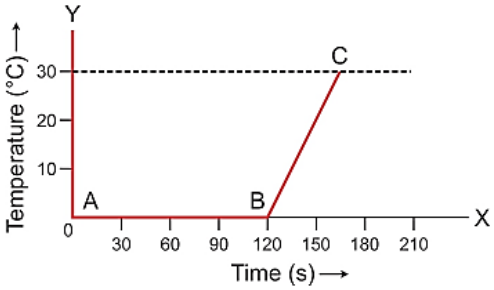
Question 1:
(a) What do you understand by the change of phase of a substance?
(b) Is there any change in temperature during the change of phase?
(c) Does the substance absorb or liberate any heat energy during the change of phase?

Solution 1:
(a) The process of change from one state to another at a constant temperature is called the change of phase of substance.
(b)There is no change in temperature during the change of phase.
(c)Yes, the substance absorbs or liberates heat during the change of phase.

Question 2:
Explain the terms melting and melting point

Solution 2:
Melting: The change from solid to liquid phase on heating at a constant temperature is called melting.
Melting point: The constant temperature at which a solid changes to liquid is called the melting point.

Question 3:
Describe an experiment to show that there is absorption of heat energy when the ice melts.

Solution 3:


Experiment to show that there is absorption of heat energy when ice melts:

1) Take a boiling test tube and fill it half with the ice chips. Insert a thermometer gently into the ice taking care that its bulbs does not touch the walls of test tube. Note the temperature of ice. It will be 0^oC.

2) Heat the test tube slowly over the flame and note the temperature after every half minute till the temperature of water formed after melting of ice increases to 30^oC.

Plot a graph between temperature and time. This graph is called heating curve of ice. From the graph, it is clear that the temperature of ice remains constant equal to 0^oC in the AB part till the whole ice is melted. The heat supplied during this time is being used in melting the ice. After this, the temperature of water formed by melting the ice begins to rise in the part BC. Thus, change of phase occurs in part AB and heat energy is absorbed during this time without any rise in temperature.

Question 4:
A substance undergoes (i) a change in its temperature, (ii) a change in its phase without change in its temperature. In each case, state the change in energy of molecules of the substance.

Solution 4:
(i) Average kinetic energy of molecules changes.
(ii) Average potential energy of molecules changes.

Question 5:
How does the (a) average kinetic energy (b) average potential energy of molecules of a substance change during its change in phase at a constant temperature?

Solution 5:
(a) Average kinetic energy does not change.

(b) Average potential energy increases.
Explanation: When a substance is heated at constant temperature (i.e. during its phase change state), the heat supplied makes the vibrating molecules gain potential energy to overcome the intermolecular force of attraction and move about freely. This means that the substance changes its form.
However, this heat does not increase the kinetic energy of the molecules, and hence, no rise in temperature takes place during the change in phase of a substance.
This heat supplied to the substance is known as latent heat and is utilized in changing the state of matter without any rise in temperature.

Question 6:
State the effect of presence of impurity on the melting point of ice. Give one use of it.

Solution 6:
The melting point of ice decreases by the presence of impurity in it.
Use: In making the freezing mixture by adding salt to ice. This freezing mixture is used in preparation of ice creams.

Question 7:
State the effect of increase of pressure on the melting point of ice.

Solution 7:
The melting point of ice decreases by the increase in pressure. The melting point of ice decrease by 0.0072°C for every one atmosphere rise in pressure.

Question 8:
Fig 11. 11 shows the variation in temperature with time when some wax cools from the liquid phase to the solid phase. (i) In which part of the curve, the wax is in liquid phase? (ii) What does the part QS of the curve represent? (iii) In which part of the curve, the wax will be the in the liquid as well as solid phase? (iv) In which part of the curve, the wax is in solid phase?

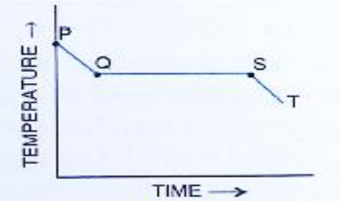


Fig. 11.11

Solution 8:

(i) In part PQ, the wax is in liquid phase.
(ii) In the part QS, temperature remains constant with time, and hence, this part of the curve represents freezing.
(iii) In part QS, the wax will be in the liquid as well as solid phase.
(iv) In part ST, the wax is in solid phase.

