THERMAL PROPERTIES OF MATTER

Q.1 Define heat and temperature? Also show deference b/w them?

Ans. Heat:- The form of energy which transfers from one body to another body due to difference of temperature between them is called heat

(OR) The total K.E of molecules of a body is called heat.

Temperature:-The degree of coldness or hotness a body with respect to some standard is called temperature (OR) The average K.E of molecules of a body is called temperature.

⇨ **Difference b/W heat and temperature**

S.NO	Heat	S.NO	Temperature.
1	it is the total K.E of molecules of a body.	1	It is the average K.E of molecules of a body.
2	It gives the sensation of warmth	2	It is the degree of coldness or hotness of a body.
3	It's units are joul and calories.	3	It's units are kelvin, centigrade and Fahrenheit.

Q.2 Define thermometry? Also explain thermometric property? And temperature scale?

Ans. Thermometric: - The branch of physics which deals with the measurement of temperature.

Thermometric property:-we measure temperature by on instrument called thermometer. For construction of a thermometer we use certain physical property of matter which decreases or increases uniformly with change in temperature and this property is used for measurement of temperature which is known as thermometric property.

Usually we use the property of expansion. For example the expansion of mercury and alcohol is uniform which is mostly used for measurement of temperature in thermometer.

Temperature Scale:- see Q4

Q.3 what is thermometer? Also explain liquid in glass thermometer and clinical thermometer?

Ans. Thermometer:- The instrument which is used for measurement of temperature is called thermometer it is based on the principle of expansion of liquids on heating.

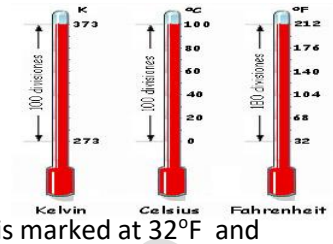
⇨ **liquid in glass thermometer:-** it consist of a graduated glass tube whose one end is sealed and the other is filled with a bulb. And glass is filled with mercury. When bulb of thermometer is heated the mercury expands up and we can easily record the reading liquid in glass thermometer is most commonly used in labor tries and it has a temperature of -10^{o}c to 110^{o} c.

⇨ **clinical thermometer:-** this thermometer consists on a glass stem whose one end is fitted with a bulb and other is sealed the stem is filled with some standard liquids like mercury etc. A small bend is given to glass stem near the bulb, so that to prevent from the easy flow of mercury toward bulb.

This thermometer is mostly used by doctors and nurse its scale only extends over a few degrees on either sides of normal body temperature 37^{o}c of 98^{o}F. There for the range of a clinical thermometer is from 35^{o}c to 43^{o}c or from 95^{o}c to 110^{o}f.

Q.4 what is meant by thermometric scale? Also discuss different sales?

Ans. <u>Thermometric or temperature scale :-</u> the scale which is made for the measurement of temperature is called temperature or thermometric scales. There are two reference points which are called fixed points and the distance b/w these points is divided in small parts and each has given a specific numerical value. There are three scales of temperature which are given below.



i. **<u>Celsius or centigrade scale:-</u>** that scale at which ice fixed point is marked o°c and steam fixed point is marked 100°c. the distance between these two point is divided into 100 equal parts and each part is known as 1 Celsius or centigrade and it is denoted by "°c" it is shown in figure.

ii. **<u>Fahrenheit scale (°F):-</u>** that scale at which ice fixed point is marked at 32°F and steam fixed point is marked at 212° F is called Fahrenheit scale the distance between these two points is divided into 180 equal parts ands each part is called one degree Fahrenheit which is denoted by :"° F"

iii. **<u>Kelvin (OR) Absolute scale:</u>** That scale at which the ice fixed point in marked at 273k and boiling point is marked at 373k. The distance between these two points is divided into 100 equal parts and each part is known as on Kelvin and denoted by k.

Q.5 Explain conversion of temperature scale?

