Unit 9 Thermal Properties of Matter

Section A Multiple Choice Questions (M.C.Qs)

Tick mark (✓) the correct answer:

01. *Heat is the form of*_____
(a) pressure (b) weight (c) energy (d) All

02. *Heat capacity is the product of mass and*_____
(a) boiling point (b) freezing point
(c) energy (d) specific heat of material

03. *The amount of heat needed to convert a substance from liquid to gas is called*_____
(a) heat of vaporization (b) specific heat
(c) latent heat of fusion (d) All

04. *Thermal energy transfer required per unit mass to increase the temperature by 1°C or 1 K is called*_____
(a) latent heat of Vaporization (b) specific heat capacity
(c) latent heat of fusion (d) thermal capacity

05. *A fixed temperature at which a pure liquid boils is called* _____
(a) melting point (b) freezing point (c) boiling point (d) Both 'a' and 'b'

06. *The melting point of ice at normal atmospheric pressure is*_____
(a) 0°C (b) 0 K (c) 100°C (d) Both 'a' and 'b'

07. *Thermal energy transfer required to change a solid into liquid without changing its temperature is called* _____
(a) latent heat of Fusion (b) latent heat of vaporization
(c) latent heat of boiling (d) specific heat capacity

08. *Thermal energy transfer required to change a liquid into gas without changing its temperature is called*
(a) latent heat of freezing (b) latent heat of vaporization
(c) latent heat of boiling (d) latent heat of melting

09. *Evaporation can occur at*_____
(a) freezing point (b) melting point (c) boiling point (d) all temperatures

10. *Rate of evaporation of a liquid can be increased by*_____.
(a) increasing humidity (b) decreasing temperature
(c) increasing its boiling point (d) decreasing atmospheric pressure

11. *Linear thermal expansion of a solid depend upon*_____
(a) increasing in temperature (b) original length
(c) properties of material (d) all of these

PHYSICS NOTES FOR CLASS 9TH (FOR SINDH)

12. *The S.I unit of heat is:*
(a) calorie (b) joule (c) Celsius (d) Kelvin

13. *It is the degree of hotness of a body.*
(a) Heat (b) Specific heat (c) Temperature (d) Latent heat

14. *Thermometer is a device, used to measure:*
(a) temperature (b) heat (c) specific heat (d) latent heat

15. *This scale of temperature is mostly used for environmental measurements.*
(a) Kelvin scale (b) Fahrenheit scale (c) Celsius scale (d) Both 'a' & 'b'

16. *This scale of temperature is mostly used for industrial measurements.*
(a) Kelvin scale (b) Fahrenheit scale (c) Celsius scale (d) Both 'a' & 'b'

17. *Which one is correct to convert temperature from Celsius scale to Kelvin scale?*
(a) $K = 1.8°C + 273$ (b) $K = 1.8°C - 273$ (c) $K = °C - 273$ (d) $K = °C + 273$

18. *Which one is correct to convert temperature from Celsius scale to Fahrenheit scale?*
(a) $°F = 1.8°C - 32$ (b) $°F = 1.8°C + 32$ (c) $°F = 1.8°C - 273$ (d) $°F = 1.8°C + 273$

19. *Which one is correct to convert temperature from Fahrenheit scale to Celsius scale?*
(a) $°C = \frac{°F - 32}{1.8}$ (b) $°C = \frac{°F + 32}{1.8}$ (c) $°C = \frac{°F - 1.8}{32}$ (d) $°C = \frac{°F + 1.8}{32}$

20. *Specific heat of water is:*
(a) 240 $Jkg^{-1}K^{-1}$ (b) 2400 $Jkg^{-1}K^{-1}$ (c) 420 $Jkg^{-1}K^{-1}$ (d) 4200 $Jkg^{-1}K^{-1}$

21. *Boiling point of water is:*
(a) 100 K (b) 100°F (c) 100°C (d) 92.8°F

22. *It is a term in physics that describe how much heat is added to a substance to raise its temperature by 1°C*
(a) Latent heat of Fusion (b) Latent heat of vaporization
(c) Specific heat capacity (d) Heat capacity

23. *Heat capacity depends upon the nature of material*
(a) increasing in temperature (b) original length
(c) nature of material (d) all of these

24. *Amount of heat required to raise the temperature of 1kg of a substance through 1°C is called:*
(a) Latent heat of Fusion (b) Latent heat of vaporization
(c) Specific heat capacity (d) Heat capacity

25. *Equation of specific heat capacity 'c' is as under:*
(a) $\frac{Q}{\Delta T}$ (b) $\frac{\Delta Q}{m\Delta T}$ (c) $\frac{\Delta T}{m\Delta Q}$ (d) $\frac{m\Delta Q}{\Delta T}$

26. *Joule per kilogram per Kelvin ($Jkg^{-1}K^{-1}$) is the S.I unit of:*
(a) specific heat capacity (b) heat capacity
(c) latent heat of Fusion (d) thermal expansion

27. *The heat of fusion for water at 0° C is approximately:*
(a) 2230 Joules per gram (b) 2130 Joules per gram
(c) 1230 Joules per gram (d) 334 Joules per gram

28. *The heat of vaporization for water at 100°C is about:*
(a) 2230 Joules per gram (b) 2130 Joules per gram
(c) 1230 Joules per gram (d) 334 Joules per gram

29. *Wet clothes dry in sun due to the:*
(a) heat capacity (b) specific heat (c) evaporation (d) latent heat

30. *Which statement is true for evaporation?*

(a) It only takes place with the supply of an external heat source.
(b) It occurs only at a certain temperature called "Boiling point".
(c) It does not cause cooling.
(d) It takes place only at the liquid surface.

31. *Which statement is NOT true for boiling?*

(a) It only takes place with the supply of an external heat source.
(b) It does not cause cooling.
(c) No formation of bubbles
(d) It takes place throughout the liquid.