Question 9:

The diagram in Fig 11.12 below shows the change of phase of a substance on a temperature time graph.

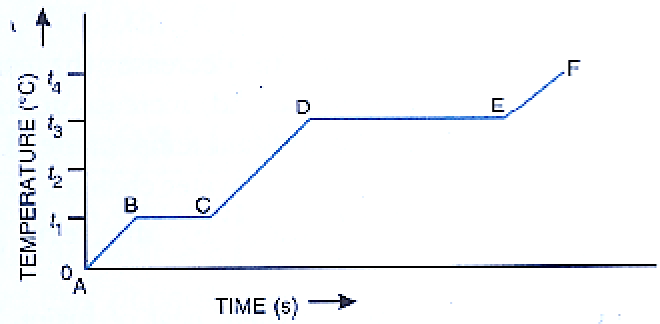


Fig. 11.12

(a) What do the parts AB, BC, CD and DE represent?
(b) what is the melting points of the substance?
(c) what is the boiling points of the substance?

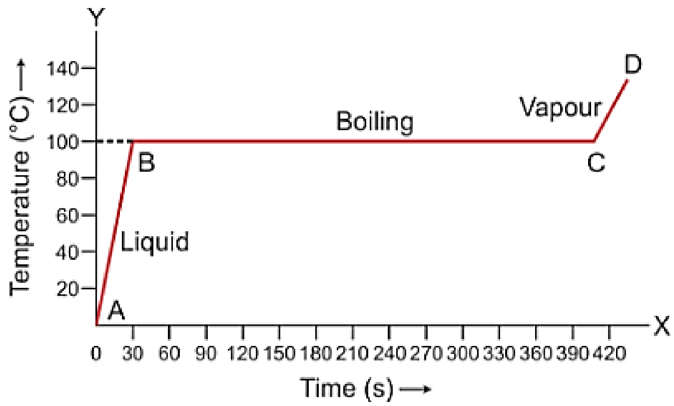
Solution 9:

(a) AB part shows rise in temperature of solid from 0 to T_1°C, BC part shows melting at temperature T_1°C, CD part shows rise in temperature of liquid from T_1°C to T_3°C , DE part shows the boiling at temperature T_3°C.
(b) T_1°C.
(c) T_3°C.

Question 10:

1 kg of ice at 0°C is heated at a constant rate and its temperature is recorded after every 30 s till steam is formed at 100°C. Draw a temperature time graph to represent the change of phase.

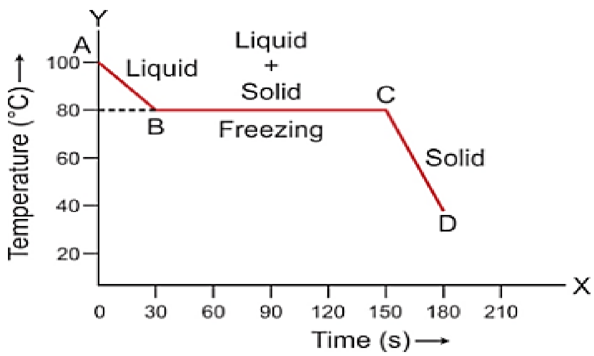
Solution 10:



Question 11:

The melting point of naphthalene, a crystalline solid is 80℃ and the room temperature is 30℃. A sample of liquid naphthalene at 100℃ is cooled down to the room temperature. Draw a temperature time graph to represent this cooling.

Solution 11:



Question 12:

Explain the terms boiling and boiling point

Solution 12:

Boiling: The change from liquid to gaseous phase on heating at a constant temperature is called boiling.

Boiling point: The particular temperature at which vaporization occurs is called the boiling point of liquid.

Question 13:
How is the volume of water affected when it boils at 100°C?

Solution 13:
Volume of water wills increases when it boils at 100°C.

Question 14:
How is the boiling point of water affected when some salt is added to it?

Solution 14:
The boiling point of water increases on adding salt.

Question 15:
What is the effect of increase in pressure on the boiling point of a liquid?

Solution 15:
The boiling point of a liquid increases on increasing the pressure.

Question 16:
Write down the approximate range of temperature at which water boils in a pressure cooker.

Solution 16:
In a pressure cooker, the water boils at about 120°C to 125°C.

Question 17:
It is difficult to cook vegetables on hills and mountains. Explain the reason.

Solution 17:
This is because at high altitudes atmospheric pressure is low; therefore, boiling point of water decreases and so it does not provide the required heat energy for cooking.

