# THE CAMBRIDGE SCHOOL

## A PROJECT OF AZAM ACADEMY

# PHYSICS

## FOR CLASS – 10th


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# ***Chapter # 10 (Simple HarmonicMotion)***

- **Choose the correct answer from the following choices:**

**i.** **Which of the following is an example of a simple harmonic motion?**
(GW 12-I) (BP 12-II) (FB 13-II) (SW 15-I) (AK 15-II)

(a) motion of a simple pendulum (b) the motion of ceiling fan
(c) the spinning of the Earth on its axis (d) a bouncing ball on a floor

**ii.** **If the mass of the bob of a pendulum is increased by a factor of 3, the period of the pendulum's motion will.**(LHR 12-I) (AK 13-I) (FB 14-I) (SW 15-II)

(a) be increased by a factor of 2 (b) remain the same
(c) be decreased by a factor of 2 (d) by decreased by a factor 4

**iii.** **Which of the following devices can be used to produce both transverse and longitudinal waves?** (DG 14-I) (SG, FB 15-II)

(a) a string (b) a ripple tank
(c) a helical spring (slinky) (d) a tuning fork

**iv.** **Waves transfer:** (GW, SG 12-I) (BP, SG, SW, FB 13-I) (AK 213-II) (LHR 14-I) (GW, RWP, SW 14-II) (GW, BP, FB 15-I)**.**

(a)energy (b) frequency
(c) wavelength (d) velocity

**v.** **Which of the following is a methoed of energy transfer?**
(SG 12-I) (FB 13-I) (SW 14-I) (SG 14-II) (SG, FB 15-I) (LHR 15-II)

(a) conduction (b) radiation
(c) wave motion (d) all of these

**vi.** **In a vacuum, all electromagnetic waves have the same:**
(BP 12-I) (SG 13-I) (FB 13-II) (FB 14-I) (LHR 15-I) (RWP 15-II)

(a) speed (b) frequency
(c) amplitude (d) wavelength

**vii.** **A large ripple tank with a vibrator working at a frequency of 30 Hz produces 25 complete waves in a distance of 50cm. the velocity of the wave is:**
(SG, LHR 14-II)

(a) 53 $cms^{-1}$ (b) 60 $cms^{-1}$
(c) 750 $cms^{-1}$ (d) 1500 $cms^{-1}$

**viii.** **Which of the following characteristics of a wave is independent of the others?**
(MN, SG 14-I) (RWP 15-I) (FB 15-II)

(a) speed (b) frequency
(c) amplitude (d) wavelength

**ix. The relation between v, *f* and $\lambda$ of a wave is:**

(LHR, SG, 12-II) (SW 13-I) (GW 14-II) (GW, FB 14-I) (LHR 15-I) (MN 15-II)

(a) $vf = \lambda$ (b) $f\lambda = v$

(c) $v\lambda = f$ (d) $v = \lambda / f$

***ANSWER:***

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| **i.** | a. | **ii.** | b. | **iii.** | c. | **iv.** | a. | **v.** | d. |
| **vi.** | a. | **vii.** | b. | **viii.** | c. | **ix.** | b. | | |

# Review Questions

- **Write short answers of the following questions:**

**10.1. What is simple harmonic motion? What are the nnecessary conditions for a body to execute simple harmonic motion?**

(LHR 13-I) (SG 14-I) (SW 14-II) (RWP, BP, GW, LHR 15-I) (DG, MN 15-II

Ans: **Simpe Harmonic Motion:** Simpe harmonic motion occurs **"***When the net force is proportional to the displacement from the mean position and is always directed towards the mean position***"**.

**Condtions of S.H.M** (GW 14-II)

**i.** Vibrating body has inertia.

**ii.** Vibrating body possess restoring force.

**10.2. Think of several examples in everyday life that are simple harmonic?**

Ans: The common examples are motion of ball in bowl, motion of swing, motion of simple pendulum, motion of mass attached to spring etc.

**10.3. What are damped oscillations? How damping progressively reduces the amplitude of oscillation?** (AK 14-II)

Ans: **Damped Oscillation:"***The oscillations of a system in the presence of some resistive force are damped oscillations***"**.

Friction reduces the mechanical energy of system as time passes and the motion damped as shown in fig.

**PTB, PAGE # 7, FIG # 10.5**

**10.4. How can you define the term wave? Elaborate the difference between mechanical and electromagnetic waves? Give examples of each.**

(LHR, GW 12-II) (GW 13-II) (RWP 15-I, II)

Ans: **Wave:"***A wave is disturbance in the medium which causes the particles of the medium to undergo vibratory motion about their mean position in equal intervals of time***"**.

| Mechanical Waves | Electromagnetic Waves |
|---|---|

| | |
|---|---|
| • "*Waves which require any medium for their propagation are called mechanical waves*"**.** | • "*Waves which require no medium for their propagation are called electromagnetic waves*"**.** |
| **Examples:**Water waves, Sound waves etc. | **Examples:**Radio waves, X-rays, light waves etc. |

**10.5. Distinguish between longitudinal and transverse waves with suitable examples.**
(LHR 12-I) (FB 14-II) (GW 15-II)

Ans:

| Longitudinal Waves | Transverse Waves |
|---|---|
| • "*In longitudinal waves the particles of medium move back and forth* ***along the direction*** *of propagation of waves*"**.** | • "*In those waves the motion of particlesof medium is* ***peRWPendicular to the motion of wave***"**.** |
| **Examples:**Sound waves etc. | **Examples:**light waves, water waves etc. |

**10.6. Draw a transverse wave with an amplitude of 2cm and a wavelength of 4cm. label a crest and trough on the wave.**

Ans: The fig is given as:

**10.7. Derive a relationship between velocioty, frequency and wavelength of a wave. Write a formula relating velocity of a wave to its timeperiod and wavelength.**
(LHR 12-I, 15-II) (RWP, DG 14-I)

Ans: The relation between elocity, frequency and wavelength of wave is given as:

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

Here, $t = T$ and $d = \lambda$

So, $$v = \frac{\lambda}{T}$$

The equation is the relation between speed of wave (v) wavelwength (λ) and time period (T) of wave.

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

$$v = \frac{\lambda}{1/f}$$

$$v = f\lambda$$

This is called **wave equation**.

**10.8. Waves are the means of energy transfer without transfer of matter. Justify this statement with the help of a simple experiment.**

(BP 14-II)

Ans: **Experiment:** Dip a pencil into a tub of water the disturbance is produced which results in the production of waves which move the cork near disturbance. It moves up and down and the waves travel outwards. The cork repeats vibratory motion about its mean position. But it does not move outwards with waves. Hence waves transfer energy without transfer of matter.

**10.9. Explain the following properties of waves with reference to ripple tank experiment:** (LHR 13-I)

**a. Reflection** **b. Refraction** **c. Diffraction**

Ans: **(a) Reflection:"***When waves moving in one medium fall on the surface of another medium they bounce back into first medium such that the angle of incidence is equal to angle of reflection. This phenomenon is called reflection of waves***".**

Place a barrier in the ripple tank. By switching the vibrator ON, the waves start to generate. The water will reflect from the barrier.

**PTB, PAGE # 13, FIG # 10.13 a, b**

**(b) Refraction:**(MN 15-I)**"***When waves from one mediumenter in second medium at some angle their direction of travel may change. This phenomeno is called by refraction of waves.***"**

| | |
|---|---|
| switching the vibratore ON, the waves start to generate. The boundary between deep and shallow water is at some angle to wave front. So, change in direction or path of waves is refraction. | **Page # 13**<br><br>**FIG # 10.15** |

**(c) Diffraction:**(MN 15-I) (G 15-II)Bending of waves around the shaRWP edges of obstacles is called diffraction.

To observe diffraction, generate plane waves in ripple tank and place two obstacles in line such a way that separation between them is equal to wavelength of water waves.

**PTB, PAGE # 14, FIG 10.16**

**10.10. Does increasing the frequency of a wave also increase its wavelength? If not, how are these quantities related?**

Ans: **No,** increase in frequency will decrease the wavelength of wave because they are inversely proportional to each other. According to relation:

$$f \quad a \quad \frac{1}{\lambda}$$

$$f \quad = \quad \frac{v}{\lambda}$$

## Conceptual

# Questions

**10.1. If the length of a simple pendulum is doubled, what will be the change in its time period?** (GW 15-I)

Ans: If the length of pendulum is doubled then time period will increase by $\sqrt{2}$times:

$$T = 2\pi\sqrt{\frac{P}{g}}$$

$$P' = 2P$$

$$T' = 2\pi\sqrt{\frac{2P}{g}}$$

$$T' = \sqrt{2}\times 2\pi\sqrt{\frac{P}{g}}$$

$$T' = \sqrt{2}\,T$$

**10.2. A ball is dropped from a certain height onto the flor and keeps boundcing. Is the motion of the ball simple harmonic? Explain.** (RWP 14-II) (GW 15-II)

Ans: **No,** the ball will not execute S.H.M because its motion does not fulfill the conditions of S.H.M like its acceleration is not directed towards mean position.

**10.3. A student performed two experiments with a simple pendulum. He / She used to bobs of different massed by keeping other parameters constant. To his / her astonishment the time period of the mendiulum did not change! Why?** (FB 14-I)

Ans: The time period of pendulum is independent of mass of bob. It depends upon the length of string of pendulum and gravitational acceleration, According to formula.

$$T = 2\pi\sqrt{\frac{P}{g}}$$

**10.4. What types of waves do not require any material medium for their propagation?**

Ans: Electromagnetic waves require no material medium for their propagation.

**Example:**

**i.** X -rays

**ii.** Light waves etc.

**10.5. Plance waves in the ripple tank undergo refraction when they move from deep to shallow water. What change occurs in the speed of the waves?**

Ans: Speed of waves is larger in deep water than in shallow water. Due to difference in speed of waves in different medium, when they move from deep watere to shallow water, causes them to change their direction, this change is called refraction of waves.

## Important Formulas

- Time period of simple pendulum = T = $2\pi\sqrt{\frac{l}{g}}$
- Time period of mass spring system = T = $2\pi\sqrt{\frac{m}{k}}$

- f = $\frac{n}{t}$
- T = $\frac{l}{f}$
- V = $\frac{S}{t}$
- V = $f\lambda$

## Values & Units

- Unit of **Time period** = sec (s)
- Unit of **Frequency** = Hertz (Hz)
- Unit of **Wavelength** = m (metre)
- Unit of g = $ms^{-2}$
- 1 m = $10^6$
- 1 m = $10^2$cm

## Numaricals

**10.1. The time period of a simple pendulum is 2s. What will be its length on the earth? What will be its length on moon if $g_m = g_e/6$? Where $g_e = 10ms^{-2}$.**
(SG. FB 15-I)

**Ans. Given Data:**

Time period = T = 2sec.

Gravitational acceleration on Earth = $g_e$ = $10ms^{-2}$

Gravitational acceleration on Moon = $g_m$ = $\frac{g_e}{6} = \frac{10}{6}$

= $g_m$ = $1.67ms^{-2}$

**To Find:**

**(i)** Length of pendulum on Earth = $l_e$ = ?

**(ii)** Length of pendulum on moon = $l_m$ = ?

**Solution:**

$$T = 2\pi\sqrt{\frac{l}{g}}$$

By taking square on both sides:

$$T^2 = (2\pi)^2\left(\sqrt{\frac{l}{g}}\right)^2$$

$$T^2 = 4\pi^2\frac{l}{g}$$

$$l = \frac{T^2 \times g}{4\pi^2}$$

**(i) On Earth's Surface:**

$$l_e = ?$$

$$l_e = \frac{T^2 \times g_e}{4\pi^2}$$

$$l_e = \frac{(2)^2(10)}{4(3.14)^2}$$

$$l_e = \frac{4(10)}{4(9.8596)}$$

$$l_e = \frac{10}{9.8596}$$

$$l_e = 1.02\text{m}$$

**(ii) On Moon's Surface:**

$$l_m = ?$$

$$l_m = \frac{T^2 \times g_m}{4\pi^2}$$

$$l_m = \frac{(2)^2(1.67)}{4(3.14)^2}$$

$$l_m = \frac{4(1.67)}{4(9.8596)}$$

$$l_m = \frac{1.67}{9.8596}$$

$$l_m = 0.169\text{m}$$

$$l_m = 0.17\text{m}$$

**10.2. A pendulum of length 0.99m is taken to the moon by an astronaut. The time period of the pendulum is 4.9s. What is the value of g on surface of the moon?** (MN 15-1, II)

**Ans. Given Data:**

Length of pendulum on moon = $l_m$ = 0.99m
Time period of pendulum on moon = $T_m$ = 4.9sec

**To Find:**

Gravitational acceleration on moon = $g_m$ = ?

**Solution:**

At the surface of moon:

$$T = 2\pi\sqrt{\frac{l_m}{g_m}}$$

By taking square on both sides:

$$T^2 = 4\pi^2 \left(\sqrt{\frac{l_m}{g_m}}\right)^2$$

$$T^2 = 4\pi^2 \frac{l_m}{g_m}$$

$$g_m = 4\pi^2 \frac{l_m}{T^2}$$

$$g_m = 4(3.14)^2 \frac{0.99}{(4.9)^2}$$

$$g_m = \frac{4(9.8596)(0.99)}{24.01}$$

$$g_m = \frac{39.044}{24.01}$$

$$\mathbf{gm = 1.63ms^{-2}}$$

**10.3. Find the time periods of a simple pendulum of 1 meter length, placed on Earth and on Moon. The value of g on the surface ofmoon is 1/6th of its value on earth, where $g_c$ is $10ms^{-2}$.**

(FB 15-II)

**Ans. Given Data:**

Length of simple pendulum = $l$ = 1m

$g_e$ = $10ms^{-2}$

$g_m$ = $\frac{g_e}{6} = \frac{10}{6} = 1.67ms^{-2}$

**To Find:**

**(i)** Time period on Earth = $T_e$ = ?

**(ii)** Time period on Moon = $T_m$ = ?

**Solution:**

$$T = 2\pi\sqrt{\frac{l}{g}}$$

**(i) On Earth Surface:**

$$T_e = 2\pi\sqrt{\frac{l}{g_e}}$$

$$T_e = 2(3.14)\sqrt{\frac{1}{10}}$$

$$T_e = (6.28)\sqrt{0.1}$$

$$T_e = (6.28)(0.316)$$

$$T_e = 1.985 \text{ sec}$$

$$\boldsymbol{T_e = 2sec}$$

**(ii) On Moon Surface:**

$$T_m = 2\pi\sqrt{\frac{l}{g_m}}$$

$$T_m = 2(3.14)\sqrt{\frac{1}{1.67}}$$

$$T_m = (6.28)\sqrt{0.598}$$

$$T_m = (6.28)(0.773)$$

$$T_m = 4.856 \text{ sec}$$

$$T_m = 4.9 \text{ sec}$$

**10.4. A simple pendulum completes on vibration in two seconds. Calculate its length, when g = 10.0ms$^{-2}$.**
(FB 15-I)

**Ans. Given Data:**

Time period of simple pendulum = T = 2sec
Gravitational acceleration = g = 10ms-2.

**To Find:**

Length of pendulum = l = ?

**Solution:**

$$T = 2\pi\sqrt{\frac{l}{g}}$$

By taking square on both sides,

$$T^2 = 4\pi^2\left(\sqrt{\frac{l}{g}}\right)^2$$

$$T^2 = 4\pi^2\frac{l}{g}$$

$$l = \frac{gT^2}{4\pi^2}$$

$$l = \frac{(10)(2)^2}{4(3.14)^2}$$

$$l = \frac{10(4)}{4(9.8596)}$$

$$l = \frac{10}{9.8596}$$

$$\boldsymbol{l = 1.02m}$$

**10.5. If 100 waves pass through a point of a medium in 20 seconds, what is the frequncey and the time period of the wave? If its wavelength is 6cm, calculate the wave speed.**

**Ans. Given Data:**

| | | | | | |
|---|---|---|---|---|---|
| | Number of waves | = | n | = | 100waves |
| | Time for 100 waves | = | t | = | 20 sec |

**To Find:**

| | | | | | |
|---|---|---|---|---|---|
| **(i)** | Frequency | = | f | = | ? |
| **(ii)** | Time period | = | T | = | ? |
| **(iii)** | Speed of wave | = | v | = | ? |

**Solution:**

| | | | | | |
|---|---|---|---|---|---|
| **(i)** | **Frequency** | **=** | **f** | **=** | **?** |
| | Frequency | = | f | = | $\frac{n}{t}$ |
| | | | f | = | $\frac{100}{20}$ |
| | | | f | = | 5Hz |
| **(ii)** | **Time period** | **=** | **T** | **=** | **?** |
| | | | T | = | $\frac{1}{f}$ |
| | | | T | = | $\frac{1}{5}$ |
| | | | T | = | 0.2 sec |
| **(iii)** | **Speed of wave** | **=** | **v** | **=** | **?** |
| | | | v | = | f $\lambda$ |
| | | | v | = | (5) (0.06) |
| | | | **v** | **=** | **0.3ms$^{-1}$** |

**10.6. A wooden bar vibrating into the wtger surface in a ripple tank has a frequency of 12Hz. The resulting wave has a wavelength of 3cm. What is the speed of the wave?**

**Ans.** **Given Data:**

Frequency of vibrating bar = f = 12Hz

$\lambda$ = 3cm = $\frac{3}{100}$ = 0.03m

**To Find:**

v = ?

**Solution:**

$v = f\lambda$

$v = (12)(0.03)$

$v = 0.36 ms^{-1}$

**10.7. A transverse wave produced on a spring has a frequency of 190 Hz and travels along the length of the spring of 90m, in 0.5 s.**

**(a) What is the period of the wave?**

**(b) What is the speed of the wave?**

**(c) What is the wavelength of the wave?**

**Ans.** **Given Data:**

Frequency = f = 190 Hz

Length = s = 90 m

Time = t = 0.5 sec

**(a) Time period = ?**

$$T = \frac{1}{190}$$

$$T = 0.005 \text{ sec}$$

$$T \approx \mathbf{0.01 \text{ sec}}$$

**(b) Speed = v = ?**

$$v = \frac{s}{t}$$

$$v = \frac{90}{0.5}$$

$$\mathbf{v = 180 ms^{-1}}$$

**(c) Wavelength = $\lambda$ = ?**

$$v = f\lambda$$

$$\lambda = \frac{v}{f}$$

$$\lambda = \frac{180}{190}$$

$$\lambda = 0.947 \text{ m}$$

$$\boldsymbol{\lambda = 0.95m}$$

**10.8. Water waves in a shallow dish are 6.0cm long. At one point, the water moves up and down at rate of 4.8 oscillations per second.**

**(a) What is the spped of the water waves?**

**(b) What is the period of the water waves?**

**Ans. Given Data:**

Wavelength of water wave = $\lambda$ = 6.0cm

$\lambda = \frac{6}{100}$m = 0.06m

Oscillation per seond (Frequency) = f = 4.8 Hz

**To Find:**

**(a)** Speed of water waves = v = ?

**(b)** Time period = T = ?

**Solution:**

**(a) Speed of water waves = v = ?**

$$v = f\lambda$$

$$v = (4.8)(0.06)$$

$$v = 0.288 \text{ms}^{-1}$$

$$v = 0.29 \text{ms}^{-1}$$

**(b) Time period = T = ?**

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

$$T = \frac{1}{4.8}$$

$$T = 0.208 \text{ sec}$$

$$\mathbf{T = 0.21sec}$$

**10.9. At one end of a ripple tank 80cm across a 5Hz vibrator produces waves whose wavelength is 40mm. Find the time the waves need to cross the tank.**

**Ans. Given Data:**

Length of ripple tank = l = S = 80 cm = $\frac{80}{100}$m

S = 0.8m

Frequency of virbator = f = 5Hz

Wavelength = $\lambda$ = 40mm

= $\lambda$ = $40 \times 10^{-3}$m

**To Find:**

Time = t = ?

**Solution:**

$$v = f\lambda$$
$$v = (5)(40 \times 10^{-3})$$
$$v = 200 \times 10^{-3}$$
$$v = 0.2ms^{-1}$$

**We know that:**

$$v = \frac{S}{t}$$
$$t = \frac{S}{v}$$
$$t = \frac{0.8}{0.2}$$
$$\mathbf{t = 4sec}$$

**10.10. What is the wavelength of the radio waves transmitted by an FM station at 90 MHz? Where 1 M = $10^6$, and speed of radio wave is $3 \times 10^8 ms^{-1}$.**

**Ans: Given Data:**

Frequency of radio waves = f = 90MHz = $90 \times 10^6$ Hz

Speed of radio waves = v = $3 \times 10^8 ms^{-1}$

**To Find:**

Wavelength of radio waves = $\lambda$ = ?

**Solution:**

$$v = f\lambda$$
$$v = \frac{v}{f}$$
$$\lambda = \frac{3\times10^8}{90\times10^6}$$
$$\lambda = \frac{1}{30} = 10^2$$
$$\lambda = 0.0333 \times 10^2 m$$
$$\boldsymbol{\lambda = 3.33m}$$

* * * * * * * * * * *

# ***Chapter # 11 (Sound)***

- **Choose the correct answer from the following choices:**

**i. Which is an example of a longitudinal wave?**
(BP 12-I) (FB 13-II) (FB, LHR 15-I) (SG 15-II).

(a) sound wave (b) light wave
(c) radio wave (d) water wave

**ii. How does sound travel from its source to your ear?**

(a) by changes in air pressure (b) by virbations in wires or strings
(c) by electromagnetic wave (d) by infrared waves

**iii. Which form of energy is sound?**
(SG, GW 15-I) (GW 13-I) (BP, SW, SG, RWP 13-II) (FB 14-II) (GW, FB 15-II)

(a) elwectrical (b) mechanical
(c) thermal (d) chemical

**iv. Astronauts in space need to communicate with each other y radio links because:**

(a) sound waves travel very slowly in space (b) sound waves travel very fast in space
(c) sound waves cannot travel in space (d) sound waves have low frequency inc space

**v. The loudness of a sound is most closely related to its** (AK 15-I) (MN 15-II)**.**

(a) period (b) frequency
(c) amplitude (d) wavelength

**vi. For a normal person, audible frequency ragne for sound wave lies between.**
(GW 12-I) (BP, AK 13-I) (SW 14-I) (SW, GW, SG 14-II)

(a) 10Hz to 10kHz (b) 20Hz to 20kHz
(c) 25Hz to 25kHz (d) 30Hz to 30kHz

**vii. When the frequency of a sound wave is increased, which of the following decrease?**

(a) i only (b) iii only
(c) i and ii only (d) i and iii only

***ANSWER:***

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| **i.** | a. | **ii.** | a. | **iii.** | **b.** | **iv.** | c. | **v.** | c. |
| **vi.** | b. | **vii.** | c. | | | | | | |

# Review Questions

- **Write short answers of the following questions:**

**11.1. What is necessary condition for the production of sound?**
(LHR 12-13-I) (GW 13-II), 14-I) (SG, BP 14-II) (MN, FB 15-I) (BP 15-II)

Ans: *Sound is produced by vibrating bodies*. Due to vibration of bodies the air around them also vibrates and the air vibration produces sensation of sound in air.