Ans. <u>Relation b/w different scales of temperature:-</u>some time we need to convert the temperature measured co efficient of linear expansion and "d" is give by;

D = $\Delta L/Lo\Delta T$……(4)

If we have Lo = 1m and $\Delta T = 1^o$ then eq (4) becomes;

D = $\frac{\Delta L}{1.1} => d = \Delta L$ … … … … … ….(5)

So, according to eq (5) we can define "a" as the increase in per unit length per degree is called co efficient ;of linear expansion of that body the value of a depends upon the nature of material and it is different for different materials the S.i unit of co efficient of linear expansion is K.

Now as we know that find length of rod is given by;

L_t = L + ΔL……(6)

Putting value of $\Delta L\ from\ eq\ (3) in\ given\ by;\ \Delta L = a\ Lo\Delta T$

Lt = Lo + d Lo ΔT … … … … … . (7)

Eq (1) shows the final length of rod**.**

Q.6 Define and explain volume(cubical) expansion?

=> **<u>cubical expansion:-</u>**the expansion occurred in the volume of substance due to heat is called volume or cubical thermal expansion.

<u>Explanation:-</u> let suppose the initial volume of a block is "vo" at temperature to when temperature is increased by $\Delta T\ then its\ volume\ is\ also\ increased\ by\ \Delta v$ .the increase in volume is directly proportional to original volume of block and change in temperature.

i.e $\Delta v\ \varphi$ vo ……(1)

.$\Delta v\ \varphi\ \Delta T$ … … … … … . (2)

Combining eq (1) and eq (2) we get

.$\Delta v\ \varphi v_o \Delta T$

⇨ $\Delta v = \gamma v_o \Delta T \quad => \gamma = \frac{\Delta v}{vo\Delta T}$……(3)

⇨ $where$ "γ" is constant and it is co efficient of volume expansion now of v_o=1m^3 and $\Delta T = 1^o$ then eq (3) becomes,

$\gamma = \Delta v/1m.1^o$

$\gamma = \Delta v$……(4)

$so\ we\ can\ also\ define\ y\ as\ change\ per\ unit\ volume\ per\ degree$ rise in temperature is known as co-efficient of volume expansion it depends upon material and is different for different materials its unit is K^{-1} co efficient of volume expansion of solids is three times the co efficient of linear expansion y = 3d

now the final volume of a body is given by;

$v = v_o + \gamma v_o \Delta T$

$v = v_o (1 + \gamma \Delta T)$

$by\ this\ equation\ we\ can\ find\ the\ final\ volume\ of\ a\ body;$

Q.7 Give some practical application of thermal expansion?

Ans. Some practical application of thermal expansion in our daily life is given below.

- **Railway line:-**During the construction of railway lines small gapes are lift in rails, Because they are made of steel which expand in summer and contract in winter so by gapes we can prevent by bending of rails.
- **To remove a tight glass stopper from a bottle:-** when a bottle top is too tight to open then we place the bottle top in got water for a while because of which the bottle top expands which can be opens easily.
- **Fixing of iron ring to a cart wheel:-** when we place on iron ring around Tonga wheel we heat it before placing because the diameter of wheel of Tonga is greater than ring at room temperature but on heating the ring expands. Which can be placed around wheel?
- **Gapes b/w the roof girders and steel bridges:-**Gapes are lift at the end of roofs. Iron girders and steel bridges. Because in summer the girders and steel of bridges expands due to heat so by gape we can avoid bending.
- **Bimetallic strips:-**bimetallic strips are consists of two strips who co efficient of expansion are very different from each other. When there is increase in their temperature they expand unequally and this property of bimetallic is used for different purposes.

Q.8 what is meant by thermal expansion of liquids? Also explain real and apparent expansion of liquids?

- **Expansion of liquids:-**The increase in volume of liquid is known as thermal expansion of liquids as we know that liquids have neither length nor area so, we study only volume expansion of liquids in case of liquids there is two types of expansion given below.
- **Real expansion of liquids:-**The real increase in the volume of a liquid because of heat is called real expansion (Vernal) of liquid?
- **Apparent expansion of liquids:-**apparent increase in the volume of a liquids because of heat is called apparent expansion (V apparent) of liquids.
- **Explanation:-**we can explain the expansion of liquids as well as real and apparent expansion of liquids when a liquid is heated in container as shown 1st the volume of liquid falls from "A" to "B" when this liquid is more heated it rises again to point "c" in this experiment expansion b/w "A εc"

  Is known as apparent expansion while expansion.

  b/w "B ε C is known as real expansion.