Question 18:
Complete the following sentences:

(a) When ice melts, its volume __________

(b) Decrease in pressure over ice _________ its melting point.

(c) Increase in pressure __________ the boiling point of water.
(d)A pressure cooker is based on the principle that boiling point of water increases with the __________
(e) The boiling point of water is defined as __________

Solution 18:

(a) When ice melts, its volume decreases.
(b) Decrease in pressure over ice increases its melting point.
(c) Increase in pressure increases the boiling point of water.
(d)A pressure cooker is based on the principle that boiling point of water increases with the increase in pressure.
(e) The boiling point of water is defined as the constant temperature at which water changes to steam.

Question 19:

What do you understand by the term latent heat?

Solution 19:

Latent heat: The heat energy exchanged in change of phase is not externally manifested by any rise or fall in temperature, it is considered to be hidden in the substance and is called the latent heat.

Question 20:

Define the term specific latent heat of fusion of ice state its S.I unit.

Solution 20:

The quantity of heat required to convert unit mass of ice into liquid water at 0° C (melting point) is called the specific latent heat of fusion of ice.
Its S.I. unit is Jkg^{-1}.

Question 21:

Write the approximate value of specific latent heat of ice.

Solution 21:

Specific latent heat of ice: 336000 J kg^{-1}.

Question 22:
The specific latent heat of fusion of ice is 336 J g^{-1}. Explain the meaning of its statement.

Solution 22:
It means 1 g of ice at 0^oC absorbs 360 J of heat energy to convert into water at 0^oC.

Question 23:
1 g ice of 0℃ melts to form 1 g water at 0℃. State whether the latent heat is absorbed or given out by ice.

Solution 23:
Latent heat is absorbed by ice.

Question 24:
Which has more heat: 1 g ice at 0℃ or 1g water 0℃? Give reason.

Solution 24:
1 g of water at 0^oC has more heat than 1 g of ice at 0^oC. This is because ice at 0^oC absorbs 360 J of heat energy to convert into water at 0^oC.

Question 25:
(a) Which requires more heat: 1 g ice at 0℃ or 1 g water at 0℃ to raise its temperature to 10℃?
(b) Explain your answer in part (a).

Solution 25:
(a) 1 g ice at 0^oC requires more heat because ice would require additional heat energy equal to latent heat of melting.
(b) 1 g ice at 0^oC first absorbs 336 J heat to convert into 1 g water at 0^oC.

Question 26:
Ice cream appears coder to the mouth than water at 0℃. Give reason.

Solution 26:
This is because 1 g of ice at 0^oC takes 336 J of heat energy from the mouth to melt at 0^oC. Thus, mouth loses an additional 336 J of heat energy for 1 g of ice at 0^oC than for 1g of water at 0^oC. Therefore, cooling produced by 1 g of ice at 0^oC is more than for 1g of water at 0^oC.

Question 27:
Why do bottled soft drinks get cooled, more quickly by the ice cubes than by the iced water, both at 0°C?

Solution 27:
This is because 1 g of ice at 0^oC takes 336 J of heat energy from the bottle to melt into water at 0^oC. Thus, bottle loses an additional 336 J of heat energy for 1 g of ice at 0^oC than for 1 g iced water at 0^oC. Therefore, bottled soft drinks get cooled, more quickly by the ice cubes than by iced water.

Question 28:
It is generally cold after a hail-storm then during and before the hail storm. Give reason.

Solution 28:
The reason is that after the hail storm, the ice absorbs the heat energy required for melting from the surrounding, so the temperature of the surrounding falls further down and we feel colder.

Question 29:
The temperature of the surrounding starts falling when ice in a frozen lake starts melting. Give reason.

Solution 29:
The reason is that the heat energy required for melting the frozen lake is absorbed from the surrounding atmosphere. As a result, the temperature of the surrounding falls and it became very cold.

Question 30:
Explain the following:

(i) The surrounding become pleasantly warm when water in a lake starts freezing in cold countries.

(ii) The heat supplied to a substance during it change of state, does not cause any rise in its temperature.

Solution 30:
(i) The reason is that the specific latent heat of fusion of ice is sufficiently high, so when the water of lake freezes, a large quantity of heat has to be released and hence the surrounding temperature becomes pleasantly warm.