**11.2. What is the effect of the medium on the spped of soun? In which medium sound travels more faster; air, solid or liquid? Justify your answer.**(LHR 12-I) (SG 14-I)

Ans: Every medium has distinct density. Speed of sound increases with the increase in density. So, the speed of sound is maximum in solids due to their high density. Speed of sound in solids is about fifteen times than that in gases and speed of sound in liquid is five times than gases.

**11.3. How can you prove the mechanical nature of sound by a simple experiment?**
(FB 14-II) (DG 15-I)

Ans: Sound waves require material medium for their propagation, therefore, they are mechanical waves.

**Experiment:** Suspend an electric bell in bell jar with help of two wires connected to a power supply. When we switch ON the power supply, electric bell will begin to ring. Now pump out air from jar by vacuum pump. Again switch ON, no sound is heard in absence of air as a medium. Now start pumping out air from jar, the sound of bell starts becoming more and more feeble and eventually dies out.) *It is concluded that sound waves can only propagate in presence of air (medium).*

**11.4. What do you understand by the longitudinal wave? Describe the longitudinal nature of sound waves.**

Ans: **Longitudinal waves:"***In longitudinal wave the particles of the medium move back and forth along the direction of propagation of wave*.**"**

**Explanation:**Propagation of sound waves produced by vibrating tuning fork can be understood by a vibrating tuning fork as shown in fig. before the vvibration of tuning for, density of air molecules on the right side is uniform (Fig a). When the right prong of tuning fork moves from mean position O to B (Fig b), it exerts some pressure on the adjacent layer of air molecules and produces a compression and after some time rarefaction is also produced thus this sound wave show the longitudinal nature.

**PAGE # 21, FIG # 11.6 a, b, c**

**11.5. Sound is aform of wave. List at least three reasons to support the idea that sound is a wave.**

Ans: **Reasons:** Sound is a form of wave as:

**i.** Sound shows reflection like waves.

**ii.** Sound shows refraction like waves.

**iii.** Sound shows diffraction like waves.

**11.6. We know that waves manifest phenomenon of reflection, diffraction and refraction. Does sound also manifest these characteristics?**

Ans: Yes, sound waves also manifest these characteristics.

**11.7. What is the difference between the loudness and intensity of sound? Derive the relationship between the two.**

(LHR 12-II) (LHR 13-II) (FB 14-I) (BP, SW, RWP, DG, GW 14-II) (MN, LHR 15-II) (DG, BP, LHR 15-I)

Ans: **Loudness of sound:"***It is the characteristics of sound by which loud and faint sound can be distinguished*.**"**

**Intensity of sound:"***Sound energy passing per second thrugh a unit area held peRWPendicular to the direction of propagation of sound waves is called intensity of sound*.**"**

**Relationship between loudness and intensity of sound:**Loudness (L) is directly proportional to the logarithm of intensity (I).

$$L \propto \log (I)$$

$$L = K \log I$$ Here K is constant.

**11.8. On what factors does the loudness of sound depend?** (SG 14-I) (SG 15-II)

Ans: **Factors:** Loudness of sound depends upon number of actors. Some of them are given below:

**i.** Amplitude of vibrating body

**ii.** Area of vibrating body

**iii.** Distance from vibrating body

**11.9. What do you mean by the term intensity level of the sound? Name and define the unit of intensity level of sound.**(SW 14-I)

Ans: **Intensity level of the sound:"***The difference between loudness L of unknown sound and loudness Lo is called intensity level of sound*.**"**

**Unit:**The unit of intensity level of sound is bel.

Bel is biger unit while decibel is a smaller unit.

1bel = 10dB

**11.10. What are the units of loudness? Why dowe use logarithmic scale to describe the ragne of the sound intensitieis we hear?** (FB 15-II)

Ans: **Unit of Loudness:** Loudness depends upon the physical condition of the listener. It has no specific units. It is measured in terms of intensity level whose unit is (bel).

The use of logarithmic scale is due to the following law i.e. *Loudness is directly proportional to logarithm of intensity*. So, we use logarithmic scale.

**11.11. What is Difference between frequency and pitch?**
(LHR 13-I) (DK 14-I) (GW 14-II) (SG, BP, DG,GW, FB, LHR 15-I) (SG, DG, MN 15-II)

Ans: **Frequency:"***Number of waves passing through a point in unit time is called frequency*.**"**
**Pitch:"***It is the characteristics of sound by which we distinguish between a shrill and an grave sound*.**"**
**Relation between frequency and pitch:**Frequency is directly proportion to pitch.

**PTB, PAGE # 23, FIG # 11.8**

**11.12. Describe the effect of change in amplitude on loudness and the effect of change in frequency on pitch of sound.** (RWP 14-II) (SG 14-II)

Ans: If the *amplitude* of vibrating body *increases* then *loudness* also *increases*, and vice versa. *Similarly if frequency increases pitch also increases* and vice versa.

**11.13. If the pitch of sound is increased, what are the changes in the following?** (LHR 13-II)

**(a) The frequency** **(b) The wavelength**
**(c) The wave velocity** **(d) The amplitude of wave**

Ans: (a) If the pitch of sound is increased, frequency also increases.
(b) Wavelength decreases when pitch of sound increases.

$$\lambda = \frac{v}{f}$$

(c) Wave velocity remains same.
(d) Amplitude doesn't change.

**11.14. If we clap or speak in front of a building while standing at a particular distance, we rehear our sound after sometime. Can you explain how does it happen?**

Ans: This sound whch we hear is called an echo and is a esult of reflection of sound from the surface.
When sound is incident on the surface of a medium it bounces back into the first medium. This phenomenon is called echo or reflection of sound.

**11.15. What is the audible frequency range for human ear? Does thisd range varywith the age of people? Explain.** (GW, LHR 14-I) (AKM, FB 14-II) (DG, MN 15-I) (GW 15-II)

Ans: Audible frequency range is from **20Hz to 20,000H** and it varies with the age of people.

**11.16. Explain that noise is a nuisance.** (SG, FB 15-I) (RWP 15-II)

Ans: **Noise is a nuisance:** Some soundsd produce unpleasant effectsd on our ears such as sound of machinery, the slamming of a door, and sound of traffic in big cities. Sound

which as jarring and unpleasant effect on our ears is called noise. Noise corresponds to irregular and sudden vibrations produced by some sounds.

Noise has negativeeffects on human health as it can cause conditions such as hearing loss, sleep diturbances, aggression, hypertension, high stress levels. Noise can also cause accidents by interfering with communication and warning signals.

**11.17. Describe the importance of a acoustic protection.** (SG, DG 14-I, II)

Ans: **Importance of Acoustics protection:**

**i.** Reflection of sound is less prominent if the surface isd soft and irregular, but it is more prominent on rigid and smooth surface.

**ii.** Soft porous material such as draperies and rugs absorb large amount of sound energy and thus quit echoes and softening noises.

**iii.** By using soft and sound insulating materials such as curtainsk, caRWPets and doubleglazed windows we can reduce the level of noise pollution.

**iv.** If surface of the class rooms and public halls are too absorbent, then sound level is low for audience.

**11.18. What are the uses of ultrasound in medicine?**(AK14-I)

Ans: **Uses of Ultrasound:**

**i.** In medical field, ultrasonic waves are used to diagnose and treat different ailments.

**ii.** Powerful ultrasound is now being used to remove blood clots formed in the arteries.

**iii.** Ultrasound can also be used to get the pictures of thyroid gland for diagnosis puRWPoses.

## Conceptual Questions

**11.1. Why two tin cans with a string stretched between them could be better way to communicate than merely shouting through the air?**

Ans: **Reasons:**

**i.** It is due to the fact that speed of sound is 15 times higher in solids than air. So, it is eas to communicate through tin cans.

**ii.** The other reason is that, it avoids spreading of sound waves in air.

**11.2. We can recognize persons speaking with the same loudness from their voice. How is this possible?** (BP 15-II)

Ans: We can recognize persons due to difference in the quality of their sounds because every person has unique quality of sound.

**11.3. You can listrn to your friend round a corner, but you cannot see him / her. Why?** (GW 15-II)

Ans: Diffraction of sound is more prominent than diffraction of light as light waves have smaller wavelength than sound waves. So, you can't see your friend at a round corner but listen him / her.

**11.4. Why must the volume of a stereo in a room with wall-two-wall caRWPet be tuned higher than in a room with a wooden floor?**

Ans: The reflection of sund waves in wooden floor is maximum so, the sound will be higher. On the other hand, in a caRWPeted room reflection of sound waves is minimum os, the soundwill be lower.

**11.5. A student says that the two terms speed and frequency of the wave refer to the samething. What is your response?**

Ans: Speed is the distance covered by waves in unit time while frequency is number of waves passing from a point in unit time so, they are two different quantities. But the time factor is similar in both quantities.

**11.6. Two people are listening to the same music at the same distance. They disagree on its loudness. Explain how this could happen?**

Ans: Loudness depends upon the physical oconditions of listener so, the sound appears louder to a person with a sensitive ear than a person with defective ears.

**11.7. Is there any difference between echo and reflection of sound? Explain.** (RWP 14-II) (MT 14-II)

Ans: There is no diference between echo and reflection of sound because when sound falls on the surface of medium then, it bounces back to first medium this is called reflection of sound or echo of sound.

**11.8. Will two separate 50dB sounds together constitute a 100dB sound? Explain.**

Ans: No, since decibel scale is not a linear scale but a logarithmic scale, therefore, they cannot be added simply. Hence, two separate 50dB sounds together would not constitute a 100dB sound.

**11.9. Why ultrasound is useful in medical field?** (SW 14-II) (SG 15-I)

Ans: **Uses of Ultrasound:**

**i.** In medical field, ultrasonicwaves asre used to diagnose and treat different ailments.

**ii.** Powerful ultrasound is now beign used to remove blood clots formed in thearteries.

**iii.** Ultrasound can also be used to get the pictures of thyroid gland for diagnosticpure Poses.

## Important Formulas

- Intensity level of sound = $10 \log \frac{I}{I_o}$ (dB)

| | | | | | |
|---|---|---|---|---|---|
| • f | = | $\frac{n}{t}$ | • V | = | $\frac{d}{t}$ |
| • T | = | $\frac{l}{f}$ | • V | = | $f\lambda$ |
| | | | • S | = | vt |

## Values & Units

- Unit of **intensity** = I = $Wm^{-2}$
- Units of **sound level** = L – $L_o$ = dB (decibel)
  **Or** bel (larger unit)
- Unit of **wavelength** = $\lambda$ = m (metre)
- Unit of **frequency** = f = Hz (Hertz)
- *P*log 10 = 1
- **Intensity of Faitnest sound** = $I_o = 10^{-12} Wm^{-2}$.

## Numericals

**11.1. A normal conversation involves sound intensitieis of about 3.0×10-6 Wm-2. What is the decibel level for this intensity? What is the intensity of the sound for 100 dB?**
(SG 15-II)

**Ans. Given Data:**

Intensiy of sound = I = 3.0×10-6 Wm-2
Intensity of faintest sound = Io = 10-12 Wm-2

**To Find:**

**(a)** Decibel level of normal conversation = ?
**(b)** Intensity of sound = ?

**Solution:**

**(a)** **Intensity level of sound** = 10 $\log \frac{I}{I_o}$ (dB)

Intensity level of normal conversation

$$= 10 \log \frac{3.0\times10^{-6}}{10^{-12}} \text{ (dB)}$$

$$= 10 \log 3.0 \times 10^{-6+12} \text{ (dB)}$$

$$= 10 [\log 3.0 \times 10^{6}] \text{ (dB)}$$

$$= 10 [\log 3.0 + \log 10^{6}] \text{ (dB)}$$

$$= 10 [0.4771 + 6(1)] \text{ (dB)}$$

$$= 10 [0.4771 + 6] \text{ (dB)}$$

$= 10\ [6.4771]$ (dB)

$= 64.771$ (dB)

**Intenseity level of sound = 64.8dB**

**(b) Intensity level of a sound = 100dB**

$I_o$ = $10^{-12}$ $Wm^{-2}$

Intensity of the sound = I = ?

Sound level = $10\log \frac{I}{I_o}$ (dB)

$$100 = 10\log \frac{I}{10^{-12}}$$

$$100 = 10\log I - 10\log 10^{-12}$$

$$100 = 10\ (\log I - \log 10^{-12})$$

$$\frac{100}{10} = \log I - \log 10^{-12}$$

$$10 = \log I - (-12)\log 10$$

$$10 = \log I + 12\log 10$$

$$10 = \log I + 12$$

$$10 - 12 = \log I$$

$$\log I = -2$$

$$I = \text{Anti log } (\bar{2}0000)$$

$$I = 0.01\ Wm^{-2}$$

$$\mathbf{I = 10^{-2}\ Wm^{-2}}$$

**11.2. If at Anarkali bazaar Lahore, the sound intensity level is 80 dB, what will be sound intensity there?**

(RWP 15-I) (DG, RWP 15-II)

**Ans. Given Data:**

Sound level = 80dB

$I_o = 10^{-12}\ Wm^{-2}$

**To Find:**

Intensity = I = ?

**Solution:**

Sound level = $10\log \frac{I}{I_o}$ (dB)

$$80 = 10\log \frac{I}{10^{-12}}$$

$$80 = 10\log I - \log 10^{-12}$$

$$80 = 10\ (\log I - \log 10^{-12})$$

$$\frac{80}{10} = \log I - \log 10^{-12}$$

$$8 = \log I - (-12)\log 10$$

$$\therefore \log 10 = 1$$

$$8 = \log I + 12 \text{ (l)}$$

$$8 - 12 = \log I$$

$$-4 = \log I$$

$$\log I = 4.0000$$

$$I = \text{Anti log } (\bar{4}.0000)$$

$$I = 0.0001 \text{ Wm}^{-2}$$

$$\mathbf{I = 10^{-4} \text{ Wm}^{-2}}$$

**11.3. At a particular temperature, the speed of sound in air is 330ms-1. If the wavelength of a note is 5cm, calculate the frequency of the sound wave. Is this frequency lie in the audible range of the human ear?**

**Ans. Given Data:**

Speed of sound = v = 330ms-1

Wavelength of note = $\lambda$ = 5cm = $\frac{5}{100}$ m = 0.05m

**To Find:**

Frequency of sound wave = f = ?

**Solution:**

$$v = f\lambda$$

$$330 = f(0.05)$$

$$\frac{330}{0.05} = f$$

$$f = 660 \text{ Hz}$$

$$\mathbf{f = 6.6 \times 10^{3} \text{ Hz}}$$

**Yes, this frequency lies in audible range.**

**11.4. A doctor coutns 72 heartbeats in 1 min. Calculate the frequency and period f the heartbeats.**

(GW 15-I, II)

**Ans. Given Data:**

No of heart beats = n = 72

Time = t = 1 min. = 60sec

**To Find:**

**(i)** Frequency = f = ?

**(ii)** Time period = T = ?

**Solution:**

**(i) Frequency = f = ?**

$$\text{Frequency} = f = \frac{n}{t}$$

$$f = \frac{72}{60}$$

$$\mathbf{f = 1.2\ Hz}$$

**(ii) Tiem period = T = ?**

$$\text{Time period} = T = \frac{1}{f}$$

$$T = \frac{1}{1.2}$$

$$\mathbf{T = 0.83s}$$

**11.5. A marine survey ship sends a sound wave straight to the seabed. It receives an echo 1.5 s later. The speed of sound in sea water is 1500ms$^{-1}$. Find the depth of the sea at this position.**

**Ans. <u>Given Data:</u>**

| | | | | |
|---|---|---|---|---|
| Time for echo | = | T | = | 1.5s |
| Time for wave to reach to seabed | = | t | = | $\frac{T}{2}$ |
| | | t | = | $\frac{1.5}{2}$ |
| | | t | = | 0.75s |
| Speed of sound | = | v | = | 1500ms$^{-1}$ |

**<u>To Find:</u>**

| | | | | |
|---|---|---|---|---|
| Depth of sea | = | S | = | ? |

**<u>Solution:</u>**

$$S = vt$$

$$S = 1500 \times 0.75$$

$$\mathbf{S = 1125m}$$

**11.6. A student clapped his hands near a cliff and heard the echo after 5s. What is the distance of the cliff from the person if the speed of the sound, v is taken as 346 ms$^{-1}$?**

**Ans. <u>Given Data:</u>**

| | | | | |
|---|---|---|---|---|
| Time for echo | = | T | = | 5s |

Time of sound to reach to the cliff =

t = $\frac{T}{2} = \frac{5}{2} = 2.5$

Speed of sound = v = 346ms$^{-1}$

**To Find:**

Distance of cliff from person = S = ?

**Solution:**

$$S = vt$$

$$S = 346 \times 2.5$$

$$\mathbf{S = 865m}$$ –

**11.7. A ship sends out ultrasound that returns from the seabed and is detected after 3.42s. If the speed of ultrasound through seawater is 1531ms$^{-1}$, what is the distance of the seabed from the ship?**

**Ans. Given Data:**

Time in which ultrasound return from seabed to ship = T = 3.42s

Speed of sound in water = v = 1531m/sec

**To Find:**

Distance from the ship to seabed d = ?

**Solution:**

$$v = \frac{d}{t}$$

$$d = v \times t$$

$$d = (1531)\ (3.42)$$

$$d = 5236m$$

Required distance would be half of the covered distance which is depth of seabed from the ship.

$$d = \frac{5236}{2}$$

**Depth of seabed = 2618m**

**11.8. The highest frequency sound humans can hear is about 20,000 Hz. What is the wavelength of sound in air at tthis frequency at a temperature of 20$^{o}$C? What is the wavelength of the lowest sounds we can hear of about 20Hz? Assume the speed of sound in air at 20$^{o}$C is 343 ms$^{-1}$.**

**Ans. Given Data:**

Frequency of loud sound = f1 = 20,000 Hz

Speed of sound = v = 343ms-1

Frequency of lowest sound =

f2 = 20Hz

**To Find:**

**(i)** Wavelength of loud sound = $\lambda_1$ = ?

**(ii)** Wavelength of lowest sound = $\lambda_2$ = ?

**Solution:**

**(i) Wavelength of loud sound = $\lambda_1$=?**

$$v = f_1\lambda_1$$

$$343 = (20000)\lambda_1$$

$$\frac{343}{20000} = \lambda_1$$

$$\lambda_1 = 0.01715\text{m}$$

$$\boldsymbol{\lambda_1 = 1.7 \times 10^{-2}\text{m}}$$

**(ii) Wavelength of lowest sound = $\lambda_2$=?**

$$v = f_2\lambda_2$$

$$343 = (20)\lambda_2$$

$$\frac{343}{20} = \lambda_2$$

$$\boldsymbol{\lambda_2 = 17.2\text{m}}$$

**11.9. A sound wave has frequency of 2 kHz and wave length 35 cm. How long will it take to travel 1.5km?**

(LHR 15-II)

**Ans. Given Data:**

Frequency of sound wave = f = 2kHz

= $2 \times 10^3$Hz

Wavelength of sound wave = $\lambda$ = 35cm = $\frac{35}{100}$m

$\lambda$ = 0.35m

Distance covered by sound = S = 1.5km

= $1.5 \times 10^3$m

**To Find:**

Time = T = ?

**Solution:**

**(i)** $\mathbf{v = f\lambda}$

$$v = 2 \times 10^3 \times 0.35$$

$$v = 0.7 \times 103 ms^{-1}$$

$$\mathbf{v = 700 ms^{-1}}$$

**(ii)** $\mathbf{S = vt}$

$$1.5 \times 10^3 = (0.7 \times 10^3)t$$

$$\frac{1.5 \times 10^3}{0.7 \times 10^3} = t$$

$$\mathbf{t = 2.1 sec}$$

* * * * * * * * * *



## *Chapter # 12 (Geometrical Optics)*

- **Choose the correct answer from the following choices:**

**i.** **Which of the following quantity is not changed during refreaction of light?** (GW 14-II) (SG, BP, FB 15-II)

(a) its direction (b) its speed

(c) its frequency (d) its wavelength

**ii.** **A converging mirror with a radius of 20 cm creates a real image 30 cm from the mirror. What is the object distance?** (BP 14-II) (AK 15-I)

(a) – 5.0 cm (b) – 7.5 cm

(c) – 15 cm (d) – 20 cm

**iii.** **An object is placed at the centre of curvature of a concave mirror. The image produced by the mirror is located.**

(a)out beyond the centre of curvature (b) at the centre of curvature

(c) between the centre of curvature and the focal point

(d) at the focal poitn

**iv. An object is 14cm in front of a convex mirror. The image is 5.8cm behind the mirror. What is the focal length of the mirror?** (LHR 14-II)

(a) – 4.1 cm (b) – 8.2 cm
(c) – 9.9 cm (d) – 20 cm

**v. The index of refraction depends on.** (LHR 13-15-I) (FB 14-15-I)

(a) the focal length (b) the speed of light
(c) the image distance (d) the object distance

**vi. Which type of image is formed by a convex lens on a screen?** (SG, SW 14-II)

(a) inverted and real (b) inverted and virtual
(c) upright and real (d) upright and virtual

**vii. Which htype image is produced by the converging lens of human eye if it views a distant object?** (GW 12-15-I) (MN 15-II)

(a) real, erect, same size (b) real, inverted, diminished
(c) virtual, erect, diminished (d) virtual, inverted, magnified

**viii. Image formed on a camera is:** (FB 14)

(a) virtual, upright and diminished (b) real, inverted and diminished
(c) virtual, upright and magnified (d) real, inverted and magnified

**ix. If a ray of light in glass is incident on an air surface at an angle greater than the critical angle, the ray will:**

(a) refract only (b) reflect only
(c) partially refract and partially reflect (d) diffract only

**x. The crtitical angle for a beam of light passing from water into air is 48.8 degrees. This means that all light rays with an angle of incidence greater than this angle will be.**

(a) absorbed (b) totally reflected
(c) partially reflected and partially transmitted (d) totally transmitted

***ANSWER:***

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| **i.** | **c.** | **ii.** | c. | **iii.** | b. | **iv.** | a. | **v.** | b. |
| **vi.** | **d.** | **vii.** | b. | **viii.** | b. | **ix.** | b. | **x.** | b. |

## Review Questions

- **Write short answers of the following questions:**

**12.1. What do you understand by reflection of a light? Draw a diagram to illustrate reflection at a plane surface?** (GW 14-I) (SW 14-II) (DG 15-I) (BP, LHR 15-II)

Ans: **Reflection of light:**"*Whenlight travelling in a certain medium falls on the surface of another medium, a part of it bounces back in the same medium this is called reflection of light*."

**PTB PAGE # 37, FIG # 12.1**

**12.2. Describe the following terms used in reflection**

**(a) Normal** **(b) Angle of incidence**

**(c) Angle of reflection**

Ans: **Normal:***A line (imaginary) at right angle to plane is called normal*. **ON** in figure shows normal.