32. *Evaporation causes:*

(a) boiling *(b)* freezing *(c)* fusion *(d)* cooling

33. *Volatile liquids have:*

(a) low boiling point *(b)* high boiling point *(c)* low freezing point *(d)* high freezing point

34. *Which statement is NOT correct?*
The rate of evaporation increases with:

(a) with the increase in temperature *(b)* with the increase in wind speed
(c) with the increase in humidity *(d)* with the increase in surface area of liquid

35. *Salty water evaporates:*

(a) more faster than pure water *(b)* more slowly than pure water
(c) with the same rate *(d)* No evaporation occurs

36. *The co-efficient of volume expansion of liquids is:*

(a) zero *(b)* equal to that of solids
(c) greater than solids *(d)* less than solids

37. *If "β" is the coefficient of volume expansion and "α" is the coefficient of linear expansion than:*

(a) $\beta = 2\alpha$ *(b)* $\beta = 3\alpha$ *(c)* $\alpha = 2\beta$ *(d)* $\alpha = 3\beta$

38. *It is used to control temperature of ovens, irons water heaters, refrigerators, air conditioners and so on.*

(a) Bimetallic thermostat *(b)* Rivet
(c) Radiator *(d)* Mercury

Answers

1.	(c)	2.	(d)	3.	(a)	4.	(b)	5.	(c)	6.	(a)	7.	(a)
8.	(b)	9.	(d)	10.	(c)	11.	(d)	12.	(b)	13.	(c)	14.	(a)
15.	(c)	16.	(a)	17.	(d)	18.	(b)	19.	(a)	20.	(d)	21.	(c)
22.	(d)	23.	(c)	24.	(c)	25.	(b)	26.	(a)	27.	(d)	28.	(a)
29.	(c)	30.	(d)	31.	(c)	32.	(d)	33.	(a)	34.	(c)	35.	(b)
36.	(c)	37.	(b)	38.	(a)								

Section B & C

Short & Detailed Answer Questions

Introduction

The objective of this unit is to create critical logical thinking among the students so that they can observe and analyze the physical quantities and changes taking place in their surroundings.

- How does the water in our surroundings help us to maintain the temperature of the environment?
- Why do different liquids heat up in a different manner at the same time and same temperature?
- What is the importance of specific heat in everyday life?
- How evaporation takes place and its effects on the surrounding?
- What happens when the temperature of solids and liquids increases?
- How does the physical state of matter changes from one state to other?
- Why do wet clothes take more time to dry out on a cloudy day?
- What is the role of thermal expansion in our daily life?

Q.1 ***Define heat. What is its unit?***

Ans: ***Heat:*** Heat is a form of energy that transfers from a hot body to a cold body as a result of the difference in temperature between them.

Unit of Heat: As heat is a form of energy. Therefore its S.I unit is joule. Its other unit is a calorie.

Q.2 ***Define temperature. Write its unit.***

Ans: ***Temperature:*** It is a degree of hotness of a body. It determines the direction of the flow of heat from one body to the other body.

For example, a hot cup of tea is placed on a table, after some time the tea in the cup becomes cold because the surrounding temperature is lower than that of the hot tea. Hence heat flows from the hot cup to the surrounding.

Unit of Temperature: S.I unit of temperature is Kelvin. Its other units are Celsius and Fahrenheit.

Q.3 ***How many ways does heat transfer take place? Write the names of them.***

Ans: Heat transfers in three ways:

(i) Conduction (ii) Convection (iii) Radiation

Q.4 ***What is a thermometer?***

Ans: ***Thermometer:*** A thermometer is a device used to measure temperature.
For example, a clinical thermometer is used to measure the temperature of the human body.

Q.5 ***Write the names of different scales to measure temperature.***

Ans: Thermometers have different scales to measure temperature. There are three scales of temperature.

(i)	Celsius scale	(Mostly used for environmental measurements).
(ii)	Fahrenheit scale	(Mostly used for clinical measurements).
(iii)	Kelvin scale	(Mostly used for industrial measurements)

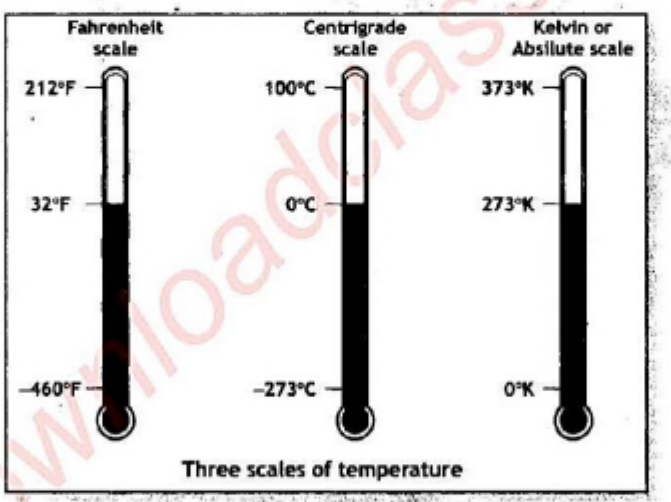
More Information:

The temperature of a small cup of tea might be the same as the temperature of a large cup of tea, but the large cup of tea has more amount of heat, because it has more tea, has an amount of thus more total thermal energy.

Q.6 *Write down the types of scales with which we can measure the temperature.*

Ans: ***Types of Scales:*** There are three types of scales from which we can measure the temperature.

1. ***Celsius Scale or Centigrade:*** In this scale, the lower foxed point is at 0°C which is the freezing point of water and the upper fixed point is at 100°C which is the boiling point of water. The interval between these two points is divided into 100 equal divisions or units. Each division is called a degree Celsius.
2. ***Fahrenheit Scale:*** In this scale, the melting point of ice is taken as the lower fixed point which is marked as 32°F and the boiling point of water is taken as the upper fixed point which is marked as 212°F. There are 180 equal divisions or units between these points.
3. ***Kelvin Scale:*** In this scale, the melting point of ice is taken as 273K and the boiling point of water 373K. There are 100 equal units between these points. The zero of this scale marked 0K starts from –273°C.



Three scales of temperature

Q.7 *How can we convert temperatures from one scale to another scale?*

Ans: These three scales of temperature are interconvertible.
Therefore temperature measured in Celsius scale can be converted into Kelvin and Fahrenheit scales as follows:

Conversion of temperature from Celsius scale to Kelvin scale:

$$K = °C + 273$$

Conversion of temperature from Celsius scale to Fahrenheit scale:

$$°F = 1.8°C + 32$$

More Information:

The specific heat of water is 4200 $Jkg^{-1}K^{-1}$.
The boiling point of water is 100°C.

Q.8 *What is heat capacity? Write its formula and units. Name the factor on which heat capacity depends.*

Ans: ***Heat Capacity:*** Heat capacity is a term in physics that describes how much heat is added to a substance to raise its temperature by 1°C.

Formula: Mathematically $C = \frac{Q}{\Delta T}$

where Q = amount of heat absorbed and ΔT = change in temperature

Unit: The unit of heat capacity is JK^{-1}.

