X – PHYSICAL SCIENCE

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SCHOOL:

X – PHYSICAL SCIENCE
INDEX

BLUE STARS HIGHER SECONDARY SCHOOL
X-PHYSICAL SCIENCE
UNIT: 1 – LAWS OF MOTION

I. Answer briefly

1. Define inertia. Give its classification.

Inertia:

The inherent property of a body to resist any change in its state of rest or the state of uniform motion, unless it is influenced upon by an external unbalanced force, is known as **'inertia'.** Types of Inertia,

- **Inertia of rest**
- **Inertia of motion**
- **Inertia of direction**

2.Classify the types of force based on their application.

Types of Force:

There are two types of forces based on their application,

- **Like parallel forces**
- **Unlike parallel forces**

3.If a 5N and a 15N forces are acting opposite to one another. Find the resultant force and the direction of action of the resultant force.

Given:

$F_1 = 5$ N $\quad\quad$ $F_2 = 15$ N

Resultant Force (R) = $F_2 - F_1$

$= 15 - 5$

$R = 10$ N

The resultant force acting along the direction of F_2

4.Differentiate mass and weight.

Difference between mass and weight:

Mass	Weight
• The quantity of matter contained in the body.	• The gravitation force exerted on it due to the Earth's gravity alone.
• Scalar quantity.	• Vector quantity.
• SI unit is kilogram (Kg).	• SI unit is newton (N).
• Constant at all the places	• Variable with respect to gravity.

5.Define moment of a couple.

Moment of a couple:

Rotating effect of a couple is known as **moment of a couple.** The SI unit of moment of couple is Nm.

Moment of a couple = Force × perpendicular distance between the line of action of forces

$$\mathbf{M = F \times S.}$$

6.State the principle of moments.

Principle of moments:

When a number of like or unlike parallel forces act on a rigid body and the body is in equilibrium, then the algebraic sum of the moments in the clockwise direction is equal to the algebraic sum of the moments in the anticlockwise direction.

7.State Newton's second law.

Newton's second law:

"The force acting on a body is directly proportional to the rate of change of linear momentum of the body and the change in momentum takes place in the direction of the force".

8.Why a spanner with a long handle is preferred to tighten screws in heavy vehicles?

A long handle is preferred to tighten screws in heavy vehicles. Because,

This is because turning effect to tighten the screws depends upon the perpendicular distance of the applied force from the axis of rotation is power arm. Larger the power armless is the force required to turn the screws. So spanner is provided with a long handle.

9.While catching a cricket ball the fielder lowers his hands backwards. Why?

catching a cricket ball the fielder lowers his hands backwards. Because,

In cricket, a fielder pulls back his hands while catching the ball. He experiences a smaller force for a longer interval of time to catch the ball, resulting in a lesser impulse on his hands.

10.How does an astronaut float in a space shuttle?

Astronaut float in a space shuttle:

Astronauts are not floating but falling freely around the earth due to their huge oribital velocity. Since space station and astronauts have equal acceleration, they are under free fall condition. Hence, both the astronauts and the space station are in the state of weightlessness.

II. Solve the Given Problem.

1.Two bodies have a mass ratio of 3:4. The force applied on the bigger mass produces an acceleration of 12 ms^{-2}.What could be the acceleration of the other body, if the same force acts on it.

Given:

Let mass of the body A = 3 m

Let mass of the body B = 4 m

Acceleration (a) = 12ms^{-2}

For Body B

F = m x a

F = 4 m x 12 ms^{-2}

F = 48 N

For Body A

F = m x a

$a = \frac{F}{m} = \frac{48\ N}{3\ m}$

a = 16 ms^{2}

Acceleration (a) = 16 ms^{2}

2.A ball of mass 1 kg moving with a speed of 10 ms^{-1} rebounds after a perfect elastic collision with the floor. Calculate the change in linear momentum of the ball.

Given:

Mass of the ball = 1 Kg

Velocity of the ball before collision

$u = 10$ m/s

Velocity of the ball after collision

$v = -10$ m/s

Change in momentum

$\Delta P = m\,v - mu$

$\Delta P = m\,(v-u)$

$\Delta P = 1\,(-10-10) = -20$ Kg m/s

Change in momentum $\Delta P = -20$ Kg m/s

3.A mechanic unscrew a nut by applying a force of 140 N with a spanner of length 40 cm. What should be the length of the spanner if a force of 40 N is applied to unscrew the same nut?

Given:

$F_1 = 140$ N $\quad d_1 = 40$ cm $\quad F_2 = 40$ N $\quad d_2 = ?$

In both the cases, moment of forces applied are equal.

$$F_1 \times d_1 = F_2 \times d_2$$

$$d_2 = \frac{F_1 \mathrm{X}\, d_1}{F_2}$$

$$d_2 = \frac{140 \mathrm{X}\, 40}{40}$$

$d_2 = 140$ cm

4.The ratio of masses of two planets is 2:3 and the ratio of their radii is 4:7 Find the ratio of their accelerations due to gravity.

The ratio of masses of two planets

$M_1:M_2 = 2:3$

The ratio of radii of two planets

$R_1:R_2 = 4:7$

Formula:

$$g_1 = \frac{GM_1}{R_1^2}\; g_2 = \frac{GM_2}{R_2^2}$$

$$\frac{g_1}{g_2} = \frac{GM_1}{R_1^2} \mathrm{X} \frac{R_2^2}{GM_2}$$

$$= \frac{M_1}{R_1^2} \mathrm{X} \frac{R_2^2}{M_2}$$

$$= \frac{2}{(4)^2} \mathrm{X} \frac{(7)^2}{3} = \frac{2}{16} \mathrm{X} \frac{49}{3}$$

$$= \frac{1}{8} \mathrm{X} \frac{49}{3}$$

$$\frac{g_1}{g_2} = \frac{49}{24}$$

$$g_1 : g_2 = 49:24$$

III. Answer in Detail.

1.What are the types of inertia? Give an example for each type.

Types of Inertia,

a) **Inertia of rest:**

The resistance of a body to change its state of rest is called inertia of rest.

Example:

When you vigorously shake the branches of a tree, some of the leaves and fruits are detached and they fall down.

b) **Inertia of Motion:**

The resistance of a body to change its state of motion is called inertia of motion.

Example:

An athlete runs some distance before jumping. Because this will help him jump longer and higher.

c) **Inertia of direction:**

The resistance of a body to change its direction of motion is called inertia of direction.

Example:

When you make a sharp turn while driving a car, you tend to learned sideways.

2.State Newton's laws of motion?

Newton's First Law:

This law states that "everybody continues to be in its state of rest or the state of uniform motion along a straight line unless it is acted upon by some external force."

Newton's Second Law:

According to this law, "the force acting on a body is directly proportional to the rate of change of linear momentum of the body and the change in momentum takes place in the direction of the force".

Newton's Third Law:

Newton's third law states that **'**for every action, there is an equal and opposite reaction. They always act on two different bodies'.

3.Deduce the equation of a force using Newton's second law of motion.

The equation of a force using Newton's second law of motion.

"**The force acting on a body is directly proportional to the rate of change of linear momentum of the body and the change in momentum takes place in the direction of the force**".

Let, 'm' be the mass of a moving body, moving along a straight line with an initial speed 'u' After a time interval of 't', the velocity of the body changes to 'v' due to the impact of an unbalanced external force F.

Initial momentum of the body P_i= mu

Final momentum of the body $P_f = m\,v$

Change in momentum $\Delta p = P_f - P_i$

$= m\,v - mu$

By Newton's second law of motion,

Force, F ∝ rate of change of momentum

$$F \propto \frac{\text{change in momentum}}{\text{time}}$$

$$F \propto \frac{m\,v - mu}{t}$$

$$F = \frac{km\,(v-u)}{t}$$

Here, k is the proportionality constant. k = 1 in all systems of units. Hence,

$$F = \frac{m\,(v-u)}{t}$$

Since,

$$\text{Acceleration} = \frac{\text{Change in velocity}}{\text{time}}$$

$$a = \frac{(v-u)}{t}$$

Hence, we have

F = m × a

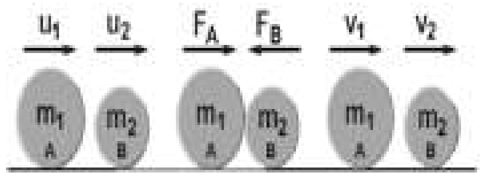
Force = mass × acceleration

- No external force is required to maintain the motion of a body moving with uniform velocity.
- When the net force acting on a body is not equal to zero, then definitely the velocity of the body will change.
- Thus, change in momentum takes place in the direction of the force. The change may take place either in magnitude or in direction or in both.

4.State and prove the law of conservation of linear momentum.

- There is no change in the linear momentum of a system of bodies as long as no net external force acts on them.
- Let us prove the law of conservation of linear momentum with the following illustration:

Proof:



Let two bodies A and B having masses m_1 and m_2 move with initial velocity u_1 and u_2 in a straight line. Let the velocity of the first body be higher than that of the second body. i.e., $u_1 > u_2$. During an interval of time t second, they tend to have a collision. After the impact, both of them move along the same straight line with a velocity v_1 and v_2 respectively.

Force on body B due to A,

$$F_A = \frac{m_2(v_2 - u_2)}{t}$$

Force on body A due to B,

$$F_B = \frac{m_1(v_1 - u_1)}{t}$$

By Newton's III law of motion,

Action force = Reaction force

$$F_B = -F_A$$

$$\frac{m_1(v_1 - u_1)}{t} = - \frac{m_2(v_2 - u_2)}{t}$$

$m_1(v_1 - u_1) = - [m_2 (v_2 - u_2)]$

$m_1v_1 - m_1u_1 = - m_2v_2 + m_2u_2$

$\mathbf{m_1v_1 + m_2v_2 = m_1u_1 + m_2u_2}$

The above equation confirms **in the absence of an external force, the algebraic sum of the momentum after collision is numerically equal to the algebraic sum of the momentum before collision.**

Hence the law of conservation linear momentum is proved.

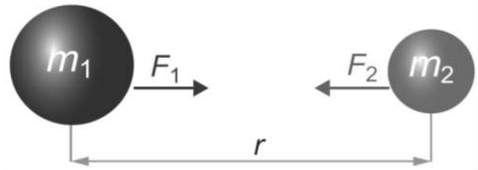
5.Describe rocket propulsion.

- Propulsion of rockets is based on the law of conservation of linear momentum as well as Newton's III law of motion.
- Rockets are filled with a fuel (either liquid or solid) in the propellant tank.
- When the rocket is fired, this fuel is burnt and a hot gas is ejected with a high speed from the nozzle of the rocket, producing a huge momentum.
- To balance this momentum, an equal and opposite reaction force is produced in the combustion chamber, which makes the rocket project forward.
- While in motion, the mass of the rocket gradually decreases, until the fuel is completely burnt out.
- Since, there is no net external force acting on it, the linear momentum of the system is conserved.
- The mass of the rocket decreases with altitude, which results in the gradual increase in velocity of the rocket.
- At one stage, it reaches a velocity, which is sufficient to just escape from the gravitational pull of the Earth. This velocity is called escape velocity.

6.State the universal law of gravitation and derive its mathematical expression.

Newton's universal law ofgravitation:

This law states that **every particle of matter in this universe attracts every other particle with a force. This force is directly proportional to the product of their masses and inversely proportional to the square of the distance between the centres of these masses. The direction of the force acts along the line joining the masses**.



Force between the masses is always attractive and it does not depend on the medium where they are placed. Let, m_1 and m_2 be the masses of two bodies A and B placed r metre apart in space

Force, $F \propto m_1 \times m_2$

$$F \propto \frac{1}{r^2}$$

On combining the above two expressions

$$F \propto \frac{m_1 m_2}{r^2}$$

$$F = \frac{G m_1 m_2}{r^2}$$

Where G is the universal gravitational constant. Its value in SI unit is 6.674×10^{-11} N m^2kg^{-2}.

6.Give the applications of universal law gravitation.

- Dimensions of the heavenly bodies can be measured using the gravitation law. Mass of the Earth, radius of the Earth, acceleration due to gravity, etc. can be calculated with a higher accuracy.
- Helps in discovering new stars and planets.
- One of the irregularities in the motion of stars is called 'Wobble' lead to the disturbance in the motion of a planet nearby. In this condition the mass of the star can be calculated using the law of gravitation.
- Helps to explain germination of roots is due to the property of geotropism which is the property of a root responding to the gravity.
- Helps to predict the path of the astronomical bodies.

IV. HOT Questions

1.Two blocks of masses 8 kg and 2 kg respectively lie on a smooth horizontal surface in contact with one other. They are pushed by a horizontally applied force of 15 N. Calculate the force exerted on the 2 kg mass.

If 2 blocks are of mass 8kg and 2kg

Given:

m_1 = 8 kg m_2 = 2 kg F = 15 N

F = m x a → F = (m_1+m_2) x a

15 = (8+2) x a

15 = 10a

$a = \frac{15}{10} = \frac{3}{2}$ ms^{-2}

The force exerted by mass of 2 kg. So

F = m x a

$F = 2 \times \frac{3}{2}$

Exerted force = 3 N

2.A heavy truck and bike are moving with the same kinetic energy. If the mass of the truck is four times that of the bike, then calculate the ratio of their momenta. (Ratio of momenta = 1:2)

Given:

m_1 = Truck mass v_1 = Truck velocity

m_2 = Bike mass $\quad$ v_2 = Bike velocity

Given Kinetic Energy are equal

$m_1 = 4m_2$

Ratio of momentum =?

According to Kinetic Energy. Since K.E are equal

$$\frac{1}{2} m_1 v_1^2 = \frac{1}{2} m_2 v_2^2$$

$$\frac{m_1}{m_2} = \frac{v_2^2}{v_1^2}$$

$$\frac{4m_2}{m_2} = \frac{v_2^2}{v_1^2}$$

$$\frac{v_2}{v_1} = 2$$

$$\frac{v_1}{v_2} = \frac{1}{2}$$

Ratio of momentum = $\frac{m_1 v_1}{m_2 v_2}$

$$= \frac{4m_2}{m_2} \text{X} \frac{v_1}{v_2}$$

$$= 4 \text{ X } \frac{1}{2}$$

$$= \frac{2}{1}$$

Ratio of momentum = 2:1

3."Wearing helmet and fastening the seat belt is highly recommended for safe journey" Justify your answer using Newton's laws of motion.

Wearing helmet:

- It is strongly recommended for safe journey, because when a person fall from bike he exerts a force equal to product of mass of the person and acceleration of the bike (Newton's II law).
- According to Newton's III law, in turn the ground offers an equal and opposite force on the person, which will produce large damage. In order to minor damages the person must wear helmet.

Fastening the seat belt:

- It will not allow a person to move from seat why the vehicle comes to rest suddenly by applying brake or by having some accidents.
- This is due to inertia of motion (Newton's I law). When the speeding vehicle stops suddenly the lower part in contact with the seat stops while the upper part of the body tends to maintain its uniform motion. Hence the person will turn forward and obtain injuries. In order to avoid this, fastening of seat belt is important.