**Angle of incidence:***Angle between incidence ray and normal is called angle of incidence*. It is showns as ∠**i**.

**Angle of reflection:***The angle between the reflected ray and normal is called angle of reflection*. It is shown as ∠**r**.

**12.3. State laws of reflection. Describe how they can be verified graphically?** (AK, FB 14-II) (MN, LHR 14-I) (GW, FB 15-I) (GW, SG, MN 15-II)

Ans: **Laws of reflection:**

**i.** The incident ray, the normal and the reflected ray at the point of incidence all lie in the same plane.

**ii.** The angle of incidence is equal to the agle of reflection i.e. ***i* = r**.

**12.4. Define refraction of light. Describe the passage of light through parallel sides transparent material.** (BP 14-ii) (FB, LHR 15-I)

Ans: **Refraction of light:**"*The process of bending of light as it pases from air into glass and vice versa is called refeaction of light*."

**Explanation:**Refraction of light can be explained with the help of Fig. a ray of light IO travelling from air falls on the surface of a glass block.

At he air glass interface, the ray of light IO changes direction and bends towars the normal and travelsalogn he path OR inside the glass block. The rays IO and OR are called the incident ray and the refracted ray respectively.

**12.5. Define the following terms used in refraction:**

**(a) Angle of incidence** **(b) Angle of refraction**

Ans: **(a) Angle of incidence:**"*The angle formed by incident ray with normal is called angle of incidence*."

**(b) Angle of reftaction:** (FB 15-II)

"The angle formed by refracted ray with normal is called angle of refraction."

**12.6. What is meant by refractive index of a material? How would you determine the refractiver index of a rectangular glass slab?** (GW 12-I) (LHR 14-I) (BP 15-II)

Ans: **Refractive index:"***The refractive index 'n' of a medium isd th ratio of the speed of light* **'c'** *in air to the speed of light in the medium***'v'**.

$$\text{Refractive index} = \frac{\text{Speed of light in air}}{\text{Speed of light in medium}}$$

$$\mathbf{n} = \frac{c}{v}$$

**12.7. State the laws of refraction of light and show that how they ay be verified using rectangular glass slab and pins?** (GW 13-I) (SW 14-I) (RWP 15-I)

Ans: **Laws of refraction of light:**

**i.** The incident ray, the refracted ray and the normal at the point of incidence all lie in the same plane.

**ii.** The ratio of thesine of the angle of incidence 'i' of the sin of angle of reftaction 'r' is always equal to a constant i.e.

$$\frac{\sin i}{\sin r} = n$$

**PTB, PAGE # 42, FIG # 12.8**

**12.8. What is meant by the term total internal reflection?** (GW 13-II) (BP 14-I) (SW, GW 14-II) (GW 15-I, II) (LHR 15-II) (SG 15-I, II)

Ans: **Total internal reflection:"***When angle of incidence is greater than critical angle then no refraction occurs but light reflects back into denser medium. This d phenomenon is called total internal reflection*.**"**

**12.9. State the conditions for total internal reflection.** (LHR 12-I) (GW 13-I) (DG 15-II)

Ans: **Conditions for T.I.R:**

**i.** The nagle of incidence should be greater than critical angle.

**ii.** The light should enter from a denser medium to a rarer medium

**12.10. What is critical angle? Derive a relationship between the critical angle and the refractive index of a substance.** (LHR 12-II) (SW 14-I) (SG 14-I) (DG 15-I, II)

Ans: **Critical angle:"***The angle of incidence that causes the refracted ray in rarer medium to bend through* $90^o$ *called critical angle*.**"**

**Relationship between critical angle and refactive index:**The relationship for rays from denser to rare medium is.

$$\frac{1}{n} = \frac{\sin i}{\sin r} = \frac{\sin c}{\sin r} \qquad (\therefore i = c)$$

$$n = \frac{\sin r}{\sin c} = \frac{\sin 90^o}{\sin c} \qquad (\therefore r = 90^o)$$

$$(\therefore \sin 90^o = 1)$$

$$n = \frac{1}{\sin c}$$

**12.11. What are optical fibres? Describe how total internal reflection is used in light propagating through optical fibres?** (LHR 13-II) (FB 15-I, II) (MN 15-I)

Ans: **Optical fibres:** A thin like glass rod through which light propagates by total internal reflection is called optical fiber. In figure shows that light through optical fiber passes by T.I.R due to high refractive index of core.

**PTB, PAGE # 45, FIG # 12.14**

**12.12. Define the following temrs applied to a lens:**
(RWP, GW 14-I) (AK 14-II) (GW 15-II) (RWP 15-I, II)

**(a) Principal axis** **(b) Optical centre**

**(c) Focal length**

Ans: **Principal axis:***Each of the two surfaces of a spherical lens is a section of a sphere. The line passing through the two centres of curvatures of the lens is called principal axis.*

**Optical centre:"***A point***(C)***on the principal axis at the centre of lens is called optical centre*.**"**

**Focal length, f:"***This is the distance between the optical centre and the principal focus*.**"**

**12.13. What is meant by the principal focus of a (a) convex lens (b) a concave lens? Illustrate your answer with ray diagrams.** (DG 14-II)

Ans: **Principal focus of convex lens:** The light rays travelling parallel to the principal axis of a convexc lens after refraction meet at a point on the principal axis, called principal focus or focal point F. Hence, convex lens is also called **converging lens**.

**Principal focus of a concave lens:** For a concave lens, the parallel rays appear to come from a point behind the lens called principal focus F. Hence concave lens is also called **diverging lens**.

**PTB PAGE # 48, FIG 12.20**

**12.14. Describe how light is refracted through convex lens?** (FB 15-I)

Ans: **Refraction through convex lens:**

**i.** When parallel light rays passes through the center of lens, they pass through focal point after refraction.

**ii.** When they pass through optical center they does not refract.

**iii.** The rays passing through principal focus become parallel to principal axis after refraction.

**PTB PAGE # 48, FIG 12.21**

**12.15. With the help of a ray diagram, how you can show the use of thin converging lens as a magnifying glass.** (DK 14-I) (LHR 15-I) (BP 15- II)

Ans: Magnifying glass is a convex lens which magnifies images of small objects.

**PTB**

**12.16. A coin is placed at a focal point of a converging lens. Is an image formed? What is its nature?**

Ans: No, image is formed because light rays move parallel to each other after refraction.

**12.17. What are the difference between real and virtual images?**

Ans:

| Virtual image | Real image |
|---|---|
| **1.** Virtual image can't be obatinaed on screen. | **1.** Real image can be obtained on the screen. |
| **2.** This image is larger than object. | **2.** This imageis samller than object. |
| **3.** Convex mirror forms *virtual image*. | **3.** **Concave** mirreor forms *real image*. |
| **4.** For virtual image, q is taken as *negative*. | **4.** For real image, p and q are taken as *positive*. |
| **5.** Virtual image is *upright, erect*. | **5.** Real image is *inverted*. |

**12.18. How does a converging lens form a virtual imageof a real object? How does a diverging lens can form a real image of a real object?**

Ans: **Virtual image of real object through converging lens:** The real object is placed between optical center and focus point of converging lens. If the object is on left side the virtual image is formed behind the object on the left side of lens.

**PTB, PAGE # 51, FIG # 12.25 (e)**

**Real image of real object formed by diverging lens:** No, real image is formed of real object by diverging lens. Instead, it forms virtual image.

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**12.19. Define power of a lens and its units.** (MT 14-II) (GW 15-I, II) (RWP 15-II)

Ans: **Power of lens:** "*The power of lens is the reciprocal of focal length.*"

**Formula:** $P = \frac{1}{f}$

**Unit:** Its unit is Diopter **(D)**

$$1D = 1m^{-1}$$

**12.20. Describe the passage of light through a glass prism and measure the angle of deviation.**

Ans: **Refraction through prims:** Prism is a transparent object (made of optical glass) with at least two polished plane faces inclined towards each other from which light is refracted.

In case of trnalgular prism, the emergent ray is not parallel to the incident ray. It is deviated by the prism from its original path.the incident ray PE makes an angle of incidence 'i' at point E and is refracted towards the normal N as EF. The refracted ray EF makes an angle 'r' inside the rism and travels to the other face of the prism. This ray emerges out from prism at point F making and angle 'e'. Hence the emerging ray FS is not parallel to the incident ray PE but is deviated by an angle D which is called angle of deviation.

**PTB PAGE # 47, FIG # 12.17**

**12.21. Define the terms resolving power and magnifying power.** (LHR 12-I) (RWP 14-I) (SW 14-I) (RWP, DG, SG 15-II)

Ans: **Resolving power:** **"***The resolving power of an instrument is its ability to distinguish between two closely placed objects or point source*.**"**

**Magnifying power:** **"***The ratio of angles subtended by image as seen through optical device to that subtended by object at unaided eye is called magnifying power*.**"**

$$M = \frac{\theta}{\theta'}$$

**12.22. Draw the ray diagrams of:** (LHR 12-II)

**(a) Simple microscope** **(b) Compound microscope**

**(c) Refracting telescope**

Ans: **Simple microscope:**

**PTB PAGE # 55, FIG # 12.30**

**Compound microscope:**

**PTB PAGE # 57, FIG # 12.32**

**Refracting telescope:**

**PTB PAGE # 58, FIG # 12.34**

**12.23. Mention the magnifying powers of the following optical instrument?** (GW 12-I) (MN 15-II)

**(a) Simple microscope** **(b) Compound microscope**

**(c) Refracting telescope**

Ans: **Simple microscope:**

$$(M) = 1 + \frac{d}{f}$$

**Compound microscope:**

$$(M) = \frac{L}{f_o}\left(1 + \frac{D}{f_e}\right)$$

**Refracting telescope:**

$$(M) = \frac{f_o}{f_e}$$

**12.24. Draw ray diagrams to show the formation of images in the normal human eye.**

Ans:

**PTB PAGE # 59, FIG # 12.35**

**12.25. What is meant by the terms nearsightedness and farsightedness? How can these defects be corrected?**

Ans: **Nearsightedness:** *A person suffering from nearsightedness or shortsightedness cannot see distant objects clearly.*

**i.** This can be corrected by using diverging lens (concave lens).

**Farsihtedness (hypermetropia):** *The disability of the eye to form distinct image of nearby objects on its retina is known as farsightedness.*

**i.** This can be corrected by using converging lens (convex lens).

# Conceptual Questions

**12.1. A man raises his left and in a plane mirror, the image facing him is raising his right hadnd. Explain why?**

Ans: Light rays from left and reflected in a mirror causing an inverted image. So, the image of whole body isd inverted and image of left hand appears as right hand.

**12.2. In your own words, explain why light waves are refractedat a boundary between two materials?**

Ans: Speed of light is diferent in different mediums. When light waves enter from one material to other, their speed is changed which results in changein wavelength as well. Therefore, light waves deviate from their path and refract. Thus, light waves are refracted at a boundary between two materials.

**12.3. Explain why a fish under water appears to be at a different depth below the surface than it actually is. Does it appear deeper or shallower?** (BP 15-II)

Ans: This phenomenon is due to refraction of light as light eneters from air to water. it beds towards the normal. That's why image do not form at actual depth.

**Why or why not concave mirrors are suitable for make up?** (RWP 15-I)

Ans: If the object is at focus point then its magnified and real image is formed. In this case it is suitable for makeup but when the object is behind focus point then its clear image is not formed so in this case it is not suitable for makeup.

**12.4. Why is the driver's side mirror in many cars convex rather than plane or concave?**

Ans: Convex mirror is a converging mirror which froms the clear image of far objects. So, in car the mirro gives the accurate picture of road and other vehicles.

**12.5. When an optician's testing room is small, he uses a mirror to help him test the eye sight of his patients. Explain why?**

Ans: To increase the distance of alphabets from patient, the optician uses plane mirror if his testing room is small.

**12.6. How does the thickness of lens affect its focal length?**

Ans: Thickness of lens is greatly affected by its focal length. If the thickness of lens is large, focal length will be short and vice versa.

**12.7. Under what conditions will a converging lens form a virtual image?** (RWP 14-II) (GW 15-I)

Ans: When an object is placed among principal focus and optical centre then the image formed will be virtual.

**12.8. Under what conditions will a converging lens form a real image that is same size as the object?** (MN 15-I)

Ans: When the object is placed at "2F" from optical centre of convex lens, it forms a real image that has same size as that of object.

**12.9. Why do we use refracting telescope with large objective lens of large focal length?** (GW 12-II)

Ans: In refracting telescope, objective lens of larger focal length is used to gather more light from weak distant sources. It not only makes them more visible but increases resolving power of telescope.

## Important Formulas

- $f = \frac{R}{2}$
- $\frac{1}{f} = \frac{1}{p} + \frac{1}{q}$
- $m = \frac{h_i}{h_o} = \frac{q}{p}$
- $n = \frac{\sin \theta_1}{\sin \theta_2}$
- $n = \frac{\sin \angle i}{\sin \angle r}$
- $\sin \angle c = \frac{1}{n}$

## Sign Conventions

**For mirros:**

| Quantity | When positive (+) | When negative (-) |
|---|---|---|
| Object distance P | Real object | Virtual object |
| Image distance **q** | Real image | Virtual image |
| Focal length **f** | Concave mirror | Convex mirror |

**For lenses:**

- Focal length of covnex lens = **f** = +ve
- Focal length of concave lens = **f** = -ve
- If object is at left side of lens = **p** = +ve
- If object is at right side of lens = **p** = -ve
- Distance of real image = **q** = +ve
  (at right side of lens)
- Distance of virtual image = **q** = -ve
  (at left side of lens)

## *Chapter # 12 (Geomatrical optics)*

**12.1. An object 10.0 cm in front of a convex mirror forms an image 5.0 cm behind the mirror. What is the focal length of the mirror?** (GW 12-II) (RWP 15-I) (FB 15-II)

**Ans.** **Given Data:**

**0**

p = 10cm

q = -5cm (negative sign because image is behind the mirror)

**To Find:**

Focal length = f = ?

**Solution:**

$$\frac{1}{f} = \frac{1}{p} + \frac{1}{q}$$

$$\frac{1}{f} = \frac{1}{10} + \frac{1}{-5} = \frac{1}{10} - \frac{1}{5} = \frac{1-2}{10}$$

$$\frac{1}{f} = \frac{-1}{10}$$

**f = -10cm**

*-ve indicates that its focus point is virtual.*

**12.2. An object 30.0 cm tall is located 10.5 cm from a concave mirror with focal length 16cm (a) where is the image located? (b) How high is it?**

**Ans. Given Data:**

Object height = ho = 30cm

p = 10.5cm

f = 16cm

**To Find:**

**(a)** Position of image = q = ?

**(b)** Height of image = hi = ?

**Solution:**

**(a)** $\frac{1}{f} = \frac{1}{p} + \frac{1}{q}$

$\frac{1}{q} = \frac{1}{f} - \frac{1}{p}$

$= \frac{1}{16} - \frac{1}{10.5}$

$= \frac{1}{16} - \frac{10}{105}$

$= \frac{105-160}{16\times105}$

$\frac{1}{q} = \frac{-55}{16\times105}$

$q = \frac{-16\times105}{55}$

**q = -30.54cm**

**(b)** $m = \frac{\text{Height of image}}{\text{Height of object}} = \frac{H.I}{H.O} = \frac{q}{p}$

$\frac{H.I}{30} = \frac{30.54}{10.5}$

$H.I = \frac{30.54\times30}{10.5}$

**H.I = 87.26cm**

**12.3. An object and its image in a concave mirror are the same height, yet inverted, when the object is 20.0 cm from the mirror. What is the focal length of the mirror?** (LHR 15-I)

**Ans. Given Data:**

If H.I = H.O ∴H.I = Height of image

∴H.O = Height of object

**To Find:**

f = ?

**Solution:**

If H.I = H.O then,

$$m = \frac{\text{Height of image}}{\text{Height of object}} = \frac{H.I}{H.O} = I$$

$$m = I$$

$$m = \frac{q}{p}$$

$$I = \frac{q}{p}$$

$$p = q$$

$$q = 20cm$$

$$\frac{1}{f} = \frac{1}{p} + \frac{1}{q}$$

$$\frac{1}{f} = \frac{1}{20} + \frac{1}{20}$$

$$\frac{1}{f} = \frac{2}{20}$$

**f = 10cm**

**12.4. Find the focal length of a mirror that forms an image 5.66cm behind a mirror of an object placed at 34.4cm in front of the mirror. Is the mirror concave or convex?** (LHR 15-II)

**Ans. Given Data:**

q = -5.66cm (negative sign is because image is behind the mirror)

p = 34.4cm

**To Find:** f = ?

**Solution:**

$$\frac{1}{f} = \frac{1}{34.4} + \frac{1}{-5.66}$$

$$\frac{1}{f} = \frac{10}{344} - \frac{100}{566}$$

$$= \frac{2830 - 17200}{97352}$$

$$\frac{1}{f} = \frac{-14370}{97352}$$

$$f = \frac{-97352}{14370}$$

**f = -6.77cm**

**12.5. An image of a statue appears to be 11.5cm behind a concave mirror with focal length 13.5cm. Find the distance from the statue to the mirror.**

**Ans. Given Data:**

q = 11.5cm

f = 13.5cm

**To Find:**

p = ?

**Solution:**

$$\frac{1}{f} = \frac{1}{p} + \frac{1}{q}$$

$$\frac{1}{p} = \frac{1}{f} - \frac{1}{q}$$

$$\frac{1}{p} = \frac{1}{13.5} - \frac{1}{11.5}$$

$$\frac{1}{p} = \frac{10}{135} - \frac{10}{115}$$

$$\frac{1}{p} = \frac{1150 - 1350}{135 \times 115}$$

$$\frac{1}{p} = \frac{-200}{135 \times 115}$$

$$p = \frac{135 \times 115}{200}$$

p = -77.62cm

**p = 77.62cm**

**12.6. An image is produced by a concave mirror of focal length 8.70cm. The object is 13.2cm tall at distance 19.3cm from the mirror. (a) Find the location and height of the image. (b) Find the height of the image produced by the mirror if the object is twice as far from the mirror.**

**Ans. Given Data:**

f = 8.7cm

Height of object = H.O = 13.2cm

p = 19.3cm

**To Find:**

**(a)** Location of image = q = ?

**(b)** Height of image = H.I = ?

**Solution:**

**(a)** $\frac{1}{f} = \frac{1}{p} + \frac{1}{q}$

$\frac{1}{q} = \frac{1}{f} - \frac{1}{p}$

$\frac{1}{q} = \frac{1}{8.7} - \frac{1}{19.3}$

$\frac{1}{q} = \frac{10}{87} - \frac{10}{193}$

$\frac{}{q} = \frac{1679 - 1}{1060}$

$\mathbf{q = 15.84cm}$

$\frac{h_i}{h_o} = \frac{q}{f}$

$h_i = \frac{q}{p} \times h_o$

$h_i = \frac{15.84}{19.3} \times 13.2$

$\mathbf{h_i = 10.83cm}$

**(b)** $P = 2p$

$\frac{H.I}{H.O} = \frac{q}{p}$

$H.I = \frac{q \times H.O}{2p}$

$H.I = \frac{15.84 \times 13.2}{2 \times 19.3}$

$\mathbf{H.I = 5.4cm}$

**12.7. Nabeela uses a concave mirror when applying makeup.The mirror has a radius of curvature of 38.0cm. (a) What is the focal length of the mirror? (b) Nabeela is located 50cm from the mirror. Where will her image appear? (c) Will the image be upright or inverted?**

**Ans. Given Data:**

R = 38cm

p = 50cm

**To Find:**

**(a)** Focal length f = ?

**(b)** q = ?

**(c)** Nature of image = ?

**Solution:**

**(a)** $f = \frac{R}{2}$

$= \frac{38}{2}$

f = 19cm

**(b)** $\frac{1}{f} = \frac{1}{p} + \frac{1}{q}$

$\frac{1}{19} = \frac{1}{50} + \frac{1}{q}$

$\frac{1}{q} = \frac{1}{19} - \frac{1}{50}$

$\frac{1}{q} = \frac{50-19}{950}$

$\frac{1}{q} = \frac{31}{950}$

$q = \frac{950}{31}$

**q = 30.64cm**

**(c)** **inverted**

**12.8. An object 4cm high is placed at a distance 12cm from a convex lens of focal length 8cm. Calculate the position and size of the image. Also state the nature of the image.** (GW 15-I, II)

**Ans. Given Data:**

H.O = 4cm

P = 12cm

f = 8cm

**To Find:**

q = ?

H.I = ?

Nature of image = ?

**Solution:**

$\frac{1}{f} = \frac{1}{p} + \frac{1}{q}$

**(b) i.** $\frac{1}{f} - \frac{1}{p} = \frac{1}{q}$

$$\frac{1}{8}-\frac{1}{12}=\frac{1}{q}$$

$$\frac{6-4}{48}=\frac{1}{q}$$

$$\frac{2}{48}=\frac{1}{q}$$

$$\frac{1}{24}=\frac{1}{q}$$

**q = 24cm**

**ii.** $m = \frac{\text{Height of image}}{\text{Height of object}} = \frac{q}{p}$

$$\text{Height of image} = \frac{q \times \text{Height of object}}{p}$$

$$= \frac{24 \times 4}{12}$$

Height of image = 8cm

***(c)*** *Image is real, inverted and magnified.*

**12.9. An object 10cm high is placed at distance of 20cm from a concave lens of focal length 15cm. Calculate the position and size of the image. Also, state the nature of the image.** (SG 15-I) (DG 15-II)

**Ans.** **Given Data:**

Height of object = 10cm

p = 20cm

f = -15cm (for concave lens)

**To Find:**

q = ?

Height of image = ?

**Solution:**

$$\frac{1}{f}=\frac{1}{p}+\frac{1}{q}$$

$$\frac{1}{q}=\frac{1}{f}-\frac{1}{p}$$

$$\frac{1}{q}=\frac{1}{-15}-\frac{1}{20}=\frac{-4-3}{60}$$

$$\frac{1}{q}=\frac{-7}{60}$$

$$q = \frac{-60}{7}$$

**q = -8.57cm**

**(b)** $m = \frac{\text{Height of image}}{\text{Height of object}} = \frac{q}{p}$

$$\text{Height of image} = \frac{q \times \text{Height of object}}{p}$$

$$\text{Height of image} = \frac{8.57 \times 10}{20}$$

**Height of image = 4.28cm**

*Image is virtual, erect and diminished.*

***(c)***

**12.10. A convex lens of focal length 6cm is to be used to form a virtual image three times the size of the object. Where must the lens be placed?** (SG 15-II)

**Ans. Given Data:**

f = 6cm

m = 3

$m = \frac{q}{p}$

$3 = \frac{q}{p}$

-3p = q (-ve sign for virtual iamge)

To Find:

P = ?