The factor on which heat capacity depends: Heat capacity depends upon the nature of the material. For example, two beakers contain equal masses of water and oil are heated by the same gas burner for three minutes. Then it is observed that the temperature of oil may rise twice that of water.

Q.9 *Define specific heat capacity. Write its expression and unit.*

Ans: ***Specific Heat Capacity:*** When comparing the heat capacity of different substances, we are talking about their specific heat capacity. Hence specific heat capacity can be defined as:
The amount of heat required to raise the temperature of 1 kg of a substance through 1°C is called the specific heat capacity of that substance.

Expression: Equation of specific heat capacity 'c' is as under:

$$c = \frac{C}{m} = \frac{1}{m} = \frac{Q}{\Delta T}$$

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

where "c" is constant which depends upon the nature of the material of the body. This constant is called specific heat capacity or specific heat.

Unit: Its S.I unit is joule per kilogram per Kelvin ($Jkg^{-1}K^{-1}$).

The given table shows the specific heat capacity of different substances of common use.

	Specific heat capacity (J/kg °C)
Water	4.18×10^3
Ethyl alcohol	2.46×10^3
Ice	2.1×10^3
Aluminium	9.2×10^2
Glass	8.4×10^2
Iron	4.5×10^2
Copper	3.8×10^2
Silver	2.4×10^2
Lead	1.3×10^2

Specific Heat Capacity of different substances.

Q.10 *Write down the factors on which specific heat capacity depends.*

Ans: ***Factors:***

1. It depends on the nature of the substance and is entirely independent of its mass and the rise in temperature.
2. If "c" is small for substance, the heat needed will also be small.
3. If "c" is large, the head needed will also be large under the similar condition of mass and rise in temperature for all substance.

Q.11 *What are the effects of large specific heat of water?*
OR Write examples of specific heat capacity from daily life experience.

Ans: ***Effects due to large specific heat of water:*** We know that water has a large specific heat, due to this quality it plays an important role in everyday life.

(i) A large amount of water in oceans and lakes help to maintain the temperature ranges in their surroundings.

(ii) Water with coolant is used to reduce the temperature of an engine through the radiator of the vehicle.

(iii) Water also helps to maintain our body temperature.

More Information:
Soil has a specific heat capacity of 810 $Jkg^{-1}K^{-1}$, which is about 5 times less than that of water.

Q.12 *Define heat of fusion.*

Ans: ***Heat of Fusion:*** The heat absorbed by a unit mass of a solid at its melting point to convert solid into liquid without change of temperature is called "heat of fusion".

Q.13 Define and explain the heat of vaporization.

Ans: ***Heat of Vaporization:*** Heat of vaporization is defined as:
The amount of heat energy required to change the state of a substance from liquid to vapour form, without changing its temperature is called "heat of vaporization".

Explanation: When a beaker is filled with water placed on a burner to boil, the temperature of water gradually raises until it reaches 100°C. At this temperature it starts to boil, that is to say, that bubbles of vapour formed at the bottom and start to rise to the surface and then escape in the form of steam. At this stage, the temperature of water (liquid) and water vapours (gas) is the same. Thus the heat energy which is required to convert water from liquid to vapour state is known as "heat of vaporization".

More Information:
- The heat of fusion for water at 0°C is approximately 334 Joules per gram.
- The heat of vaporization for water at 100°C is about 2230 Joules per gram.

Activity

Encourage students to take solid ice pieces in a container and supply heat through a burner, and observe the process of the heat of fusion in class/lab.

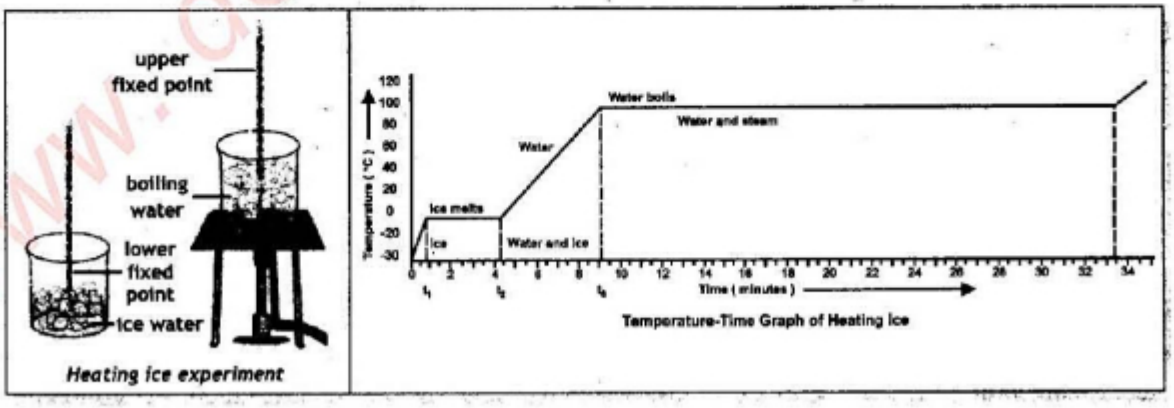
Q.14 Write the experiments to determine the latent heat of fusion and latent heat of vaporization of ice and water respectively.

Ans: Experiments, given below, determine the latent heat of fusion and latent heat of vaporization of ice and water respectively by sketching the temperature-time graph of heating ice. This experiment has two parts.

(i) Conversion of ice into water *(ii)* Conversion of water into steam

Experiment to Convert Ice (solid) into Water (liquid):

Take a container and place it on a stand. Put small pieces of ice in the container. Suspend a thermometer in the container to measure the temperature. Take a stopwatch to measure accurate time at different stages. Now place the container on the burner. The ice will start melting after absorbing heat. The temperature will remain same up to 0°C until all the ice melts. Note the time t_1 and t_2, which the ice takes to melt completely into the water at 0°C. Supply heat continuously to water at 0°C, again note the time, its temperature will start to increase.

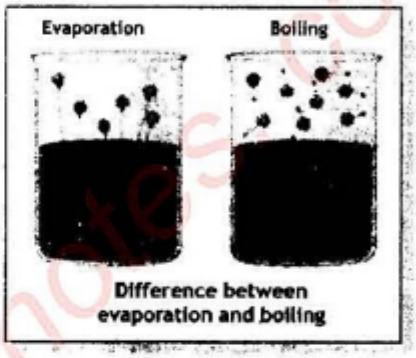


Note the time, which water in the container takes to reach its boiling point at 100°C from 0°C. Draw a temperature–time graph as shown in the given graph. Calculate the heat of the fusion of ice from the data using the graph.