  Ie real expansion = Apparent expansion + expansion of flask.

  BC = AC + AB

  Where expansion b/w "A εB" shows expansion of flask. Because on heating 1st the container expands and then liquid expands. Real increase in a cubic meter volume of liquid because of 1k rise in temperature is called co efficient of real expansion and it is represented by $\gamma_v = \gamma a + \gamma g$

Q. 9 explain the anomalous expansion of water? Also describe its effect's?

Ans. **Anomalous expansion of water:-** Generally when the temperature of liquids increases from O°C .they begins to expand but when the temperature of water increases form 4°C it begins to expand.

Similarly when temperature decreases the water begins to contract. When temperature falls from4^{o}C to O^{o}C then the water begins to expand. Thus the ice possesses greater volume than water and can float easily on surface irregular or anomalous expansion of water.

- **Effects of anomalous of water.**
  In cold season, the surface water of lake may be frozen. But at depth, the water remains at 4^{o}c which keeps the marine animals in safe and sound condition.
- In winter season, the water may be frozen inside the pipes and due to expansion the frozen water the pipes often burst in winter season.
- The water absorbed by rocks freezes in winter season and thus expand as a result breaks occurs in rocks.

Q10: Define And Explain Heat Capacity?

Ans: **Heat Capacity:** "The quantity of heat required to rise the temperature of a substance by 1 ^{0}c or 1K is called heat capacity of a substance".

Explanation:

If "ΔQ" is change in heat and "ΔT" is change in temperature then heat capacity is given by following cm=ΔQ/ΔT

The value of "cm" depends upon the following.

1) The nature of material.
2) The mass of material.
3) The rise in temperature.

It's unit in S.I is jowl per Kelvin i.e. J/k.

Q11: Define and explain specific heat capacity?

Ans: Specific Heat Capacity: "The amount of heat required to raise the temperature of 1Kg of a substance by 1^{0}C or 1 K is called specific heat capacity.

Explanation: The amount of heat depends upon mass of body "m" and change in temperature "ΔT" as given below.

ΔQ ∝ m (i)

ΔQ ∝ ΔT (ii)

Combining Eq (i) and Eq (ii) we get.

ΔQ ∝ mΔT = ΔQ=Constant mΔT

=ΔQ = C. mΔT = C= ΔQ/mΔT.

Where "C" is knowing as specific heat capacity of substance and its unit is J/Kg.K.

Q12: Describe the effects of high specific heat of water?

Ans: As we know that water has a highest specific heat. So in this universe it is a very useful material for storing and caring huge amount of heat energy. Some effects of its high specific heat are given below.

1) **Hot Water bottles:** A hot water bottle remains warm for a long time. It can be use for therapeutic and other useful purposes.
2) **Water as coolant in radiator:** Water carries the unwanted heat from engine of a car to radiator and keep the engine in working condition.

3) **Internal heating of building:** The water can be used the internal heating of a building during winter season. The hot water carries huge amount of heat from the surface to the room. By this way moderate temperature can be maintained inside the room.

Q13: What is meant by latent heat of fusion of solids and specific latent heat of fusion of solids? Explain the hidden heat by molecular theory?

Ans**: Latent heat of fusion of solid:**

The amount of heat required to convert a given mass of a substance from solid state of liquid state without any rise in temperature is called latent heat of fusion of solids.

Specific latent heat of fusion of solids:

The amount of heat energy required to convert a mass of 1 KG from a solid state without any rise in temperature is knowing as specific latent heat of fusion of solids.