Solution:

**(a)** $\frac{1}{f} = \frac{1}{p} + \frac{1}{q}$

$\frac{1}{6} = \frac{1}{p} - \frac{1}{3p}$

$\frac{1}{6} = \frac{3-1}{3p}$

$\frac{1}{6} = \frac{2}{3p}$

3p = 12

**P = 4cm**

**12.11. A ray of light from air is incident on a liquid surface at an angle of incidence $35^o$. Calculate the angle of refraction if the refractive index of the liquid is**

**1.25. Also calculate the critical angle between the liquid air inter-face.** (FB 15-I) (DG, MN 15-II)

**Ans.** **Given Data:**

$\theta_1 = 35^o$

Refractive index = n = 1.25

**To Find:**

$\theta_2$ = ?

Critical angle = c = ?

**Solution:**

For critical angle,

**(a)** $\sin \angle c = \frac{1}{n}$

$\text{Sin} \angle c = \frac{1}{1.25}$

$\text{Sin} \angle c = 0.8$

$\angle c = \sin^{-1}(0.8)$

$\angle \mathbf{c = 53.13^o}$

**(b)** $n = \frac{\sin\theta_1}{\sin\theta_2}$

$1.25 = \frac{\sin 35^o}{\sin\theta_2}$

$\text{Sin } \theta_2 = \frac{\sin 35^o}{1.25}$

$= \frac{0.57}{1.25}$

$\text{Sin } \theta_2 = 0.456$

$\theta_2 = \sin^{-1}(0.456)$

$\boldsymbol{\theta_2 = 27.13^o}$

**12.12. The power of a convex lens is 5D. At what distance the object should be placed from the lens so that ists real and 2 tiems larger image is formed?** (RWP, BP 15-II)

**Ans.** **Given Data:**

Power = P = 5D

$$f = \frac{1}{p} = \frac{1}{5}$$

$f = 0.2m$

$f = 0.2 \times 100cm$

$f = 20cm$

$m = 2$

**To Find:**

$p = ?$

**Solution:**

$$m = \frac{q}{p}$$

$$2 = \frac{q}{p}$$

$$2p = q$$

$$\frac{1}{f} = \frac{1}{p} + \frac{1}{q}$$

$$\frac{1}{20} = \frac{1}{p} + \frac{1}{2p}$$

$$\frac{1}{20} = \frac{2+1}{2p}$$

$$\frac{1}{20} = \frac{3}{2p}$$

$$2p = 60$$

**p = 30cm**

* * * * * * * * * * *

## *Chapter # 13 (Electrostatics)*

- **Choose the correct answer from the following choices:**

**i.** **A positive electric charge.** (GW, SG 14-II)

(a) attracts toher positive charge (b) repels other positive charge

(c) attracts a neutral charge (d) repels a neutral charge

**ii.** **An object gains excess negative charge after being rubbed against another object, which is:**

(a) neutral (b) negatively charged

(c) positively charged (d) either a, b and c

iii. **Two uncharged objects A and B are rubbed against each other. When object B is placed neara negatively charged object C, the two objects repel each other. Which of these statement istreu about object A?**

(a) remain uncharged (b) becomes positively charged
(c) becomes negatively charged (d) unpredictable

iv. **When you rub a plastic rod against your hair severl times and put it near some bits of paper, the pieces of papers are attracted towards it. What does this observation indicate?**

(a) the rod and the paper are oppositely charged (b) the rod acquires a positive charge
(c) the rod and the paper have the same charges (d) the rod acquires a negative charge

v. **According to Colulomb's law, what happends to the attraction of two oppositely charged objects as their distances of separation increases? (GW 15-I)**

(a) increase (b) decreases
(c) remains unchanged (d) cannot be determined

vi. **The Coulomb's law is valid for the charges which are.**

(a) moving and point charges (b) moving and non-point charges
(c) stationary and point charges (d) stationary and large size charges

vii. **A positive and negative charge are initially 4 cm apart. When they are moved closer together so that they are now only 1 cm part, the force between them is:**

(a) 4 times smaller than before (b) 4 times larger than before
(c) 8 times larger than before (d) 16 times larger than before

viii. **Five joules of work is needed to shift 10 C of charge from one place to another. The potential difference between the places is.** (BF, LHR 15-I)

(a) 0.5 V (b) 2 V
(c) 5 V (d) 10 V

ix. **Two charged spheres are separated by 2mm. which of the following would produce the greatest attractive force?** (SG 15-II)

(a) +1q and +4q (b) -1q and -4q
(c) +2q and +2q (d) +2q and -2q

x. **Electric field lines.** (MN 14-I) (FB 15-II)

(a) always cross each other (b) never corss each other
(c) cross each other in the region of strong field
(d) cross each other in the region of weak field

xi. **Capacitance is defined as:**

(SG, GW 14-II) (FB, GW, LHR 14-I) (GW, FB, LHR 15-I) (BP, MN, LHR 15-II)

(a) VC (b) Q/V

(c) QV (d) V/Q

***ANSWER:***

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| **i.** | b. | **ii.** | c. | **iii.** | b. | **iv.** | a. | **v.** | b. |
| **vi.** | c. | **vii.** | d. | **viii.** | a. | **ix.** | d. | **x.** | b. |
| **xi.** | b. | | | | | | | | |

# Review Questions

- **Write short answers of the following questions:**

**13.1. How can you show by simple experiments that there are two types of electric charges?** (FB 15-I)

Ans: **Experiment:** Take a glas rod and rub it with silk and suspend it horizontally. When we bring the plastic rod rubbed with fur near to the suspended glass rod, we observe that both the rods attract each other because the rods are unlike and their attraction implies that charges on two rods are not of the same kind but of opposite nature.

**13.2. Describe the method of charging bodies by electrostatic induction.** (FB 15-I, II)

Ans: **Method of charging bodies by electrostatic induction:** If we bring charged plastic rod near suspended neutral aluminium rod, both rods attract each other as shown in Fig. this attraction between the charged and uncharged rods shows as if both rods have unlike charges, but this is not true. Charged plastic rod produced displacement of positive and negative charges on the neutral aluminium rod which is the cause of attraction between them. But total charge on aluminium rod is still zero. This shows that a body can be charged by electrostatic induction.

**Figure**

**13.3. How does electrostatic induction differ from charging by friction?**

Ans: Electrostatic induction is different from charging by friction because in electrostatic induction we charge a bdoy with another charged body without physical ccontact but in friction, body is charged by rubbing or physical contact.

**13.4. What is gold leaf electroscope? Discuss its working principle with a laballed diagram.**

(AK, SW 14-II) (RWP, LHR 15-I) (GW 15-II)

Ans: **Gold leaf electroscope:** The gold leaf electroscope is a sensitive instrument for detecting presence and nature charges.

**Principle:** It works on electrostatic induction.

**Working:** It consist of a brass rod with a brass disk at the top and two thim leaves of gold foil hanging at the bottom. The rod passes through an insulator that keeps the rod in place. Charges can move freely from the disk to the leaves through the rod. A thin aluminium foil is attached on the lower portion of the inside of the jar. Usually, the aluminium foil is grounded by connecting a copper wire. This protects the leaves from the external electrical disturbances.

**13.5. Suppose you have a glass rod which becomes positively charged when you rub it with wool. Describe how would you charge the electroscope.** (RWP 15-II)

**(a) Negatively** **(b) Positively**

Ans: **Charging on Electroscope:** Electroscope can be charged by the process of electrostatic induction.

**Negatively:** Electroscope can be charged by process of conduction. Touch a negatively charged rod with disk of a neutral electroscope. Negative charge from rod will transfer to electroscope and will cause its leaves to diverge.

**Positively:** in order to produce positive charge on the electroscope, bring a negatively charged body near the disk of the electroscope. Positive charge will appear on the disk of the electroscope while negative charges will shift to the leaves. By connecting to earthed aluminium foil, charge of the leaves will flow to the Earth through the wire. Now break the Earth connection, remove the rod, the electroscope will be left with positive charge.

**13.6. With the help of electroscope how you can find preence of charge on a body?** (GW 12-II)

Ans: **Detecting presence of charge:** In order to detect the presence of charge on anybody, bring the body near the disk of an uncharged electrosdcope. If the body is neutral there will be no deflection of the leaves. *But if the body is positively or negatively charged, the leaves of the electroscope diverge.* For example, if the body is negatively charged then due to electrostatic induction, positive charge will appear on the disk while negative charge will appear on the leaves. The leaves of electroscope repel; each other and diverge because each leave getssiimlar charge. *The divergence of leaves will depend on the amount of charge*.

**13.7. Describe how you would determine the nature of charge on a body by using electroscope?** (MN 14-I) (RWP 14-II)

Ans: **Detecting the nature of charge:** For the detection of type of charge on a body, electroscope is first charged either positively or negatively. Suppose the electroscope is positively harged as explained before. Now in order to detect the type of charge on a body, bring the charged body near the disk of the positiverly charged electroscope. If the

*divergence* of the leaves *increases* the body carries *positive charge*. On the other hand if the *divergence decreases*, the body has *negative charge*.

**13.8. Explain Coulomb's law of electrostatic and write its mathermatical form.**
(LHR 12-I, II) (GW 13-II) (DG, FB, MN, SW 14-I, II) (RWP, LHR 15-I, II) (SG 15-II)

Ans: **Coulomb's law:"***The force of attraction or respulsion between two point charges is directly proportional to the product of the magnitude of charges and inversely proportion to the square of the distance between them***"**. Therefore,

Mathematical expression:

$$F = k\frac{q_1 q_2}{r^2} \text{ where } k = 9 \times 10^9 \text{ Nm}^2/\text{C}^2$$

**13.9. What is meant by electric field and electric instensity?**
(LHR 12-I, 13-II, 14-I, II) (GW 12-I, II) (SW, RWP, GW 14-I) (AK,M FB 14-II) (RWP, BP, GW, MN 15-I) (SG, DG, MN 15-II)

Ans: **Electric field:"***It is a region around the charge in ewhich it exerts electrostatic force on another charge*.**"**

**Electric intensity:"***The strength of electric field at any point in space is called electric field intensity*.**"**

**Formula:** $E = \frac{F}{q_o}$

**Unit:** $NC^{-1}$

**13.10. Is electric intensity a vector quantity? What will be its direction?** (FB 14-II)

Ans: **Yes,** electric intensity is vector quantity.

**Direction:** its direction is ame as that of the force acting on the positive charge. If the test charge free to move it will move in the direction of electric intensity.

**13.11. How would you define potential difference between two points? Define its unit.**
(GW 13-I) (BPM, LHR 14-II) (MN 14-I) (RWP, GW, MN 15-I) (BP 15-II)

Ans: **Potential difference:"***The energy supplied by a unit charge as it moves from one point to other in the direction of field is called potential difference*.**"**

**Unit:** The unit of potential difference is **volt (V)**.

**Volt:"***If one joule of work is done against electric field in bringing one coulomb positive charge from infinity to a oint in the electric field then potential at that point is one volt*.**"**

**13.12. Show that potential difference can be described as energy transfer per unit charge between the two points?**

Ans: If the potential of point A is $V_a$ and that of point B is $V_b$, the potential energy of the charge at these points will be qVa and qVb respectively.the changein potential energy

othe charge when it moves from point A to B will be equal to $qV_a - qV_b$. This energy is utilized in doing some useful work. Thus energy supplied by the charge = $q(V_a - V_b)$

$$\therefore W = qV$$

$$\Delta V = \frac{w}{q}$$

If 'q' is one coulomb, then the potential difference between two points becomes equal to the energy supplied by the charge.

**13.13. What do you mean by the capacitance of a capacitor? Define untis of capacitance.** (LHR 12-I) (GW, SG, GW, LHR, AK 14-I) (FB 14-II) (SG, DG 15-II) (BP 15-I)

Ans: **Capacitance:"***Capacitance is the ability of a capacitor to store charge.***"**

$$C = \frac{Q}{V}$$

**Units:** Its units is **Farad (F)**.

**One Farad:"***If one coulomb of charge given to the paltes of a capacitor produces a potential difference of one volt between the plates of the capacitor then its capacitance woule be one farad.***"**

**13.14. Derive the formula for the effective capacitance for a series combination of a number of capacitors.**
(LHR 12-II) (GW 13-I) (DG, GW, FB 15-I) (MN 15-II)

Ans: **Effective capacitanceof series combination:**

**i.** Each capacitor has the same charge across it.

$$Q_1 = Q_2 = Q_3 = Q$$

**ii.** The voltage of the battery has been divide among the various capacitors.

$$\text{Hence } V = V_1 + V_2 + V_3$$

$$= \frac{Q}{C_1} + \frac{Q}{C_2} + \frac{Q}{C_3}$$

$$= Q\left[\frac{1}{C_1} + \frac{1}{C_2} + \frac{1}{C_3}\right]$$

$$\frac{V}{Q} = \left[\frac{1}{C_1} + \frac{1}{C_2} + \frac{1}{C_3}\right]$$

**iii.** Thus, we can replace series combination of capacitors with one equivalent capacitor having capacitance $C_T$ i.e.

$$\frac{1}{C_T} = \frac{1}{C_1} + \frac{1}{C_2} + \frac{1}{C_3}$$

In the case of 'n' capacitors connected in series, we have

$$\frac{1}{C_T} = \frac{1}{C_1} + \frac{1}{C_2} + \frac{1}{C_3} \ldots\ldots\ldots + \frac{1}{C_n}$$

**13.15. Discuss different types of capacitors.** (GW 15-I, II)

Ans: **Types of capacitors:** Capacitors are generally of two types:

i. Variable capacitors

ii. Fixed capacitors

**Fixed capacitors:** Fixed capacitors are further types:

i. Parallel plate capacitors
ii. Spherical capacitors
iii. Paper capacitor
iv. Mica capacitor
v. Cylindrical capacitor

**13.16. What is the difference between variable and fixed type capacitor?** (GW 12-13-II) (GW,S SG, DG, 14-I, II) (LHR 13-I, 15-I, II) (MN 15-II)

Ans:

| Fixed Capacitor | Variable Capacitor |
|---|---|
| "*The capacitor which has fixed capacitance is called fixed capacitor*." | "*The capacitor whose capacitance is variable is called variable capacitor*." |

**13.17. Enlist some uses of capacitors.** (BP, RWP, GW 14-II) (AK 14-I) (LHR 15-I, II)

Ans: **Uses of capacitors:**

**i.** They are used for tuning transmitter and radio.
**ii.** They are used in fan motors.
**iii.** They are used in circuits of computer etc.

**13.18. Discuss one application of static electricity.**

Ans: **Electrostatic air cleaner:** An electrostatic air cleaner is used in homes to relieve the discomfort of allergy sufferers. Air mixed ith dust and pollen eneters the device across a positiverly charged mesh. The airborne particles become positiverly charged when they make contact with the mesh. Then they pass through a second, negatively charged mesh. *The electrostatic force of attraction between the positiverly charged particles in the air and the negatively charged mesh causes the particles to precipitate out on the surface of the mesh.*

Through this process we can remove a very high percentage of contaminants from the air stem.

**13.19. What are hazards of static electricity?** (SG 14-I) (MN 15-II)

Ans: **Hazards of static electricity:** Static electricity is a major cause of fires and explosions at many places. A fire or an explosion may occur due to excessive uild-up of electric charges produced by friction.

Static electricity can be generated by the friction of the gasoline begin pumped into a vehicle or container. It can also be produced when we getg out the car or remove an

article of clothing. Static charges are dangerous. If static charges are allowed to discharge through the areas where there is petrol vapour a fire can occur.

## Conceptual Questions

**13.1. An electrified rod attracts pieces of paper. After a while these pieces fly away! Why?**

Ans: When electrified rod attracts pieces of paper, aftera while thes pieces fly away because some electrons move to rod and rod becomes neutral.

**13.2. How much negative charge has been removed from a positively charged electroscope, if it has a charge of $7.5 \times 10^{-11}$C?** (MN 15-II)

Ans: Charge of $-7.5 \times 10^{-11}$C has been removed from positively charged electroscope beacause negative charge is equal to positive charge.

**13.3. In what direction will a positiverly charged particle move in an electric field?** (SG 14-II)

Ans: The positively charged particle move alogn the direction of electric intensity. In an electric field the direction of electric field intensity can also be represented by electric lines of force. So, the positive charge particle move in the direction ofelectric lines of force. i.e. from higher to lower potential.

**13.4. Does each capacitor carry equal charge in series combination explain.**

Ans: Yes, each capacitor carries equal charge because if the battery supplies charge on the left plate of a capacitor (C1), -Q charge is induced, then on its right palte, +Q charge on the left of the capacitor C2 is induced.

i.e. $Q1 = Q2 = Q$

**13.5. Each capacitor in parallel combination has equal potential difference between its two plates justify the statement.**

Ans: Each capacitor carries equal potential difference because each capacitor is conneted directly wth the terminals of battery. i.e.

$$V = V1 = V2$$

**13.6. Perhaps you have seen a gasoline truck trailing a metal chain beneath it. What puRWPose does the chain serve?**

Ans: Due to friction the truck body gets charged and it may cause explosion. So, the metal chain continuously transfers the charge from truck to ground and the spark is removed.

**13.7. If a high-voltage power line fell across your car while you were in the car, why should you not come out of the car?**

Ans: Because the tyres of the car are insulator. So, that the current can't pas sthrough them but when we come out and in contact with the car and fro mthe body of car the current will pass through our ody which may cause death.

**13.8. Explain why, a glass rod can be charged by rubbing when held by hand but an iron rod cannot be charged by rubbing, if held by hand?**

Ans: By rubbing glass rod, charge does not flow to our body (which is a good conductor) and remains on rod. But charge of iron rod flows to earth through our body and rod loses its charge.

## Important Formulas

- $Q = ne$
- $F = k\frac{q_1 q_2}{r^2}$
- $V = \frac{W}{Q}$
- For series combination $\frac{1}{C_{eq}} = \frac{1}{C_1} + \frac{1}{C_2}$
- For parallel combination: $C_{eq} = C_1 + C_2$
- $E = q(V_a - V_b)$
- $E = \frac{F}{q_o}$
- $Q = CV$

## Values & Units

- $k = 9 \times 10^9 Nm^2C^{-2}$
- $1\mu C = 10^{-6}C$
- Unit of **force** = Newton (N)
- Unit of **charge** = Coulomb (C)
- Unit of **potential difference** = V = $(JC^{-1})$
- Unit of **electric intensity** = $NC^{-1}$
- Unit of **capacitance** = Farad (F)

## Numericals

**13.1. The charge of how many negatively charged particles would be equal to 100$\mu$c. Assume charge on one negative paticles is $1.6\times10^{-19}$C?**
(GW, LHR 12-II)

**Ans. Given Data:**

Charge = Q = $100\mu C = 100 \times 10^{-6}C$ ($\therefore 1\mu C = 10^{-6}C$)

Charge on an electron = e = $1.6 \times 10^{-19}C$

**To Find:**

No. of charges = n = ?

**Solution:**

$$Q = ne$$

$$n = \frac{Q}{e}$$

$$n = \frac{100\times10^{-6}}{1.6\times10^{-19}}$$

$$n = 62.5\times10^{-6+19}$$

$$n = 62.5\times10^{13}$$

$$\mathbf{n = 6.25\times10^{14}}$$

**13.2. Two point charges $q_1 = 10\mu C$ and $q_2 = 5\mu C$ are placed at distance of 150cm. What will be the Coulomb's force between them? Also find the direction of the force.**

(LHR 13-II) (SG 15-I) (GW 15-II)

**Ans.** **Given Data:**

$q_1 = 10\mu C = 10\times10^{-6}C$

$q_2 = 5\mu C = 5\times10^{-6}C$ $(\therefore 1\mu C = 10^{-6}C)$

Distance between charges $= r = 150cm$

$r = \frac{150}{100}m$

$r = 1.5m$

$k = 9\times109Nm^2C^{-2}$

**To Find:**

Force $= F = ?$

Direction of force = ?

**Solution:**

$$F = k\frac{q_1q_2}{r_2}$$

$$F = 9\times10^9\frac{(10^1\times10^{-6})(5\times10^{-6})}{(1.5)^2}$$

$$F = 9\times10^9\frac{(10^{-5})(5\times10^{-6})}{2.25}$$

$$F = \frac{9\times5\times10^9}{2.25}\times10^{-5}\times10^{-6}$$

$$F = \frac{45}{2.25}\times10^{9-5-6}$$

$$F = 20\times10^{9-11}$$

$$F = 20\times10^{-2}N$$

$$\mathbf{F = 0.2N}$$

**Direction:** *As both charges are same so force between the two charges is repulsive* ***(force of repulsion)***.

**13.3. The force of repulsion between two identical positive charges is 0.8 N, when the charges are 0.1m apart. Find the value of each charge.**

**Ans.** **Given Data:**

Force = F = 0.8N

r = 0.1m

k = $9\times109 Nm^2C^{-2}$

**To Find:**

$q_1 = q_2 = q = ?$

**Solution:**

$F = k\frac{q_1q_2}{r^2}$ $(q_1 = q_2 = q)$

$$F = \frac{kq^2}{r^2}$$

$$r^2F = kq^2$$

$$q^2 = \frac{r^2f}{k}$$

$$q^2 = \frac{(0.1)^2(0.8)}{9\times10^9}$$

$$q^2 = \frac{(0.01)(0.8)}{9\times10^6}$$

$$q^2 = \frac{8\times10^{-3}}{9\times10^9}$$

$$q^2 = 0.888\times10^{-3-9}$$

$$q^2 = 0.888\times10^{-12}$$

$$\sqrt{q^2} = \sqrt{0.888 \times (10^{-6})^{-2}}$$

$$q = 0.942\times10^{-6}$$

$$\mathbf{q = 9.42\times10^{-7}C}$$

**13.4. Two charges repel each other with a force of 0.1N when they are 5cm apart. Find the forces between the same charges when they are 2 cm apart.**

**Ans.** **Given Data:**

$F_1 = 0.1N$

$r_1 = 5cm = \frac{5}{100} m = 0.05m$

**To Find:**

$F_2 = ?$ (when $r^2 = 2cm$)

**Solution:**

$$F_1 = k\frac{q_1 q_2}{r_1}$$

Since, both charges repel each other, they are similar charges.

$$F_1 = k\frac{qq}{r^2}$$

$$F_1 = k\frac{q^2}{r^2}$$

$$q_2 = \frac{r^2 F_1}{k}$$

$$q^2 = \frac{(0.05)^2(0.1)}{9\times10^9}$$

$$q^2 = \frac{2.5\times10^{-4}}{9\times10^9}$$

$$q^2 = 0.277 \times 10^{-9-4}$$

$$q^2 = 0.277 \times 10^{-13}$$

$$q^2 = 2.77 \times 10^{-14}$$

$$\sqrt{q^2} = \sqrt{2.77 \times (10^{-7})^2}$$

$$\mathbf{q = 1.664 \times 10^{-7} C}$$

$F_2 = ?$

$$F_2 = k\frac{q_1 q_2}{r_2}$$

$$F_2 = k\frac{qq}{r^2}$$

$$F_2 = k\frac{q^2}{r^2}$$

$$F_2 = \frac{9\times10^9(1.664\times10^{-7})^2}{(0.02)^2}$$

$$F_2 = \frac{9\times10^9(2.768)\times10^{-14}}{4\times10^{-4}}$$

$$F_2 = \frac{24.912}{4} \times 10^{9-14+4}$$

$$F_2 = 6.228 \times 10^{-1} N$$

$$\mathbf{F_2 = 0.62N}$$

**13.5. The electric potential at a point in an electric field in $10^4$V. If a charge of +100$\mu$ is brought from infinity to this point. What would be the amount of work done on it?**

**Ans. Given Data:**

Electrical potential = V = $10^4$ Volts

Charge = Q = $100\mu C$

Q = $100\times10^{-6}C(\therefore 1\mu C=10^{-6}C)$

**To Find:**

Work = W = ?