UNIT : 2- OPTICS

I.ANSWER BRIEFLY

1. **What is refractive index?**

   Refractive index:

   The ratio of speed of light in vacuum to the speed of light in a medium is defined as refractive index 'μ' of that medium.

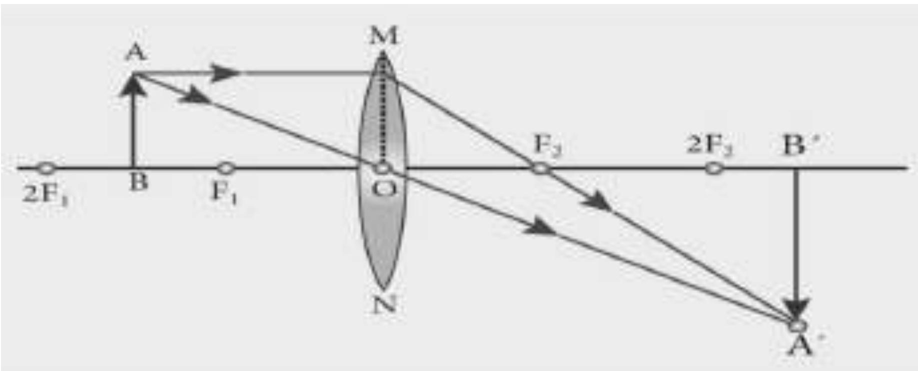
2. **State Snell's law.**

   Snell's law:

   The ratio of the sine of the angle of incidence and sine of the angle of refraction is equal to the ratio of refractive indices of the two media. This law is also known as Snell's law,

$$\frac{\text{Sin i}}{\text{Sin r}} = \frac{\mu_2}{\mu_1}$$

3. **Draw a ray diagram to show the image formed by a convex lens when the object isplaced between F and 2F.**



object isplaced between F and 2F.

4. **Define dispersion of light.**

   Dispersion of light:

   When a beam of white light or composite light is refracted through any transparent media such as glass or water, it is split into its component colours. This phenomenon is called as 'dispersion of light'.

5. **State Rayleigh's law of scattering.**

   Rayleigh's law of scattering:

   Rayleigh's scattering law states that, "The amount of scattering of light is inversely proportional to the fourth power of its wavelength".

   Amount of scattering 'S' $\propto 1/\lambda^4$

6. **Differentiate convex lens and concave lens.**

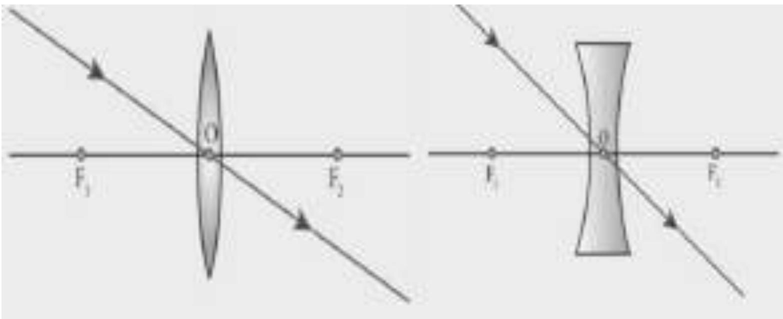
COVEX LENS	CONCAVE LENS
• A convex lens is thicker in the middle than at edges.	• A concave lens is thinner in the middle than at edges.
• It is a converging lens.	• It is a diverging lens.
• It produces mostly real images.	• It produces virtual images.

• It is used to treat hypermeteropia.	• It is used to treat myopia.

7. **What is power of accommodation of eye?**
   Power of accommodation of eye
   The ability of the eye lens to focus nearby as well as the distant objects is called power of accommodation of the eye.
8. **What are the causes of 'Myopia'?**
   Myopia causes due to,
   - Lengthening of eye ball.
   - Nearby objects can be seen clearly, but distant objects cannot be seen clearly.
9. **Why does the sky appear in blue colour?**
   The sky appear in blue colour. Because,
   When sunlight passes through the atmosphere, the blue colour (shorter wavelength) is scattered to a greater extent than the red colour (longer wavelength). This scattering causes the sky to appear in blue colour.
10. **Why are traffic signals red in colour?**
    - The wavelength of red colour is more than other colours.
    - Red colour will travel longer distance without scattering.
    - Red colour gets least scattered and reaches people.
    - So it is used in traffic signals.

II. GIVE THE ANSWER IN DETAIL.

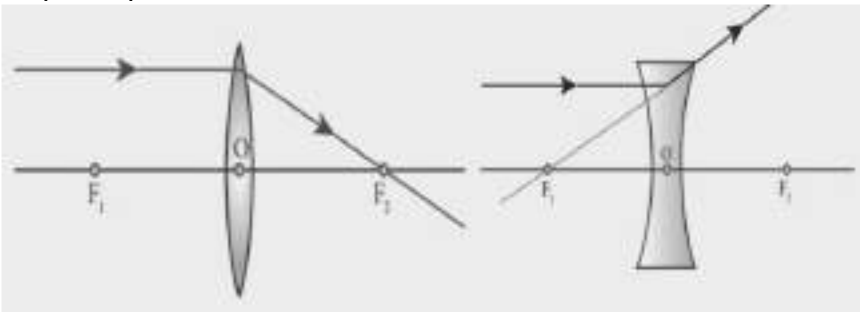
1. **List any five properties of light**.
   The properties of light,
   - Light is a form of energy.
   - Light always travels along a straight line.
   - Light does not need any medium for its propagation. It can even travel through vacuum.
   - The speed of light in vacuum or air is, $c = 3 \times 10^8\ ms^{-1}$.
   - Since, light is in the form of waves, it is characterized by a wavelength (λ) and a frequency (ν), which are related by the following equation:
     $c = \nu \lambda$ (c - velocity of light).
   - Different coloured light has different wavelength and frequency.
   - Among the visible light, violet light has the lowest wavelength and red light has the highest wavelength.
   - When light is incident on the interface between two media, it is partly reflected and partly refracted.
2. **Explain the rules for obtaining images formed by a convex lens with the help of ray diagram.**
   Rule-1:
   When a ray of light strikes the convex or concave lens obliquely at its optical centre, it continues to follow its path without any deviation.



Rays passing through the optical centre.

Rule-2:

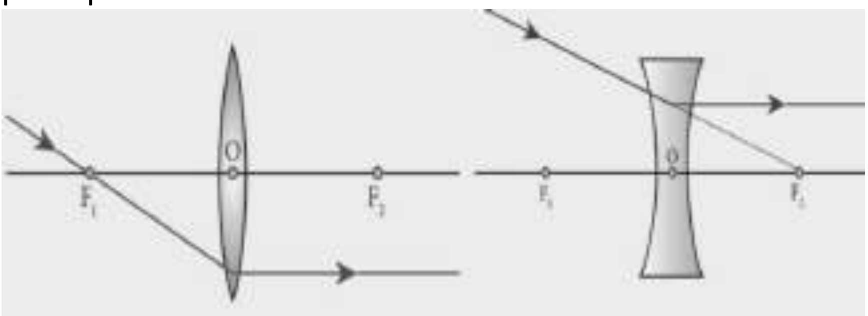
When rays parallel to the principal axis strikes a convex or concave lens, the refracted rays are converged to (convex lens) or appear to diverge from (concave lens) the principal focus.



Rays passing parallel to the optic axis.

Rule-3:

When a ray passing through (convex lens) or directed towards (concave lens) the principal focus strikes a convex or concave lens, the refracted ray will be parallel to the principal axis.



Rays passing through or directed towards the principal focus.

3. **Differentiate the eye defects: Myopia and Hypermetropia.**

Sl.No	MYOPIA	HYPERMETROPIA
1.	It is also known as short sightedness, occurs due to the lengthening of eye ball.	It is also known as long sightedness, occurs due to the shortening of eye ball.
2.	With this defect, nearby objects can be seen clearly but distant objects cannot be seen clearly.	With this defect, distant objects can be seen clearly but nearby objects cannot be seen clearly.
3.	The focal length of eye lens is reduced or the distance between eye	The focal length of eye lens is increases or the distance between eye lens and

	lens and retina increases.	retina decreases.
4.	The far point will not be infinity for such eyes and the far point has come closer.	The near point will not be at 25cm for such eyes and the near point has moved farther.
5.	Due to this, the image of distant objects are formed before the retina.	Due to this, the image of nearby objects are formed behind the retina.
6.	This defect can be corrected using a concave lens.	This defect can be corrected using a convex lens.
7.	A suitable focal length of the concave lens to be used to correct this defect.	A suitable focal length of the concave lens to be used to correct this defect.
8.	The length of the required concave lens is, f= xy / x-y	The focal length of the required convex lens is, f= dD / d-D

4. **Explain the construction and working of a 'Compound Microscope'.**

Compound microscope is also used to see the tiny objects. It has better magnification power than simple microscope.

Construction

- A compound microscope consists of two convex lenses. The lens with the shorter focal length is placed near the object, and is called as 'objective lens' or 'objective piece'.
- The lens with larger focal length and larger aperture placed near the observer's eye is called as 'eye lens' or 'eye piece'.
- Both the lenses are fixed in a narrow tube with adjustable provision.

Working:

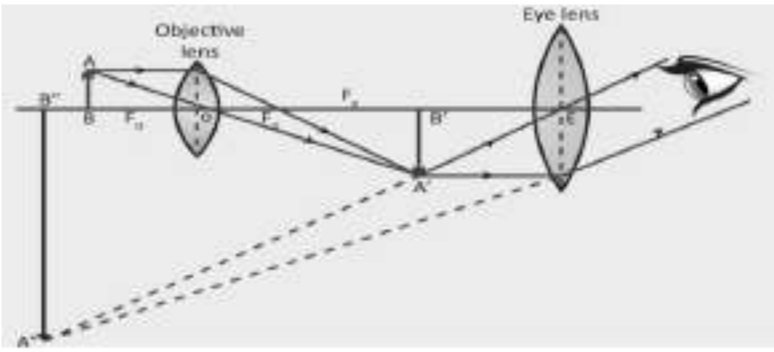


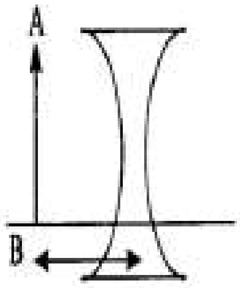
Image formation in compound Microscope.

- The object (AB) is placed at a distance slightly greater than the focal length of objective lens ($u > f_o$).
- A real, inverted and magnified image (A'B′) is formed at the other side of the objective lens. This image behaves as the object for the eye lens. The position of the eye lens is adjusted in such a way, that the image (A'B') falls within the principal focus of the eye piece. This eye piece forms a virtual, enlarged and erect image (A″ B″) on the same side of the object.
- Compound microscope has 50 to 200 times more magnification power than simple microscope.

III. NUMERICAL PROBLEMS.

1. **An object is placed at a distance 20cm from a convex lens of focal length 10cm. Find the image distance and nature of the image.**

Given



U= -20cm f= 10cm

$$\frac{1}{f} = \frac{1}{v} - \frac{1}{u}$$

$$\frac{1}{v} = \frac{1}{f} + \frac{1}{u}$$

$$\frac{1}{v} = \frac{1}{10} - \frac{1}{20}$$

$$\frac{1}{v} = \frac{2-1}{20}$$

$$\frac{1}{v} = \frac{1}{20}$$

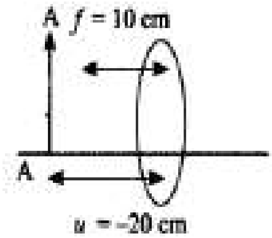
V = 20 cm

Nature of the image:

Real enlarged and inverted image.

2. **An object of height 3cm is placed at 10cm from a concave lens of focal length 15cm. Find the size of the image.**

Given:



u= -10cm (left side of the lens)

f= -15cm (left side of the lens)

h= 3cm

$$\frac{1}{f} = \frac{1}{v} - \frac{1}{u}$$

$$\frac{1}{v} = \frac{1}{f} + \frac{1}{u}$$

$$= \frac{1}{-15} + \frac{1}{-10}$$

$$\frac{1}{v} = \frac{-1}{15} - \frac{1}{10}$$

$$\frac{1}{v} = \frac{-10-15}{150}$$

$$\frac{1}{v} = \frac{-25}{150}$$

$$\frac{1}{v} = \frac{-1}{6}$$

V = -6 cm

Magnification:

$$m = \frac{v}{u} = \frac{-6}{-10}$$

m= 0.6

$$m = \frac{h'}{h} \rightarrow h' = m \times h$$

h'= 0.6 x 3

h'= 1.8cm

Nature of the image:

When an object is placed at 10cm from the left side of the lens, a virtual image is formed between the optical centre and focus of a concave lens. The size of the image is smaller than that of the object.

IV. Higher order thinking (HOT) questions:

1. **While doing an experiment for the determination of focal length of a convex lens, Raja Suddenly dropped the lens. It got broken into two halves along the axis. If he continues his experiment with the same lens,**
   (a) can he get the image?
   (b) Is there any change in the focal length?
   Answer:
   (a) Yes, he can get the image, because the lens is broken into two hlaves along the axis.
   (b) No, focal length remains the same for the lens if it's broken or not broken.

2. **The eyes of the nocturnal birds like owl are having a large cornea and a large pupil. How does it help them?**
   - Owl has large pupil so that it provides a larger pathway for light to flow towards the retina
   - In addition it has large comer so that a bigger image of the insects would be formed on the retina.
   - In this way the eyes of the nocturnal birds help them to identify the elements in the surroundins.

UNIT: 3 – THERMAL PHYSICS

I. Answer in briefly;

1. Define one calorie.

Calorie:

One calorie is defined as the amount of heat energy required to rise the temperature of 1 gram of water through 1°C.

2. Distinguish between linear, areal or superficial expansion and Cubical Expansion.

Linear Expansion	Areal Expansion	Cubical Expansion
When a body is heated or cooled, the length of the body changes due to change in its temperature. Then the expansion is said to be linear or longitudinal expansion	If there is an increase in the area of a solid object due to heating, then the expansion is called superficial or areal expansion	If there is an increase in the volume of a solid body due to heating, then the expansion is called cubical or volumetric expansion.
$\frac{\Delta L}{L_O} = \alpha_L \Delta T$	$\frac{\Delta A}{A_O} = \alpha_A \Delta T$	$\frac{\Delta V}{V_O} = \alpha_V \Delta T$

3. What is co-efficient of cubical expansion?

The ratio of increase in volume of the body per degree rise in temperature to its unit volume is called as coefficient of cubical expansion. This is also measured in K^{-1}.

$$\alpha_V = \frac{\Delta V}{V_O \Delta T}$$

4. State Boyle's law.

When the temperature of a gas is kept constant, the volume of a fixed mass of gas is inversely proportional to its pressure.

$$P \propto \frac{1}{V}$$

In other words, for an invariable mass of a perfect gas, at constant temperature, the product of its pressure and volume is a constant.