Explanation of hidden heat by molecular theory:

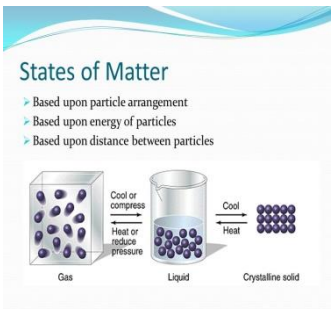
When a solid is heated The K.E of molecules increases because of which vibration and amplitude of molecules also increases due to which the intermolecular force among molecules becomes weaker and weaker. As a result the molecules of solids begin to separate from each other and this solid starts to melt. This process continues until the whole solid is converted into liquid state.

During this process the given heat is totally used for conversion of solid into liquid state. So temperature remains constant An this constant heat is known as latent heat of fusion of solids.

If "ΔQ" is the amount of heat given to a mass "m" then the latent specific can be written as: Hf=ΔQ/m

Q14: Explain change of state of water an ice to water phase diagram?

Ans: **Change of state of matter:**



Suppose a heat is given to a beaker which is filled with pieces of ice and a thermometer is also inserted in ice as shown .

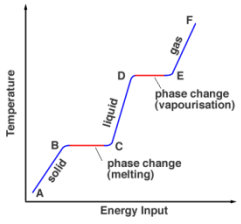
Let the initial temperature of ice is -10^{0}c which changes 0^{0}c because of heat and ice begins to melt. At this stage there is no further change in temperature because of total amount of heat supplied is used to convert ice into liquid and this heat is called latent heat of fusion of ice.

Now when ice is totally converted into water and then temperature is reaches to 100^{0}c and water start boiling . Now on further heating there is no change in temperature because the total amount of heat is used to change water into vapors. And this heat is known as latent heat of vaporization.

Ice to water phase diagram: Ice to water phase diagram is shown in figure. Where point shows total ice at -10^{0}c. "AB" shows rise in temperature from -10^{0}c to 0^{0}c because of heat.

Point "B" Shows melting point of ice. Line "BC" shows latent heat of fusion

Of ice and there is no changes in temperature.



Line "CD" show rise in temperature from 0^0c to 100^0c and point "D" shows

Boiling point of water.

At line "DE" there is no change temperature and it shows latent heat of vaporization.

Q15: What do you mean by latent heat of vaporization and specific latent heat of vaporization?

Explain hidden heat by molecular theory?

Ans: **Latent heat of vaporization:**

The amount of heat energy required to vaporize a given mass of liquid at its boiling points without any rise in its temperature is known as latent heat of vaporization.

Specific latent heat of vaporization:

The amount of heat energy required to vaporize 1kg of a liquid at its boiling point without any rise in temperature is called specific latent heat of
vaporizatio
ΔQ *is the amount of heat energy whic vaporize a mass* m*then the latent heat of vaporization is given by*;

ΔQ = mHv =>**(HV) liquid =** $\Delta Q/m$

Where Hv is latent heat of vaporization of liquid.

Explanation by molecular theory:-when a liquid is heated. The KE of molecules increases. Because of which vibration and amplitude of molecules also increases due to molecular force among molecules become weaker and weaker. As a result the molecules of liquids become able to move away from each other and at 100^o c begins to evaporate. This process is continues until the whole liquid is converted into gaseous state.
During this process the given heat is totally used for conversion of liquid into gasses state. So temperature remains constant and this constant heat is known as latent heat of vaporization liquids.

Q.16 what is meant by evaporation of liquids? On which factors does it depend?

Evaporation of liquids:- The process by which a liquid slowly changes into its vapors below its boiling point is called evaporation (OR) the process by which a liquid changes into its vapors at any temperature without the aid of any external source of heat is known as evaporation of liquids.
Explanation:-evaporation can occur at any temperature even when temperature is below the boiling point for e3xampale a spreader wet cloth becomes dry on big exposed to the air in a short time due to evaporation of water molecules.
Factor4s on which it depends:- the evaporation of liquid depend upon the following factors.

- **nature of liquid:-** liquids having low boiling point well evaporate rapidly than liquids having high B.: for example rate of evaporation of alcohol is higher.
- **Temperature of liquids:**- if the temperature is higher, then the molecules well have more K.E and they can easily evaporate from the surface of liquids. For example when iron is pushed on wet cloths, it dry out quickly and easily.
- **Temperature of surrounding:**- The higher the temperature of surrounding, the higher well be3 the rate of evaporation. Because wet cloths in summer season dry quickly as compare to winter season.