**Solution:**

$$V = \frac{W}{Q}$$

$$W = QV$$

$$W = (100\times10^{-6})\,(10^4)$$

$$W = (10^{-4})\,(10^4)$$

$$W = 10^{-4+4}$$

$$W = 10^{o}$$

**W = 1J**

**13.6. A point charge of +2C is transferred from a point at potential 100V to a point at potential 50V, what would be the energy supplied by the charge?**
(FB 15-II)

**Ans. Given Data:**

Q = +2C

Va = 100 volts, Vb = 50 volts

**To Find:**

E = ?

**Solution:**

$$E = q\,(V_a - V_b)$$

$$E = 2\,(100 - 50)$$

$$E = 2\,(50)$$

**E = 100J**

**13.7. A capacitor holds 0.06 coulombs of charge when fully charged by a 9-volt battery. Calculate capacitance of the capacitor.**
(SG 15-II)

**Ans. Given Data:**

Charge = Q = 0.06C

Voltage =

V = 9volts

**To Find:**

Capacity = C = ?

**Solution:**

$$Q = CV$$

$$C = \frac{Q}{V}$$

$$C = \frac{0.06}{9}$$

$$C = 6.666\times10^{-3}F$$

$$\mathbf{C = 6.67\times10^{-3}F}$$

**13.8. A capacitor holds 0.03 coulombs of charge when fully charged by a 6-volt battery. How much voltage would be required for it to hold 2 coulombs of charge?**

(MN 15-II)

**Ans. Given Data:**

$$Q_1 = 0.03C$$

$$V_1 = 6V$$

$$Q_2 = 2C$$

**To Find:**

$$V_2 = ?$$

**Solution:**

$$Q = CV$$

$$C = \frac{Q}{V}$$

For First capacitor

$$C = \frac{Q_1}{V_1} \quad \text{.....(i)}$$

$$C = \frac{Q_2}{V_2} \quad \text{.....(ii)}$$

By comparing (i) and (ii)

$$\frac{Q_1}{V_1} = \frac{Q_2}{V_2}$$

$$V_2 = \frac{Q_2 V_1}{Q_1}$$

$$V_2 = \frac{2\times6}{0.03}$$

$$V_2 = \frac{12}{0.03}$$

$$V_2 = \frac{12}{3/100}$$

$$V_2 = \frac{1200}{3}$$

**$V_2$ = 400 Volts**

**13.9. Two capacitors of capacitance 6$\mu$F and 12$\mu$F are connected in series with a 12V battery. Find the equivalent capacitance of the combination. Find the charge and ther potential difference across each capacitor.**

**Ans. <u>Given Data:</u>**

$C_1 = 6\mu F = 6\times10^{-6}F$

$C_2 = 12\mu C = 12\times10^{-6}F$

$V = 12$ volts

**<u>To Find:</u>**

(a) $C_{eq}$ = ?

(b) Q = ?

(c) $V_1$ = ?

(d) $V_2$ = ?

**<u>Solution:</u>**

**(a) $C_T$ = ?**

$$\frac{1}{C_T} = \frac{1}{C_1} + \frac{1}{C_2}$$

$$\frac{1}{C_T} = \frac{1}{6} + \frac{1}{12}$$

$$\frac{1}{C_T} = \frac{2+1}{12}$$

$$\frac{1}{C_T} = \frac{3}{12}$$

$$C_T = \frac{12}{3}$$

**$C_T$ = 4$\mu$F**

**(b) Q = ?**

**For series combination charge through each capacitor would be same i.e.**

$Q = C_{eq}.V$

$Q = (4\mu F)(12)$

**Q = 48$\mu$C**

**(c)** $\mathbf{V_1 = ?}$

$$Q = C_1V_1$$

$$V_1 = \frac{Q}{C_1}$$

$$V_1 = \frac{48\mu C}{6\mu F} \left(\therefore \frac{Coulumn}{Farad} = volt\right)$$

$$V_1 = 8 \text{ volt}$$

**(d)** $\mathbf{V_2 = ?}$

$$Q = C_2V_2$$

$$V_2 = \frac{Q}{C_2}$$

$$V_2 = \frac{48\mu C}{12\mu F}$$

$$\mathbf{V_2 = 4 \text{ volt}}$$

**13.10. Two capacitors of capacitances of 6$\mu$F and 12$\mu$F are connected in parallel with a 12V battery. Find the equivalent capacitance of the combination. Find the charge and the potential difference across each capacitor.**

**Ans.** **Given Data:**

$C_1 = 6\mu F = 6 \times 10^{-6} F$

$C_2 = 12\mu F = 12 \times 10^{-6} F$

**To Find:**

(a) $C_{eq}$ = ?

(b) $Q_1$ = ? $Q_2$ = ?

(c) Potential difference = V = ?

**Solution:**

**(a)** $\mathbf{C_T = ?}$

$$C_T = C_1 + C_2$$

$$C_T = 6\mu F + 12\mu F$$

$$C_T = 18\mu F$$

**(b)** $\mathbf{Q_1 = ?}$ $\mathbf{Q_2 = ?}$

$$Q = CV$$

$$Q_1 = C_1V$$

$$Q_1 = 6 \times 10^{-6} \times 12$$

$$\mathbf{Q_1 = 72\mu C}$$

$$Q = CV$$

$$Q_2 = C_2V$$

$$Q_2 = 12 \times 10^{-6} \times 12$$

$$Q_2 = 144 \times 10^{-6}C$$

$$\mathbf{Q_2 = 144\mu C}$$

**(c) Potential difference = V =?**

*When capacitors are connected in parallel combination then potential difference in each capacitor would be same as that of battery i.e.* **V = 12 volts.**

* * * * * * * * * * *

## *Chapter # 14 (Current Electricity)*

- **Choose the correct answer from the following choices:**

**i.** **An electric current in conductors is due to the flow of.** (SG 14-II) (FB 15-I)

(a) positive ions (b) negative ions

(c) positive charges (d) free electrons

**ii.** **What is the voltage acros a 6Ω resistor when 3A of current passes through it?** (LHR 12-II) (BP 14-II) (GW 15-I, II) (SG, DG 15-II)

(a) 2 V (b) 9 V

(c) 18 V (d) 36 V

**iii.** **What happens to the intensity or the brightness of the lamps connected in series as more and more lamps are added.** (AK 13-I) (SG 15-I) (LHR 15-I)

(a) increases (b) drecreases

(c) remains the same (d) cannot be predicted

**iv.** **Why should household appliances be connected in parallel with the voltage source?**

(a) to increase the resistance of the circuit

(b) to decrease the resistance of the circuit

(c) to provide each appliance the same voltage as the power source

(d) to provide each appliance the same current as the power source

**v.** **Electric potential and e.m.f**

(a) are the same terms (b) are the different temrs

(c) have different units (d) both b and c

**vi.** **When we double the voltage in a simple electric circuit, we double the.** (LHR 13-II)(GW 14-I)

(a) current (b) power

(c) resistance (d) both a and b

**vii.** **If we double both the current and the voltage in a circuit while keeping its resistance constant, the power:**

(a) remains unchanged

(b) halves

(c) doubles (d) quadruples

**viii. What is the power rating of a lamp connected to a 12V source when it carries 2.5A?** (LHR 12-II) (LHR, SW, GW 14-II) (SW, MN 14-I) (MN 15-II)

(a) 4.8 W (b) 14.5 W

(c) 30 W (d) 60 W

**ix. The combined resistanec of two identical resistors, connected in series is 8Ω. Their combined resistance in a parallel arrangement will be.** (FB 15-II)

(a) 2Ω (b) 4Ω

(c) 8Ω (d) 12Ω

***ANSWER:***

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| **i.** | d. | **ii.** | c. | **iii.** | c. | **iv.** | c. | **v.** | b. |
| **vi.** | d. | **vii.** | d. | **viii.** | c. | **ix.** | a. | | |

# Review Questions

- **Write short answers of the following questions:**

**14.1. Define and explain the term electric current.** (RWP, BP, GW 14-I) (MN, LHR 14-II) (SW 14-I, II) (FB 15-I) (BP 15-I, II) (MN, GW 15-II)

Ans: **Electric current:**"*The rate of flow of electric charge through any cross- sectional area is called current*."

If the charge **Q** is passing through any area in time **t**, then current **I** flowing through it will be given by.

**Formula:** $\text{Current} = \frac{\text{Charge}}{\text{Time}}$

Or $I = \frac{Q}{t}$

**Unit:** SI unit of current is **ampere (A).**

**One ampere:**"*If a charge of one coulomb passed through a cross-sectional area in one second, then current is one ampere*."

**14.2. What is the difference between electronic current and conventional current?** (GW 12-II, 13-I) (SW, AK 14-II) (BP, RWP 15-I)

Ans:

| Electronic current | Conventional current |
|---|---|
| • Rate of flow of charges through any corss sectional area *from negative terminal to positive terminal* is called | • Current flowing *from positive to negative terminal* of a battery due to the flow of positive chages is called |

| | |
|---|---|
| *electronic current.* | *conventional current.* |

**14.3. What do you mean by the term e.m.f? Is it really a force? Explain.**
(BP, SG, SW, MN, LHR 14-I, II)

Ans: **E.m.f:"***It is the energy supplied by a batter to a unit positive charge when it flows through the closed circuit*.**"**

**OR**

**"***The energy converted from non-electrical forms to electrical form when one coulomb of positive charge passes through the battery*."

**Formula:** $\text{e.m.f} = \frac{\text{Energy}}{\text{Charge}}$

$E = \frac{W}{Q}$

**Unit:**The unit for e.m.f is $\mathbf{JC^{-1}}$ which is equal to volt **(V)** in SI system.

E.m.f is not a force, it is actually a voltage between terminals of battery, when no current flows is circuit.

**14.4. How can we differentiate between e.m.f and potential difference?**
(BP, GW, LHR 14-I) (BP, SG, SW, MN, LHR 14-II) (DG, BP, 15-I, II) (GW 15-II)

Ans: **Difference between emf and potential difference:** E.m.f of a battery is total energy supplied in driving one coulomb of charge in complete circuit in which the cell is connected. The complete circuit includes cell and external circuit. Whereas, potential difference determines the energy required between two terminals of circuit to move charge (only external circuit).

**14.5. Explain Ohm's law. What are its limiatations?**

Ans: **Ohm's law:"***The amount of current passing through a conductor is directly proportional to the potential difference applied across its ends, provided the temperatgure and the physical state of the conductor doesd not change*."

**Mathematical form:**

$V \propto I \quad (T = \text{constant})$

$V = IR$

Where R is the constant proportionality and is the resistance of the conductors. Its SI units is ohm, denoted by a symbol Ω.

**Limitations of Ohm's law:**

**i.** Ohm's law is applicable when temperatue of conductor is kep constant.

**ii.** Conductors obey Ohm's law as logn as the electric current through them is not very large.

**iii.** The physical state of the conductor also remains same.

**14.6. Define resistance and its units.** (MN 14-I, II) (DK 14-II) (LHR 14-I) (SG 15-II) (FB 15-I, II)

Ans: **Resistance:**"*The property of a substance which offers opposition to the flow of current through, it is called its resistance.*"

**Unit:** Its unit is **Ohm (Ω)**.

**Ohm:**"*When a potential difference of one volt is applied across the ends of a conductor and one ampere of current passes through it, its reistance will be one ohm.*"

**14.7. What is the difference between conductors and insulators?**
(LHR 12-II) (BP, SG, DG, AK 14-II) (FB 14-I) (RWP 15-I) (DG, MN, GW 15-II)

Ans:

| Conductors | Insulators |
|---|---|
| • "*Conductors are those substances from which electricity and heat can pass easily.*"<br>**e.g.** Metals are mostely conductor. | • "*Insulators are those substances from which electricity and heat can't pass easily.*"<br>**e.g.** Rubber glass etc. |

**14.8. Explain the energy dissipation in a resistance. What is Joule's law?**
(LHR, GW 12-I) (SW, BP, SG, MN, GW, LHR 13-I) (RWP, AK, LHR 14-I, II) (BP, FB 15-I) (RWP, SG 15-II)

Ans: **Energy dissipation:** The electrical energy can be utilized for different useful puRWPoses. For example, bulb converts electrical energy itno light and heat. Heart and iron itno heat and fans into mechanical energy.

**Energy dissipated = W = I2Rt**

**Joule's law:**"*The amount of heat generatd in resistance due to flow of charges is equal to the product of square of current I, resistance R and the time duration.*"

**Mathematical equation:**

$$W = I^2Rt$$

**14.9. What is the difference between A.C and D.C?** (GW 13-II) (DG 14-I)

Ans: **A.C:**"*The current which changes its direction again and again is known as alternating current* (A.C)."

**D.C:**"*The current which always flows in one direction is called riect current* (D.C)."

**14.10. Discuss the main features of parallel combination of restors.**
(LHR 13-I) (MN 15-I) (RWP, GW 15-II)

Ans: **Parallel combination of resistor:**

**i.** The voltage is same across each resistor which is equal to the voltage of the battery.

$$V = V_1 = V_2 = V_3$$

**ii.** The current through each resistor is not same.

$$I_T = I_1 + I_2 + I_3$$

$$I_1 = \frac{V}{R_1},\ I_2 = \frac{V}{R_2} \text{ and } I_3 = \frac{V}{R_3}$$

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

$$I = V\left(\frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3}\right)$$

$$\frac{V}{R_e} = V\left[\frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3}\right]$$

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

**iii.** Hence, equivalent resistance will be:

$$\frac{1}{R_e} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3} + \ldots\ldots + \frac{1}{R_n}$$

**14.11. Determine the equivalent resistance of series combination of resistors.** (RWP 15-II)

Ans: **Series combination:**

**i.** The current passing through each resistor is the same. i.e. $I = I_1 = I_2 = I_3$

**ii.** The total voltage in a series circuit divides among the individual resistors.

$$V = V_1 + V_2 + V_3$$

According to Ohm's law

$$V = IR_1 + IR_2 + IR_3$$

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

We know that

$$\therefore V = IR_e$$

Put in above equation,

$$IR_e = I(R_1 + R_2 + R_3)$$

$$R_e = R_1 + R_2 + R_3$$

**14.12. Describe briefly the hazards of household electricity.** (DK 14-I)

Ans: **Insulation damage:** All electrical wires are well insulated with some plastic cover for the puRWPose of safety. But when electrical current exceeds the rated current carrying capacity of the conductor, it can produce excess current that can damage insulation due to overhaeating cables. This results into a short circuit which can severely damage electrical devices or persons.

**Damp conditions:** Dry human skin ahs a reistance of 100,000 ohms or more! But under damp conditions (wet environment) resistance of human skin is reduced drastically to few hundred ohms, which cause fatal accidents.

**14.13. Describe four safety measures that should be taken in connection with the household circuit.** (MN 15-I)

Ans: In order to protect persons, devices and property from the hazards of electricity there is a need of extensive safety mearsures in household electricity.

**i.** Fuse **ii.** Circuit breaker

**iii.** Earth wire

**iv.** Neutral wire

**14.14. Design a circuit diagram for a study room that needs the following equipments in parallel:**

**(a) One 100W lamp operated by one switch.**

**(b) One reading lamp fitted with a 40W bulb which can be switched ON and OFF from two points.**

**(c) What is the advantage of connecting the equipments in parallel instead of series combination? (LHR 14-II)**

Ans: Following is the circuit diagram of part (a) & part (b).

(a)


(b)


(c) The circuit of parallel combination is better than series combination because in parallel combination each appliance gains voltage equal to voltage of battery.

# Conceptual Questions

**14.1. Why in conductors charge is transferred by free electrosn rather than by positive charges?**

Ans: Positive charges are bound to nucleus and cannot move randomly while free electrons are not bound to the force of nucleus and can move randomly. These electrons travel in specific direction, when conductor is connected with battery.

**14.2. What is the difference between cell and battery?** (GW 14-II)

Ans: **Cell:** A cell consists of two metal electrodes dipped into an electrolyte. It is a device which converts chemical energy into electrical.

**Battery:** Batter is the group of large number of cells. Batteries store larger energy as compared to cell.

**14.3. Can current flow in a circuit without potential difference?**

Ans: No, current can't flow in a circuit without potential difference.

**14.4. Two points on an object are at different electric potentials. Does charge necessarily flow between them?**

Ans: Yes, due to potential differences, charges always flow from higher to lower potential.

**14.5. In order to measure current in a circuit, why ammeter is always connected in series?** (GW 14-I) (FB 14-II)

Ans: Ammeter is always connected in series so that current flowing in series combination always remains same and the current flowing through the circuit will be equal to current flowing through ammeter.

**14.6. In order to measure voltage in a circuit voltmeter is always connected in parallel. Discuss.**

Ans: Voltmeter is connected parallel to the circuit so that the voltage in the parallel combination always remains same and the voltage across the circuit will be equal to voltage of voltmeter.

**14.7. How many watt-hours are there in 1000 joules?** (SG 15-I)

Ans:

$$\text{Energy} = 1000$$

$$\text{Power} = \frac{\text{Energy}}{\text{time}}$$

$$P = \frac{W}{t}$$

$$W = P \times t$$

$$1 \text{ joule} = 1 \text{ watt} \times 1 \text{ second}$$

$$\Rightarrow = (1 \text{ hr} = 3600 \text{ sec})$$

$$1J = 1 \text{ watt} \times \frac{1}{3600} \text{ hr}$$

$$1J = \frac{1}{3600} \text{ watt} \times \text{hour}$$

Multiplying both sides by 100,

$$1000J = \frac{1}{3600} \times 100 \text{ watt hour}$$

$$1000J = \frac{1000}{3600} \text{ watt hour}$$

$$\mathbf{1000J = 0.2777 \text{ watt hour}}$$

**14.8. From hour experience in watching cars on the roads at night, are atuomoobile connected in series, or in parallel?**

Ans: The headlamps of automobiles are connected in parallel so that the potential at both sides of headlamps remains same.

**14.9. A certain flash light can use a 10 ohm bulb or a 5 ohm bulb. Which bulb should be used to get the brighter light? Which bulb will discharge the battery first?** (GW 15-II)

Ans: Bulb with 5 ohm resistance will be more brighter and will discharge first. As lower resistance means larger current will pass through and it will glow more brightly. When larger current pases through circuit, battery will discharge quickly.

**14.10. It is impracticable to connect and electric bulb and an electric heater in series. Why?**

Ans: If these appliancesare connected in series the voltage across both the appliances change and the circuit will be short. As, it will increase resistance of circuit and decrease current as well as power through appliances.

**14.11. Does a fuse in a circuit control the potential difference or the current?** (GW 13-II)

Ans: Fuse in a circuit is used to control the flow of current up to safety limit.

# Important Formulas

- $I = \frac{Q}{t}$
- $V = IR$
- $W = I^2Rt$
- $P = VI = I^2R = \frac{V^2}{R}$

- For series combination: $R_e = R_1 + R_2$
- For parall combination: $\frac{1}{R_e} = \frac{1}{R_1} + \frac{1}{R_2}$
- Energy kWh $= \frac{\text{Power (watt)} \times \text{time (hrs)}}{1000}$
- Electricity price $= \frac{\text{Power (watt)} \times \text{time (hrs)} \times \text{unit price}}{1000}$
- Monthly bill $= \frac{\text{Power (watt)} \times \text{time (hrs)} \times \text{unit price} \times 30}{1000}$

# Values & Units

- $1mA = 10^{-3}A$
- $1k\Omega = 10^{3}\Omega$
- $1M\Omega = 10^{6}\Omega$
- Unit of **current** = ampere (A) = $CS^{-1}$
- Unit of **voltage** = volt (V) = $JC^{-1}$
- Unit of **reistance** = Ohm ($\Omega$) = $VA^{-1}$
- Unit of **power** = watt (W) = $Js^{-1}$
- Unit of **electrical energy** = Joule (J) = Watt sec

# Numericals

**14.1. A current of 3mA is flowing through a wire for 1 minute. What is the charge flowing through the wire?**
(FB, LHR 15-I) (DG, FB 15-II)

**Ans. Given Data:**

Current = I = 3mA

I = $3\times10^{-3}$A ($\therefore$milli = $10^{-3}$)

**To Find:**

Charge = Q = ?

**Solution:**

$$I = \frac{Q}{t}$$

$$Q = I \times t$$

$$Q = 3 \times 10^{-3} \times 60$$

$$\mathbf{Q = 180 \times 10^{-3} C}$$

**14.2. At 100,000Ω how much current flows through your body if you touch the terminals of a 12-V battery? If your skin is wet, wso that your resistance is only 1000Ω, how muh current would your receive from the same battery?**
(GW 15-I)

**Ans. Given Data:**

R1 = 100,000 Ω

V = 12 volts

$R_2$ = 1000 Ω

**To Find:**

(a) $I_1$ = ?

(b) $I_2$ = ?

**Solution:**

$$V = IR$$

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

**(a) $I_1$ = ?**

$$I_1 = \frac{12}{10^5}$$

$$I_1 = 12 \times 10^{-5} \text{ A}$$

$$\mathbf{I_1 = 1.2 \times 10^{-4} A}$$

**(b) $I_2$ = ?**

$$I_2 = \frac{V}{R_2}$$

$$I_2 = \frac{12}{1000}$$

$I_2 = 12 \times 10^{-3}$ A

$$\mathbf{I_2 = 1.2 \times 10^{-2}\ A}$$

**14.3. The resistance of a conductor wire is 10 MΩ. If a potential difference of 100 volts is applied across its ends, then find the value of current passing through it in mA.**

(LHR 15-I)

**Ans.** **Given Data:**

R = 10MΩ = 10 × 106Ω (∴ M = $10^6$)

*Potential difference* = V = 100*volt*

**To Find:**

Current = I = ?

**Solution:**

$$V = IR$$

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

$$I = \frac{100}{10 \times 10^6}$$

$$I = 10^{-5}\ A$$

$$I = 10^{-2} \times 10^{-3}\ A$$

($10^{-3}$ = milli)

$$I = 10^{-2} mA$$

$$\mathbf{I = 0.01mA}$$

**14.4. By appling a potential differenc of 10 V across a conductor, a current of 1.5 A passes through it. How much energy would be obtained from the currwent in 2 minutes?**

(SG, FB 15-I) (BP 15-II)

**Ans.** **Given Data:**

V = 120 Volt

I = 1.5 Amp

Time = t = 2 min = 2 × 60 = 120 sec

**To Find:**

Energy = W = ?