Experiment to Convert Water (Liquid) into steam (Gas): It is continuity of the previous experiment. The container now contains boiling water we continue to supply heat to water, till all the water converts into steam. Note the time during which water in the container completely changed into steam at its boiling point, using the temperature-time graph. Calculate the heat of vaporization of water.

Q.15 *Define and explain evaporation.*

Ans: ***Evaporation:*** The process in which the water changes from liquid to gas or vapour form is known as "evaporation". It is our common observation that wet clothes dry in sun due to evaporation. The water in the wet cloth takes heat energy from the sun and gets evaporated. Similarly, the water taken from the sea is kept under the sun for a long period of time leading to the evaporation of the water molecules and as a result, the common salt is formed, which is left as remnants in this whole process. We mostly notice that water placed in a pot, disappear slowly. It is because of the evaporation process.



Difference between evaporation and boiling

Evaporation Causes Cooling: When evaporation occurs, the molecules of water with greater Kinetic energy escape from its surface. So the molecules of water with lower Kinetic energy are left behind. This results in a decrease in the temperature of the water. Hence, evaporation causes cooling.

Q.16 *Define volatile liquids.*

Ans: ***Volatile Liquids:*** Some liquids have a low boiling point due to which they change from liquid to vapour very easily at ordinary temperature, these liquids are called 'volatile liquids'.

Q.17 *Describe the factors that influencing surface evaporation.*

Ans: ***Factors which Influencing Surface Evaporation:***

(i) ***Temperature:*** With the increase in temperature the rate of evaporation also increases.
(ii) ***Wind Speed:*** The rate of evaporation also increases with the increase in wind speed.
(iii) ***Surface Area of Liquid:*** The rate of evaporation increases with the increase in surface area of the liquid.
(iv) ***Humidity:*** The rate of evaporation decreases with an increase in humidity.
(v) ***Nature of Liquid:*** The nature of liquid also affects the rate of evaporation. Liquid with a lower boiling point have greater vapour pressure and evaporate more rapidly.
(vi) ***Solute Concentration:*** Salty water evaporates more slowly than pure water.

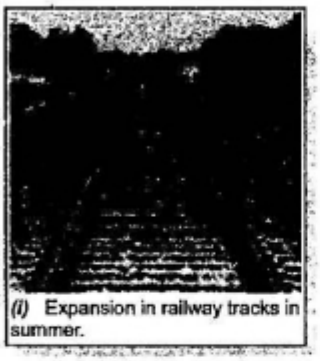
Q.18 *What is the freezing point of ethanol on the Celsius scale?*

Ans: The freezing point of ethanol is –114.1°C.

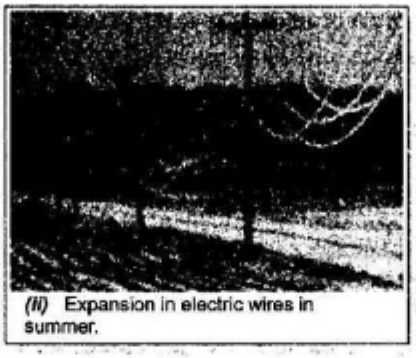
Q.19 *Define thermal expansion. Give some examples of thermal expansion in solids.*

Ans: ***Thermal Expansion:*** Most solid materials expand on heating and squeeze on cooling because on heating the kinetic energy of their molecules increases.
Therefore changes take place in shape, area and volume of the substances with the temperature change. This is called "thermal expansion", defined as:
The expansion of substance on heating is called thermal expansion.

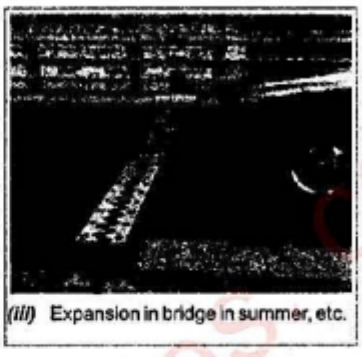
Examples of Thermal Expansion:



(i) Expansion in railway tracks in summer.



(ii) Expansion in electric wires in summer.



(iii) Expansion in bridge in summer, etc.

Q.20 *Define linear expansion. Derive the expression $\Delta L = \alpha L \Delta T$.*

Ans: ***Linear Expansion:*** The expansion in length of a solid object on heating is called linear expansion.

Derivation: It is one-dimensional expansion as it occurs only along the length of the object. Suppose a rod of some material with original length L, at initial temperature T, is heated through a certain temperature T', then its length increase and become L'. Therefore

Change in temperature = $\Delta T = T' - T$ ..... *(i)*

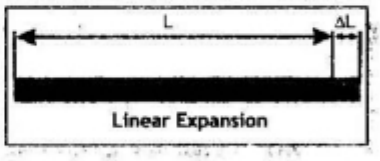
Change in length = $\Delta L = L' - L$ ..... *(ii)*

It has been experimentally proved that change in length is directly proportional to the original length and change in temperature. Therefore

ΔL = (constant)$L\Delta T$ ..... *(iii)*

This constant is denoted by α and is called coefficient of linear expansion. It depends upon the nature of the material. Therefore equation (iii) can be written as:

$\Delta L = \alpha L \Delta T$

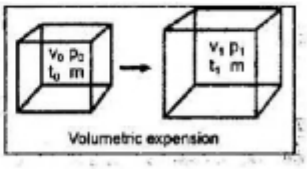


Linear Expansion

Q.21 *Define volume expansion and derive its expression.*

Ans: ***Volume Expansion:*** The expansion in the volume of a solid object on heating is called volume expansion.

It is a three-dimensional expansion as it occurs along the length, width and height of the object.



Volumetric expension

Derivation: Consider a solid body having volume V, at some initial temperature T. When the body is heated its temperature changes from T to T' and its volume becomes V'.

Therefore, Change in temperature = $\Delta T = T' - T$ ..... *(i)*

Change in volume = $\Delta V = V' - V$ ..... *(ii)*

It has been experimentally proved that change in volume is directly proportional to the original volume and change in temperature.

ΔV = (constant) $V\Delta T$ ..... *(iii)*

This constant is denoted by "β" and is called the coefficient of volume expansion. It depends upon the nature of the material.