(ii) Heat supplied to a substance during its change of state, does not cause any rise in its temperature because this is latent heat of phase change which is required to change the phase only.

MULTIPLE CHOICE TYPE:

Question 1:

The S.I. unit of specific latent heat is:

(a) cal g^{-1} (b) cal $g^{-1}K^{-1}$

(c) J kg^{-1} (d) J kg^{-1} K^{-1}

Solution 1:

J kg^{-1}

Question 2:

The specific latent heat of fusion of water is:

(a) 80 cal g^{-1} (b) 2260 J g^{-1}

(c) 80 J g^{-1} (d) 336 J kg^{-1}

Solution 2:

80 cal g^{-1}

NUMERICALS:

Question 1:

10g of ice at 0℃ absorbs 5460 J of heat energy to melt and change to water at 50℃. Calculate the specific latent heat of fusion of ice. Specific heat capacity of water is 4200 J kg^{-1} K^{-1}

Solution 1:

Mass of ice = 10g = 0.01kg

Amount of heat energy absorbed, Q = 5460J

Specific latent heat of fusion of ice = ?

Specific heat capacity of water = 4200J$kg^{-1}K^{-1}$

Amount of heat energy required by 10g (0.01kg) of water at 0°C to raise its temperature by 50°C = 0.01 × 4200 × 50 = 2100J.

Let Specific latent heat of fusion of ice=L Jg^{-1}.

Then,

$Q = mL + mc\Delta T$

5460 J =10 × L + 2100J

L = 336Jg^{-1}.

Question 2:

How much heat energy is released when 5.0 of water at 20°C changes into ice at 0°C? Take specific heat capacity of water = 4.2 J kg^{-1} K^{-1}, Specific latent heat of fusion of ice 336 J g^{-1}

Solution 2:

Mass of water m = 5.0 g
specific heat capacity of water c = 4.2 J g^{-1} K^{-1}
specific latent heat of fusion of iceL = 336 J g^{-1}
Amount of heat energy released when 5.0 g of water at 20°C changes into water at 0°C = 5 x 4.2 × 20 = 420 J.
Amount of heat energy released when 5.0g of water at 0°C changes into ice at 0°C = 5 × 336J = 1680J.
Total amount of heat released = 1680 J + 420 J = 2100 J.

Question 3:

A molten metal of mass 150 g is kept at its melting point 800°C. When it is allowed to freeze at the same temperature, it gives out 75,000 J of heat energy.
(a) What is the specific latent heat of the metal?
(b) If the specific heat capacity of metal is 200 J kg^{-1} K^{-1}, how much additional heat energy will the metal give out in cooling to – 50 °C?

Solution 3:

Mass of metal = 150 g
Specific latent heat of metal

$$L = \frac{Q}{m} = \frac{75000}{150} = 500\,Jg^{-1}$$

Specific heat capacity of metal is 200 J kg^{-1} K^{-1}.
Change in temperature= 800 − (−50) = 850°C (or 850 K).

$$\Delta Q = mc\Delta T = 0.15 \times 200 \times 850 = 25500J$$

Question 4:

A refrigerator converts 100g of water at 20°C to ice at – 10°C in 73.5 min. Calculate the average the rate of heat extraction in watt. The specific heat capacity of water is 4.2 J kg^{-1} K^{-1}, Specific latent heat of ice is 336 J g^{-1} and the specific heat capacity of ice if 2.1 J kg^{-1} K^{-1}.

Solution 4:

Amount of heat released when 100g of water cools from 20° to 0°C = 100 × 20 × 4.2 = 8400J.
Amount of heat released when 100g of water converts into ice at 0°C = 100 × 336 = 33600J.

Amount of heat released when 100g of ice cools from 0^oC to -10^oC = 100 × 10 × 2.1 = 2100J.
Total amount of heat = 8400 + 33600 + 2100 = 44100J.
Time taken = 73.5min = 4410s.
Average rate of heat extraction (power)

$$P = \frac{E}{t} = \frac{44100}{4410} = 10W$$

Question 5:

In an experiment, 17g of ice is used to bring down the temperature of 40 g of water at 34°C to its freezing temperature. The specific heat capacity of water is 4.2 J kg^{-1} K^{-1}. Calculate the specific latent heat of ice. State one important assumption made in the above calculation.