- **Area of exposed surface of liquid:**- if the surface are of liquid is greater then the molecules will evaporate more easily for example roads dry out quickly become.
- **Movement of air:**- evaporation also depends on moment of air greater the speed of flow of air higher well rate of evaporation. For example cloths dry sooner on windy day.
- **Air pressure on the surface of liquid:**- it also depends upon the pressure on the surface of liquid. If there is more then evaporation well be slow.

Q.17 How evaporation produce cooling?

Ans. according to K.E theory of molecules every liquid contain molecules which possess different K.E ranging from minimum to maximum.

Now those molecules whose K.E is maximum are able to overcome the inter molecular forces and escape out form liquid surface. The remaining molecules possess low K.E. we also know that K.E is directly proportion to the temperature. So the molecules of low K.E possess low temperature thus evaporation cause cooling effect.

Q.18 write the application of evaporation by cooling?

- **Cooling by Fans:-**in hot seasons we use fan. They increase the speed of air due to which rate of evaporation of perspiration from bodies also increases. And we get a cooling sensation. By this way perspiration help us cooling our and regulates temperature. Similarly room of water.
- **Fever control:-**when a person is suffering from high fever. We apply a wet towel on forehead of patient. When water dope evaporates from to well they absorb the heat from his head

And the patient remains safe and does not suffer any brain damage.

- **Refrigerators:-** A volatile liquid is used in refrigerator called Freon. The Freon evaporates in the pipes of freezer which draws the necessary latent heat from food inside Refrigerators and cooling is produced.

COCEPTUAL QUESTIONS

Q.1 see for ans Q10 b/w the ……..)

Q.2 why liquid have two coefficients of expansion?

Ans. When heat is supplied to liquid in a container. Then expansion occurs in liquid as well as the container. The expansion only liquid is known as real expansion while that of liquid plus container is called apparent expansion that's why liquid has two coefficient of expansion. ie (i) coefficient of real expansion. (ii) Coefficient of apparent expansion.

Q.3 ice melts to form water at o°cAt what temperature does water freezes to form ice?

Ans. We know that during phase change the temperature remains constant. Therefore the water will freezes at same temperature at O°C to from ice.

Q.4 see for ans Q5 water is cooling.

Q.5 why do we sweet in summer?

Ans. We sweet in summer because the temperature of our body rises. We want to keep the temperature suitable we give out heat from our body because of which sweet drops comes out from our body through pores of our skin.

Q.6 what is the effect of high specific heat of water on the climate of cloistral area?

Ans. In cloistral area during day time the land is heated more. So the heated air rises up and its place it occupied by cold air of sea level. Such movement of air is known as see breeze. This process is reversed during night. Thus in cloistral areas a moderate are maintained throughout the year.

Q.7 why does the temperature does not change during change of state?

Ans. The temperature dos not change during change of state because matter the supplied heat only increases P.E of molecules because of which their bonds becomes weaker and separate from each other. As there is no change in K.E there for temperature remains constant.

Q. 9 see for ans Q10 at page 63 .

Q.10 if a hot piece of thick glass is dipped in hot cold water it breaks give reason?

Ans. If a hot piece of thick glass is dipped in cold water it breaks because the outer surface contract and the interior side is still hot and because of this unbalanced condition it breaks.

Q.11**why do soda water bottles often burst in summer? How can burstable minimized?**

Ans. In summer soda water expands because of which because of which at the bottle burst to minimize this bursting space should be left at the tope of soda water in bottle which expansion of soda water in bottle.

Q.12 does land cool at a slower or faster rate than sea water? Give one reason for your answer?

Ans. The land cools faster than sea water because the specific beat water is more than that of soil.

Q.13 why is water at the bottom of a water fall is warmer than water at the top of water falt?

Ans. We now that K.E of a water fall is maximum at bottom and K>E is directly proportional to temperature that's why water at bottom of a water is warmer than water at top.