Therefore equation *(iii)* can be written as:

$\Delta V = \beta V \Delta T$

PHYSICS NOTES FOR CLASS 9TH (FOR SINDH)

Q.22 Show that β = 3α. OR What is the relation between α and β?

Ans: The coefficient of volume expansion of liquid is greater than solids.
As the linear expansion occurs in one dimension whereas volume expansion occurs in three dimensions. Hence, the coefficient of volume expansion "β" is three times than coefficient of linear expansion "α":

Therefore:

$$\beta = 3\alpha$$

Substance	Coefficient
Aluminum	25×10^{-6}
Brass or Bronze	19×10^{-6}
Brick	09×10^{-6}
Copper	17×10^{-6}
Glass (Plate)	09×10^{-6}
Glass (Pyrex)	03×10^{-6}
Ice	51×10^{-6}
Iron or steel	11×10^{-6}
Lead	29×10^{-6}
Quartz	0.4×10^{-6}
Silver	19×10^{-6}

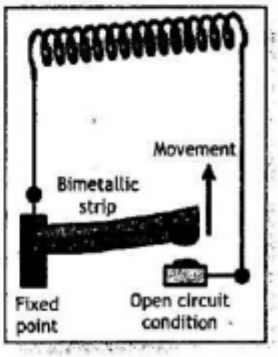
Q.23 Name some applications of thermal expansion.

Ans: ***Application of Thermal Expansion:*** Thermal expansion of solids is useful in some situations of daily life and in some situations it creates problems. Some applications of thermal expansion are:

(a) Bimetallic thermostat *(b)* Rivets *(c)* Car Radiator Coolant
(d) Mercury in Thermometer

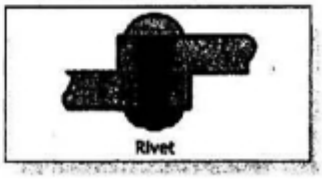
Q.24 Define bimetallic thermostat. What are its uses?

Ans: ***Bimetallic Thermostat:*** Bimetallic thermostat is used to control the temperature of ovens, irons water heaters, refrigerators, air-conditioners and so on. It is designed to bend when it becomes hot. Two metals with different coefficients of linear expansion are joined firmly to make it. When it is heated, the metal with a large value of the coefficient of linear expansion causes the strip to bend. In this way, it cuts off the current supply. The current supply to the circuit is restored when it cools down.



Q.25 What are rivets? Write their uses.

Ans: ***Rivets:*** Rivets are used in shipbuilding and other industries to join metal plates. A red-hot rivet is passed through holes in two metal plates and hammered until ends are rounded. The rivet contracts on cooling and pulls the two plates tightly together.



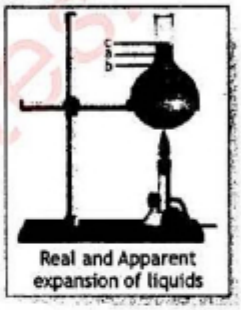
Q.26 How can a metal rim be fixed on a wooden wheel?


Wooden Wheel

Ans: A metal rim can be fixed on a wooden wheel of a bull cart. The diameter of the metal rim is set a little bit smaller than the diameter of the wooden wheel. The diameter of the metal rim increases on heating and can easily be put over the wooden wheel. It contracts on cooling and holds the wooden wheel tightly.

Q.27 What do you know about the real and apparent expansion of liquids?

Ans: ***Real and Apparent Expansion of Liquids:*** Consider a flask, filled with water up to level "a". The flask is placed on a burner, as shown in the given figure.



Real and Apparent expansion of liquids

Heat starts to flow through the flask to water. So, the flask expands first. Due to the expansion of the flask, the level of water falls from point "a", level L_1 to point "b", level L_2. So, when water gets heated, it starts to expand from a point "b" beyond its original level.

Thus the expansion of water appears from level "L_1" point "a" to level "L_2" point "c" is called "apparent expansion of water". But in a real sense, the water on heating has expanded from level "L_2" point "b" to level "L_3" point "c" which is the "real expansion of water".

Real expansion = L_2 to L_1 i.e. from point "b" to "c", as shown in the figure.

Q.28 Explain two types of thermal expansion.

Ans: See "Short & Detailed Answer Questions" - Q.20 & Q.21

Q.29 How would you find the specific heat of a solid?

Ans: ***Method:***

In this method a certain amount of water of known mass and temperature is kept in a vessel called calorimeter. Usually we fill the two-third of the calorimeter with water at room temperature. A known mass of substance (solid), whose heat is to be determined, is heated through a certain temperature and then put in to the water contained in the calorimeter. According to the law of heat exchange, the heat is lost by the hot substance and gained by the water and calorimeter. we take the following observations.

Observations:

Mass of the calorimeter and stirrers	$= m_1$ kg
Mass of the calorimeter + stirrer + H_2O	$= m_2$ kg
Temperature of the calorimeter + H_2O	$= t_1$°C
Temperature of the substance	$= t_2$°C
Temperature of the mixture	$= t_3$°C
Mass of calorimeter + stirrer + H_2O + substance	$= m_3$ kg
Mass of H_2O	$=(m_2 - m_1)$ kg
Mass of substance	$= (m_3 - m_2)$ kg
Specific heat of water	$= C = 4200$ J/kg K
Specific heat of Calorimeter made of copper	$= C_1 = 390 \frac{J}{kg\ K}$
Specific heat of substance	$= C_2$

Calculation

Now we calculate the heat lost and gained separately

Heat lost by the substance $= C_2 (m_2 - m_3) (t_2 - t_3)$

Now we calculate heat gained by the calorimeter and water

Heat gained by the calorimeter $= C_1m_1 (t_3 - t_1)$

Heat gained by water $= C(m_2 - m_1) (t_3 - t_1)$

So, the total heat gained by calorimeter and water is,

Heat gained $= C_1m_1(t_3 - t_1)+C(m_2 - m_1)(t_3 - t_1)$

By using law of heat exchange,

Heat lost = Heat gained

$C_2 (m_1 - m_2)(t_2 - t_3) = C_1m_1 (t_3 - t_1) + C(m_2 - m_1) (t_3 - t_1)$

$$C_2 = \frac{C_1m_1 (t_3 - t_1) + C(m_2 - m_1) (t_3 - t_1)}{(m_1 - m_2)(t_2 - t_3)}$$

Q.30 ***Write down the freezing and boiling points of following: (i) Acetic acid (ii) Benzene (iii) Chloroform (iv) Water***

Ans:

Water	0.0	100
Acetic acid	17.0	118.1
Benzene	5.5	80.2
Chloroform	-63.5	61.2
Ethanol	-114.7	78.4

Freezing and boiling points of different solvent

Differences

01. ***Differentiate between heat and temperature.***

Ans:

	Heat	Temperature
01	Heat is energy that flows from a high temperature object to low temperature object.	Temperature is degree of hotness and coldness.
02	Heat of a body is the sum of all kinetic and potential energy of all molecules constituting the body.	Temperature of a bady is the average kinetic energy of its molecules.
03	Heat can be measured by a calorimeter.	Temperature of a bady is measured by thermometer.
04	S.I. unit of heat is Joule.	S.I. unit of temperature is Kelvin (K), but it is also measured on "F" or "C" scales.