Solution 5:

Mass of ice m_1 = 17 g
Mass of water m_2 = 40 g.
Change in temperature = 34 – 0 = 34K
Specific heat capacity of water is $4.2Jg^{-1}K^{-1}$.
Assuming there is no loss of heat, heat energy gained by ice (latent heat of ice), Q= heat energy released by water
Q = 40 × 34 × 4.2 = 5712 J.
Specific latent heat of ice =

$$L = \frac{Q}{m} = \frac{5712}{17} = 336Jg^{-1}$$

Question 6:

Find the result of mixing 10 g of ice at - 10°C with 10 g of water at 10°C. Specific heat capacity of ice = 2.1 J kg^{-1} K^{-1}, Specific latent heat of ice = 336 J g^{-1} and specific heat capacity of water = 4.2 J kg^{-1} K^{-1}

Solution 6:

Let whole of the ice melts and let the final temperature of the mixture be T^oC.
Amount of heat energy gained by 10g of ice at -10^oC to raise its temperature to 0^oC = 10 × 10 × 2.1 = 210J
Amount of heat energy gained by 10g of ice at 0^oC to convert into water at 0^oC = 10 × 336 = 3360 J
Amount of heat energy gained by 10g of water (obtained from ice) at 0^oC to raise its temperature to T^oC = 10 × 4.2 × (T − 0) = 42T

Amount of heat energy released by 10g of water at 10°C to lower its temperature to T°C = 10 × 4.2 × (10 − T) = 420 − 42T
Heat energy gained = Heat energy lost
210 + 3360 + 42T = 420 − 42T
T = −37.5°C
This cannot be true because water cannot exist at this temperature.
So whole of the ice does not melt. Let m gm of ice melts. The final temperature of the mixture becomes 0°C.
So, amount of heat energy gained by 10g of ice at -10°C to raise its temperature to 0°C = 10 × 10 × 2.1 = 210J
Amount of heat energy gained by m gm of ice at 0°C to convert into water at 0°C = m × 336 = 336m J
Amount of heat energy released by 10g of water at 10°C to lower its temperature to 0°C = 10 × 4.2 × 10 − 0) = 420
Heat energy gained = Heat energy lost
210 + 336m = 420
m = 0.625 gm

Question 7:

A piece of ice of mass 40 g is added to 200 g of water at 50°C, Calculate the final temperature of water when all the ice has melted. Specific heat capacity of water = 4200 J kg^{-1} K^{-1}, and specific latent heat of fusion of ice = 336 × 10^3 J kg^{-1}.

Solution 7:

Let final temperature of water when all the ice has melted = T°C.
Amount of heat lost when 200g of water at 50°C cools to T°C =
200 × 4.2 × (50 − T) = 42000 − 840T
Amount of heat gained when 40g of ice at 0°C converts into water at 0°C.= 40 × 336J = 13440 J
Amount of heat gained when temperature of 40g of water at 0°C rises to T°C = 40 × 4.2 × (T-0) = 168T
We know that
Amount of heat gained = amount of heat energy lost.
13440 + 168T = 42000 − 840T
168T + 840T = 42000 − 13440
1008T = 28560
T = 28560/1008 = 28.33°C.

Question 8:

250 g of water at 30℃ is contained in a copper vessel of mass 50g. Calculate the mass of ice required to bring down the temperature of the vessel and its contents to 5℃. Given: specific latent heat of fusion of ice = 336 × 10^3 J kg^{-1}, specific heat capacity of copper = 400 J kg^{-1} K^{-1}, specific heat capacity of water = 4200 J kg^{-1} K^{-1}

Solution 8:

Mass of copper vessel m_1 = 50 g.
Mass of water contained in copper vessel m_2 = 250 g.
Mass of ice required to bring down the temperature of vessel = m
Final temperature = 5^o C.
Amount of heat gained when 'm' g of ice at 0^o C converts into water at 0^o C = m × 336 J
Amount of heat gained when temperature of 'm' g of water at 0^o C rises to 5^o C = m × 4.2 × 5
Total amount of heat gained = m × 336 + m × 4.2 × 5
Amount of heat lost when 250 g of water at 30^o C cools to 5^o C = 250 × 4.2 × 25 = 26250 J
Amount of heat lost when 50 g of vessel at 30^o C cools to 5^o C = 50 × 0.4 × 25 = 500 J
Total amount of heat lost = 26250 + 500 = 26750 J
We know that amount of heat gained = amount of heat lost
m × 336 + m × 4.2 × 5 = 26750
357 m = 26750
m = 26750/357 = 74.93 g
Hence, mass of ice required is 74.93 g.