(i.e) PV = constant

5. State-Charles law of volume.

Charles's law was formulated by a French scientist Jacques Charles. According to this law, When the pressure of gas is kept constant, the volume of a gas is directly proportional to the temperature of the gas.

$$V \propto T$$

$$\frac{V}{T} = \text{constant.}$$

6. Distinguish between ideal gas and real gas.

IDEAL GAS	REAL GAS
If the atoms or molecules of a gas do not interact with each other, then the gas is said to be an ideal gas or a perfect gas.	If the molecules or atoms of a gases interact with each other with a definite amount of intermolecular or inter atomic force of attraction, then the gases are said to be real gases.

when the pressure is low or the temperature is high because the inter atomic or intermolecular forces of attraction are weak in ideal gas. Hence, a real gas at low pressure or high temperature can be termed as a perfect gas.	At very high temperature or low pressure, a real gases behaves as an ideal gases because in this condition there is no inter atomic or inter molecular force of attraction.

7. What is co-efficient of real expansion?

Coefficient of real expansion is defined as the ratio of the true rise in the volume of the liquid per degree rise in temperature to its unit volume. The SI unit of coefficient of real expansion is K^{-1}.

8. What is co-efficient of apparent expansion?

Coefficient of apparent expansion is defined as the ratio of the apparent rise in the volume of the liquid per degree rise in temperature to its unit volume. The SI unit of coefficient of apparent expansion is K^{-1}.

II. Numerical Problems.

1. Find the final temperature of a copper rod. Whose area of cross section changes from 10 m² to 11 m² due to heating. The copper rod is initially kept at 90 K. (Coefficient of superficial expansion is 0.0021/K)

Given

α_A =0.0021 k^{-1}

T_i = 90k

A_O = 10m²

ΔA = 11-10 = 1m²

$$\frac{\Delta A}{A_O} = \alpha_A \Delta T$$

$$\frac{\Delta A}{A_O} = \alpha_A (T_f - T_i)$$

$$\frac{1}{10} = 0.0021 \ (T_f - 90)$$

$$\frac{1}{10 \text{ X } 0.0021} = T_f - 90$$

$$\frac{1}{10 \text{ X } 0.0021} + 90 = T_f$$

$$\frac{1}{0.021} + 90 = T_f$$

T_f = 47.62 + 90

T_f = 137.6 K

2. Calculate the coefficient of cubical expansion of a zinc bar. Whose volume is increased 0.25 m3 from0.3 m^3 due to the change in its temperature of 50 K.

Given

ΔT = 50k

V_0 = 0.3 m^3

ΔV =0.25 m^3

α_V= ?

$$\frac{\Delta V}{V_O} = \alpha_V \Delta T$$

$$\alpha_V = \frac{\Delta V}{V_O \Delta T}$$

$\alpha_V = \frac{0.25}{0.3 \text{ X } 50} = \frac{0.25}{15}$

α_V = 0.0166 k^{-1}

III. Answer in Detail.

1. Derive the ideal gas equation.

The ideal gas equation is an equation, which relates all the properties of an ideal gas. An ideal gas obeys Boyle's law and Charles' law and Avogadro's law. According to Boyle's law,

PV = constant ________________(1)

According to Charles's law,

V / T = constant________________(2)

According to Avogadro's law,

V/n = constant ________________(3)

After combining equations (1), (2) and (3), we can get the following equation.

PV/nT = constant _______________(4)

The above relation is called the combined law of gases. If you consider a gas, which contains µ moles of thegas, the number of atoms contained will be equal to µ times the Avogadro number, N_A.

i.e. n = μN_A __________________(5)

Using equation (5), equation (4) can be written as

PV / $\mu N_A T$ = constant

The value of the constant in the above equation is taken to be k_B, which is called as Boltzmann constant(1.38×10^{-23} JK^{-1}). Hence, we have the following equation:

PV / $\mu N_A T = k_B$

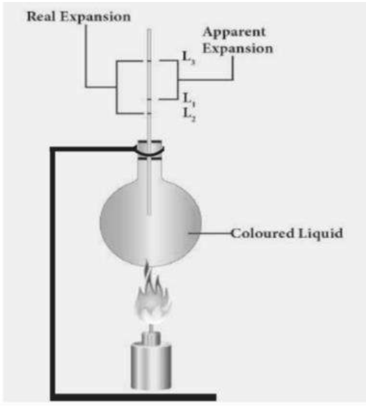
PV = $\mu N_A k_B T$

Here, $\mu N_A K_B$ = R, which is termed as universal gas constant whose value is 8.31 J $mol_{-1}K_{-1}$.

PV = RT __________________(6)

Ideal gas equation is also called as equation of state because it gives the relation between the state variable sand it is used to describe the state of any gas.

2. Explain the experiment of measuring the real and apparent expansion of a liquid with a neat diagram.



- To start with, the liquid whose real and apparent expansion is to be determined is poured in a container up to a level. Mark this level as L_1.
- Now, heat the container and the liquid using a burner.
- Initially, the container receives the thermal energy and it expands.
- As a result, the volume of the liquid appears to have reduced. Mark this reduced level of liquid as L_2.
- On further heating, the thermal energy supplied to the liquid through the container results in the expansion of the liquid. Hence, the level of liquid rises to L_3.
- Now, the difference between the levels L_1 and L_3 is called as apparent expansion, and the difference between the levels L_2 and L_3 is called real expansion.
- The real expansion is always more than that of apparent expansion.

Real expansion = $L_3 - L_2$

Apparent expansion = $L_3 - L_1$.

IV. HOT Question.

1.If you keep ice at 0°C and water at 0°C in either of your hands, in which hand you will feel more chillness? Why?

Ice transfer more chillness to our hands than water. Due to thermal conduction in between ice and environment. The latent heat of vapourisation for ice is more than water at 0^{O}c.

UNIT:4- ELECTRICITY

I. Very Short Answer questions.

1. Define the unit of current.

The SI unit of electric current is ampere (A). The current flowing through a conductor is said to be one ampere, when a charge of one coulomb flows across any cross-section of a conductor, in one second. Hence,

$$1 \text{ ampere} = \frac{1 \text{ coulomb}}{1 \text{ second}}$$

2. What happens to the resistance, as the conductor is made thicker?

As the resistance is inversely proportional to the area, ($R \propto 1/A$) thick wires will cause low resistance .

3. Why is tungsten metal used in bulbs, but not in fuse wires?

It is because tungsten has a very high melting point. Fuse wires should have low melting point. If tungsten is used as a fuse wire, then it will not melt even when large amount of current is passed through it , and the appliance will be damaged.

4. Name any two devices, which are working on the heating effect of the electric current.

(i) Electric Heater (ii) Electric Iron.

II. Short Answer questions.

1. Define electric potential and potential difference.

Electrical potential :

The electric potential at a point is defined as the amount of work done in moving a unit positive charge from infinity to that point against the electric force.

Electric potential Difference :

The electric potential difference between two points is defined as the amount of work done in moving a unit positive charge from one point to another point against the electric force.

2. What is the role of the earth wire in domestic circuits?

- This wire provides a low resistance path to the electric current.
- The earth wire serves as a protective conductor, which saves us from electric shocks.

3. State Ohm's law.

According to Ohm's law, at a constant temperature, the steady current 'I' flowing through a conductor is directly proportional to the potential difference 'V' between the two ends of the conductor.

$$I \propto V.$$

Hence, I/V = constant.

The value of this proportionality constant is found to be $1/R$. Therefore,

$$I = (1/R)\,V$$

$$V = IR.$$

4.Distinguish between the resistivity and conductivity of a conductor.

Resistivity	Conductivity
The Electrical resistivity of a material is defined as the resistance of a conductor of unit length and unit area of cross section.	The reciprocal of electrical resistivity of a material is called its electrical conductivity.
Its unit is ohm metre.	Its unit is $Ohm^{-1}\,m^{-1}$ or mho m^{-1}

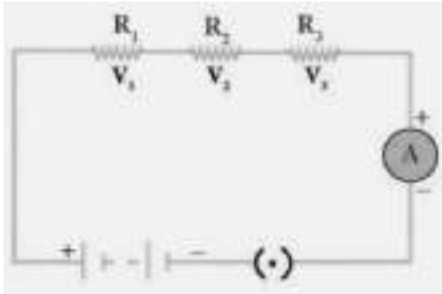
5. What connection is used in domestic appliances and why?

- The connections in houses for domestic appliances are parallel so that even disconnection of one circuit does not affect the other
- To get equal voltages for all appliances, parallel circuit is used.

III. Long Answer Questions.

1. With the help of a circuit diagram derive the formula for the resultant resistance of three resistances connected: a) in series and b) in parallel.

Resistance in Series:



Let, three resistances R_1, R_2 and R_3 be connected in series,

Let the current flowing through them be I.

According to Ohm's Law, the potential differences V_1, V_2 and V_3 across R_1, R_2 and R_3 respectively, are given by:

$V_1 = I R_1$ _________ (1)

$V_2 = I R_2$ _________ (2)

$V_3 = I R_3$ _________(3)

The sum of the potential differences across the ends of each resistor is given by:

$V = V_1 + V_2 + V_3$

Using equations (1), (2) and (3), we get

$V = I R_1 + I R_2 + I R_3$ ___________ (4)

The effective resistor is a single resistor, which can replace the resistors effectively, so as to allow the same current through the electric circuit. Let, the effective resistance of the series-combination be R_S. Then,

$V = I R_S$ ________________(5)

Combining equations (4) and (5), you get,

$I R_S = I R_1 + I R_2 + I R_3$

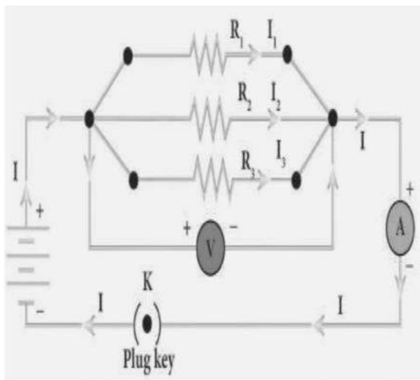
$R_S = R_1 + R_2 + R_3$ _______________ (6)

Thus, when a number of resistors are connected in series, their equivalent resistance or effective resistance is equal to the sum of the individual resistances. When 'n' resistors of equal resistance R are connected in series, the equivalent resistance is 'n R'. i.e.,

$R_S = n R$

The equivalent resistance in a series combination is always greater than the highest of the individual resistances.

Resistances in Parallel :



Consider three resistors R_1, R_2 and R_3 are connected across two common points A and B. The potential difference across each resistance is the same and equal to the potential difference between A and B. The current I arriving at A divides into three as I_1, I_2 and I_3passing through R_1, R_2 and R_3 respectively.

According to the Ohm's law,

$I_1 = \frac{V}{R_1}$_______________(1)

$I_2 = \frac{V}{R_2}$ ________________(2)

$I_3 = \frac{V}{R_3}$ ________________(3)

The total current through the circuit is given by

$I = I_1 + I_2 + I_3$

Using equations (1), (2) and (3), you get

$I = \frac{V}{R_1} + \frac{V}{R_2} + \frac{V}{R_3}$ __________(4)

Let the effective resistance of the parallel combination of resistors be RP. Then,

$I = \frac{V}{R_P}$ _________________(5)

Combining equations (4) and (5), you have

$$\frac{V}{R_P} = \frac{V}{R_1} + \frac{V}{R_2} + \frac{V}{R_3}$$

$$\frac{1}{R_P} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3}$$

Thus, when a number of resistors are connected in parallel, the sum of the reciprocals of the individual resistances is equal to the reciprocal of the effective or equivalent resistance. When 'n' resistors of equal resistances R are connected in parallel, the equivalent resistance is $\frac{R}{n}$.i.e.

$$\frac{1}{R_P} = \frac{1}{R} + \frac{1}{R} + \frac{1}{R} \ldots\ldots \frac{1}{R} + = \frac{n}{R}$$

Hence, $R_P = \frac{R}{n}$.

The equivalent resistance in a parallel combination is less than the lowest of the individual resistances.

2. a) What is meant by electric current?

Electric current is defined as the rate of flow of charges in a conductor. If Q is the charge flowing for a time of t seconds in a conductor, then

I = Q/t

b) Name and define its unit.

The SI unit of electric current is ampere (A). The current flowing through a conductor is said to be one ampere, when a charge of one coulomb flows across any cross-section of a conductor, in one second. Hence,

$$\textbf{1 ampere} = \frac{\textbf{1 coulomb}}{\textbf{1 second}}$$

c) Which instrument is used to measure the electric current? How should it be connected in a circuit?

An ammeter is a device used to measure the electric current in a circuit. An ammeter is always connected in series with a device to measure its current.

3. a) State Joule's law of heating.

- Let 'I' be the current flowing through a resistor of resistance 'R', and 'V' be the potential difference across the resistor.

- The charge flowing through the circuit for a time interval ‘t’ is ‘Q’. The work done in moving the charge Q across the ends of the resistor with a potential difference of V is VQ.
- This energy spent by the source gets dissipated in the resistor as heat.
  Thus, the heat produced in the resistor is:

$$\mathbf{H = W = VQ}$$

We know that the relation between the charge and current is Q = I t. Using this, we get

$$\mathbf{H = V\,I\,t}$$

From Ohm’s Law, V = I R. Hence, you have

$$\mathbf{H = I^2\,R\,t}$$

This is known as Joule’s law of heating.

b) An alloy of nickel and chromium is used as the heating element. Why?

An alloy of nickel and chromium is used as the heating element. Because:

- it has high resistivity,
- it has a high melting point,
- it is not easily oxidized.

c) How does a fuse wire protect electrical appliances?

- The fuse wire is connected in series, in an electric circuit.
- When a large current passes through the circuit, the fuse wire melts due to Joule’s heating effect and hence the circuit gets disconnected.
- Therefore, the circuit and the electric appliances are saved from any damage.
- The fuse wire is made up of an alloy whose melting point is relatively low.

4. Explain about domestic electric circuits. (circuit diagram not required).

- The electricity produced in power stations is distributed to all the domestic and industrial consumers through overhead and underground cables.
- The first stage of the domestic circuit is to bring the power supply to the main-box from a distribution panel, such as a transformer. The important components of the main-box are: (i) a fuse box and (ii) a meter.
- The meter is used to record the consumption of electrical energy.
- The fuse box contains either a fuse wire or a miniature circuit breaker (MCB).
- The function of the fuse wire or a MCB is to protect the house hold electrical appliances from overloading due to excess current.
- An MCB is a switching device, which can be activated automatically as well as manually.
- It has a spring attached to the switch, which is attracted by an electromagnet when an excess current passes through the circuit. Hence, the circuit is broken and the protection of the appliance is ensured.
- The electricity is brought to houses by two insulated wires.
- Out of these two wires one wire has a red insulation and is called the ‘live wire’.
- The other wire has a black insulation and is called the ‘neutral wire’.
- The electricity supplied to your house is actually an alternating current having an electric potential of 220V.