**Solution:**

$$W = I^2Rt$$

$$W = I(IR)t$$

$$W = I(V)t$$

$$W = (1.5)\ (10)\ (120)$$

$$\mathbf{W = 1800J}$$

**14.5. Two resistances of 2kΩ and 8kΩ are joined in series, if a 10V battery is connected across the ends of this combination, find following quantities.**

**(a) The equivalent resistance of the series combination.**

**(b) Current passing through each of the resistances.**

**(c) The potential difference across each resistance.**

**Ans. Given Data:**

$R_1 = 2k\Omega = 2 \times 10^3\Omega$

$R_2 = 8k\Omega = 8 \times 10^3\Omega$

$V = 10V$

**To Find:**

$R_e = ?$

$V_1 = ?$

$V_2 = ?$

$I = ?$

**Solution:**

$$R_e = R_1 + R_2$$

$$R_e = 2k\Omega + 8k\Omega$$

$$\mathbf{R_e = 10k\Omega}$$

As the circuit is in series so same value of current will pass through each resistance.

$$I = I_1 = I_2$$

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

By putting value

$$I = \frac{10}{10 \times 10^3}$$

$$I = 1 \times 10^{-3}A$$

$$\mathbf{I = 1mA}$$

Potential difference across first resistance = $V_1 = IR_1$

$$= 1 \times 10^{-3} \times 2 \times 10^3$$

$$\mathbf{V_1 = 2V}$$

Potential difference across around resistance = $V_2 = IR_2$

$$= 1 \times 10^{-3} \times 8 \times 10^3$$

$$\mathbf{V_2 = 8V}$$

**14.6. Two resistance of 6kΩ and 12kΩ are connected in parallel. A 16V battery is connected across it ends, find the values of the following quantities:**

**(a) Equivalent resistance of the parallel combination.**

**(b) Current passing through each of the resistance.**

**(c) Potential difference across each of the resistance.**

(DG, FB 15-I) (RWP, MN 15-II)

**Ans. Given Data:**

$R_1 = 6k\Omega = 6 \times 10^3\Omega$

$R_2 = 12k\Omega = 12 \times 10^3\Omega$

$V = 6V$

**To Find:**

$R_e = ?$

$I_1 = ?$

$I_2 = ?$

$V_1 = ?$

$V_2 = ?$

**Solution:**

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

$$\frac{1}{R_e} = \frac{1}{6} + \frac{1}{12}$$

$$\frac{1}{R_e} = \frac{2+1}{12}$$

$$\frac{1}{R_e} = \frac{3}{12}$$

$$\mathbf{R_e = 4k\Omega}$$

*Hence equivalent resistance is* 4kΩ.

**i.** As the circuit is parallel so potential difference across each resistance is equal to potential of battery.

$$\mathbf{V = V_1 = V_2 = 6V}$$

**ii.** Quantity of current through first resistance,

$$= I_1 = \frac{V_1}{R_1}$$

$$= \frac{6}{6\times10^3}$$

$$= 1 \times 10^{-3}$$

$$I_1 = 1mA$$

**iii.** Quantity of current through second resistance,

$$I_2 = \frac{V_2}{R_2}$$

$$= \frac{6}{12\times10^3}$$

$$= \frac{1}{2\times10^3}$$

$$= 0.5 \times 10^{-3}$$

$$I_2 = 0.5mA$$

**14.7. An electric bulb is marked with 220V, 100W. Find the resistance of the filament of the bulb. If the bulb is used 5 hours daily, find the energy in kilowatt-hour consumed by the bulb in one month (30 days).**
(DG 15-I)

**Ans. Given Data:**

Voltage of bulb = V = 220V
Power of bulb = P = 100W
Daily use of bulb = t = 5h
No. of days for bulb = 30 days

**To Find:**

Resistance of bulb filament = R = ?
Energy consumed by bulb = E = ?

**Solution:**

$$P = I^2R$$

But according to Ohm's law

$$(I = \frac{V}{R})$$

$$P = (\frac{V}{R})^2 \times R$$

$$P = \frac{V^2}{R^2} \times R$$

$$P = \frac{V^2}{R}$$

$$R = \frac{V^2}{P}$$

By putting values

$$R = \frac{(220)^2}{100}$$

$$R = \frac{48400}{100}$$

$$\mathbf{R = 484\Omega}$$

Time in 30 days = 30 × 5 = 150 hours

$$\text{Energy in kilowatt hour} = \frac{\text{power(watt)} \times \text{time(hour)}}{1000}$$

$$= \frac{150 \times 100}{1000}$$

$$\mathbf{= 15kWh}$$

**14.8. An incandescent light bulb with an operation resistance of 95Ω is labeled "150W." is this bulb designed for use in a 120-V circuit or a 220-V circuit? Explain with calculations.**

**Ans. <u>Given Data:</u>**

R = 95Ω

P = 150W

$V_1$ = 120volt

$V_2$ = 220volt

**<u>To Find:</u>**

V = ?

**<u>Solution:</u>**

We know that

$$P = \frac{V^2}{R}$$

$$V^2 = PR$$

$$V^2 = 150 \times 95$$

$$V^2 = 14250$$

**Taking square root on btoh sides.**

$$\sqrt{v^2} = \sqrt{14250}$$

**V = 120 volts**

*This bulb is designed for 120V.*

**14.9. A house is installed with.**

**(a) 10 bulbs of 60 W each of which are used 5 hours daily.**

**(b) 4 fans of 75 W each of which run 10 hours daily.**

**(c) One T.V. of 100W which is used for 5 hours daily.**

**(d) One electric iron of 1000W which is used for 2 hours daily.**

**If the cost of one unit of electricity is Rs. 4. Find the monthly expenditure of electricity (one month = 30 days).**

**Ans.** **Given Data:**

| | | |
|---|---|---|
| Power of 10 bulb | = 60W × 10 = 600W | t = 5h |
| Power of 4 fans | = 75W × 4 = 300W | t = 10h |
| Power of 1 iron | = 1000W × 1 = 1000W | t = 2h |
| Power of 1 T.V. | = 100W × 1 = 100W | t = 5h |
| One unit price | = 4Rs. | |

**To Find:**

Monthly cost of electricity of house = ?
(30 days)

**Solution:**

Energy consumed by bulb $= \frac{\text{power(watt)} \times \text{time(hour)}}{1000}$

$= \frac{600 \times 5 \times 30}{1000} = \frac{90000}{1000}$

$= 90$ units

Energy consumed by fans $= \frac{\text{power(watt)} \times \text{time(hour)}}{1000}$

$= \frac{300 \times 10 \times 30}{1000} = \frac{90000}{1000}$

$= 90$ units

Energy consumed by iron $= \frac{2 \times 1000 \times 30}{1000} = \frac{60000}{1000}$

$= 60$ units

Energy consumed by TV $= \frac{100 \times 5 \times 30}{1000} = \frac{15000}{1000}$

$= 15$ units

Total consumed energy in units = 90 + 90 + 60 + 15

= 255 units

Price of electricity = 255 × 4 = 1020Rs.

*Hence total price of electricity is 1020 rupees.*

**14.10. A 100W lamp bulb and a 4kW water heater are connected to a 250V supply. Calculate.**

**(a) The current which flows in each appliance and**

**(b) The resistance of each appliance when in use.**

**Ans. Given Data:**

Power = $P_1$ = 100W (lamp)

Power = $P_2$ = 4kW (heater)

$P_2 = 4 \times 10^3 W$

V = 250 V

To Find:

**(a)** $I_1$ = ?

$I_2$ = ?

**(b)** $R_1$ = ?

$R_2$ = ?

Solution:

**(a) Current in lamp: ($I_1$)**

$$P = VI$$

$$P_1 = VI_1$$

$$I_1 = \frac{P_1}{V_1}$$

$$I_1 = \frac{100}{250}$$

$$\mathbf{I_1 = 0.4A}$$

**Current in heater: ($I_2$)**

$$P_2 = VI_2$$

$$I_2 = \frac{P_2}{V}$$

$$I_2 = \frac{4\times10^3}{250}$$

$$I_2 = 0.016\times10^3 A$$

$$\mathbf{I_2 = 16A}$$

**(b) Resistance in Lamp: ($R_1$)**

$$V = IR$$

$$V = I_1R_1$$

$$250 = (0.4)R_1$$

$$\frac{250}{0.4} = R_1$$

$$625\Omega = R_1$$

$$\mathbf{R_1 = 625\Omega}$$

**Resistance in heater: ($R_2$)**

$$V = IR$$

$$V = I_2R_2$$

$$250 = 16(R_2)$$

$$\frac{250}{16} = \frac{4\times10^3}{250}$$

$$\mathbf{R_2 = 15.625\Omega}$$

**14.11. A resistor of resistance 5.6Ω is connected across a battery of 3.0V by means of wire of neglible resistance. A current of 0.5A passes through the resistor. Calculate the** (RWP 15-I) (LHR 15-II)

**(a) Power dissipated in the resistor.**

**(b) Total power produced by the battery.**

**Ans. <u>Given Data:</u>**

Resistance of resistor = 5.6Ω

Voltage of battery = V = 3.0 volts

Current = I = 0.5A

**<u>To Find:</u>**

**(a)** Power dissipation in the resistor = $P_1$ = ?

**(b)** Total power produced by the battery = $P_2$ = ?

**<u>Solution:</u>**

**(a)** Power dissipation through resistor = $P_1 = I^2R$

$$P_1 = (0.5)^2(5.6)$$

$$P_1 = (0.25)(5.6)$$

$$P_1 = 1.4W$$

**(b)** Total power produced by the battery = $P_2 = IV$

$$P_2 = (0.5)(3.0)$$

$$P_2 = 1.5W$$

***(c)*** **Give the reason of difference between these two quantities.**

**Ans.** *Some power is lost by internal resistance of the battery.*

❋ ❋ ❋ ❋ ❋ ❋ ❋ ❋ ❋ ❋

## ***Chapter # 15 (Electromagnetism)***

- **Choose the correct answer from the following choices:**

**i.** **Which statement is true about the magnetic poles?** (GW 14-I)

(a) unlike poles repel (b) like poles attract

(c) magnetic poles do not affect each other (d) a single magnetic pole does not exist

**ii.** **What is the direction of the magnetic field lines insdie a bar magnet?** (LHR 12-I)

(a) from north pole to south pole (b) from south pole to north pole

(c) from side to side (d) there are no magnetric field lines

**iii.** **The presence o fa magnetic field can be detected by a.**
(GW 13-I) (SG 14-II) (LHR 15-I) (RWP 15-II)

(a) small mass (b) stationary positive charge

(c) stationary negative charge (d) magnetic compass

**iv.** **If the current in wire which is placed peRWPendicular to a magnetic field increases, the force on the wire.** (LHR 14-II)

(a) increases (b) decreases

(c) remains the same (d) will be zero

**v.** **A.D.C. motor converts:**

(a) mechanical energy into electrical energy (b) mechanical energy into chemical energy

(c) electrical energy into mechanical energy (d) electrical energy into chemical energy

**vi.** **Which part of a D.C. motr reverse the direction of current through the coil every half-cycle?** (MN 14-I) (BP 14-II) (BP, FB 15-II)

(a) the armature (b) the commutator

(c) the brushes (d) the slip rings

**vii.** **The direction of induced e.m.f. in a circuit is in accordance with conservation of.**
(SG, W, RWP 14-I) (FB 14-II)

(a) mass (b) charge

(c) momentum (d) energy

**viii.** **The step-up transformer.** (FB 14-I) (SG 15-II)

(a) increases the input current (b) increases the input voltage

(c) has more turns in the primary (d) has less turns in the secondary

**ix. The turn ratios of a transformer is 10. It means.**

(GW, RWP 14-II) (DG 14-I) (RWP, GW, FB 15-I)

(a) $I_s = 10I_p$ (b) $N_s = \frac{N_p}{10}$

(c) $N_s = 10N_p$ (d) $V_s = \frac{V_p}{10}$

***ANSWER:***

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| **i.** | d. | **ii.** | b. | **iii.** | d. | **iv.** | a. | **v.** | c. |
| **vi.** | b. | **vii.** | d. | **viii.** | d. | **ix.** | c. | | |

# Review Questions

- **Write short answers of the following questions:**

**15.1. Demonstrate by an experiment that a magnetic field is produced around a straight current carrying conductor.** (FB 15-II)

Ans: **Experiment:** We take a straight conductor wire and pas it vertically through carboard and then connected the two ends with opposite battery terminals now current flows in clockwise direction. The lines of forces of the magnetic field produced around the wire would be in the form of concentric circles. If we place a compass needle at different points in the region of magnetic field, it will align along the direction of magnetic field. i.e. clock wise direction.

If we reverse the direction of the current by reversing the terminals of the battery, the compass needle also reverse its direction. The magnetic field lines will align in the anticlockwise direction.

**PTB PAGE # 119, FIG # 15.1 (a, b)**

**15.2. State and explain the rule by which the direction of the lines of the force of the magnetic field around a currnet carrying conductor can be determined?**

Ans: **Right hand grip rule:** Direction of the lines of force of magnetic field can be determined by right hand grip rule stated as follow:

**"***Grasp a wire with your right hand such that your thumb is pointed in the direction of current. Then curling fingers of your hand will point in the direction of the magnetic field.***"**

**PTB PAGE # 120, FIG # 15.2**

**15.3. You are given an unmarked magnetized steel bar and bar magnet, its north and south ends are marked N and S respectiverly. State how you you determine the polarity at each end of the unmarked bar?** (RWP 15-I)

Ans: When the north pople of marked bar magnet attracts the unmarked magnet this shows that there is a south pole on unmarked magnet and if magnets repel each other then there is a north pole.

**15.4. When a straight current carrying conductor is placed in a magnetic field, it experiences a force. State the rule by which the direction of this force can be found out?**

Ans: **Fleming's left hand rule:** The direction of the force on a current-carrying wire in a magnetic field can be found by using Fleming's left hand rule stated as:

Stretch the thumb, forfinger and the middle figner of the left hand mutually peRWPendicular to each other. *If the forefinger points in the direction of the magnetic field, the middle finger in the direction of the current, then the thumb would indicate the direction of the force acting on the conductor*.

**15.5. State that a current carrying coil in a magnetic field experiences a torque.** (GW 13-II)

Ans: Place a current carrying loop inside the magnetic field the loop will rotate due to the torque acting on the coil because when we placed the loop in magnetic field i.e. in North, pole and south and connected the end points of the loop with battery terminals. Now current flows through the loop and with the help of Fleming's left hand rule to each side of the coil. We can see force is actin upward on one side on other side forc acts downward thus this couple produces a torque.

**PTB PAGE # 12.3, FIG # 15.8**

**15.6. What is an electric motor? Explain the working principle of DC motor.**
(GW 12-II, 14-I) (LHR 13-II) (MN 15-I) (RWP 15-II)

Ans: **Electric motor:"***Electric motor is a device which converts electrical energy into mechanical energy*.**"**

**Working principle:***Current carrying coil in a magnetic field prduces torque. (electromagnetism)*

**Working of DC motor:** D.C. motor consists ofa rectangular coil PQSR mounted on a shaft or axle. Coil is placed in a field of permanent magnet or in a field which is produced by an electromagnet called *field of coil*.

When the coil of the motor is connectedto the battery, then current starts flowing through it. Simple coil cannot rotate more than $90^o$ and in vertical position no force acting on this loop so the loop will not continue to turn because both upward and ownward forces are balanced so if we change the direction of current with the help of commutator which is also connected to the brushes then this reversal of current will allow the coil to rotate continuously. In this way, electrical energy is converted itno mechanical energy.

**PTB PAGE # 124, FIG # 15.9**

**15.7. Describe a simple experiment to demonstratethat a changing magnetic field can induce e.m.f in a circuit.**

Ans: **Principle:***If we change the number of magnetic lines of force through a coil by moving it in the magnetic field, this will induce an e.m.f in the coil.*

**Experiment:** Take a bar magnet and a coil, due to relative motion of coil and bar magnet, current flows through the coil placed at different distances from the magnet.

**PTB PAGE # 126, FIG 15.12 (a, b)**

**15.8. What are the factors which affect the magnitude of the e.m.f induced in a circuit by a changing magnetic field?** (BP 15-I)

Ans: **Factors:** The magnitude of induced e.m.f in a circuit depends on the following factors:

**i.** Speed of relative motion of the coil and the magnet.

**ii.** Number of turns of the coil.

**15.9. Describe the direction of an induced e.m.f in a circuit. How does this phenomenon relate to conservation of energy?** (SG 15-II)

Ans: **Direction of induced e.m.f:"***The induced e.m.f is always opposite to the cause which produces it*.**"**

**Relation between e.m.f and conservation of energy:** When we put the wire loop in a magnetc field, work is done on the magnet to bring it close to coil. This work appears as electrical energy in the conductor. Hence, this phenomenon is manifestation of law of conservation of energy.

**15.10. Draw a labelled diagram to illustrate structure and working of AC generator.**

Ans:

**PTB PAGE # 129, FIG # 15.16**

**15.11. What do you understand by the term mutual induction?**
(LHR 12-II) (LHR, GW 13-I) (AK, RWP, LHR 14-I) (SG , GW, FB 15-I) (SG, RWP, BP, MN, FB 15-II)

Ans: **Mutual induction:"***The phenomenon of production of induced current in one coil due to change of current in a neighboring coil is called mutual induction*.**"**

**SI unit:** The SI unit of mutual induction is Henry.

**Henry:"***The mutual inductance of two coil is one henry if the current to changing at the rate of one ampere per second in primary coil produces an e.m.f of 1 volt in secondary coil*.**"**

**15.12. What is a transformer? Explain the working of transformer in connection with mutual induction.**

Ans: **Transformer:"***Transformer is an electrical device which is used to increase or decrease the value of alternating voltage*.**"**

**Working principle:** Transformer works on the principle of "*Mutual induction*."

**Working of a transformer:** A transformer has two coils, electrically insulated from each other, but wound around the same iron core. One coil is called the primary coil. The other coil is called the secondary coil. Number of turns on the primary and the secondary coils are represented by $\mathbf{N_p}$ and $\mathbf{N_s}$ respectively.

The e.m.f induced in the secondary coil, called the secondary voltage $\mathbf{V_s}$. The secondary voltage also depends on the ratio of the number of turns on the secondary coil to the number of turns on the primary coil, as shown by the following expression:

$$\frac{V_S}{V_P} = \frac{N_S}{N_P}$$

**15.13. The voltage chosen for the transmission of electric power over large distance is many times greater than the voltage of the domestic supply. State two reasons why electric power is transmitted at high voltage?**

Ans: Power is transmitted over long distances at high voltagers because:

**i.** To minimize the loss of energy in form of heat during transmission.

**ii.** This voltage is transmitted and further stepped down at main or city sub-stations.

**iii.** A high power transformer can reduce the voltage keeping power constant. That's why alternating voltage is tepped up at generating station.

**15.14. Why is the voltage used for the domestic supply much lower than the voltage at which the power is transmitted?**

Ans: The voltage used for domestic supply is much lower than voltage at generating station because required domestic voltage is 220V, but there is some loss of energy in form of heat during transmission. This power loss can be reduced by using high (Stepped-up) voltage at generating station.

## Conceptual Questions

**15.1. Suppose someone handed you three similar iron bars and told you one was not magnet, but the other two were. How would you find the iron ba that was not magnet?**

Ans: Similar poles of magnet repel each other while opposite poles attract each other. The non magnetic bar is not repelled by magnetic bar. But attract the no magnetic bar. The iron bar which is not repelled by magnetic bar is the non magnetic bar.

**15.2. Suppose you have a coil of wire and a bar magnet. Describe how you could use them to generate an electric current?**

Ans: By changing magnetic flux through coil we can generate electric current. Both coil and bar magnet move back and forth to change magnetic flux. This change of flux produces current in the coil.

**15.3. Which device is used for converting electrical energy into mechanical energy?**

Ans: D.C motor is used to convert electrical energy into mechanical energy.

**15.4. Suppose we hang a loop of wire so that it can swing easily. If we now put a magnet into the coil, the coil will start swinging. Which way will it swing relative to the magnet and why?**

Ans: When we put a bar magnet into the coil, the coil will starts swinging because when we put magnet into coil, the magnetic flux changes in the coil, so e.m.f is induced in the coil. The magnetic field produced by it, that opposes the motion of bar magnet. Direction is determined by Fleming's left hand rule.

**15.5. A conductor wire generates a voltage while moving through a magnetic field. In what direction should the wire be moved, relative to the field to generate the maximum voltage?**

Ans: When conductor wire is held perpendicular to direction of magnetic lines of force, maximum lines pass through it and hence maximum voltage is iduced. While minimum voltage is produced by placing conductor horizontally to magnetic field.

**15.6. What is the difference between a generator and motor?**
(DK 14-II) (LHR 14-II) (SG 14-I) (AK 14-II)

Ans:

| Generator | Motor |
|---|---|
| • **"***It is a device which is used to convert mechanical energy to electrical energy*.**"** | • **"***It is adevice which converts mechanical energy into electrical energy*.**"** |

**15.7. What areverses the direction of electric current in the armature coil of DC motor?**
(SW 14-I) (SG 14-I)

Ans: The direction of current is reversed in coil of DC motor with the help of split rigns (commutator).

**15.8. A wire lying peRWPendicular to an external magnetic field carries a current in the direction shiwn in the diagram in front. In what direction will the wire move due to resulting magnetic force?**

Ans: According to Fleming's left hand rule. It will move in downward direction.

**15.9. Can a transformer operate on direct current?**

Ans: No, the transformer does not operate on direct current. As transformer works on principle of mutual induction and mutual induction is shown alaways by alternating current.