Question 9:

2 kg of ice melts when water at 100℃ is poured in a hole drilled in a block of ice. What mass of water was used? Given: Specific heat capacity of water = 4200 J kg^{-1} K^{-1}, L_{ice} = 336×10^3 J kg^{-1}.

Solution 9:

Since the whole block does not melt and only 2 kg of it melts, so the final temperature would be 0 ºC.
Amount of heat energy gained by 2 kg of ice at 0ºC to convert into water at 0ºC = 2 × 336000 = 672000 J
Let amount of water poured = m kg.
Initial temperature of water = 100ºC.
Final temperature of water = 0ºC.
Amount of heat energy lost by m kg of water at 100ºC to reach temperature 0ºC = m × 4200 × 100 = 420000m J
We know that heat energy gained =heat energy lost.
672000J = m × 420000J
m = 672000/420000 = 1.6kg

Question 10:

Calculate the total amount of heat energy required to convert 100g of ice at −10℃ completely into water at 100℃. Specific heat capacity of ice = 2.1 kg^{-1} K^{-1}, specific heat capacity of water = 4.2 J kg^{-1} K^{-1}, specific latent heat of ice = 336 J g^{-1}

Solution 10:

Amount of heat energy gained by 100 g of ice at -10^o C to raise its temperature to 0^o C =
100 × 2.1 × 10 = 2100 J
Amount of heat energy gained by 100 g of ice at 0^o C to convert into water at 0^o C =
100 × 336 = 33600 J
Amount of heat energy gained when temperature of 100 g of water at 0^o C rises to 100^o C =
100 × 4.2 × 100 = 42000 J
Total amount of heat energy gained is = 2100 + 33600 + 42000 = 77700 J = 7.77 × 10^4 J

Question 11:

The amount of heat energy required to convert 1 kg of ice at – 10℃ to water at 100℃ is 7,77,000 J. Calculate the specific latent heat of ice. Specific heat capacity if ice = 2100 J kg^{-1} K^{-1}, Specific heat capacity of water = 4200 J kg^{-1} K^{-1}

Solution 11:

Amount of heat energy gained by 1kg of ice at −10^{o}C to raise its temperature to 0^{o}C = 1 × 2100 × 10 = 21000 J
Amount of heat energy gained by 1kg of ice at 0^{o}C to convert into water at 0^{o}C = L
Amount of heat energy gained when temperature of 1kg of water at 0^{o}C rises to 100^{o}C = 1 × 4200 × 100 = 420000 J
Total amount of heat energy gained = 21000 + 420000 + L = 441000 + L.
Given that total amount of heat gained is = 777000J.
So,
441000 + L = 777000.
L = 777000 − 441000.
L = 336000JKg^{-1}

EXCERCICE. 11 C

Question 1:
Explain the meaning of green house effect.

Solution 1:
The earth receives heat radiations from sun which reach us after passing through its atmosphere. The earth's atmosphere is transparent for the visible and thermal radiations of short wavelengths coming from the sun. The earth's surface and objects on it thus become warm in the day time. After the sunset, the earth's surface and the objects on it radiate the infrared radiations of long wavelengths. A part of these radiations are reflected back by the clouds and a part of it is absorbed by the green house gases like carbon dioxide, methane, water vapours and chlorofluorocarbons. Thus the clouds and green house gases prevents a large fraction of radiations given out by the earth's surface, from escaping into the space. This phenomenon is called greenhouse effect.

Question 2:
Name two green house gases.

Solution 2:
Carbon dioxide, methane, water vapours and chlorofluorocarbons.

Question 3:
Name the radiations for which the green house gases are (A) transparent (b) opaque.

Solution 3:
(a) Short wavelength radiations
(b) Long wavelength radiations

Question 4:
Name three fossil fuels that emit carbon dioxide into the atmosphere

Solution 4:
Coal, petroleum, natural gas.

Question 5:

How does green house effect help in keeping the temperature of earth's surface suitable for living of human beings?