02. ***Write down the differences between heat capacity and specific heat capacity?***

Ans:

	Heat Capacity	Specific Heat Capacity
01	It is defined as the quantity of heat required to produce unit temperature change.	It is the quantity of heat to change the temperature of unit mass of a substance by one degree Celsius

03	Its S.I. unit is J/K.	Its S.I. unit is J/kg K.
04	Its value depends on mass and nature of the substance.	Its value depends on the nature of the substance.

03. ***What are the differences between boiling point and evaporation?***

Ans: ***Difference between Boiling point and Evaporation***

	Evaporation	***Boiling***
01	It takes place without the supply of external heat source.	It only takes place with the supply of external heat source.
02	It occurs at any temperature below boiling point.	It occurs only at a certain temperature called "boiling point"
03	It causes cooling.	It does not causes cooling.
04	It is relatively slow.	It is relatively slow.
05	It take place only at the liquid surface.	It take place throughout the liquid.
06	No formation of bubbles	Bubbles are formed.

04. ***Differentiate between the heat of fusion and heat of vaporization.***

Ans:

	Heat of Fusion	***Heat Of Vaporization***
Definition	The amount of heat that a solid substances requires to change its phase from solid phase to liquid phase at a constant temperature	The amount of heat that a liquid substance requires to change its phase from the liquid phase to vapor phase at a constant temperature
Chemical Symbol	Latent heat of fusion is denoted by H_f	Latent heat of Vaporization is denoted by H_v
Temperature	The change in heat the melting point of a substance.	The change in heat the boiling point of a substance.

Scientific Reasons

01. ***Why we cannot tell the temperature of a body by touching it?***

Ans: Sense of touch, not a reliable technique to measure hotness or coldness because if we take our hand from cold water to normal water, it appears warm. On the other hand, if we take our hand from warm water to normal water, it appears cold. Thus, the same water may give us different feelings.

One reason is that we can't feel the temperature of an object, we feel the temperature of our own flesh. When we touch something hot, it heats up our skin, and that heat in our skin is what we feel. That may seem trivial, but the problem is that our body is constantly circulating blood into our flesh, which means that, if we touch something with low thermal conductivity (Styrofoam, for example), the temperature of our own blood will tend to overwhelm the temperature flow from the object, making it impossible to accurately gauge the temperature of the object itself.

02. ***Why does sand heat up quicker than water?***

Ans: Water has very high specific heat, while the sand has relatively low specific heat, therefore the sand heats up very quickly with little energy.

PHYSICS NOTES FOR CLASS 9TH (FOR SINDH)

03. ***Why does the temperature not increase when ice is heated at 0°C?***

Ans: When we heat ice, the individual molecules gain kinetic energy, but until the temperature reaches the melting point, they don't have the energy to break the bonds that hold them in a crystal structure. They vibrate more quickly within their confines as we add heat, and the temperature of the ice goes up. At a critical point - the melting point - they acquire enough energy to break free. When that happens, all the heat energy added to the ice is absorbed by H_2O molecules changing phase. There's nothing left to increase the kinetic energy of the molecules in the liquid state until all the bonds holding the molecules in a crystal structure have been broken. Consequently, the temperature remains constant until all the ice has melted.

04. ***Why does the temperature not increase when water is heated at 100°C? Explain.***

Ans: When water is kept boiling, the temperature remains at 100 °C (212 °F) until the last drop evaporates because all the heat being added to the liquid is absorbed as latent heat of vaporization and carried away by the escaping vapour molecules.

05. ***Why does evaporation cause cooling?***

Ans: When evaporation occurs, the molecules of water with greater Kinetic energy escape from its surface. So the molecules of water with lower Kinetic energy are left behind. This results in a decrease in the temperature of the water. Hence, evaporation causes cooling.

06. ***Why do we feel cold when we come out directly under a heavy wind after taking bath?***

Ans: We feel cold when we come out directly under a heavy wind after taking bath. This is due to the reason that water molecules with greater kinetic energy escape from our skin surface, while the molecules with lower kinetic energy are left behind. This lowers the temperature of the water on our skin and we feel cold.

07. ***Water causes our skin to become cold but it is not felt as spirit. Why?***

Ans: Methylated ether has a low boiling point. If a little amount of methylated spirit is taken on our hand, it evaporates rapidly and our hand feels instantly cold. To change spirit from liquid to vapour requires latent heat which is obtained from our hand thus our hand losses heat and we feel cool. Water also causes the hand to become cold but it is not felt as spirit. The water has a high boiling point than spirit so it evaporates slowly at the temperature of our hand and hence it does not cause the cooling effect.

08. ***Why do solid expand? OR What is the reason for the expansion of solids on heating?***

Ans: ***Expansion of Solid:*** The molecules of solid materials vibrate at their mean positions. So, when a solid is heated, its molecules vibrate with greater amplitudes due to an increase in its kinetic energy. As a result, the solid expands its length and volume.

09. ***Engine coolant is used in car radiator in place of pure water. Why?***

Ans: Engine coolant is used in car radiators in place of pure water because water has greater volume expansion it can expand enough to damage the engine or radiator.

10. ***Why is mercury used in thermometers?***

Ans: ***Mercury in Thermometer:*** Mercury expands on heating and contracts on cooling. It does not stick to the walls of a thermometer. Therefore Mercury is placed in a long-sealed capillary tube in a thermometer. Change in the temperature is measured by the position of mercury in a capillary tube which has calibrated marks "F", C or K scale.

11. ***Small gaps are left at the joints of a section of rail tracks. Why?***

Ans: The rail tracks are made up of metals and hence they expand in summer due to hot weather. Hence, small gaps are left at the joints of a section of tracks. This allows the tracks to expand safely. If these gaps are not left between the tracks, the tracks buckled and trains would be de tracked (derailed).