- Both, the live wire and the neutral wire enter into a box where the main fuse is connected with the live wire.
- After the electricity meter, these wires enter into the main switch, which is used to discontinue the electricity supply whenever required. After the main switch, these wires are connected to live wires of two separate circuits.
- Out of these two circuits, one circuit is of a 5 A rating, which is used to run the electric appliances with a lower power rating, such as tube lights, bulbs and fans.
- The other circuit is of a 15 A rating, which is used to run electric appliances with a high power rating, such as air-conditioners, refrigerators, electric iron and heaters.
- It should be noted that all the circuits in a house are connected in parallel, so that the disconnection of one circuit does not affect the other circuit. One more advantage of the parallel connection of circuits is that each electric appliance gets an equal voltage.

5. a) What are the advantages of LED TV over the normal TV?

- It has brighter picture quality.
- It is thinner in size.
- It uses less power and consumes very less energy.
- Its life span is more.
- It is more reliable.

b) List the merits of LED bulb.

Merits of a LED bulb

- As there is no filament, there is no loss of energy in the form of heat. It is cooler than the incandescent bulb.
- In comparison with the fluorescent light, the LED bulbs have significantly low power requirement.
- It is not harmful to the environment.
- A wide range of colours is possible here.
- It is cost-efficient and energy efficient.
- Mercury and other toxic materials are not used in LED bulbs.

IV. Numerical Problem.

1. An electric iron consumes energy at the rate of 420 W when heating is at the maximum rate and 180W when heating is at the minimum rate. The applied voltage is 220 V. What is the current in each case?

At maximum Rate,

Given:

P = 400 W

V = 220 V

P = VI

$$I = \frac{P}{V}$$

$$I = \frac{420}{220} = 1.9090 \text{ A}$$

At minimum Rate,

Given:

P = 180 W

V = 220 V

P = VI

I = $\frac{P}{V}$

I = $\frac{180}{220}$ = 0.8181 A

2. A 100 watt electric bulb is used for 5 hours daily and four 60 watt bulbs are used for 5 hours daily. Calculate the energy consumed (in kWh) in the month of January.

Solution :

Energy used by 100 W bulb is,

$$E = P \times t$$
$$= 100 \times 5$$
$$= 500\ W$$

Energy used by 60 W bulbs,

$$E = 4 \times 60 \times 5$$
$$= 1200\ W$$

Total energy per day,

$$= 500\ + 1200$$
$$= 1700\ W$$

No of days in January $= 31\ days$

Energy consumed in January

$$= 31 \times 1.7$$
$$= 52.7\ KW.$$

3. A torch bulb is rated at 3 V and 600 mA. Calculate it's.

a) power

b) resistance

c) energy consumed if it is used for 4 hour.

Solution :

V = 3V ; I = $\frac{600}{1000}$ = 0.6 A

a) POWER :

P = V × I = 3 × 0.6

P = 1.8 W

b) RESISTANCE:

R = $\frac{V}{I}$ = $\frac{3}{0.6}$

R = 5 ohm

c) ENERGY CONSUMED = Power × time

= 1.8 × 4 =7.2 watt hour.

4. A piece of wire having a resistance R is cut into five equal parts.

a) How will the resistance of each part of the wire change compared with the original resistance?

b) If the five parts of the wire are placed in parallel, how will the resistance of the combination change?
c) What will be ratio of the effective resistance in series connection to that of the parallel connection?
Solution :

a) Consider a piece of wire having resistance R. It cut into 5 equal parts. So number of equal resistors are 5. n=5. When 'n' resistors of equal resistance R are connected in series, the equivalent resistance is 'nR'

$R_S = nR$

$R_S = 5R$

$R_S = \frac{1}{5}$ x R

R =0.2 R_S

Each part of resistance 'R' is equal to 0.2 time of original resistance.

b) Effective Resistance of 5 Resistors

$$\frac{1}{R_P} = \frac{1}{R} + \frac{1}{R} + \frac{1}{R} + \frac{1}{R} + \frac{1}{R} = \frac{5}{R}$$

$R_P = \frac{R}{5} = 0.2R$

$R_P = 0.2\ R$

C) Effective resistance of series combination

$R_S = 5R$

Effective resistance of series combination

$R_P = \frac{R}{5}$

The ratio of series connection to the parallel connection

$$\frac{R_S}{R_P} = \frac{5R}{\left[\frac{R}{5}\right]} = 5R \times \frac{5}{R}$$

$$\frac{R_S}{R_P} = 25$$

RS : RP = 25: 1

V. HOTS:

1. Two resistors when connected in parallel give the resultant resistance of 2 ohm; but when connected in series the effective resistance becomes 9 ohm. Calculate the value of each resistance.

Solution :

Resultant resistance of parallel combination

$R_P = 2\Omega$

Resultant resistance of series combination

$R_s = 9\Omega$

$$\frac{1}{R_P} = \frac{1}{R_1} + \frac{1}{R_2}$$

$$\frac{1}{2} = \frac{1}{R_1} + \frac{1}{R_2}$$

$$\frac{1}{2} = \frac{1}{R_1} + \frac{1}{R_2}$$

$$\frac{1}{2} = \frac{R_1 + R_2}{R_1 R_2}$$

$2(R_1 + R_2) = R_1R_2$ _____________(1)

$R_S = R_1 + R_2$

$9 = R_1 + R_2$

$R_1 = 9 - R_2$ _____________(2)

Substitute equation (2) in (1)

$2(9 - R_2 + R_2) = (9 - R_2) R_2$

$18 = 9R_2 - R_2^2$

$R_2^2 - 9R_2 + 18 = 0$

$(R_2 - 3)(R_2 - 6) = 0$

$R_2 = 3, 6$

When $R_1 = 3\Omega$, $R_2 = 9 - 3 = 6\Omega$

When $R_1 = 6\Omega$, $R_2 = 9 - 6 = 3\Omega$.

2. How many electrons are passing per second in a circuit in which there is a current of 5 A?

Solution :

For 1 coulomb number of electrons = $\frac{1}{e} = \frac{1}{Charge}$

$\frac{1}{e} = \frac{1}{1.6 \, X \, 10^{-19}} = 6.25 \text{ X } 10^{18}$ electrons.

Number of electrons for 1A = $6.25 \text{ X } 10^{18}$ electrons.

For 5A of current number of electrons = $5 \text{ X } 6.25 \text{ X } 10^{18}$

$= 31.25 \text{ X } 10^{18}$

$= 3.125 \text{ X } 10^{19}$

3. A piece of wire of resistance 10 ohm is drawn out so that its length is increased to three times its original length. Calculate the new resistance.

Solution :

Resistance (R) = $\frac{Resistivity\ (r) X\ Length\ (L)}{Area\ (A)}$

$R = \frac{\rho l}{A}$

When the length increases by three times, the cross section will reduce by three times. Hence the length will be 3L while,

Area = $\frac{A}{3}$

New Resistance R' = $\frac{\rho 3L}{[A/3]}$

$R' = 9 \text{ X } \frac{\rho L}{A}$

$= 9 \text{ X } 10 = 90\ \Omega$

Therefore the new resistance = 90 ohm

UNIT:5- ACOUSTICS

I. Answer Briefly.

1. What is a longitudinal wave?

Longitudinal wave:

Sound waves are longitudinal waves that can travel through any medium (solids, liquids, gases) with a speed that depends on the properties of the medium.

2. What is the audible range of frequency?

Audible waves :

These are sound waves with a frequency ranging between 20 Hz and 20,000 Hz. These are generated by vibrating bodies such as vocal cords, stretched strings etc.

3. What is the minimum distance needed for an echo?

Ans : 17.2 m.

4. What will be the frequency sound having 0.20 m as its wavelength, when it travels with a speed of 331 ms^{-1}?

Ans :

$\lambda = 0.20$ m; $V = 331\ ms^{-1}$

$V = n\lambda$

$n = \frac{V}{\lambda}$

$n = \frac{331}{0.20}$

n= 1655 Hz.

5. Name three animals, which can hear ultrasonic vibrations.

Ans : Bat, Mosquito, Dogs.

II. Answer Briefly.

1. Why does sound travel faster on a rainy day than on a dry day?

During rainy days, the moisture content is more in the atmosphere and speed or velocity of sound.

2. Why does an empty vessel produce more sound than a filled one?

- The sound is produced by the vibration of the vessel.
- More the vibration amplitude and frequency more is the noise.
- The empty one will be the condition allowing more amplified vibration because of more free space inside it (less molecules) that's why empty vessels make more noise.
- There is a lot of space for the surface to vibrate. But when it is filled then the surface is constrained by an outward force.
- More is the pressure less is sound. That is why solid body makes least sound.

3. Air temperature in the Rajasthan desert can reach 46°C. What is the velocity of sound in air at that temperature? (V0 = 331 ms^{-1})

Ans :

Velocity of Sound

$$V_0 = 331\ ms^{-1}$$

Air temperature

$$T = 46\ °C$$

Velocity of sound in Air temperature

$$V_T = (V_0 + 0.61\ T)\ ms^{-1}$$

$$= 331 + (0.61 \times 46)$$

$$= 331 + 28.06$$

$$V_T = 359.06\ ms^{-1}.$$

4. Explain why, the ceilings of concert halls are curved.

When a person is talking at one focus, his voice can be heard distinctly at the other focus. It is due to the multiple reflections of sound waves from the curved walls.

5. Mention two cases in which there is no Doppler effect in sound?

i) When source (S) and listener (L) both are at rest.

ii) When S and L move in such a way that distance between them remains constant.

III. Problem Corner.

1.A sound wave has a frequency of 200 Hz and a speed of 400 ms^{-1} in a medium. Find the wavelength of the sound wave.

Given:

n = 200 Hz; V = 400 m/s

V = nλ

$\lambda = \frac{V}{n}$

$= \frac{400\ m/s}{200\ Hz}$

λ= 2 m.

2. The thunder of cloud is heard 9.8 seconds later than the flash of lightning. If the speed of sound inair is 330 ms^{-1}, what will be the height of the cloud?

Given,

Speed = 330 m/s; Time = 9.8 sec

Let, Height = Distance

Speed $= \frac{Distance}{Time}$

We know,

Distance = Speed × Time

Distance of the cloud = 330 × 9.8

Distance of the cloud = 3234 m.

3. A person who is sitting at a distance of 400 m from a source of sound is listening to a sound of 600Hz. Find the time period between successive compressions from the source?

Given,

Frequency (v) = 600 Hz

Time period = ?

We know that,

Frequency $= \frac{1}{T}$

$T = \frac{1}{Frequency}$

$T = \frac{1}{600\ Hz}$

T = 0.0016 Sec.

Thus, time interval between two consecutive compression of the given wave is equal to 0.0016 seconds.

4. An ultrasonic wave is sent from a ship towards the bottom of the sea. It is found that the time interval between the transmission and reception of the wave is 1.6 seconds. What is the depth of these a, if the velocity of sound in the seawater is 1400 ms^{-1}?

Given,

V = 1400 m/s T = 1.6 seconds

Let, Distance = speed × time

2d = V × t

d = $\frac{V \, X \, t}{2}$

= $\frac{2240}{2}$

d = 1120 m.

5. A man is standing between two vertical walls 680 m apart. He claps his hands and hears two distinct echoes after 0.9 seconds and 1.1 second respectively. What is the speed of sound in the air?

Given:

$t_1 = 0.9s; t_2 = 1.1s; d = 680m \; then \; V = ?$

$d_1 = \frac{Vt_1}{2}$

$d_2 = \frac{Vt_2}{2}$

By adding the equation 1 and 2, we get

$d_1 + d_2 = \frac{1}{2}(Vt_1 + Vt_2)$

But $d_1 + d_2 = d$

$d = \frac{1}{2}(Vt_1 + Vt_2)$

The factor by V in equation 3

$d = \frac{V}{2}(t_1 + t_2)$

$680m = \frac{V}{2}(0.9 + 1.1)s$

$680m = \frac{V}{2}(2)s$

$V = \frac{680m}{s}$.

Therefore the velocity of air is $680 \; m/s$.

6. Two observers are stationed in two boats 4.5 km apart. A sound signal sent by one, under water,

reaches the other after 3 seconds. What is the speed of sound in the water?

Solution :

Speed = distance/ time

As sound signal sent by one boat reaches the other boat.

Here distance between two observers = 4.5 Km

= (4.5 × 1000) m

= 4500 m

Total time taken by sound signal to reach other = 3 sec

According to the formula speed of sound in water $=\frac{Distance}{Time}$

$= \frac{4500\ m}{3\ s}$

= 1500 m/s.

7. A strong sound signal is sent from a ship towards the bottom of the sea. It is received back after 1s.What is the depth of sea given that the speed of sound in water 1450 ms^{-1}? Given,

V = 1450 ms^{-1} t = 1 s

This question is based on echo, the formula for echo is

Distance $=\frac{Velocity\ X\ Time}{2}$

$D=\frac{1450}{2}$

D = 725 m

The distance is 725 m.

IV. Answer in Detail.

1.What are the factors that affect the speed of sound in gases?

There are three factors that affect the speed of sound in gases:

- Effect of density
- Effect of temperature
- Effect of relative humidity

Effect of density :

The velocity of sound in a gas is inversely proportional to the square root of the density of the gas. Hence, the velocity decreases as the density of the gas increases.

$$\mathbf{v \propto 1/\sqrt{d}}$$

Effect of temperature :

The velocity of sound in a gas is directly proportional to the square root of its temperature. The velocity of sound in a gas increases with the increase in temperature.

$v \propto \sqrt{T}$. Velocity at temperature T is given by the following equation:

$\mathbf{V_T = (V_o + 0.61\ T)\ m\ s^{-1}}$ Here,

v_o is the velocity of sound in the gas at 0° C. For air, v_o = 331 m s^{-1}. Hence, the velocity of sound changes by 0.61 m s^{-1} when the temperature changes by one degree celsius.

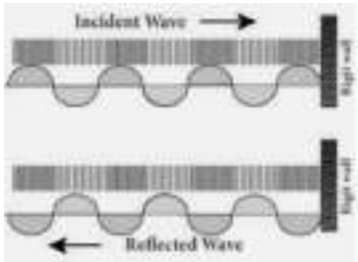
Effect of relative humidity :

When humidity increases, the speed of sound increases. That is why you can hear sound from long distances. clearly during rainy seasons.

2.What is mean by reflection of sound? Explain.

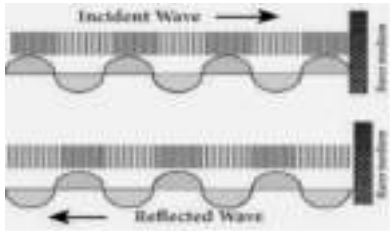
When sound waves travel in a given medium and strike the surface of another medium, they can be bounced back into the first medium. This phenomenon is known as reflection. In simple the reflection and refraction of sound is actually similar to the reflection of light. Thus, the bouncing of sound waves from the interface between two media is termed as the reflection of sound. The waves that strike the interface are termed as the incident wave and the waves that bounce back are termed as the reflected waves

a) Reflection at the boundary of a rarer medium.