Solution 5:

From sun, we receive 1366W m^{-2} energy at the top of our earth's atmosphere, out of which only 235Wm^{-2} energy reaches near the earth's surface. The earth and ocean surface absorbs 168 W m^{-2} energy and only 67 W m^{-2} energy remains in the lower atmosphere. With this much energy received on earth surface, its actual surface temperature would have been around -18^{0}C which is quite uncomfortable for human living. Fortunately the greenhouse gases present in the earth's atmosphere contribute in trapping the heat energy within the atmosphere and they produce an average warming effect of about 33^{0}C to keep the effective temperature around 15^{0}C. So, greenhouse effect helps in keeping the temperature of earth's surface suitable for living of human beings.

Question 6:

Give three reasons for the increase of green house gases.

Solution 6:

Three reasons for increase of greenhouse gases:

1. The burning of fuels, deforestation and industrial production
2. Increase of population.
3. Imbalance of carbon dioxide cycle

Question 7:

State the effect of enhancement of green house effect.

Solution 7:

The effect of enhancement of greenhouse effect are:

1. The variable change in the climate in different parts of the world has created difficulty and forced the people and animals to migrate from one place to another place.
2. It has affected the blooming season of the different plants.
3. The climate changes have shown the immediate effect on simple organism and plants.
4. It has affected the world's ecology.
5. It has increased the heat stroke deaths.

Question 8:
What is meant by global warming?

Solution 8:
Global warming means the increase in the average effective temperature of earth's surface due to an increase in the amount of greenhouse gases in its atmosphere.

Question 9:
State the impact of global warming on life on the earth.

Solution 9:
The effect of enhancement of greenhouse effect are:

1. The variable change in the climate in different parts of the world has created difficulty and forced the people and animals to migrate from one place to another place.
2. It has affected the blooming season of the different plants.
3. The climate changes have shown the immediate effect on simple organism and plants.
4. It has affected the world's ecology.
5. It has increased the heat stroke deaths.

Question 10:
How will rise in sea level affect population in coastal countries?

Solution 10:
Due to rise in sea level the building and roads in the coastal areas will get flooded and they could suffer damage from hurricanes and tropical storms.

Question 11:
What impact will global warming have on the health of the affected population?

Solution 11:
Due to global warming, many new diseases have emerged because bacteria can survive better in increased temperature and they can multiply faster. It is extending the distribution of mosquitoes due to increase in humanity levels and their frequent growth in warmer atmosphere. This has resulted in increase of many new diseases. The deaths due to heat stroke have certainly increased.

Question 12:
How will climate changes affect the various animal species?

Solution 12:
At the present rate of increase of green house effect, it is expected that nearly 30% of animal species will extinct by the year 2050 and up to 70% by the end of the year 2100. This will disturb ecosystem. The animals from the equatorial region will shift to higher latitude in search of ice and cold region. The absorption of carbon dioxide by the ocean will cause acidification due to which marine species will migrate.

Question 13:
What impact will climate changes have on the crops of food?

Solution 13:
At the present rate of increase of green house effect, it is expected that nearly 30% of the plant species will extinct by the year 2050 and up to 70% by the end of the year 2100. In the near future, warming of nearly $3^{o}C$ will result in poor yield in farms in low latitude regions. This will increase the rise of malnutrition.

Question 14:
How will global warming disturb the ecological balance?

Solution 14:
At the present rate of increase in green house effect, is estimated that nearly 30% of the plant and animal species will extinct by the year 2050 and upto 70 % by the end of year 2100. This will disrupt ecosystem. The animals from the equatorial region will shift to higher latitude in search of cold regions. The absorption of carbon dioxide by ocean will cause acidification due to which marine species will migrate.

Question 15:
State three ways to minimize the global warming.

Solution 15:
Avoid Deforstation

By Conservation of water.

Usage of fossil fuel should be reduced.

Question 16:
What is carbon tax? Who shall pay this tax?
Solution 16:
The tax calculated on the basis of: carbon emission from industry, number of employee hour and turnover of the factory is called carbon tax.
This tax shall be paid by industries. This will encourage the industries to use the energy efficient techniques.

MUTIPLE CHOICE

Question 1:
Without green house effect, the average temperature of earth's surface would have been:
(a) – 18°C (b) 33°C
(c) 0°C (d) 15°C
Solution 1:
−18° C

Question 2:
The global warming has resulted:
(a) the increase in yield of crops
(b) the decrease in sea levels
(c) the decrease in human deaths
(d) the increase in sea levels
Solution 2:
The increase in sea levels.
Explanation: Due to global warming, the average temperature of the Earth has increased and has lead to the melting of ice around both the poles. This melting of ice has lead to an increase in the level of water in sea.