# Important Formulas

- $\frac{N_S}{N_P} = \frac{V_S}{V_P}$
- $V_P I_P = V_S I_S$

# Numerical

**15.1. A transformer is needed to convert a mains 240V supply into a 12V supply. If there are 2000 turns on the primary coil, then find the number of turns on the secondary coil.**

(RWP, DG, FB 15-II)

**Ans. Given Data:**

$V_P = 240V$

$V_S = 12V$

$N_P = 2000$

**To Find:**

$N_S = ?$

**Solution:**

$$\frac{N_S}{N_P} = \frac{V_S}{V_P}$$

$$N_S = \frac{V_S \times N_P}{V_P}$$

$$N_S = \frac{12 \times 2000}{240}$$

$$N_S = 100$$

**$N_S$ = 100 turns**

**15.2. A step-up transformer has a turn ratio of 1:100. An alternating supply of 20V is connected across the primary coil. What is the secondary voltage?**

(BP 15-II)

**Ans. Given Data:**

For step up transformer,

$N_P : N_S = 1:100$

$$\frac{N_P}{N_S} = \frac{1}{100}$$

$V_P = 20V$

**To Find:**

$V_S = ?$

**Solution:**

$$\frac{V_S}{V_P} = \frac{N_S}{N_P}$$

$$V_S = \frac{N_S \times N_P}{N_P}$$

$$V_S = \frac{100}{1} \times 20$$

$$\mathbf{V_S = 2000V}$$

**15.3. A step-down transformer has a turns ratio of 100:1. An ac voltage of amplitude 170V is applied to the primary. If the current in the primary is 1.0mA, what is the current in the secondary?**

(LHR 15-I, II)

**Ans. Given Data:**

For step down transformer,

$N_S : N_P = 1:100$

$$\frac{N_S}{N_P} = \frac{1}{100}$$

$V_P = 170V$

$I_P = 1.0M = 1 \times 10^{-3}A$

**To Find:**

$I_S = ?$

**Solution:**

$$\frac{V_S}{V_P} = \frac{N_S}{N_P}$$

$$V_S = \frac{N_S}{N_P} \times V_P$$

$$V_S = \frac{1}{100} \times 170$$

$$V_S = 1.7V$$

**For ideal transformer**:

Power of primary coil = power of secondary coil

$$P_P = P_S$$

$$I_P V_P = I_S V_S$$

$$\frac{I_P V_P}{V_S} = I_S$$

$$\frac{1 \times 10^{-3} \times 170}{1.7} = I_S$$

$$\mathbf{I_S = 0.1A}$$

**15.4. A transformer, designed to convert the voltage from 240V A.C. main to 12V, has 4000 turns on the primary coil. How many trusn should be on the secondary coil? If the transformer were 100% efficient, what current would flow through the primary coil when the current in the secondary coil was 0.4A?**

**Ans. Given Data:**

$V_P = 240V$

$V_S = 12V$

$N_P = 4000$

$I_S = 0.4A$

**To Find:**

$N_S = ?$

$I_P = ?$

**Solution:**

$$\frac{N_S}{N_P} = \frac{V_S}{V_P}$$

$$N_S = \frac{V_S \times N_P}{V_P}$$

$$N_S = \frac{12 \times 4000}{240}$$

$$\mathbf{N_S = 200 \text{ turns}}$$

**For ideal transformer**:

$$P_P = P_S$$

$$I_P V_P = I_S V_S$$

$$I_P = \frac{I_S V_S}{V_P}$$

$$I_P = \frac{0.4 \times 12}{240}$$

$$\mathbf{I_P = 0.02A}$$

**15.5. A power station generates 500MW of a electrical power which is fed to a transmission line. What current would flow in the transmission line, if the input voltage is 250kV?**

(MN 15-II)

**Ans. Given Data:**

Power = $P = 500 \times 10^6 W$

$V = 250kV = 250 \times 10^3 V$

**To Find:**

I = ?

**Solution:**

$$P = VI$$

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

$$I = \frac{500 \times 10^6}{250 \times 10^3}$$

$$I = 2 \times 10^3 A$$

$$\mathbf{I = 2kA}$$

* * * * * * * * * * *

## *Chapter # 16 (Basic Electronics)*

- **Choose the correct answer from the following choices:**

**i.** **The puRWPose by which electrons are emitted by a hot metal surface is known as:** (RWP, MN 14-I) (SW, SG 14-II) (LHR 14) (FB 15-I) (SG, LHR 15-II)

(a) boiling (b) evaporation

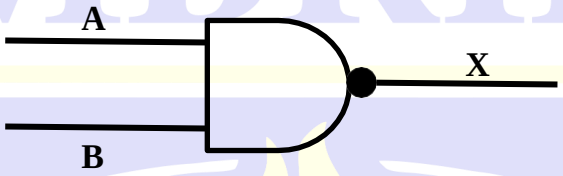
(c) conduction (d) thermionic emission

**ii.** **The particles emitted from a hot cathode surface are:** (RWP 14)

(a) positive ions (b) negative ions

(c) protons (d) electrons

**iii.** **The logical operation performed by this gate is:** (FB 14-I) (SW 14-II) (GW 15-I) (RWP, FB 15-II)




(a) AND (b) NOR

(c) NAND (d) OR

**iv.** **AND gate can be formed by using two:** (LHR 12-II) (GW 13-I, 15-II)

(a) NOT gates (b) OR gates

(c) NOR gates (d) NAND ggates

**v.** **The output of a two-input NOR gate is 1 when:** (RWP 14-II) (GW, BP 14-I)

(a) A is 1 and B is 0 (b) A is 0 and B is 1

(c) both A and B are 0 (d) both A and B are 1

**vi.** **If X = A.B, the X is 1 when:** (DG 14-I) (BP 15-II)

(a) A and B are 1 (b) A or B is 0

(c) A is 0 and B is 1 (d) A is 1 and B is 0

**vii. The output of a NAND gate is 0 when.**

(SW 14-I) (MN 15-I)

(a) both of its inputs are 0 (b) both of its inputs are 1

(c) any of its inputs is 0 (d) any of its inputs is 1

***ANSWER:***

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| **i.** | d. | **ii.** | d. | **iii.** | c. | **iv.** | d. | **v.** | c. |
| **vi.** | a. | **vii.** | b. | | | | | | |

# Review Questions

- **Write short answers of the following questions:**

**16.1. Describe, using one simple diagram in each case, what happends when a narrow beam of electrons ispassed through (a) a uniform electric field (b) a uniform magnetic field. What do thes results indicate about the charge on electron?**

Ans: **(a) Deflection of electrons by electric field:** When an electron beam passed between the two plates, it can be seen that the electrons are deflected towards the positive plate. The degree of deflection of electron from their original direction is proportriona lto the strength of the electric field applied.

**PTB PAGE # 141, FIG # 16.2**

**(b) Deflection of electrons by magnetic field:** Now we apply magnetic field at right angle to the bema of electrons by using a horseshoe magnet. We will notice that the sport of the electrons beam on the screen is getting deflected from its original direction.

**PTB PAGE # 141, FIG # 16.3**

**16.2. Explain the working of different parts of oscilloscope.**

(RWP 14-I) (AK 14-II) (SG, LHR 15-I) (DG, RWP 15-II)

Ans: The cathode-ray oscilloscope (C.R.O) consists of the following components:

**Components:**

**i.** The electron gun **ii.** The deflection plates

**iii.** A fluorescent screen

**The electron gun:** Produces a beam of ast moving electrons with the help of filament, grid and set of anodes.

**The deflection plates:** After leaving the electron gun, the electron beam passes between a pair of horizontal plates. A potential difference applied between these plates eflects the beam in a vertical plane.

**The fluorescent screen:** The screen of a cathode-ray tube consists of a thin layer of phosphor, which is a material that gives light as a result of bombardment by fast moving electrons.

**16.3. Name some uses of oscilloscope.** (RWP, BP 15-I)

Ans: **Uses of oscilloscope:**

**i.** Oscilloscope is ued for displaying wave form.

**ii.** Measurign voltages.

**iii.** Ragne finding (In Radar).

**iv.** Echo (by sound find the depth of sea).

**v.** In medical instrument i.e. show heart beat.

**16.4. Considering and oscilloscope explain:** (RWP, AK, LHR 14-I) (RWP 14-II) (GW 15-I)

**(a) How the filament is heated?**

**(b) Why the filament is heated?**

**(c) Why the anode potential is kept positive with respect to the cathode potential?Why a large potential is applied between anode and cathode?**

**(d) Why the tube is evacuated?**

Ans: **i.** Filament is heated electrically by a battery (6V supply).

**ii.** By heating filament a fine beam of electrons is obtained.

**iii.** The anode potential is kept positive w.r.t cathode to attract the electrons emitted from cathode.

**iv.** To accelerate the electrons emitted from heated filament positive potential of anode is used. In this way the electrons are focused into a fine beam as they pass through anode.

**v.** Ionization of gases present in tube occurs due to high voltage applied acorss tube so it must be evacuated.

**16.5. What is electron gun? Describe the process of thermionic emission.** (GW, RWP 15-I) (SG, FB 15-II)

Ans: **Electron gun:** The electron gun consists of an electron source which is an electrically heated cathode that ejects electrons.

**Process:** Electron gun also has an electrode called grid G for controlling the flow of electron in the beam. The grid is connected to a negative potential. The more negative this potential, the more electrons will be repelled from the grid. The negative potential of the grid can be used as brightness control. The anode is connected to positive potential

and hence is used to accelerate the electrons. The electrons are focused into a fine beam as they pass through the anode.

**16.6. What do yo understand by digital and analogue quantities?**
(GW 12-I) (RWP, SG, DG 14-I) (MN, LHR 15-I)

Ans:

| Analogue Quantities | Digital Quantities |
|---|---|
| **"***The quantities whose values vary continuously are called analogue quantities.***"** | **"***The quantities whose vaslue vary in non continuous manner are called digital electronics.***"** |
| **Examples:** Temeprature, time, pressure etc. | **Examples:** Radar system, digital watches, digital telephones. |

**16.7. Differentiate between analogue electronic and digital electronic. Write down the names of five analogue and five digital devices that are commonly used in everyday life.**
(LHR 13-II) (SW, GW 14-I, II) (DG, FB 14-I) (BP 14-II) (BP, GW, FB 15-I) (SG , BP, GW, FB, LHR 15-II)

Ans:

| Analogue Electroncis | Digital Electronics |
|---|---|
| **"***The branch of electronic which deals with analogue quantities is called analogue electronics.***"** | **"***The branch of electronic which deals with digital quantities is called digital electronics.***"** |
| **Devices:** Radio, Amplifier, loudspeakers, Microphone, Television. | **Devices:** Computers, Radar system, Modern CD and DVD players. |

**16.8. State and explain for each case whether the information given by the following devices is in analogue or a digital form.**

**(a) A moving coil voltmeter measuring the e.m.f of a cell.**
**(b) A microphone generating an electric current.**
**(c) A central heating thermostat controlling the water pump.**
**(d) Automatic traffic lights controlling the flow of traffic.**

Ans: (a) Provides an information in the ofmrof analogue form.
(b) In the form of analogue form.

(c) In the form of analogue signal.

(d) On the asis of digital quantities.

**16.9. Write down some benefits of using digital electronics over analogue electronics.**

Ans: **Advantages of digital electronics:**

**i.** The big advantage of digital electronic is quality.

**ii.** There is no interference or loss of strength in digital signal travelling in an optical fibre.

**iii.** Digital technology in TV gives excellent view and allow you to be interactive.

**iv.** Smart ID cars are beign developed. Passport, national insurancecard and driving license, all of this data would be held digital in the tiny chip.

**v.** Now, today everything is going digital like digital cameras are fast replacing traditional film equipment.

**16.10. What are the three universal logic gates? Give their symbols and truth tables.** (MN 15-I) (RWP, MN, FB 15-II)

Ans: **"**The circuit which implements the AND operation is known as AND gate.**"**

**PTB PAGE # 147, FIG # 16.9**

**"**The electronic circuit which implements the OR operation is known as OR gate.**"**

**PTB PAGE # 148, FIG # 16.11**

**"**NOT gate performs the basic logical function called inversion or complementation.**"**

**PTB PAGE # 149, FIG # 16.13**

# Conceptual Questions

**16.1. Name two factors which can enhance thermionic emission.** (RWP 14-II) (FB 15-I)

Ans: **Factors:** The two factors which can enhance thermionic emission are:

**i.** By increasing temperature of Filament.

**ii.** By increasing voltage.

**16.2. Give three reasons to support the evidence that cathode rays are negatively charged electrons.**

Ans: **Reasons:**

**i.** They deflected towards positive terminal when pass through electric field.

**ii.** While passing from nagetic field they bend towards the North pole.

**iii.** Cathode rays have reducing effect and cause chemical change, which shows theyare negatively charged.

**16.3. When electrosn pass through two parallel plates having opposite charges, they are deflected towards the positiverly charged plate. What important characteristic of the electron can be inferred from this?**

Ans: Electrons are deflected towards positive plate, it means that hey are negatively charged particles.

**16.4. When a moving electron enters the magnetic field, it is deflected from its straight path. Name two factors which can enhance electron deflection.**

Ans: **Factors:** The factors which enhance the electron deflection are:

**i.** By increasing strength of magnetic field.

**ii.** By increasing the strength of electric field.

**16.5. How can you compare the logic operation X = A.B with usual operation of the multiplication?**

Ans: According to the truth table of ANDgate operation (X=A.B) it is clear that (X=A.B) behave as multiplicative inverse. Every time the result is zero when multiplied with Boolean variable. So, logic operation X=A.B act as operation of multiplication.

| **Truth Table** | | |
|---|---|---|
| **A** | **B** | **X = A.B** |
| 0 | 0 | 0 |
| 0 | 1 | 0 |
| 1 | 0 | 0 |
| 1 | 1 | 1 |

**16.6. NAND gate is the reciprocal of AND gate. Discuss** (SG, MN 14-II)

Ans: NAND gate is the reciprocal of AND gate as in NAND gate the values of AND gates are inverted by NOT gate $X = \overline{AB}$

**16.7. Show that the circuit given belwo acts OR gate.**

**PAGE # 154**

Ans: $X = A + B$

But after NOR operation

$X = \overline{A+B}$

Again after NOT operation

$X = \overline{\overline{A+B}}$

$\overline{\overline{A+B}} = A + b$

Now see the table of this case as:

| **A** | **B** | **X = A + B** | **$X = \overline{AB}$** | **$\overline{\overline{A+B}}$** |
|---|---|---|---|---|
| 1 | 1 | 1 | 0 | 1 |

| | | | | |
|---|---|---|---|---|
| 0 | 0 | 0 | 1 | 0 |
| 1 | 0 | 1 | 0 | 1 |
| 0 | 1 | 1 | 0 | 1 |

**16.8. Show that the circuit given below acts as AND gate.**

**PAGE # 154**

Ans: In this circuit two NOT operations are working as inputs terminals of NOR gate. From the following table it is clear that this circuit acts as AND gate:

| A | B | $\bar{A}$ | $\bar{B}$ | $\overline{A+B}$ | $\overline{\overline{A}+\overline{B}}$ |
|---|---|---|---|---|---|
| 0 | 0 | 1 | 1 | 1 | 0 |
| 0 | 1 | 1 | 0 | 1 | 0 |
| 1 | 0 | 0 | 1 | 1 | 0 |
| 1 | 1 | 0 | 0 | 0 | 1 |



## *Chapter # 17 (Information and Communication Technology)*

- **Choose the correct answer from the following choices:**

**i. In computer terminology information means:**
(LHR, GW 14-II) (MN, SG 14-I) (LHR 15-I) (MN, FB 15-II)

(a) any data (b) raw data
(c) processed data (d) large data

**ii. Which is the most suitable means of reliable continuous communication between an orbiting satellite and Earth?** (BP 14-I) (BP, SG 15-I)

(a) microwaves (b) radio waves
(c) sound waves (d) any light wave

**iii. The basic operations performed by a computer are:** (MN 14-I) (FB 15-I)

(a) arithmetic operations (b) non-arithmetic operations
(c) logical operations (d) both a and c

**iv. The brain of any computer system is:**

(SW 14-I) (SG, SW 14-II) (BP, RWP, MN 15-I) (BP, FB 15-II)

(a) monitor (b) memory
(c) CPU (d) control unit

**v. Which of the following is not processing?** (FB 14-II) (FB, GW 14-I) (GW 15-I) (MN 15-II)

(a) arranging (b) manipulating
(c) calculating (d) gathering

**vi. From which of the following you can get information almost about everything?** (GW 14-I) (FB, LHR 15-I)

(a) book (b) teacher
(c) computer (d) internet

**vii. What does the term e-mail stand for?** (LHR, SW, DG 14-I) (BP 14-II) (RWP 15-I) (BP 15-II)

(a) emergency mail (b) electronic mail
(c) extra mail (d) external mail

***ANSWER:***

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| **i.** | c. | **ii.** | a. | **iii.** | d. | **iv.** | c. | **v.** | c. |
| **vi.** | d. | **vii.** | b. | | | | | | |

## Review Questions

- **Write short answers of the following questions:**

**17.1. What is the difference between data and information?** (SG 15-I) (FB 15-I, II)

Ans: **Data:**"*Data is the collection of acts and figues that are used by programs to produce useful information.*"

**Information:**"*Computer processes data and converts it into useful information. Data after process is called information.*"

**17.2. What do you understand by information and Communication Technology (ICT)?** (DG, BP, LHR 15-I) (RWP 15-II)

Ans: **Information and Communication Technology:** Information and Communication Technology is defined as the scientific methods and means to store, process and transmit vast amounts of information in seconds weith the help of electronic equipments.

**17.3. What are the components of information technology" clearly indicate the function of each component.** (AK 14-I) (FB 14-II)

Ans: Components of Information Technology:

**Hardware:** The term hardware refers to machinery. This includes the central processing unit (CPU) and all of its support equipments.

**Software:** The term software refers to computer programmes and the manuals that support them.

**Data:**Data are facts and figures that are used by programs to produce useful information.

**Procedures:**These are set of instruction and rules to design and use information system. These are written in manulas and documents for use.

**People:**Every CBIS needs people if it is to be useful, who influence the success or failure of information systems. People design and operate the software, they feed input data.

**17.4. Differentiate between primary memory and secondary memory.**
(SG 14-II) (FB 15-I, II) (MN 15-II)

Ans:

| Primary memory | Secondary memory |
|---|---|
| **1.** *The main memory of computer is called primary memory*. | **1.** *The secondary level memory of computer is secondary memory*. |
| **2.** It is used in computer as temporary memory. | **2.** It is used to store data permanently incomputer. |
| **3.** It vanishes when computer is switched off. | **3.** When we open a program, data is moved from secondary storage into primary storage. |
| **4.** RAM is primary memory. | **4.** The secondary storage devices are audio-video, casettes, hard disk. |

**17.5. Name different iformation storage devices and describe their uses. (RWP 15-II)**

Ans: **Information storage devices:**

**Primary memory:** It is based on electronics and consists of integrated circuits (ICs). Random access memory (RAM), is used in comuter as temporary memory. RAM vanishes when the computer is switched off.

**Secondary storage devices:** The data storage devices are generally the secondary memory of the computer. It is used to store the data permanently in the computer.

**Audio and video casettes:** These devices are based on magnetism, audio cassettes consists of a tape of magnetic material on which sound is recorded in a marticular pattern of a magnetic field.

**Magnetic disks:** There are different types of magnetic disk coated with a layer of some magnetic material. The read / write head of disks are similar to the record replay head on a tape recorder. It magnetizes parts of the surface to record information.

**Hard disk:** Most users rely on hard disks ars their primary storage devices. *A hard disk is a rigid, magnetically sensitive disk theat spins rapidly and continuously inside the computer chassis* or in a separate box connected to the computer housing.

**Compact disc (CDs):** This is based on laser technology. It is a molded plastic disc on which digital data is stored in the form of microscopic reflecting and non-reflecting spots which are called "pits" and "lands" respectively.

**Flash drive:** It is also an electronic based device and consists of data storage ICs. *A flash drive is a small storage device that can be used to transport files from one computer to another.*

**17.6. Explain briefly the transmission of radio waves through space?** (GW 15-I,II) (RWP 15-I)

Ans: **Transmission of radio waves through space:** Information in the form of audio frqucny (AF) signals may be transmitted directly by cable. However, in order to send information over a long distance, it has to be superimposed on electromagnetic waves. The transmission by radio waves consists in two parts i.e radio station and receiver.

In radio station sound waves changed itno electromagnetic waves and through in space and receiver receive these signals through space and convert into again sound waves.

**PTB PAGE # 159, 160, FIG # 17.4**

**17.7. How light signals are sent through optical fibre?**

Ans: **Light signals through optical fibre:** Waves of visible light have a much higher frequency than that of radiowaves. This means, rate of sending information with light beams is larger than that with radiowaves or microwaves. An optical fibre has been used as transmission channlel for this puRWPose. An optical fibre with a coating of lower refractive index is a thin strand of high-quality glass that absorbs very little light.

*Light that eneers the core at one end of the optical fibre goes straight and hits the inner wall (the cladding) of fibre optics. If the angle of incidence with cladding is less than the critical angle, some of the light will escape the fibre optics and is lost.*

**17.8. What is computer? What is the role of computer in everyday life?**
(LHR, GW 12-I) (DG, BP, RWP, LHR 14-I, II) (DG 15-II)

Ans: **Computer:***Computer is machine that can be programmed to accept the data (input) process it (processing) to give useful information (output) and store it (storage) for future.*

**i.** Computer work through an instruction of hardware and software.

**Use of computer in everyday life:**

**i.** Computer is used in offices for preparing letters, documents and reports.

**ii.** In hotels, computers are used for advance booking of rooms, preparing bills and providing enquiry service.

**iii.** In railways, computer are used for rail reservation, printing of tickets and preparatiosn of reservation charts.

**iv.** In medical field, doctors use comuter for diagnosing illness and treatment of diseases.

**v.** An architect engineer use computer for building designing and city planning.

**vi.** In meteorology department, computrs are used for weather forecasting.

**17.9. What is the difference between hardware and software? Name different softwares.** (GW 15-I, II) (RWP, MN 15-I)

Ans: **Hardware:"***The term hardware refers a machinery (physically existence).***"** This includes the central processing unit (CPU), and all of its supporting equipments.

**Examples:** CPU, monitor, mouse, printer.

**Software:"***The term software refers to computer programs and the manuals that support them.***"**

**Examples:** Microsoft window, Microsoft Excel, Microsoftg word.

**17.10. What do understand by the term word processing and data managing?** (GW 12-II) (GW, LHR 13-II) (DG, MN, FB 14-II) (MN, LHR 15-II) (BP 15-I) (FB 15-I, II)

Ans: **Word processing:"***Word procssign is such a use of computers through which we can write a letter, article book or prepare a report.***"**

**Data managing:"***To collect all information regarding a subject for any puRWPose more than one inter linked files which may help when needed is called data managing.***"**

**17.11. What is internet? Internet is a useful source of knowledge and information. Discuss.** (LHR 12-I) (GW 13-15-II) (BP 15-I) (SG 15-I, II)

Ans: **Internet:"***Internet is a system inw which many computer networks all over the world are connected together to communicate with each other through communication medium.***"**

**OR**

The internet is the interconnection of millions of computers.

**Importance of internet:** In internet, millions of computers remain connected together through well laid communication system. Thus like a telephone system any computer of any city ca n establish a connection with any other computer of any other city and exchange data or message with it. It is essential that every educated person becomes familiar with computer. The ability to use computer is basic and necessary to a person's formal education as reading, writing and arithmetic. The internet is connection of millions computers all over the world. So, people exchange information and knowledge at international level.

**17.12. Discuss the role of information technology in school education.** (GW, LHR 12-I) (MN 15-II)

Ans: **Role of IT in education:** The role of IT in school education cannot be ignored. In fact, use of computer in school education has made it easier for teachers to impart knowledge

and for students to acquire it. Today teachers are using multimedia in classrooms to make the teaching and learning process more effective. The use of audio-video visuals in class roomteaching invites greatest interests for students.

## Conceptual Questions

**17.1. Why optical fibre is more useful tool for the communication process?** (SG 14-I)

Ans: In optical fibre data transferred in form of light waves. So, very large amount of data can be sent over long distances without aanty interruption on othr hand. Copper cables are interrupted by large data, long distance and noise etc.