Q.14 why is ice at O°C a better coo lent of soft drinks than water at O°C?

Ans. The ice at **O°C**a better coo lent of soft drinks than water at **O°C** because ice will absorb more heat from the soft drinks to change to change into water at **O°C.**

Numerical problems

1) **A person running fever has a temperature of 104° F. what is his temperature in degree centigrade "°C" .?**

Solution:- temperature in Fahrenheit = TF = **104° F**

Centigrade = Tc= ?

TF = $\frac{9}{5}$ = Tc + 32 =>$\frac{9}{5}$ Tc = Tf – 32

Tc = $\frac{9}{5}$ (Tf – 32 => Tc = $\frac{9}{5}$ $(140 - 32)$

Tc = $\frac{5}{9}$ x ~~72~~^{8} **=>Tc = 40°**

2) **A railway line 1200km long is laid at 25°C .by how much will it contract in winter when the temperature falls to 15°C ? by how much well it expand when the temperature rises to 40°C in summer? A = 12 x 10^{-6}m °C^{-1}**

Lo = 1200km = 1200 x 10^3m = 1.2 x 10^6m

To = 25°C i) T = 15°C ii) T = 40° C

Fin ΔL in both cases ie ΔL =?

(i) As we know that ΔL = LOΔT

⇨ $\Delta L = (12\ x\ 10^{-6})$ (1.2 x 10^6) [25 – 15]

$\Delta L = 12\ x\ 1.2\ x\ \cancel{10^{-6}}\ x\cancel{10^{6}}$ x 10

ΔL = 12 x 1.2 x 10 =>ΔL = 12 x 12 =>$\Delta L = 144m$

(ii) now at T = 40°C:-

$\Delta L = a\ Lo\ \Delta T$ =>ΔL = (12 x 10^{-6}) (1.2 x 10^{+6})(40 – 25)

⇨ ΔL = 12 x 1.2 x 10^{-6} x 10^{6} x 15

⇨ $\Delta L = 12\ x\ 1.2\ x\ 15$ =>$\Delta L = 216m$

3) **The volume of a brass ball is 800 cm^3 at 20°C. find out new volume of ball if temperature is raised to 52°C? y = 57 x 10^{-6} c^{-1}.**

⇨ Vo = 800cm^3 To = 20°C

Final temperature = T = 52°C y = 57 x 10^{-6} c^{-1}

Volume = v =?

As we know that v = v_o (1 + ay ΔT)

V = 800 [1+57 x 10^{-6} (52 – 20)]

⇨ v = 800 (1+57 x 32 x 10^{-6}) => v = 800[1+ 1824 x 10^{-6}

⇨ v = 800 (1 + 0.001824) => v = 80/45cm^3

4) **A brass disc dt 293k has a diameter of o.o30m and a hole of diameter 0.10m is out in center calculate diameter of whole when temperature of disc is raised**

T 323k d = 19 x 10^{-6} k^{-1}

Solution:- initial diameter of whole = do = 0.10m.

Temperature = To = 293k

Final temperatur3e = T = 323k

Initial length of whole = Lo = do d = 19 x 10^{-6} k^{-1}

Final length of whole = L = d

Now we know that:- L = Lo (1 + d ΔT)

⇨ D = do [1 + a (T – to)]

⇨ D = d= [1 + 19 x 10^{-6} (323 – 293)]

⇨ D = 0.10[1 + 19 x 10^{-6} x 30]

⇨ D = 0.10 [1 + 570 x 10^{-6}] => d = 0.10 [1 +_ 0.000570]

⇨ D = 0.10(1.000570) => d = 0.100057m

5) **0.5kg of copper needs 1950T of heat to rise its temperature through 10°C. calculate the heat capacity?**

Solution:- mass of copper = 0.05kg

Required heat = $\Delta Q = 1950T$

Change in temperature = ΔT = 10^{oC}

Heat capacity = C =?

As we know that:-

C = $\Delta Q/\Delta T$ => C = 195~~0~~/1~~0~~

⇨ C = 195/T/C