- Consider a wave travelling in a solid medium striking on the interface between the solid and the air.
- The compression exerts a force F on the surface of the rarer medium. As a rarer medium has smaller resistance for any deformation, the surface of separation is pushed backwards. As the particles of the rarer medium are free to move, a rarefaction is produced at the interface.
- Thus, a compression is reflected as a rarefaction and a rarefaction travels from right to left.

b) Reflection at the boundary of a denser medium.



- A longitudinal wave travels in a medium in the form of compressions and rarefactions. Suppose a compression travelling in air from left to right reaches a rigid wall.
- The compression exerts a force F on the rigid wall. In turn, the wall exerts an equal and opposite reaction **R = – F** on the air molecules.
- This results in a compression near the rigid wall.
- Thus, a compression travelling towards the rigid wall is reflected back as a compression.
- That is the direction of compression is reversed.

c) Reflection at curved surfaces.

- when the sound waves are reflected from the curved surfaces, the intensity of the reflected waves is changed.
- When reflected from a convex surface, the reflected waves are diverged out and the intensity is decreased.
- When sound is reflected from a concave surface, the reflected waves are converged and focused at a point.
- So the intensity of reflected waves is concentrated at a point.

3. a) What do you understand by the term 'ultrasonic vibration'?

The vibrations whose frequencies are greater than 20000Hz are called Ultrasonic Vibrations.

b) State three uses of ultrasonic vibrations.

- Ultra sonic vibrations are used in SONAR to measure the depth of sea (or ocean) and to locate under water objects like Submarines, sea – rocks and shipwrecks
- It is used for scanning and imaging the position and growth of a foetus and presence of stones in the gall bladder and kidney.

- It is used for homogenizing milk in milk plants where fresh milk is agitated with desired quantity of fat and powdered milk to obtain toned milk.

c) Name three animals which can hear ultrasonic vibrations.

Bats can hear ultrasonic sounds having frequencies up to 1,20,000 Hz. Some animals like dogs and dolphins can hear sounds having frequencies up to 40000 Hz.

4. What is an echo?

- An echo is the sound reproduced due to the reflection of the original sound from various rigid surfaces such as walls, ceilings, surfaces of mountains, etc.
- If you shout or clap near a mountain or near a reflecting surface, like a building you can hear the same sound again.
- The sound, which you hear is called an echo. It is due to the reflection of sound.

a) State two conditions necessary for hearing an echo.

The persistence of hearing for human ears is 0.1 second. This means that you can hear two sound waves clearly, if the time interval between the two sounds is at least 0.1 s. Thus, the minimum time gap between the original sound and an echo must be 0.1 s.
The above criterion can be satisfied only when the distance between the source of sound and the reflecting surface would satisfy the following equation:

$$\text{Velocity} = \frac{Distance\ travelled\ by\ sound}{Time\ taken}$$

$$V = \frac{2d}{t}$$

$$d = \frac{Vt}{2}$$

Since, t = 0.1 second, Then

$$d = \frac{V\ X\ 0.1}{2} = \frac{V}{20}$$

Thus the minimum distance required to hear an echo is 1/20th part of the magnitude of the velocity of sound in air. If you consider the velocity of sound as 344 m s^{-1}, the minimum distance required to hear an echo is 17.2 m.

b) What are the medical applications of echo?

The medical applications of echo:

The principle of echo is used in obstetric ultrasonography, which is used to create real-time visual images of the developing embryo or fetus in the mother's uterus. This is a safe testing tool, as it does not use any harmful radiations.

c) How can you calculate the speed of sound using echo?

Ans : The sound pulse emitted by the source travels a total distance of 2d while travelling from the source to the wall and then back to the receiver. The time taken for this has been observed to be 't'.
Hence, the speed of sound wave is given by:

$$\text{Velocity} = \frac{Distance\ travelled\ by\ sound}{Time\ taken}$$

$$V = \frac{2d}{t}$$

UNIT:6-NUCLEAR PHYSICS

I. Numerical Problems.

1. $_{88}Ra^{226}$ experiences three α - decay. Find the number of neutrons in the daughter element.

$88^{Ra^{226}}$ consider as a parent element that is $88^{X^{226}}$ and their daughter element is $Z^{Y^{A}}$

According to α decay process,

$$88^{Ra^{26}} \xrightarrow{3\alpha decay} + 82^{X^{214}} + 3\ \ 2^{He^{4}}$$

During the 3α decay, the atomic number decreases by 6 and mass number decreases by 12.

So the number of neutrons in the daughter element

$$N = A - Z$$
$$N = 214 - 82 = 126$$

Number of neutrons in the daughter element

$$N = 132.$$

2. A cobalt specimen emits induced radiation of 75.6 millicurie per second. Convert this disintegration in to becquerel (one curie = 3.7×10^{10} Bq)

Cobalt specimen emits induced radiation = 75.6 millicurie per second

$$(1 \text{ curie} = 3.7 \times 10^{10} Bq)$$

So 75.6 millicurie $= 76.6 \times 10^{3} \times 1\ curie$

$$= 75.6 \times 10^{-3} \times 3.7 \times 10^{10} Bq$$
$$= 279.72 \times 10^{7}$$
$$= 2.7972 \times 10^{9} Bq$$

75.6 millicurie per second is equivalent to $2.7972 \times 10^{9} Bq$.

II. Answer in One or Two Word (VSA)

1. Who discovered natural radioactivity?

Henri Becquerel.

2. Which radioactive material is present in the ore of pitchblende?

Uranium.

3. Write any two elements which are used for inducing radioactivity?

Boron, Aluminium.

4. Write the name of the electromagnetic radiation which is emitted during a natural radioactivity.

γ – rays.

5. If A is a radioactive element which emits an α - particle and produces $_{104}Rf^{259}$. Write the atomic number and mass number of the element A.

Element A = $_{106}Sg^{263}$

Atomic number of A = 106,

Mass number of A = 263.

6. What is the average energy released from a single fission process?

3.2×10^{-11}J.

7. Which hazardous radiation is the cause for the genetic disease?

γ – rays.

8. What is the amount of radiation that may cause death of a person when exposed to it?

Acute radiation Syndrome is a collection of health effects that are present within 24 hrs of exposure to ionizing radiation. It is also called radiation poisoning, radiation sickness and radiation toxicity.

9. When and where was the first nuclear reactor built?

Chicago, USA 1942.

10. Give the SI unit of radioactivity.

Becquerel.

10. Which material protects us from radiation?

Lead.

III. Answer the following questions in few sentences.

1. Write any three features of natural and artificial radioactivity.

S.No.	Natural radioactivity	Artificial radioactivity
1	Emission of radiation due to self–disintegration of a nucleus.	Emission of radiation due to disintegration of a nucleus through induced process
2	Alpha, beta and gamma radiations are emitted.	Mostly elementary particles such as neutron, positron, etc., are emitted.
3	It is a spontaneous process.	It is an induced process.
4	Exhibited by elements with atomic number more than 83.	Exhibited by elements with atomic number less than 83.
5	This cannot be controlled.	This can be controlled.

2. Define critical mass.

- The minimum mass of a fissile material necessary to sustain the chain reaction is called 'critical mass (m_c)'.
- It depends on the nature, density and the size of the fissile material.

3. Define one roentgen.

Roentgen (R):

It is The radiation exposure of γ and x-rays is measured by another unit called roentgen. One roentgen is defined as the quantity of radioactive substance which produces a charge of 2.58×10^{-4} coulomb in 1 kg of air under standard conditions of pressure, temperature and Humidity.

4. State Soddy and Fajan’s displacement law.

- When a radioactive element emits an alpha particle, a daughter nucleus is formed whose mass number is less by 4 units and the atomic number is less by 2 units, than the mass number and atomic number of the parent nucleus.
- When a radioactive element emits a beta particle, a daughter nucleus is formed whose mass number is the same and the atomic number is more by 1 unit, than the atomic number of the parent nucleus.

5. Give the function of control rods in a nuclear reactor.

Control rod :

Control rods are used to control the number of neutrons in order to have sustained chain reaction. Mostly boron or cadmium rods are used as control rods. They absorb the neutrons.

6. In Japan, some of the new born children are having congenital diseases. Why?

- The nuclear bomb that was dropped in Hiroshima during World War II was called as 'Little boy'.
- It was a gun type bomb which used a uranium core.
- The bomb, which was subsequently dropped over Nagasaki was called as 'Fat man'.
- It was an explosion type bomb, which used a plutonium core.
- Due to this some of the new born children are having congenital diseases.

7. Mr. Ramu is working as an X - ray technician in a hospital. But, he does not wear the lead aprons. What suggestion will you give to Mr. Ramu?

Lead aprons are the most effective personal radiation protection means and should be worn by everyone in a fluoroscopy room (except the patient).Lead aprons may reduce the dose received by over 90% depending on the energy of the X- rays and the lead equivalent thickness of the apron.

8. What is stellar energy?

Fusion reaction that takes place in the cores of the Sun and other stars results in an enormous amount of energy, which is called as 'stellar energy'. Thus, nuclear fusion or thermonuclear reaction is the source of light and heat energy in the Sun and other stars.

9. Give any two uses of radio isotopes in the field of agriculture?

- The radioisotope of phosphorous (P-32) helps to increase the productivity of crops.
- The radiations from the radioisotopes can be used to kill the insects and parasites and prevent the wastage of agricultural products.

XI. Answer the following questions in detail.

1. Explain the process of controlled and uncontrolled chain reactions.

Two kinds of chain reactions are possible. They are;

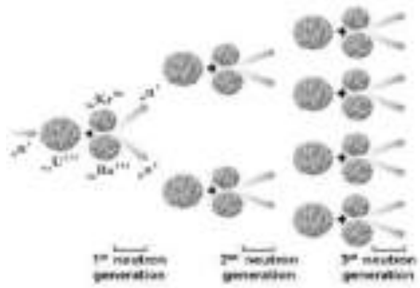
(i) controlled chain reaction and

(ii) (ii) uncontrolled chain reaction.

i)Controlled chain reaction:

In the controlled chain reaction the number of neutrons released is maintained to be one. This is achieved by absorbing the extra neutrons with a neutron absorber leaving only one neutron to produce further fission. Thus, the reaction is sustained in a controlled manner. The energy released due to a controlled chain reaction can be utilized for constructive purposes. Controlled chain reaction is used in a nuclear reactor to produce energy in a sustained and controlled manner.

ii) Uncontrolled chain reaction:



In the uncontrolled chain reaction the number of neutrons multiplies indefinitely and causes fission in a large amount of the fissile material. This results in the release of a huge amount of energy within a fraction of a second. This kind of chain reaction is used in the atom bomb to produce an explosion. Figure represents an uncontrolled chain reaction.

2.Compare the properties of alpha, beta and gamma radiations.

Properties	α rays	βrays	γ rays
What are they?	Helium nucleus ($_2He^4$) consisting of two protons and two neutrons.	They are electrons ($_{-1}e^0$), basic elementary particle in all atoms.	They are electromagnetic waves consisting of photons.
Charge	Positively charged particles. Charge of each alpha particle = +2e	Negatively charged particles. Charge of each beta particle = –e	Neutral particles. Charge of each gamma particle = zero
Ionising power	100 time greater than β rays and 10,000 times greater than γ rays	Comparatively low	Very less ionization power
Penetrating power	Low penetrating power (even stopped by a thick paper)	Penetrating power is greater than that of α rays. They can penetrate through a thin metal foil.	They have a very high penetrating power greater than that of β rays. They can penetrate through thick metal blocks.
Effect of electric and magnetic field	Deflected by both the fields. (in accordance with Fleming's left hand rule)	Deflected by both the fields; but the direction of deflection is opposite to that for alpha rays. (in accordance with Fleming's left hand rule)	They are not deflected by both the fields.
Speed	Their speed ranges from 1/10 to 1/20 times the speed of light.	Their speed can go up to 9/10 times the speed of light.	They travel with the speed of light.

3.What is a nuclear reactor? Explain its essential parts with their functions.

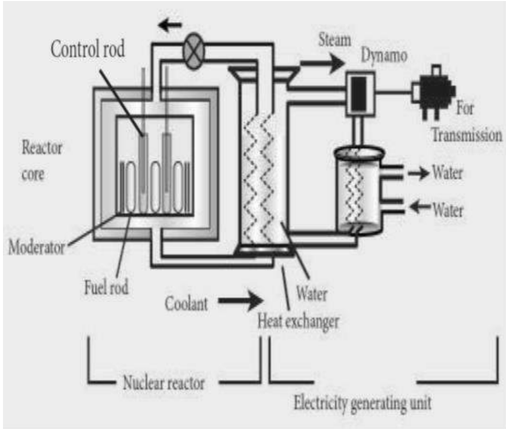
A Nuclear reactor is a device in which the nuclear fission reaction takes place in a self-sustained and controlled manner to produce electricity. The first nuclear reactor was built in 1942 at Chicago, USA.

Components of a nuclear reactors :

The essential components of a nuclear reactor are,

(i) fuel, (ii) moderator, (iii) control rod, (iv) coolant and (v) protection wall.

i) **Fuel :** A fissile material is used as the fuel. The commonly used fuel material is uranium.



ii) **Moderator :** A moderator is used to slow down the high energy neutrons to provide slow neutrons. Graphite and heavy water are the commonly used moderators.

iii) **Control rod :** Control rods are used to control the number of neutrons in order to have sustained chain reaction. Mostly boron or cadmium rods are used as control rods. They absorb the neutrons.

iv) **Coolant :** A coolant is used to remove the heat produced in the reactor core, to produce steam. This steam is used to run a turbine in order to produce electricity. Water, air and helium are some of the coolants.

v) **Protection wall :** A thick concrete lead wall is built around the nuclear reactor in order to prevent the harmful radiations from escaping into the environment.

XII. HOT Questions.

1. Mass number of a radioactive element is 232 and its atomic number is 90. When this element undergoes certain nuclear reactions, it transforms into an isotope of lead with a mass number 208 and an atomic number 82. Determine the number of alpha and beta decay that can occur.?

Atomic number Z = 90

Daughter element:

Mass number A = 208

Atomic number Z = 82

Difference in mass number = 232 – 208 = 24

Difference in atomic number = 90-82 = 8

Atomic number of $\alpha = 2$

Atomic number of $\beta = -1$

Mass number of $\alpha = 4$

Mass number of $\beta = 0$

Difference in mass number in transformations$= 24$

Number of a decays $= \frac{24}{4} = 6$

Difference in atomic number $= 8$

$$\Delta Z = 6\alpha + 4\beta$$
$$= 6(2) + 4(-1)$$
$$= 12 - 4$$
$$= 8$$

∴ Number of β decays = 4

∴ Number of α decays = 60.

2. 'X – rays should not be taken often'. Give the reason.

X- rays and gamma rays can cause a number of other problems besides cancer. Lower doses of radiation, such as from imaging tests are not known to cause short – term health problems.

3. Cell phone towers should be placed far away from the residential area – why?

- Cell towers produce non ionizing radiation with a wavelength longer than that of visible light. If cell towers residing in our area, then turnoff all lights, because short wavelength, like X-rays and Gamma rays are dangerous, ionizing radiation.
- Long wave ultra violet light, with a wave length shorter than visible light, causes sunburn.
- Shorter still is short UV light, that with continued exposure can cause melanoma (wear sunscreen).