Gap between Rail Tracks

12. ***Why does heat flows from a hot body to a cold body?***

Ans: The atoms of a hot body have higher Kinetic Energy than that of a cold body. So the atoms of the hot body move and collide with the atoms of the cold body and transfer heat. Since the atoms of the cold body are at a lower kinetic energy level hence they do not move and collide.

PHYSICS NOTES FOR CLASS 9TH (FOR SINDH)

Section D — Numerical

Worked Examples of the Textbook

01. ***The temperature of Hyderabad on a hot day is 45 degrees Celsius (45°C). What will be its equivalent temperature on Fahrenheit Scale?***

Solution:

Step 1: Write the known quantities and point out quantities to be found.

$°C = 45°$ $°F = ?$

Step 2: Write the formula and rearrange if necessary.

$°F = 1.8°C + 32$

Step 3: Put the value in formula and calculate.

$°F = 1.8\ (45) + 32 = 113°$

Hence, the equivalent temperature in the Fahrenheit scale is 113°F.

02. ***The thermal energy required to raise the temperature of 50g of water from 40°C to 70°C is 6300 Joules. Calculate the specific heat capacity of water.***

Solution:

Step 1: Write down known quantities and quantities to be found.

$T_1 = 40°C = 40°C + 273 = 313\ K$ $T_2 = 70°C = 70°C + 273 = 343\ K$

$\Delta T = T_2 - T_1 = 343\ K - 313\ K = 30\ K$ $\Delta Q = 6300\ J$

$m = 50\ g = 0.05\ kg$ $c = ?$

Step 2: Write down formula and rearrange if necessary.

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

Step 3: Put values in the formula and calculate.

$$c = \frac{(6300\ J)}{(0.05kg)(30\ K)} = 4200\ Jkg^{-1}K^{-1}$$

Hence, the specific heat of water is $c = 4200\ Jkg^{-1}K^{-1}$

03. ***A copper rod 15m long is heated, so that its temperature changes from 30°C to 85°C. Find the change in the length of the rod. The coefficient of linear expansion of copper is $17 \times 10^{-6}°C^{-1}$.***

Solution:

Step 1: Write down known quantities and quantities to be found.

$L = 15\ cm$ $T = 30°C$ $T' = 85°C$

$\Delta T = T' - T = 85°C - 30°C = 55°C$

$\alpha = 17 \times 10^{-6}°C^{-1}$ $\Delta L = ?$

Step 2: Write down the formula and rearrange if necessary.

$\Delta L = \alpha L \Delta T$

Step 3: Put values in the formula and calculate.

$\Delta L = (17 \times 10^{-6}°C^{-1})(15\ m)(55°C) = 0.014\ m$

Hence, the change in length of the copper is 0.014m.

PHYSICS NOTES FOR CLASS 9TH (FOR SINDH)

Solved Numerical

(01.) ***Convert 30° into Kelvin and Fahrenheit Scale.***

Solution:

Data: °C = 30° K = ? °F = ?

Working Formula: To convert °C into °F: °F = 1.8°C + 32

°F = 1.8(30) + 32 = 54 + 30 = 84

°F = 84° Ans.

To convert °C into K: K = °C + 273

K = 30 + 273 = 303 K

K = 303 K Ans.

(02.) ***Convert 212°F into Celsius and Kelvin.***

Solution:

Data: °F = 212° °C = ? K = ?

Working Formula: To convert °F into °C: °F = 1.8°C + 32

$1.8°C = °F - 32$

$°C = \frac{°F-32}{1.8}$

$°C = \frac{212-32}{1.8} = \frac{180}{1.8} =$ 100°C Ans.

To convert °C into K: K = °C + 273

K = 100 + 273 = 373 K Ans.

(03.) ***How much heat is required to boil 3 kg water which is initially 10°C?***

Solution:

Data: m = 3 kg T_1 = 10°C T_2 = 100°C

$\Delta T = T_2 - T_1$ = 100°C − 10°C = 90°C

c = 4200 J/kg°C Q = ?

Working Formula: $c = \frac{\Delta Q}{m\Delta T}$

$\Delta Q = cm\Delta T$

Calculation: ΔQ = (4200)(3)(90) = 1134000 J = 1134 KJ Ans.

(04.) ***2 kg of copper requires 2050 J of heat to raise its temperature through 10°C. Calculate the heat capacity of the sample.***

Solution:

Data: m = 2 kg ΔT = 10°C c = 385 J/kg.°C ΔQ = ?

Working Formula: $c = \frac{\Delta Q}{m\Delta T}$

$\Delta Q = cm\Delta T$

Calculation: ΔQ = (385)(2)(10) = 7700 J Ans.

(05.) ***An iron block of volume 3m³ is heated so that its temperature changes from 25°C to 100°C. If the coefficient of linear expansion of iron is 11 × 10⁻⁶°C⁻¹, what will be the new volume of iron block after heating?***

Solution:

Data: V = 3 m³ T = 25°C T' = 100°C

ΔT = T' - T = 100°C - 25°C = 75°C

α = 11 x 10⁻⁶°C⁻¹ ΔV = ?

We know that β = 3α, therefore β = 3(11x10⁻⁶) = 0.000033 °C⁻¹

Working Formula: ΔV = βVΔT

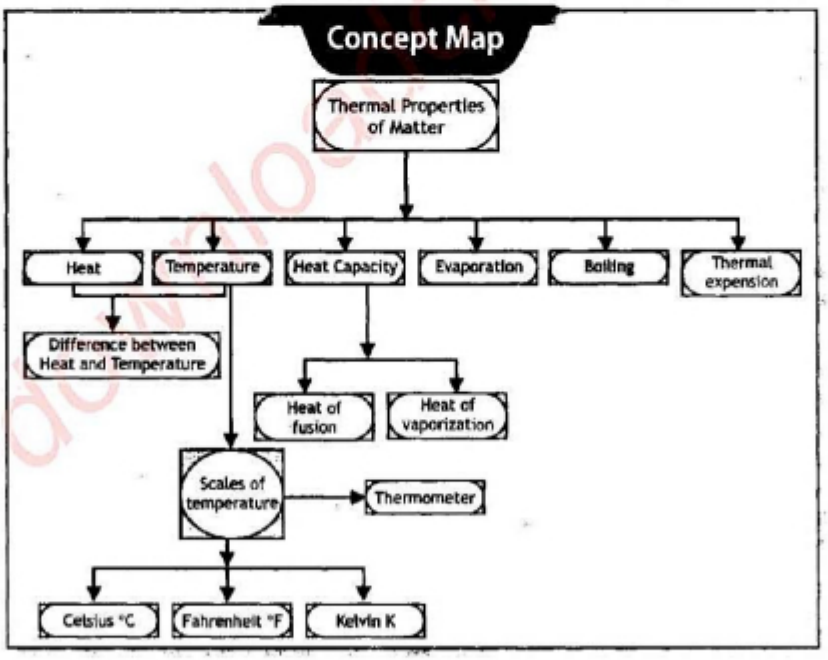
Calculation: ΔV = (0.000033°C⁻¹)(3 m³)(75°C) = 0.007425 m³ Ans.