**17.2. Which is more reliable floppy disk or hard disk?** (GW 12-15-I) (SG, GW 14-I)

Ans:

| Hard Disk | Floppy Disk |
|---|---|
| **1.** Hard disk can hold hundreds or thousands of megabytes of information. | **1.** Flopy disk can hod 3 megabytes. |
| **2.** It can store data for long term. | **2.** It can store data for short term. |
| **3.** Data can be transferred quickly. | **3.** Data cannot be transferred quickly. |

**17.3. What is the difference between RAM and ROM memories?** (RWP 14-I) (MN 15-II)

Ans:

| RAM | ROM |
|---|---|
| **1.** RAM stands for *Random Access Memory*. | **1.** Rom stands for *Read Only Memory*. |
| **2.** It is main memory of computer and vanishes when the computer is switched. | **2.** This memory is permanent and does not vanish when omputer is switched off. |
| **3.** It is *primary memory*. | **3.** It is *secondary memory*. |

## ***Chapter # 18 (Atomic and Nuclear physics)***

- **Choose the correct answer from the following choices:**

**i. Isotopes are atoms of same elemnt with different:** (BP 14-II) (MN 14-I) (GW 15-II)

(a) atomic mass

(b) atomic number

(c) number of protons (d) number of electrons

**ii. One of the isotopes of uranium is $^{238}_{92}U$. The number ofneutrons in the isotope is:** (GW 14-I)

(a) 92 (b) 146

(c) 238 (d) 330

**iii. Which among the following radiations has more penetrating power? (SW 14-II)**

(a) a beta particle (b) a gamma ray

(c) an alpha particle (d) all have the same penetrating ability

**iv. What happens to the atomic number of an element which emits one alpha particle?** (SG 14-II)

(a) increases by 1 (b) stays the same

(c) decreases by 2 (d) decreases by 1

**v. The half-life of a certain isotope is 1 day. What is the quantity of theisotope after 2 days?**

(a) one half (b) one quarter

(c) one eighth (d) none of these

**vi. When Uranium (92 protons) ejects a beta particle, how many protons are left in the remaining nucleus?**

(a) 93 protons (b) 91 protons

(c) 90 protons (d) 89 protons

**vii. Release of energy by the sun is due to:** (SG 14-II) (SW 14-I) (BP 15-I) (FB 15-II)

(a) nuclear fission (b) nuclear fusion

(c) burning of gases (d) chemical reaction

**viii. When a heavy nucleus splits into two ligher nuclei, the process would:**

(a) release nuclear energy (b) absorb nuclear energy

(c) release chemical energy (d) absorb chemical energy

**ix. The reason of carondating work is that.**

(a) plants and animals are such strong emitters of carbon-14

(b) after a plant or animals dies, it stops taking in fresh carbon-14

(c) there is so much non-radioactive carbon dioxide in the air

(d) when a plnat or an animal die, they absorb fresh carbon-14

***ANSWER:***

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| **i.** | a. | **ii.** | b. | **iii.** | b. | **iv.** | c. | **v.** | b. |
| **vi.** | a. | **vii.** | b. | **viii.** | a. | **ix.** | b. | | |

# Review Questions

- **Write short answers of the following questions:**

**18.1. What is difference between atomic number and atomic mass number? Give a symbolical representation of a nuclide.**
(GW 12-II) (GW 13-II) (SW 14-I, II) (LHR, RWP 14-II) (DG, GW 15-II)

Ans:

| Atomic number | Mass number |
|---|---|
| **1.** *The number of protons insde the nucleus is called the atomic number.* | **1.** *The sum of protons and neutrons present inside the nucleus of anatom is called its atomic mass nmber.* |
| **2.** Atomic number depends upon the number of protons or electron of an atom. | **2.** Atomic mass number dependsd upon the number of neutrons. |
| **3.** Atomic number is represented by **Z**. | **3.** It is representd by **'A'** which is written as: **A = Z + N** |
| **4.** It is written at the bottom left side of the symbol of an element. e.g. ${}_{2}^{4}He$. | **4.** It is written at the top left side of the symbol of an element. e.g. ${}_{2}^{4}He$. |

Symbolical representation of nuclide is ${}_{Z}^{A}X$.
For example, hydrogen atom is represented like ${}_{1}^{1}H$.

**18.2. What do you mean by the term radioactivity? Why some elements are radioactive but some are not?** (LHR 13-15-I) (SG 15-II)

Ans: **Radioactivity:"***The spontaneous emission of radiation by unstable nuclei is called natural radioactivity*.**"**
**Radioactive elements:"***The elements which emit such radiations are called radioactive elements*." e.g uranium, polonium and radium etc. the element whose atomic number is less than 82, does not emit such radiations because they are stable.

**18.3. How can you make radioactive elements artificially? Describe with a suitable example.** (GW 13-II) (DG 15-I)

Ans: The process in which bombardment of protons and neutrons on the stable nuclei makes it radioactive element which is also called artificial radioactivity.
When an element whose atomic number is less than 82 is bombarded with protons or neutrons, it starts emitting radiations.
e.g. ${}_{0}^{1}n + {}_{11}^{23}Na \rightarrow {}_{11}^{24}Na$ + gamma ($\gamma$)

**18.4. What are the three basic radioactive decay processes and how do they differ from each other?**

Ans: There are three basic radioactive decay proceses and they differ by change in the atomic number and mass number.

**(a) Alpha ($\alpha$) – decay**

| | | | | |
|---|---|---|---|---|
| ${}^{A}_{Z}X$ | → | ${}^{A-4}_{Z-2}Y$ | + | ${}^{4}_{2}He$ + Energy |
| parent nuclide | | daughter nuclide | | alpha ($\alpha$) - particle |

**Example:**

| | | | | |
|---|---|---|---|---|
| ${}^{226}_{88}Ra$ | → | ${}^{222}_{86}Rn$ | + | ${}^{4}_{2}He$ + Energy |
| radium | | radon | | |

It mean in alpha decay, the proton number or **atomic number Z** of the parent nuclide reduces by **2** and its **mass number** or nucleon number **A** decreases by **4**.

**(b) Beta (Q) – decay**

| | | | | |
|---|---|---|---|---|
| ${}^{A}_{Z}X$ | → | ${}^{A}_{Z+1}Y$ | + | ${}^{0}_{-1}e$ + Energy |
| Parent Nuclide | | daughter nuclide | | beta ($\beta$) - particle |

**Example:**

| | | | | |
|---|---|---|---|---|
| ${}^{14}_{6}C$ | → | ${}^{14}_{7}N$ | + | ${}^{0}_{-1}e$ + Energy |
| carbon | | nitrogen | | beta ($\beta$) – particle |

It beta ($\beta$)-decay, **proton number Z** increases by **1** but its **mass number** remains **unchanged**.

**(c) Gamma () – decay**

**General equation:**

| | | | | |
|---|---|---|---|---|
| ${}^{A}_{Z}X$ | → | ${}^{A}_{Z}X$ | + | ($\gamma$) |
| parent nuclide | | daughter nuclide | | gamma rays |

($\gamma$)-rays are usually emitted at the same moment as either an alpha or a beta particle.

**18.5. Write the alpha decay process for ${}^{234}_{91}Pa$. Identify the parented draught nuclei in this decay.**

Ans: Alpha decay rocess of protactinium:

The decay process is given as:

| | | | | |
|---|---|---|---|---|
| ${}^{234}_{91}Pa$ | → | ${}^{230}_{89}AC$ | + | ${}^{4}_{2}He$ |
| protactinium | | actinium | | $\alpha$ – particles |

In this decay, $^{234}_{91}Pa$ is parent nuclei while $^{231}_{89}Ac$ is daughter nuclei.

**18.6. Explain whether the atomic number can increase during nuclear decay. Support your answer with an example.**

Ans: Yes, during $\beta$–decat process, the daughter nuclei has its atomic number increased by 1.

**Examples:**

$$^{A}_{Z}X \rightarrow {}^{A}_{Z+1}Y + {}^{0}_{-1}e + \text{Energy}$$

$$^{14}_{6}C \rightarrow {}^{14}_{7}N + {}^{0}_{-1}e + \text{Energy}$$

**18.7. What do you understand by half-life of a radioactive element?** (GW 13-II) (RWP 14-I, II) (FB 14-II) (SG 15-I) (MN 15-II)

Ans: **Half life:** "The time during which half of the unstable radioactive nuclei disintegrate is called the half life of the sample of radioactive element."

The process of radioactivity is random and the rate of radioactive decay is proportional to the number of unstable radioactive nuclei decays in a certain time.

**18.8. Is radioactivity a spontaneous process? Elaborate your answer with a simple experiment.**

Ans: Yes, radioactivity is a spontaneous process because such elements having atomic number more than 82 are unstable. These elements emit radiations naturally. That's why radioactivity is a spontaneous process.

In radioactive decay an unstable parent nuclide X changes itno a daughter nuclides Y with the emission of alpha ($\alpha$), beta ($\beta$) and Gamma ($\gamma$) particles.

$$^{14}_{6}C \rightarrow {}^{14}_{7}N + {}^{0}_{-1}e + \text{Energy}$$

$\beta$-particle

$$^{A}_{Z}X \rightarrow {}^{A}_{Z}X + (\gamma)$$

$\gamma$-particle

**18.9. What is meant by background radiations? Enlist some sources of background radiations.** (MN 15-I) (BP, GW, FB 15-II)

Ans: **Background radiations:"***Radiations present in atmosphere due to different radioactive substances are called background radiations.***"**

**Sources:** Everywhere in rocks, soil, water and air of our planet (Earth) there are traces of radioactive elements. They emit the radiation every time, this natural radioactivity is called the background radiation.

**18.10. Describe two uses of radioisotopes in medicine, industry or research.**

(LHR 13-I) (SW 14-I) (BP, SG, FB, LHR 15-I)

Ans: **In medicine:**

**i.** Radio Iodine -131 is used in curing cancer of thyroid gland.

**ii.** P – 32 is used to diagnose the brain tumors.

**In industry:**

**i.** To locate the wear and tear of the moving parts of machinery.

**ii.** For the location of leaks in underground pipes.

**In agriculture:**

**i.** P – 32, to find how well the plants are absorbing fertilizer.

**18.11. What are two common radiation hazards? Briefly describe the precautions that are taken against them.** (MN 15-I) (BP, SG, LHR 15-I, II)

Ans: **Radiation hazards:**

**i.** Radiation burns, mainly due to beta and gamma radiations, which may cause redness and sores on the skin.

**ii.** Sterility (i.e. inability to produce children)

**iii.** Genetic mutations in both human and plants. Some children are born with serious deformities.

**Precautions to minimize radiation dangers:**

**i.** The sources should ony handled with tongs and forceps.

**ii.** The user should use rubber gloves and hands should be washed carefully after the experiment.

**iii.** All radioactive sources should be stored in thick lead containers.

**18.12. Complete this nuclear reaction: $^{235}_{92}U \rightarrow ^{140}_{54}X + ? + ^{1}_{0}n$. Does this raeaction involve fission or fusion? Justify your answer.**

Ans: $^{235}_{92}U \rightarrow ^{140}_{54}X + ? + ^{1}_{0}n$

It isa fission reaction because a heavy nucleus splites into smaller nuclei with neutrons.

**18.13. Nuclear fusion reaction is more reliable and sustainable source of energy than nuclear fission chain reaction. Justify this statement with plausible arguments.**

Ans: Nuclear fission is more reliable tan nuclear fission.

**i.** Nuclear waste doesn't produce.

**ii.** Small nuclei combine to form heavy and large nucleus with the evolution of large amount of heat.

**18.14. A nitrogen nuclide $^{16}_{7}N$decay to become an oxygen nuclide by emitting an electron. Show this process with an equation.**

Ans: $^{14}_{7}N \rightarrow {}^{14}_{8}O + {}^{0}_{-1}\beta$

**18.15. Determine which of these radioactive decay process are possible:**

**(a)** $^{214}_{84}Po \rightarrow {}^{214}_{84}Po + {}^{4}_{2}He$

**(b)** $^{230}_{90}Th \rightarrow {}^{226}_{88}Ra + {}^{4}_{2}He$

**(c)** $^{233}_{91}Pa \rightarrow {}^{233}_{92}U + {}^{0}_{-1}\beta$

**(d)** $^{14}_{6}C \rightarrow {}^{14}_{7}N + {}^{0}_{-1}\beta$

Ans: (a) $^{214}_{84}Po \rightarrow {}^{214}_{84}Po + {}^{4}_{2}He$ Not possible

(b) $^{230}_{90}Th \rightarrow {}^{226}_{88}Ra + {}^{4}_{2}He$ Possible

(c) $^{233}_{91}Pa \rightarrow {}^{233}_{92}U + {}^{0}_{-1}\beta$ Possible

(d) $^{14}_{6}C \rightarrow {}^{14}_{7}N + {}^{0}_{-1}\beta$ Not possible

# Conceptual Questions

**18.1. Is it possible for an element to have different types of atoms? Explain.**

Ans: Yes, it is possible as from the definition of isotopes the elemtn could have same atomic number but different atomic mass. Hydrogen has three isotopes.

Protium $^{1}_{1}H$, Deutrium $^{2}_{1}H$, Tritium $^{3}_{1}H$

**18.2. What nuclear reaction would release more energy, the fission reaction or the fuision reaction? Explain.**

Ans: The fusion reaction release large amount of energy because two hydrogen atoms combine to form a single helium atom with 25.7MeV of energy and neutrons.

$$^{2}_{1}H + {}^{3}_{1}H \rightarrow {}^{4}_{3}He + {}^{1}_{0}n + \text{energy}$$

To conduct fusion reaction, fission reaction provides energy.

**18.3. Which has more penetrating power, alpha particle or gamma ray photon?** (LHR 15-II)

Ans: Gamma rays has more penetrating power, due to negligible ionization in materials, that is why beta particles have range of several metres in air. On the other hand, alpha particles have high mass and more ionizaing power, therefore, its range is only a few centimetres in air.

**18.4. What is the differenc between natural and artificial radioactivity?**
(MN, GW 14-I) (DG, AK, FB 14-II) (RWP 15-I)

Ans: **Natural radioactivity:**"*The spontaneous emission of radiation by unstable unclei (having atomic no. more than 82) is called natural radioactivity*."

**Artificaial radioactivity:**"*The emission of radiations by stable nuclei (atomic no. 82 or less than 82) with bombardment of neutrons is called artificial radioactivity*."

**18.5. How long would you likely have to wait to watch any sample of radioactive atoms completely decay?**

Ans: None of elements can ever decay completely. It depends upon the half life of radioactive element.

**18.6. Which type of natural radioactivity leaves the number of protons and the number of neutrons in the nucleus unchanged?**

Ans: Gamma decay is atype of natural radioactivity which leaves the number of protons and the number neutrons in the nucleus unchanged.

**General equation:**

$$\underset{\text{Parent nuclide}}{{}^{A}_{Z}X} \rightarrow \underset{\text{Daughter nuclide}}{{}^{A}_{Z}X} + \underset{\text{Gamma rays}}{\gamma}$$

**Examples:**

$$\underset{\text{Cobat}}{{}^{60}_{27}C_0} \rightarrow \underset{\text{Cobat}}{{}^{60}_{27}C_0} + \underset{\text{Gamma rays}}{{}^{0}_{0}\gamma} + \text{energy}$$

**18.7. How much of a 1g sample of pure radioactive matter would be left undecayed after four half lives?**

Ans: We know that

Half life formula = $\frac{1}{2^t}$

T = 4

Remaining quantity = $(\frac{1}{2})^4 \times 1g$

$= \frac{1}{16} \times 1g$

**Remaining quantity = 0.0625gm**

One gram of sample after four half liveswill be 0.0625g.

**18.8. Tritium, ${}^{3}_{1}H$ is radioactive isotope of hydrogen. It decays by emitting an electron. What is the daughter nucleus?**

Ans: **General equation:** ${}^{A}_{Z}H \rightarrow {}^{A}_{Z+1}Y + {}^{0}_{-1}e$ + Energy

**Equation for Tritium:** ${}^{3}_{1}H \rightarrow {}^{3}_{1+1}X + {}^{0}_{-1}e$ + Energy

Daughter nuclei is an isotope of helium ${}^{3}_{2}He$.

**18.9. What information about the structure of the nitrogen atom can be obtained from its nuclide ${}^{14}_{7}N$? In what way atom in ${}^{14}_{7}N$ is different from the atom in ${}^{14}_{7}N$?**

Ans: Nuclide of nitrogen = ${}^{14}_{7}N$

**Structure:**

Electrons = 7
Protons = 7
Neutrons = 7

Secondly, $^{14}_{7}N$ is different from $^{16}_{7}N$ due to different number of neutron. In $^{16}_{7}N$ the number of neutrons are nine, but no. of neutrons are same i.e. 7.

# Important Formulas

- No. of half life $= \frac{\text{Total time}}{\text{Half life}}$

  $n = \frac{T}{T_{1/2}}$

- Remaining quantity $= \frac{1}{2^n} \times N_0$

# Numerical

**18.1. The half life of $^{16}_{7}N$ is 7.3s. A sample of this nuclide of nitrogen is observed for 29.2s. Calculate the fraction of the original radioactive isotope remaining after this time.**

(GW 15-I)

**Ans. Given Data:**

Time half life = $T_{½}$ = 7.3s

t = 29.2 sec

**To Find:**

Original sample = $N_o$ = ?

**Solution:**

$$\text{No. of half life} = \frac{\text{time}}{\text{half life}}$$

$$= \frac{29.2}{7.3}$$

No. of $T_{½}$= 4

$$\text{Remaining quantity of nitrogen} = \frac{1}{2^t} \times N_o$$

$$= \frac{1}{2^4} \times N_o$$

$$= \frac{1}{16} \times N_o$$

So, after 29.2 sec, $\frac{1}{16^{th}}$ part of original sample is left.

**18.2. Cobalt-60 is a radioactive element with half life of 5.25years. What fraction of the original sample will be left after 26 years?**

(BP, FB 15-II)

**Ans. Given Data:**

Half life = $T_{½}$ = 5.25 years

t = 26 years

**To Find:**

$N_o$ = ?

**Solution:**

Let original sample = $N_o$

Remaining sample = N

$$\text{No. of half life} = \frac{\text{time}}{\text{half life}}$$

$$= \frac{26}{5.25}$$

$$\text{No. of half life} = 5$$

$$\text{Remaining quantity} = \frac{1}{2^t} \times N_o$$

$$= \frac{1}{2^5} \times N_o$$

$$\text{Remaining quantity} = \frac{1}{32} \times N_o$$

**18.3. Carbon-14 has half life 5730 years. How long will it take for the quantity of carbon-14 in a sample to drop to one-eighth of the initial quantity?**

(SG, RWP 15-II)

**Ans. Given Data:**

Half life of C-14 = $T_{½}$ = 5730 years

Original sample = $N_o$

Remaining sample = $N = \frac{N_o}{8}$

**To Find:**

Time T = ?

**Solution:**

$$N = N_o \times \frac{1}{2^n}$$

$$\frac{1}{8} = \frac{1}{2^n}$$

$$\frac{1}{2^3} = \frac{1}{2^n}$$

$$n = 3$$

After 3rd half life, $\frac{1}{8^{th}}$ part of initial carbon-14 will be:

$$T = 3T_{½}$$
$$= 3 \times 5730$$
$$= 17190$$

**$T = 1.7 \times 10^4$ years**

**18.4. Technetium-99m is radioactive element and is used to diagnose brain, thyroid, liver and kidney disease. This element has half life of 6 hours. If there is 200 mg of his technetium present, how much will be left in 36 hours?**

**Ans. Given Data:**

Half life = $T_{½}$ = 6 hours

t = 36 hours

$N_o$ = 200mg

**To Find:**

N = ?

**Solution:**

$$\text{No. of half life} = \frac{\text{time}}{\text{half life}}$$

$$= \frac{36}{6}$$

$$n = 6$$

$$N = N_o \times \frac{1}{2^n}$$

$$N = 200 \times \frac{1}{2^n}$$

$$N = \frac{200}{64}$$

**N = 3.125mg**

**18.5. Half life of a radioactive elemtn is 10 minutes. If the initial count rate is 368 counts per minute, find the time for which count rate reached 23 counts per minute.** (DG 15-I) (GW 15-II)

**Ans. Given Data:**

$T_{½}$ = 10 min

Initial count rate = 368 per minute

**To Find:**

Time T = ?

**Solution:**

$$368 \rightarrow 184 \rightarrow 92 \rightarrow 46 \rightarrow 23$$

As clear, it takes 4 half lifes for count rate decreases from 368 to 23 per min so,

Time taken = No. of half life × half life

$= 4 \times 10$

**Time taken = 40 min**

**18.6. In an experiment to measure the half life of a radioactive element, the following results were obtained:**

| **Count rate/ minute** | **400** | **200** | **100** | **50** | **25** |
|---|---|---|---|---|---|
| **Time (in minutes)** | **0** | **2** | **4** | **6** | **8** |

**Plot a graph between the count rates and time in minutes. Measure the value for the half life of the elemtn from the graph.**

**Ans. Graph between time and count rate:**

**Figure**

After two successive half life, let 'A' point which is (n = 2).

Total time = No. of half life × half life

$4 = n \times T_{½}$

$4 = 2 \times T_{½}$

$T_{½} = \frac{4}{2}$

**$T_{½}$ = 2min (half life is 2 min).**

**18.7. A sample of certain radioactive element has a half life of 1500 years. If it has an activity of 32000 counts per hour at the present time then plot a graph of the activity of this sample over the period in which it will reduce to 1/16 of its present value.**

**Ans. Given Data:**

Half life = $T_{½}$ = 1500 year

Initial count per hour = $A_o$ = 32000

Remaining $\frac{1}{16}$ of initial count rate = A = $\frac{32000}{16}$

$$A = A_o \times \frac{1}{2^n}$$

$$\frac{32000}{16} = 32000 \times \frac{1}{2^n}$$

$$\frac{1}{16} = \frac{1}{2^n}$$

$$\frac{1}{2^4} = \frac{1}{2^n}$$

**n = 4**

**8.8. Half-life of a radioactive element was found to be 4000 years. The count rates per minute for 8 successive hodurs were found to be 270, 280, 300, 30, 285, 290, 305, 312. What does the variation in count rates show? Plot a graph between the count rates and time in hours. Why the graph is a straight line rather than an exponential?**

**Ans.** *Variation in count rate shows the random nature of radioactive decay, graph is almost horizontal line, rather than exponential curvewhich is due to logn half-life as compared to period of 8 hours.*

**18.9. Ashes from a campfire deep in a cave show carbon-14 activity of only one-eighth the activity of fresh wood. How long ago was that campfire made?** (DG 15-I)

**Ans.** **Given Data:**

Original sample = No

Remaining sample = $N = \frac{N_o}{8}$

**To Find:**

Time T = ?

**Solution:**

$$N = N_o \times \frac{1}{2}$$

$$\frac{N_o}{8} = \frac{N_o}{2^n}$$

$$\frac{1}{8} = \frac{1}{2^n}$$

Total time = No. of half life × half life

$$T = nT_{½}$$

$$= 3 \times 5730$$

**Total time = 17190 years**

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