UNIT:7- ATOMS AND MOLECULES

I. Short Answer questions:

1.Define: Relative atomic mass.

Relative atomic mass of an element is the ratio between the average mass of its isotopes to $\frac{1}{12^{th}}$part ofthe mass of a carbon–12 atoms. It is denoted as A_r. It is otherwise called “Standard Atomic Weight”.

$$A_r = \frac{\text{Average mass of the isotopes of the element}}{\frac{1}{12\text{th}} \text{ of the mass one Carbon}-12 \text{ atom}}$$

2. Write the different types of isotopes of oxygen and its percentage abundance.

Isotope Mass (amu) % abundance

Isotope	Mass (amu)	% abundance
$_8O^{16}$	15.9949	99.757
$_8O^{17}$	16.9991	0.038
$_8O^{18}$	17.9992	0.205

3. Define: Atomicity.

The number of atoms present in the molecule is called its Atomicity.

4**. Give any two examples for hetero diatomic molecules.**

HCl - Hydrogen Chloride

HI - Hydrogen Iodide

Co - Carbon monoxide

5. What is Molar volume of a gas?

Molar volume of a gas

One mole of any gas occupies 22.4 litre or 22400 ml at STP. The volume is called molar volume.

6.Find the percentage of nitrogen in ammonia.

Ammonia = NH_3

Mass of Nitrogen = 14

Molecular mass of Ammonia = 1(N) + 3(H)

=1(14) + 3(1)

= 14 + 3 =17 g.

Percentage of Nitrogen = $\frac{\text{Mass of Nitrogen}}{\text{Molecular mass of ammonia}}$

= $\frac{14}{17}$X 100

Percentage of Nitrogen = 82.35%

II-Long answer questions.

1. Calculate the number of water molecule present in one drop of water which weighs 0.18 g.

Given Mass = 0.18 g

Avogadro Number = 6.023×10^{23}

Molecular Mass of water = 18 g (H_2O = 2(1) + 1(16) = 2 + 16 = 18)

No. of water molecules = $\frac{\text{Avogadro number X Given mass}}{\text{Molecular mass of water}}$

$$= \frac{6.023\ X10^{23} X\ 0.18g}{18g}$$
$$= \frac{6.023\ X10^{23} X\ 0.18\ X100}{18X10^{2}}$$
$$= \frac{6.023\ X10^{23} X\ 18}{18X10^{2}}$$
$$= \frac{6.023\ X10^{23} X10^{2} X\ 18}{18}$$
$$= 6.023\ X10^{23} X10^{-2}$$

Molecules of water=$6.023\ X10^{21}$

2. $N_2 + 3H_2 \rightarrow 2NH_3$.

(The atomic mass of nitrogen is 14, and that of hydrogen is 1)

1 mole of nitrogen (_______g) +

3 moles of hydrogen (_________ g) →

2 moles of ammonia (_________ g)

1 mole of nitrogen

= 2(N)=2(14)=28g

1 mole of nitrogen (**28** g) +

3 moles of hydrogen

=3{2 (H)} **=** 3{2 (1)}= 3 X 2 = 6

3 moles of hydrogen (**6**g) →

2 moles of ammonia

=2 {1(N) + 3(H)} = 2 {1(14) + 3(1)}

= 2 (14 + 3) = 2 X 17 = 34

2 moles of Ammonia (**34** g)

28, 6, 34

3. Calculate the number of moles in

i) 27g of Al **ii) 1.51×10^{23} molecules of NH_4Cl.**

i) No.of moles = $\frac{\text{Mass}}{\text{Atomic Mass}}$

$$= \frac{27\ g}{27\ g} = 1 \text{ mole}$$

No.of moles = 1mole

ii) No.of moles = $\frac{\text{No.of molecules of } NH_4\ Cl}{\text{Avogadro's Numbers}}$

$$= \frac{1.51\ X10^{23}}{6.023\ X10^{23}} = \frac{1}{4}$$

= 0.25 moles

4. Give the salient features of "Modern atomic theory".

- An atom is no longer indivisible(after the discovery of the electron, proton and neutron).
- Atoms of the same element may have different atomic mass (discovery of **Isotopes** $_{17}Cl^{35}$, $_{17}Cl^{37}$).
- Atoms of different elements may have same atomic masses (discovery of **Isobars** $_{20}Ar^{40}$, $_{20}Ca^{40}$).
- Atoms of one element can be transmuted into atoms of other elements. In other words, atom is no longer indestructible (discovery of **artificial transmutation**).
- Atoms may not always combine in a simple whole number ratio (Eg. Glucose $C_6H_{12}O_6$
- C:H:O = 6:12:6 or 1:2:1 and Sucrose $C_{12}H_{22}O_{11}$ C:H:O = 12:22:11).
- Atom is the **smallest particle that take part in a chemical reaction**.
- The mass of an atom can be converted into energy (**$E=mC^2$**).

5. Derive the relationship between Relative molecular mass and Vapour density.

Relative Molecular Mass :

The ratio of Mass of one molecule of gas or vapour to the mass of one atom of hydrogen.

Vapour density :

The ratio of mass of a certain volume of a gas or vapour to the mass of an equal volume of hydrogen, measured under the same conditions of temperature and pressure.

Vapour Density (V.D) = $\frac{\text{Mass of a given volume of gas or vapour at S.T.P}}{\text{Mass of the same volume of hydrogen}}$

According to Avogadro's law, equal volumes of all gases contain equal number of molecules.

Thus, let the number of molecules in one volume = n, then

V.D at S.T.P = $\frac{\text{Mass of 'n' molecules of a gas or vapour at S.T.P}}{\text{Mass of 'n' molecules of hydrogen}}$

Cancelling 'n' which is common, we get

V.D= $\frac{Mass\ of\ 1\ molecules\ of\ a\ gas\ or\ vapour\ at\ S.T.P}{Mass\ of\ 1\ molecules\ of\ hydrogen}$

However, since hydrogen is diatomic

V.D = $\frac{Mass\ of\ 1\ molecules\ of\ a\ gas\ or\ vapour\ at\ S.T.P}{Mass\ of\ 2\ atoms\ of\ hydrogen}$

Compare the formula of vapour density with relative molecular mass, they can be represented as,

V.D = $\frac{\text{Mass of 1 molecules of a gas or vapour at S.T.P}}{\text{2 X Mass of 1 atom of htdrogen}}$ ____________________(1)

Relative molecular mass (hydrogen scale)

= $\frac{\text{Mass of 1 molecule of a gas or vapour at S.T.P}}{\text{Mass of 1 atom of hydrogen}}$ ___________________(2)

Substitute equ (2) in equ (1)

V.D = $\frac{\text{Relative molecular mass}}{2}$

Now on cross multiplication,

2 X Vapour density = Relative molecular mass of a gas (or)

Relative molecular mass = 2 X Vapour density

III. HOT questions

1. Calcium Carbonate is decomposed on heating in the following reaction.

$CaCO_3 \rightarrow CaO + CO_2$

i) How many moles of Calcium Carbonate are involved in this reaction?

Ans : 1 mole of Calcium carbonate.

ii) Calculate the gram molecular mass of Calcium Carbonate involved in this reaction.

GMM of $CaCO_3$ = 1 (Ca) + 1 (C) + 3 (O)

= 1 (40) + 1 (12) + 3 (16)

= 1 (40) + 1 (12) + 48

= 40 + 12 + 48 = 100 g.

iii) How many moles of CO_2 are there in this equation?

Ans : 1 mole of CO_2.

IX. Solve the following problems

1. How many grams are there in the following?

i) 2 moles of hydrogen molecule, H_2.

Mass = No. of moles × Molecular Mass.

Mass = 2 × (2×1) = 4 g.

ii) 3 moles of chlorine molecule, Cl_2.

Mass = No. of moles × Molecular Mass.

Mass =3× (2 X 35.5)

=3×71

= 213 g.

iii) 5 moles of sulphur molecule, S_8.

Mass = No. of moles × Molecular Mass.

Mass =5 × (8×32)

=5 x 256

= 1280 g.

iv) 4 moles of phosphorous molecule, P_4.

Mass = No. of moles × Molecular Mass.

Mass = 4 x (4 × 31)

=4 x 124

= 496 g.

2. Calculate the % of each element in calcium carbonate. (Atomic mass: C-12, O-16, Ca - 40).

$CaCO_3$.

Molecular Mass of $CaCO_3$ = 1 (Ca) + 1 (C) + 3 (O)

= 1 (40) + 1 (12) + 3 (16)

= 40 + 12 + 48

= 100 g.

% of Ca in $CaCO_3$ = $\frac{\text{Mass of Ca}}{\text{Molecular mass of } CaCo_3} \times 100$

$= \frac{40\ g}{100\ g}$ X 100

= 40%

% of C in $CaCO_3$ = $\frac{\text{Mass of Carbon}}{\text{Molecular mass of } CaCo_3} \times 100$

$= \frac{12\ g}{100\ g}$ X 100

= 12%

% of O in $CaCO_3$ = $\frac{\text{Mass of Oxygen}}{\text{Molecular mass of } CaCo_3} \times 100$

$= \frac{48\ g}{100\ g}$ X 100

= 48%

3. Calculate the % of oxygen in $Al_2(SO_4)_3$. (Atomic mass: Al-27, O-16, S -32)

$Al_2(SO_4)_3$.

Molecular Mass of $Al_2(SO_4)_3$ = 2 (Al) + 3 (S) + 12 (O)

= 2 (27) + 3 (32) + 12 (16)

= 54 + 96 + 192

= 342 g.

% of Oxygen in $Al_2(SO_4)3$ = $\frac{\text{Mass of Oxygen}}{\text{Molecular Mass of} Al_2\ (SO_4)_3}$

$= \frac{192\ g}{342\ g} \times 100$

= 56.14%.

4. Calculate the % relative abundance of B -10 and B -11, if its average atomic mass is 10.804 amu.

B-10 and B-11.

Let

B-10 = X%

B-11 = (100 – X)%

Average atomic mass

$\frac{10\ X}{100} + \frac{11\ (100-X\ )}{100}$ = 10.804

10X + 11 (100–X) = 10.804 × 100

10X + 1100 – 11X = 1080.4

1100 – X = 1080.4

– X = 1080.4 – 1100

– X = –19.6

– X = – 20

X = 20

B-11 = (100–X) = (100 – 20) = 80%.

B-10 = 20%

B-11 = 80%

UNIT:8-PERIODIC CLASSIFICATION OF ELEMENTS

I. Short answer questions.

1. A is a reddish brown metal, which combines with O_2 at < 1370 K gives B, a black coloured compound. At a temperature > 1370 K, A gives C which is red in colour. Find A,B and C with reaction.

Answer:

The reddish brown metal 'A' is copper.

Compound	Molecular formula	Name
A	Cu	copper
B	CuO	copper (ii) oxide
C	Cu_2O	copper (i) oxide

On heating at different temperatures in the presence of oxygen, copper forms two types of oxides CuO,Cu_2O.

$$2\ Cu + O_2 \xrightarrow{below\ 1370\ k} 2\ CuO$$

(copper II oxide- black)

$$4\ Cu + O_2 \xrightarrow{above\ 1370\ k} 2\ Cu_2O$$

(copper I oxide – red)

2.A is a silvery white metal. A combines with O_2 to form B at 800°C, the alloy of A is used in making the aircraft. Find A and B.

Answer:

The silvery white metal. A is Aluminium.

Compound	Molecular formula	Name
A	Al	Aluminium
B	Al_2O_3	Aluminium Oxide

$$4Al + 3O_2 \xrightarrow{800^0 c} 2Al_2O_3$$

(Aluminium Oxide) (B)

3. What is rust? Give the equation for formation of rust.

When iron is exposed to moist air, it forms a layer of brown hydrated ferric oxide on its surface. This compound is known as rust and the phenomenon of formation of rust is known as rusting.

$4Fe + 3O_2 + xH_2O$. $2Fe_2O_3.xH_2O$ (Rust)

4.State two conditions necessary for rusting of iron.

Two conditions necessary for rusting of iron:

Air and Moisture are necessary for rusting of iron.

II. Long answers:

1. a) State the reason for addition of caustic alkali to bauxite ore during purification of bauxite.

Because Bauxite ore is finely ground and heated under pressure with a solution of concentrated caustic soda at 150°C to obtain Sodium meta aluminate. On diluting sodium meta aluminate with water, a precipitate of aluminium hydroxide is formed. This precipitate is filtered, washed, dried and ignited at 1000°C to get alumina.

b) Along with cryolite and alumina, another substance is added to the electrolyte mixture. Name the substance and give one reason for the addition.

Fluorspar. (It lowers the fusion temperature of electrolyte)

2. The electronic configuration of metal A is 2,8,18,1.The metal A when exposed to air and moisture forms B a green layered compound. A with con. H_2SO_4forms C and D along with water. D is a gaseous compound. Find A,B,C and D.

i) Metal A is copper.

ii) **Action of Air and Moisture :**

Copper gets covered with a green layer of Basic Copper Carbonate in the presence of CO_2 and moisture.

$$\underset{\substack{\text{Copper}\\(A)}}{2Cu} + O_2 + CO_2 + H_2O \rightarrow \underset{\substack{\text{Basic copper carbonate(Malachite green)}\\(B)}}{CuCO_3.Cu(OH)_2}$$

iii) Copper is react with Conc.H_2SO_4 to form copper sulphate and sulphur dioxide.

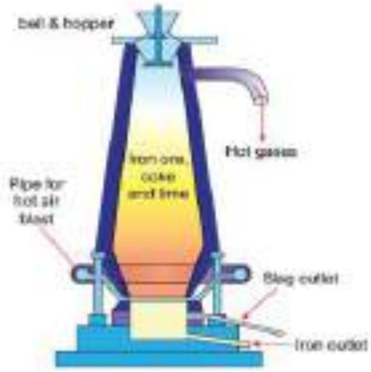
$$Cu + 2H_2SO_4 \rightarrow \underset{\substack{\text{Copper}\\\text{Sulphate}\\(C)}}{CuSO_4} + \underset{\substack{\text{Sulphur}\\\text{dioxide}\\(D)}}{SO_2\uparrow} + 2H_2O$$

Compound	Molecular Formula	Name
A	Cu	Copper
B	$CuCO_3. Cu(OH)_2$	Copper Carbonate
C	$CuSO_4$	Copper Sulphate
D	SO_2	Sulphur dioxide

3. Explain smelting process.

Smelting (in a Blast Furnace):

The charge consisting of roasted ore, coke and limestone in the ratio 8:4:1 is smelted in a blast furnace by introducing it through the hopper arrangement at the top. There are three important regions in the furnance.



(a) The Lower Region (Combustion Zone):

The temperature is at $1500\ °C$. In this region, coke burns with oxygen to form CO_2 when the charge comes in contact with a hot blast of air.

$$C + O_2 \xrightarrow[\Delta]{1500\ °C} CO_2 + Heat$$

It is an exothermic reaction since heat is liberated.