PHYSICS NOTES FOR CLASS 9TH (FOR SINDH)

Summary

- Heat is the form of energy and its unit is Joule.
- The degree of hotness or coldness of a body is called temperature.
- The temperature that determines the direction of the transfer of thermal energy is called temperature.
- Three different scales, Celsius, Fahrenheit and Kelvin are used for quantitative measurement of temperature.
- The temperature on the Celsius scale is converted into Kelvin using $K = °C + 273$.
- Temperature on Celsius scale is converted to Fahrenheit using: $F = 1.8\ °C + 32$
- Thermal energy transfer required per unit mass to raise the temperature by 1°C or 1K is called specific heat capacity.
- The product of mass and specific heat capacity is called thermal capacity or heat capacity of an object.
- Thermal energy transfer required to change the state of a substance from solid to liquid without changing its temperature is called the latent heat of fusion.
- Thermal energy transfer required to change the state of a substance from a liquid into a gas without changing its temperature is called heat of vaporization.
- The process in which liquid changes into a gas without any external energy supply is called evaporation.
- The real expansion of water is the sum of apparent expansion of water and volume expansion of flask.
- Temperature, humidity, the surface area of liquid, pressure, boiling point and moving air are the factors that affect the evaporation process of a liquid.
- An increase in length or size of a substance on heating is called thermal expansion.
- An increase in the length of a solid, when heated, is called linear thermal expansion.
- An increase in the volume of a solid, when heated, is called volume thermal expansion.
- Volume thermal expansion of a solid depends upon an increase in temperature, its original volume and properties of the material.
- The increase in the volume of a solid after heating is calculated by using $\Delta V = \beta V_o \Delta T$.

Concept Map



End of Unit Questions Solution

SECTION – A: MULTIPLE CHOICE QUESTIONS

Tick Mark (✓) the correct answer:

See "Multiple Choice Questions (M.C.Qs)" – (1) to (11)

PHYSICS NOTES FOR CLASS 9TH (FOR SINDH)

SECTION – B: STRUCTURED QUESTIONS

Heat and Temperature

01. ***(a)*** ***Define Heat and write its S.I unit.***
(b) ***Why does heat flows from hot body to cold body?***
(c) ***Convert 30° into Kelvin and Fahenheit Scale.***

Ans: For (a) see 'Short & Detailed Answer Questions' – Q.1 (b) see " Scientific Reasons" – Q.12
(c) see " Solved Numerical" – Q.1

02. ***(a)*** ***Explain three different scales of temperature along with their main uses.***
(b) ***Differentiate between heat and temperature.***
(c) ***Convert 212°F into Celsius and Kelvin.***

Ans: (a) See "Short & Detailed Answer Questions" – Q.5 & Q.6
(b) See "Differences" – Q.1 (c) See "Solved Numerical" – Q.2

Specific Heat Capacity

03. ***(a)*** ***Explain specific heat capacity***
(b) ***How would you find the specific heat of a solid?***
(c) ***How much heat is required to boil 3 kg water which is initially 10°C?***

Ans: (a) See "Short & Detailed Questions" – Q.9
(b) See "Short & Detailed Questions" – Q.29 (c) See "Solved Numerical" – Q.3

04. ***(a)*** ***Explain the effects of large specific heat of water with examples from our daily life.***
(b) ***2 kg of copper requires 2050 J of heat to raise its temperature to 10°C. Calculate the heat capacity of the sample.***

Ans: (a) See "Short & Detailed Questions" – Q.11 (b) See "Solved Numerical" – Q.4

The Heat of Fusion and Heat of Vaporization

05. ***Define heat of fusion with the help of an experiment.***

Ans: See "Short & Detailed Questions" – Q.12 & Q.14

06. ***Differentiate between the heat of fusion and heat of vaporization.***

Ans: See "Differences" – Q.4

07. ***Demonstrate heat of fusion and heat of vaporization with the help of heating ice graph.***

Ans: See "Short & Detailed Questions" – Q.14

Evaporation Process

08. ***Explain in detail, why evaporation causes cooling.*** ***Ans:*** See "Scientific Reasons" – Q.5

09. ***Differentiate between evaporation and boiling.*** ***Ans:*** See "Differences" – Q.3

10. ***Write any four factors that influence surface evaporation.***

Ans: See "Short & Detailed Answer Questions" – Q.17

11. ***Write down the freezing and boiling points of the following:***
(i) Acetic acid (ii) Benzene (iii) Chloroform (iv) Water

Ans: See "Short & Detailed Answer Questions" – Q.30

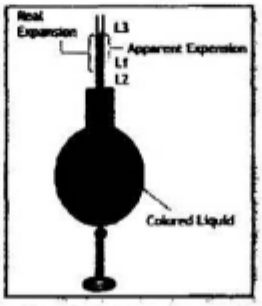
Thermal Expansion

12. ***Why do solids increase in size on heating? Explain.*** ***Ans:*** See "Reasons" – Q.8

13. ***An iron block of volume $3m^3$ is heated so that its temperature changes from 25°C to 100°C. If the coefficient of linear expansion of iron is 11×10^{-6} °C^{-1}, what will be the new volume of iron block after heating?*** ***Ans:*** See "Solved Numerical" – Q.5

14. ***(a)*** ***Draw the diagram, showing a real and apparent expansion of the liquid. Label the diagram properly.***

Ans:



(b) ***Why small gaps are left at the joints of sections of railway tracks? Explain the phenomenon involved in it.***

Ans: See "Reasons" – Q.11 and See "Short & Detailed Answer Questions" – Q.19 & Q.20