(b) The Middle Region (Fusion Zone) –

The temperature prevails at $1000°C$. In this region, CO_2 is reduced to CO.

$$CO_2 \xrightarrow[\Delta]{1000\ °C} 2\ CO - Heat$$

Limestone decomposes to calcium oxide and CO_2

$$CaCO_3 \xrightarrow[\Delta]{1000\ °C} CaO + CO_2 - Heat$$

These two reactions are endothermic due to absorption of heat. Calcium oxide combines with silica to form calcium silicate slag.

$$CaO + SiO_2 \rightarrow CaSiO_3$$

(c) The Upper Region (Reduction Zone) :

The temperature prevails at $400\ °C$. In this region carbon monoxide reduces ferric oxide to form a fairly pure spongy iron.

$$Fe_2O_3 + 3CO \xrightarrow{400\ °C} 2Fe + 3CO_2 \uparrow$$

The molten iron is collected at the bottom of the furnace after removing the slag.

The iron thus formed is called pig iron. It is remelted and cast into different moulds.

This iron is called cast iron.

III. HOT Questions

1. Metal A belongs to period 3 and group 13. A in red hot condition reacts with steam to form B. A with strong alkali forms C. Find A,B and C with reactions.

i) The metal A is Aluminium.

ii) When steam is passed over red hot aluminium, hydrogen only produced.

$$2Al + 3H_2O \rightarrow \underset{(B)}{Al_2O_3} + 3H_2\uparrow$$

B → Aluminium Oxide

iii) It reacts with strong caustic alkalis forming aluminates.

$$2Al + 2NaOH + 2H_2O \rightarrow \underset{(C)}{2NaAlO_2} + 3H_2\uparrow$$

C →Sodium meta Aluminate

Compound	Molecular Formula	Name
A	Al	Aluminium
B	Al_2O_3	Aluminium oxide
C	$NaAlO_2$	Sodium meta aluminate

2. Name the acid that renders aluminium passive. Why?

Conc. Nitric Acid (Conc.HNO_3). Concentrated and dil Nitric acid does not attack aluminium, but it renders aluminum passive due to the formation of an oxide film on its surface.

3. i) Identify the bond between H and F in HF molecule.

Ionic Bond.

ii) What property forms the basis of identification?

Electro negativity.

iii) How does the property vary in periods and in groups?

Along the period from left to right in the periodic table, the electro negativity increases because of the increase in nuclear charge which in turn attracts the electrons more strongly. On moving down a group ,the electro negativity of the elements decreases because of the increased number of energy levels.

UNIT:9-SOLUTIONS

I. Short Answer questions.

1. Define the term: Solution.

Solution is a homogeneous mixture of two or more substances.

Solute + Solvent → Solution

2. What is mean by binary solution.

A solution contains two components is called Binary solution.

Eg. Salt in water, Sugar in water.

3. Give an example each.

i) gas in liquid.

Soda water.

ii) solid in liquid.

Sodium chloride in water.

iii) solid in solid.

Copper dissolved in Gold (alloys).

iv) gas in gas.

Mixture of He – O_2 gases.

4. What is aqueous and non-aqueous solution? Give an example.

i) **Aqueous solution :**

The solution in which water acts as a solvent is called aqueous solution. eg: Common salt in water, sugar in water.

ii) **Non–aqueous solution :**

The solution in which any liquid other than water, acts as a solvent is called non–aqueous solution. eg: Sulphur dissolved in carbon di sulphide, iodine dissolved in ccl4.

5. Define Volume percentage.

Volume percentage is defined as the percentage by volume of solute present in the given volume of the solution.

Volume percentage $=\frac{\text{Volume of the Solute}}{\text{Volume of the Solute} + \text{Volume of the Solvent}} \times 100$

Volume percentage $=\frac{\text{Volume of the Solute}}{\text{Volume of the Solution}} \times 100$

6. The aquatic animals live more in cold region. Why?

Because, more amount of dissolved oxygen is present in the water of cold regions. This shows that the solubility of oxygen in water is more at low temperature.

7. Define Hydrated salt.

The number of water molecules found in the crystalline substance is called water of crystallisation. Such salts are called hydrated salts.

8. A hot saturated solution of copper sulphate forms crystals as it cools. Why?

- The number of water molecules in blue vitriol is 5, so its water of crystallisation is 5.
- When blue coloured copper sulphate crystals are gently heated, it loses its 5 water molecules and becomes anhydrous copper sulphate.
- Then add a few drops of water or allow it to cool, the colourless anhydrous salt again turns back into blue coloured hydrated salt.

9. Classify the following substances into deliquescent, hygroscopic.
Conc. Sulphuric acid, Copper sulphate penta hydrate, Silica gel, Calcium chloride, and Gypsum salt.

Deliquescent	Hygroscopic
Calcium Chloride	i) conc. H_2SO_4
	ii) Silica gel
	iii) Copper sulphate penta hydrate
	iv) Gypsum salt

II. Long Answer.

1. Write notes on; i) Saturated solution. ii) Unsaturated solution.

i) Saturated Solution

A solution in which no more solute can be dissolved in a definite amount of the solvent at a given temperature is called saturated solution.

Eg: 36 g of sodium chloride in 100 g of water at25° C.

ii) Unsaturated Solution

A solution is one that contains less solute than that of the saturated solution at a given temperature. Eg: 10 g (or) 20 g (or) 30 g of sodium chloride in 100g of water at 25° C form unsaturated solution.

2. Write notes on various factors affecting solubility.

Factors affecting solubility :

There are three main factors which govern the solubility of solute. They are;

i) Nature of the solute and solvent.
ii) Temperature.
iii) Pressure.

Nature of the solute and solvent :

The nature of the solute and solvent plays an important role in solubility. Although water dissolves an enormous variety of substances, both ionic and covalent, it does not dissolve everything.

For example: Common salt is a polar compound and dissolves in polar solvent like water. Non–polar compounds are soluble in non–polar solvents. For example: Fat dissolved in Ether.

Effect of temperature :

Solubility of a solid solute in a liquid solvent increases with increase in temperature.

In endothermic Process :

Solubility increases with increase in temperature.

In exothermic Process :

Solubility decreases with increase in temperature.

Solubility of gases in liquid :

Solubility of gases in liquid decrease with increase in temperature. Generally water contains dissolved oxygen. When water is boiled the solubility of oxygen in water decreases. So oxygen escapes in the form of bubbles.

Effect of pressure :

When the pressure is increased, the solubility of a gas in liquid increases.

Eg.: Carbonated beverages.

3. a) What happens when $MgSO_4.7H_2O$ is heated? Write the appropriate equation.

Its water of crystallisation is 7. When magnesium sulphate hepta hydrate crystals are gently heated, it loses seven water molecules and becomes an hydrous magnesium sulphate.

$$\underset{\text{Magnesium sulphate hepta hydrate}}{MgSO_4.7H_2O} \underset{Cooling}{\overset{Heating}{\rightleftarrows}} \underset{\text{(Anhydrous Magnesium sulphate)}}{MgSO_4 + 7H_2O}$$

b) Define solubility.

Solubility is defined as the number of grams of solute that can be dissolved in 100 g of a solvent to form its saturated solution at a given temperature and pressure. For example 36 g of sodium chloride need to be dissolved in 100 g of water to form its saturated solution at 25° C. Thus the solubility of NaCl in water is 36 g at 25° C. The solubility is mathematically expressed as,

$$\text{Solubility} = \frac{Mass\ of\ the\ solute}{Mass\ of\ the\ solvent} \text{ x } 100$$

4. In what way hygroscopic substances differ from deliquescent substances.

Hygroscopic	Deliquescent
When exposed to the atmosphere at ordinary temperature, they absorb moisture and do not dissolve.	When exposed to the atmospheric air at ordinary temperature, they absorb moisture and dissolve.
Hygroscopic substances do not change its physical state on exposure to air.	Deliquescent substances change its physical state on exposure to air.
Hygroscopic substances may be amorphous solids or liquids.	Deliquescent substances are crystalline solids.

5. A solution is prepared by dissolving 45 g of sugar in 180 g of water. Calculate the mass percentage of solute.

Given :

Mass of the solute = 45 g

Mass of the solvent = 180g

$$\text{Mass Percentage} = \frac{Mass\ of\ the\ solute}{Mass\ of\ the\ solute + Mass\ of\ the\ solvent} \times 100$$

$$= \frac{45\ g}{45\ g + 180\ g} \times 100$$

$$= \frac{45}{225} \times 100$$

Mass Percentage = 20%

6. 3.5 litres of ethanol is present in 15 litres of aqueous solution of ethanol. Calculate volume percent
of ethanol solution.

Given :

Volume of the solute = 3.5 lit of ethanol.

Volume of the solution = 15 lit.

Volume Percentage $= \frac{Volume\ of\ the\ solute}{Volume\ of\ the\ solution} \times 100$

$= \frac{3.5\ lit}{15\ lit} \times 100$

$= 0.23333 \times 100$

Volume Percentage = 23.33%.

III. HOTS:

1. Vinu dissolves 50 g of sugar in 250 ml of hot water, Sarath dissolves 50 g of same sugar in 250 ml of cold water. Who will get faster dissolution of sugar? and Why?

50 g of sugar in 250 ml of hot water. Because heat is expand the molecules of water. So it is easily dissolved.

2. 'A' is a blue coloured crystaline salt. On heating it loses blue colour and to give 'B'. When water is added, 'B' gives back to 'A'. Identify A and B, write the equation.

Answer:

A is a blue coloured crystalline salt => Copper Sulphate Penta hydrate

$CuSO_4.5H_2O$ (blue vitriol)

The equation is,

$$CuSO_4.5H_2O \underset{Cooling}{\overset{Heating}{\rightleftarrows}} CuSO_4 + 5H_2O$$

Copper sulphate penta hydrate (colourless)	Anhydrous copper sulphate (blue colour)

3. Will the cool drinks give more fizz at top of the hills or at the foot? Explain.

Cool drinks give more fizz at top of hills because solubility of gas is low at altitude and hence the carbon dioxide less soluble in cool drinks at altitude gives more fizz.

UNIT:10- TYPES OF CHEMICAL REACTON

I. Short Answer Questions.

1. When an aqueous solution of potassium chloride is added to an aqueous solution of silver nitrate, a white precipitate is formed. Give the chemical equation of this reaction.

$$KCl + AgNO_3 \rightarrow AgCl \downarrow + KNO_3.$$

2. Why does the reaction rate of a reaction increase on raising the temperature?

Most of the reactions go faster at higher temperature. Because adding heat to the reactants provides energy to break more bonds and thus speed up the reaction.

3. Define combination reaction. Give one example for an exothermic combination reaction

A combination reaction is a reaction in which two or more reactants combine to form a compound. It is otherwise called synthesis reaction (or) composition reaction.

$$2Mg_{(s)} + O_{2(s)} \rightarrow 2\,MgO_{(s)}$$

4.Differentiate reversible and irreversible reactions.

REVERSIBLE REACTION	IRREVERSIBLE REACTION
It can be reversed under suitable conditions	It cannot be reversed.
Both forward and backward reactions take place simultaneously.	It is unidirectional. It proceeds only in forward direction.
It attains equilibrium.	Equilibrium is not attained.
The reactants cannot be converted completely into products.	The reactants can be completely converted into products.
It is relatively slow.	It is fast.

II. Long Answer:

1. What are called Thermolysis reactions?

Thermolysis reactions:

In this type of reaction, the reactant is decomposed by applying heat. For example, on heating Mercury (II) oxide is decomposed into Mercury metal and oxygen gas. As the molecule is dissociated by the absorption of heat, it is otherwise called Thermolysis. It is a class of compound to element/element decomposition. i.e., a compound HgO is decomposed into 2 elements (Hg and Oxygen).

$$2\,HgO_{(s)} \xrightarrow{Heat} 2\,Hg_{(l)} + O_{2(g)}$$

Similarly, when Calcium carbonate is heated, it breaks down into Calcium oxide and CO2. It is a type of compound to compound/compound decomposition.

$$CaCO_{3(s)} \rightarrow CaO_{(s)} + CO_{2(g)}$$

In thermal decomposition reaction, heat is supplied to break the bonds. Such reactions, in which heat is absorbed are called Endothermic reactions.

2. Explain the types of double displacement reactions with examples.

Ans :

Double displacement reactions are classifies into 2 types. They are;

i) Precipitation reaction.

ii) Neutralisation reaction.

Precipitation Reaction :

When aqueous solutions of two compounds are mixed, if they react to form an insoluble compound and a solute compound, then it is called Precipitation reaction. Because the insoluble compound formed as one of the products and hence the reaction is so called.

Eg.: The aqueous solution of Potassium iodide and Lead (II) nitrate are mixed, a double displacement reactions take place between them.

$$Pb(NO_3)_{2(aq)} + 2KI_{(aq)} \rightarrow PbI_{2(s)}\downarrow + 2KNO_{3(aq)}$$

Potassium and Lead displace one other and form a yellow precipitate of Lead (II) iodide.

Neutralisation Reaction :

The reaction between an acid and a base. It is called Neutralisation reaction.

Acid + Base → Salt + Water

$$HCl_{(aq)} + NaOH_{(aq)} \rightarrow NaCl_{(aq)} + H_2O_{(l)}$$

Similarly, when Ammonium hydroxide reacts with Nitric acid, it forms Ammonium Nitrate and Water.

$$HNO_{3(aq)} + NH_4\,OH_{(aq)} \rightarrow NH_4NO_{3(aq)} + H_2O_{(l)}$$

3. Explain the factors influencing the rate of a reaction.

Important factors that affect rate of reaction are;

i) Nature of the reactants.
ii) Concentration of the reactants.
iii) Temperature.
iv) Catalyst.
v) Pressure.
vi) Surface area of the reactants.

i) **Nature of the Reactants** :

The reaction of sodium with hydrochloric acid is faster than that with acetic acid. Because, Hydro chloric acid is a stronger acid than acetic acid and thus more reactive. So, the nature of the reactants influence the reaction rate.

$$2Na_{(s)} + 2HCl_{(aq)} \rightarrow 2NaCl_{(aq)} + H_{2(g)} \text{ (fast)}$$

$$2Na_{(s)} + 2CH_3COOH_{(aq)} \rightarrow 2CH_3COONa_{(aq)} + H_{2(g)} \text{ (slow)}$$

ii)Concentration of the Reactants :

Changing the amount of the reactants also increases the reaction rate. The amount of the substance present in a certain volume of the solution is called 'concentration'. More the concentration, more particles per volume exist in it and hence faster the reaction. Granulated zinc reacts faster with 2M hydrochloric acid than 1M hydrochloric acid.

iii)Temperature :

Most of the reactions go faster at higher temperature. Because adding heat to the reactants provides energy to break more bonds and thus speed up the reaction. Calcium carbonate reacts slowly with hydrochloric acid at room temperature. When the reaction mixture is heated the reaction rate increases.

iv)Pressure :

If the reactants are gases, increasing their pressure increases the reaction rate. This is because, on increasing the pressure the reacting particles come closer and collide frequently.

v)Catalyst :

A catalyst is a substance which increases the reaction rate without being consumed in the reaction.

In certain reactions, adding a substance as catalyst speeds up the reaction. For example, on heating potassium chlorate, it decomposes into potassium chloride and oxygen gas, but at a slower rate. If manganese dioxide is added, it increases the reaction rate. (Here, MnO_2 act as a catalyst)

$$2KClO_3 \xrightarrow{MnO_2} 2KCl + 3O_2$$

vi) **Surface Area of the Reactants** :

When solid reactants are involve in a reaction, their powdered form reacts more readily. For example, powdered calcium carbonate reacts more readily with hydrochloric acid than marble chips. Because, powdering of the reactants increases the surface area and more energy is available on collision of the reactant particles. Thus, the reaction rate is increased.

4. How does pH play an important role in everyday life?

- Living organisms can survive only in a narrow range of pH change. Different body fluids have different pH values.
- pH of blood is ranging from 7.35 to 7.45. Any increase or decrease in this value leads to diseases. The ideal pH for blood is 7.4.
- Our stomach produces hydrochloric acid. It helps in the digestion of food without harming the stomach. During indigestion the stomach produces too much acid and this causes pain and irritation. pH of the stomach fluid is approximately 2.0.
- pH of the saliva normally ranges between 6.5 to 7.5.
- When the pH of the mouth saliva falls below 5.5, the enamel gets weathered. Toothpastes, which are generally basic are used for cleaning the teeth that can neutralise the excess acid and prevent tooth decay.
- The pH of rain water is approximately 7, which means that it is neutral and also represents its high purity. If the atmospheric air is polluted with oxide gases of sulphur and nitrogen, they get dissolved in the rain water and make its pH less than 7. Thus, if the pH of rain water is less than 7, then it is called acid rain. When acid rain flows into the rivers it lowers the pH of the river water also.
- In agriculture, the pH of soil is very important. It depends upon the nature and the range of different soil, different crops are cultivated.

5. What is a chemical equilibrium? What are its characteristics?

Chemical Equilibrium :

It is state of a reversible chemical reaction in which no change in the amount of the reactants and products takes place. At equilibrium,

Rate of Forward reaction = Rate of Backward reaction

Characteristics of Equilibrium :

- In a chemical equilibrium, the rates of the forward and backward reactions are equal.
- The observable properties such as pressure, concentration, colour, density, viscosity etc., of the system remain unchanged with time.

- The chemical equilibrium is a dynamic equilibrium, because both the forward and backward reactions continue to occur even though it appears static externally.
- In physical equilibrium, the volume of all the phases remain constant.

VII. HOT Questions:

1. A solid compound 'A' decomposes on heating into 'B' and a gas 'C'. On passing the gas 'C' through water, it becomes acidic. Identify A, B and C.

A solid compound 'A' is Calcium carbonate decomposes on heating into Calcium (B) oxide and a gas Carbon dioxide (O). On passing this Carbon dioxide (O) through water, it becomes acidic because the formation of Carbonic acid.

Compound	**Molecular Formula**	**Name**
A	$CaCO_3$	calcium carbonate
B	CaO	calcium oxide
C	CO_2	carbon dioxide

$$CaCO_3 \rightarrow CaO + CO_2$$

A B C

$$CO_2 + H_2O \rightarrow H_2CO_3$$

Carbonic acid

2. Can a nickel spatula be used to stir copper sulphate solution? Justify your answer.

The standard electrode reduction potentials are;

Since the EMF of the cell is positive the reaction will displace Copper from its solution and Copper will be deposited on the Nickel spatula. Thus Nickel cannot be used as to stir the Copper sulphate solution.

IV. Solve the Problem.

1. Lemon juice has a pH 2, what is the concentration of H^+ ions?

Solution :

pH = 2

$[H^+]$ = ?

pH = – log $[H^+]$

$\log_{10} [H^+] = -2$

$[H^+] = 10^{-2}$

$[H^+] = 0.01$ $mole^{-1}$

2. Calculate the pH of 1.0×10^{-4} molar solution of HNO_3.

Solution :

$[H^+] = 1 \times 10^{-4}$

$pH = -\log_{10} [H^+]$

$= -(\log_{10} - \log_{10}10^4$

$= -(0 - 4 \times \log_{10}10)$

$= -(4 \times 1)$

pH = 4.

3. What is the pH of 1.0×10^{-5} molar solution of KOH?

Solution :

KOH is a strong base and dissociates in its solution as,

$$KOH_{(aq)} \rightarrow K^+_{(aq)} + OH^-$$

One mole of KOH would give one mole of OH^- ions.
Therefore,

$OH^- = 1 \times 10^{-5}$ mole lit^{-1}

$pOH = -\log [OH^-]$

$= -\log \times [10^{-5}]$

$= -(-5 \times \log_{10}10)$

$= -(-5)$

$pOH = 5.$

Since,

$pH + pOH = 14$

$pH + 5 = 14$

$pH = 14 - 5$

$pH = 9.$

4. The hydroxide ion concentration of a solution is 1×10^{-11}M. What is the pH of the solution?

Solution :

$OH^- = 1 \times 10^{-11}M.$

$p[OH] = -\log [OH^-]$

$pOH = -\log (1 \times 10^{-11})M$

$= -\log_{10} (1.0 \times 10^{-11})$

$pOH = -(-11)$

$pOH = 11.$

$pH + pOH = 14$

$pH = 14 - pOH$

$pH = 14 - 11$

pH = 3.

V. Short answer questions.

1. Name the simplest ketone and give its structural formula.

Simeplest Ketone is Acetone.

Structure:

$$\begin{array}{ccc} CH_3 - & C & - CH_3 \\ & \| & \\ & O & \end{array}$$

2. Classify the following compounds based on the pattern of carbon chain and give their structural formula: (i) Propane (ii) Benzene (iii) Cyclobutane (iv) Furan

(i) Propane

$\boldsymbol{CH_3 - CH_2 - CH_3}$.

Structural formula:

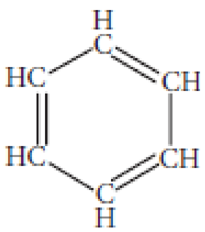
$$\begin{array}{ccccccccc} & & H & & H & & H & & \\ & & | & & | & & | & & \\ H & - & C & - & C & - & C & - & H \\ & & | & & | & & | & & \\ & & H & & H & & H & & \end{array}$$

A cyclic compound

(ii) Benzene.

$\boldsymbol{C_6H_6}$.

Structural formula.



(iii) Cyclobutane. $\boldsymbol{C_4H_8}$

Structural formula:

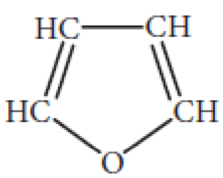
$$\begin{array}{ccccccc} & & H & & H & & \\ & & | & & | & & \\ H & - & C & - & C & - & H \\ & & | & & | & & \\ H & - & C & & C & - & H \\ & & | & & | & & \\ & & H & & H & & \end{array}$$

Allicylic compound

iv) Furan

$\boldsymbol{C_4H_4O}$.

Structural formula



3. How is ethanoic acid prepared from ethanol? Give the chemical equation.

Ethanoic acid is prepared in large scale, by the oxidation of ethanol in the presence of alkaline potassium permanganate or acidified potassium dichromate.

$$CH_3CH_2OH \xrightarrow[2(O)]{KMnO)4\ /OH^-} CH_3COOH + H_2O$$

Ethanol Ethanoic Acid

4. How do detergents cause water pollution? Suggest remedial measures to prevent this pollution?

Detergents also add another problem for aquatic life by lowering the surface tension of the water. Phosphates in detergents can lead to fresh water algal blooms that releases toxins and deplete oxygen in water ways. When the algae decompose, they use up the oxygen available for aquatic life.

Remedial Measures :

- Immediate reduction and eventual eradication of phosphates in detergents.
- Awareness among consumers to select washing products with the least amount of polluting ingredients.
- Prompt promulgation of regulations requiring appropriate labelling of detergent packages listing of the ingredients and information about use of detergents in soft and hard water.

5.Differentiate soaps and detergents.

S.No.	Soap	Detergents
1	It is a Sodium salt of long chain fatty acids.	It is sodium salts of sulphonic acids.
2	The ionic part of a soap is $-COO^-Na^+$	The ionic part in a detergent $-SO_3^-Na^+$
3	It is prepared from animal fats (or) vegetable oils.	It is prepared from hydrocarbons obtained from crude oil.
4	It forms a scum in hard water.	Does not form a scum in hard water.
5	It has poor foaming capacity.	It has rich foaming capacity.
6	Soaps are biodegradable.	Most of the detergents are non–biodegradable.

II. Long Answer questions:

1. What is called homologous series? Give any three of its characteristics?

Homologous series :

Homologous series is a group or a class of organic compounds having same general formula and similar chemical properties in which the successive members differ by a - CH_2 group.

Characteristics of Homologous series :

- Each member of the series differs from the preceding or succeeding member by one methylene group ($-CH_2$) and hence by a molecular mass of 14 amu.
- All members of a homologous series contain the same elements and functional group.
- They are represented by a general molecular formula. e.g. Alkanes, C_nH_{2n+2}.

- The members in each homologous series show a regular gradation in their physical properties with respect to their increase in molecular mass.
- Chemical properties of the members of a homologous series are similar.
- All the members can be prepared by a common method.

2. Arrive at, systematically, the IUPAC name of the compound: $CH_3–CH_2–CH_2–OH$.

Step 1 : The parent chain consists of 3 carbon atoms. The root word is 'prop'.

Step 2 : There are single bonds between the carbon atoms of the chain. So the primary suffix is 'ane'.

Step 3 : Since the compound contains –OH group, it is an alcohol. The carbon chain is numbered from the end which is closest to –OH group (Rule 3), $C_3H_3 – C_2H_2 – C_1H_2 – OH$.

Step 4 : The locant number of –OH group is 1 and thus the secondary suffix is 1–ol. The name of the compound is prop +ane + (1–0l) = propan–1–ol.

NOTE : Terminal 'e' of 'ane' is removed as per Rule 5.

3. How is ethanol manufactured from sugarcane?

Ethanol is manufactured in industries by the fermentation of molasses, which is a by product obtained during the manufacture of sugar from sugarcane. Molasses is a dark coloured synopy liquid left after the crystallisation of sugar from the concentrated sugarcane juice. Molasses contain about 30% of sucrose, which cannot be separated by crystallisation. It is converted into ethanol by the following steps.

i) **Dilution of Molasses :**

Molasses is first diluted with water to bring down the concentration of sugar to about 8 to 10 percent.

ii) **Addition of Nitrogen source :**

Molasses usually contains enough nitrogenous matter to act as food for yeast during the fermentation process. If the nitrogen content of the molasses is poor, it may be fortified by the addition of ammonium sulphate or ammonium phosphate.

iii) **Addition of Yeast :**

The solution obtained in step (ii) is collected in large ‘fermentation tanks’ and yeast is added to it. The mixture is kept at about 303K for a few days. During this period, the enzymes invertase and zymase present in yeast, bring about the conversion of sucrose into ethanol.

$$\underset{\text{Sugar}}{C_{12}H_{22}O_{11}} + H_2O \xrightarrow{\text{invertase}} \underset{\text{glucose}}{C_6H_{12}O_6} + \underset{\text{fructose}}{C_6H_{12}O_6}$$

$$\underset{\text{glucose}}{C_6H_{12}O_6} \xrightarrow{\text{zymase}} \underset{\text{ethanol}}{2C_2H_5OH} + 2\,CO_2$$

The fermented liquid is technically called wash.

iv) **Distillation of 'Wash' :**

- The fermented liquid (i.e. wash), containing 15 to 18 percent alcohol, is now subjected to fractional distillation.
- The main fraction drawn is an aqueous solution of ethanol which contains 95.5% of ethanol and 4.5% of water.
- This is called rectified spirit. This mixture is then refluxed over quicklime for about 5 to 6 hours and then allowed to stand for 12 hours.

- On distillation of this mixture, pure alcohol (100%) is obtained. This is called absolute alcohol.

4. Give the balanced chemical equation of the following reactions:

i) Neutralization of NaOH with ethanoic acid.

Ethanoic acid reacts with sodium hydroxide to form sodium ethanoate and water.

$$CH_3\ COO\ H + Na\ OH \rightarrow CH_3\ COONa + H_2O$$

ii) Evolution of carbon dioxide by the action of ethanoic acid with $NaHCO_3$.

Ethanoic acid reacts with sodium bicarbonate to give salt, water and carbon dioxide gas.

$$CH_3\ COO\ H + Na\ H\ CO_3 \rightarrow CH_3\ COONa + CO_2\uparrow + H_2O$$

iii) Oxidation of ethanol by acidified potassium dichromate.

Ethanol is oxidised to ethanoic acid with alkaline KMnO4 or acidified K2Cr2O7.

$CH_3\ CH_2\ OH$	$CH_3\ COOH + H_2O$
Ethyl alcohol	Acetic acid

iv) Combustion of ethanol.

Ethanol is highly inflammable liquid. It burns with oxygen to form carbon dioxide and water.

$$C_2\ H_5\ OH + 3O_2 \rightarrow 2\ CO_2 + 3H_2O$$

Ethanol	Carbon dioxide

5. Explain the mechanism of cleansing action of soap.

- A Soap molecule contains two chemically distinct parts that interact differently with water.
- It has one polar end, which is a short head with a carboxylate group (–COONa) and one non–polar end having the long tail made of the hydrocarbon chain.
- The polar end is hydrophilic (water loving) in nature and this end is attracted towards water.
- The non– polar end is hydrophobic (water hating) in nature and it is attracted towards water.
- Thus, the hydrophobic part of the group molecule traps the dirt and the hydrophilic part makes the entire molecule soluble in water.
- When a soap (or) detergent is dissolved in water, the molecules join together as clusters called micelles.
- Their long hydrocarbon chains attach themselves to the oil and dirt. The dirt is thus surrounded by the non– polar end of the soap molecules as shown below.
- The changed carboxylate end of the soap molecules makes the micelles soluble in water. Thus, the dirt is washed away with the soap.

III. HOT Questions:

1. The molecular formula of an alcohol is $C_4H_{10}O$. The locant number of its –OH group is 2.

i) Draw its structural formula.

```
1         2          3         4
CH3 – CH – CH2 – CH3
          |
          OH
```

ii) Give its IUPAC name.

2 – butanol.

iii) Is it saturated or unsaturated?

Saturated (C – C single bond).

2. An organic compound 'A' is widely used as a preservative and has the molecular formula $C_2H_4O_2$. Thiscompound reacts with ethanol to form a sweet smelling compound 'B'.

i) Identify the compound 'A'.

Ethanoic acid.

ii) Write the chemical equation for its reaction with ethanol to form compound 'B'.

Ethyl Ethanoate.

iii) Name the process.

Esterification.

$$CH_3\,CH_2\,OH + CH_3\,COO\,H \xrightarrow{H^+} CH_3\,CH_2\,COOCH_3 + H_2O$$

Ethanol Acetic acid Ethyl ethanoate