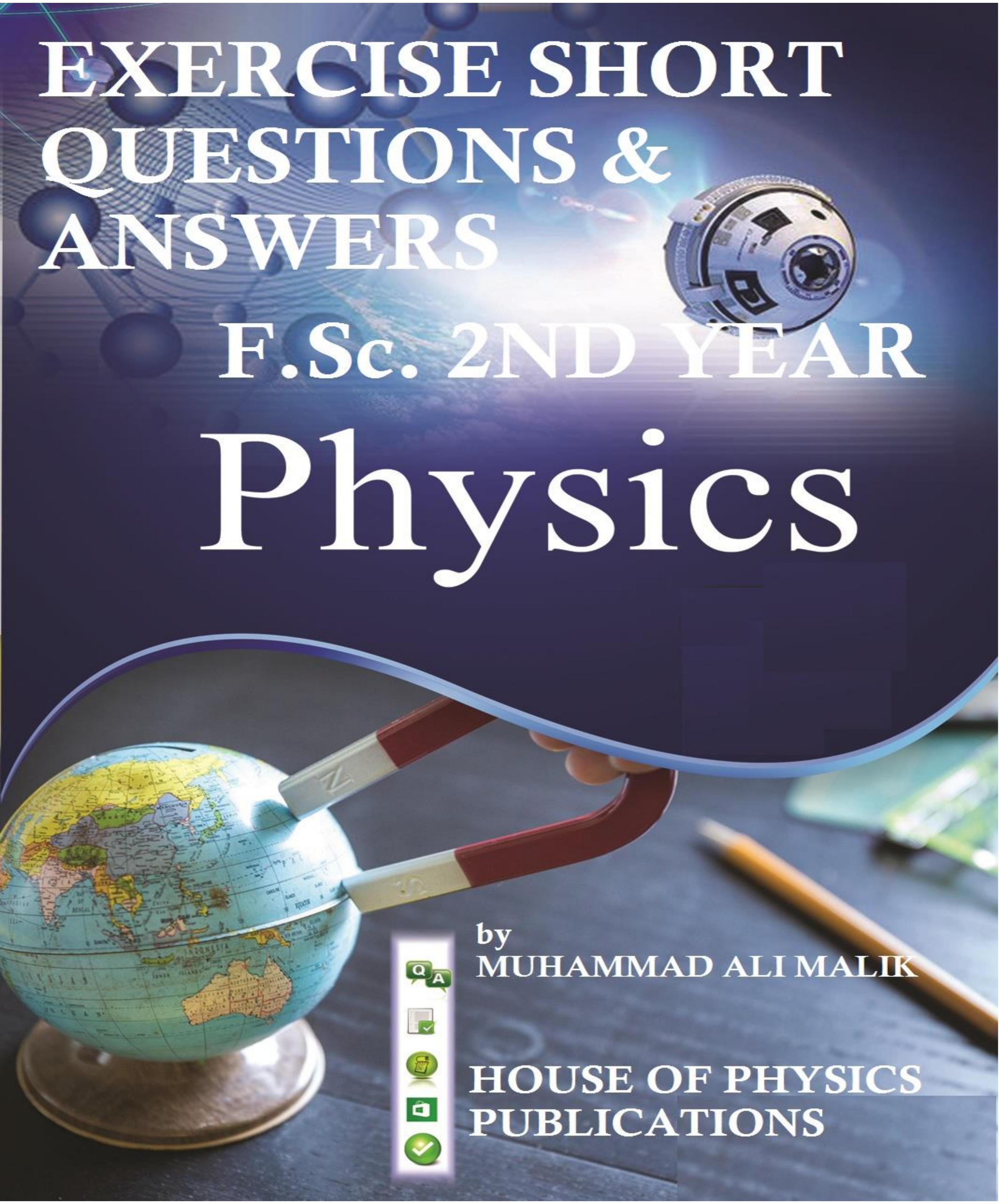
EXERCISE SHORT QUESTIONS & ANSWERS
F.Sc. 2ND YEAR
Physics
by
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HOUSE OF PHYSICS PUBLICATIONS

EXERCISE SHORT QUESTIONS

CHAPTER # 12: ELECTROSTATICS

Q # 1. The potential is constant throughout a given region of space. Is the electric field zero or non zero in this region? Explain.

Ans. The electric field intensity is described by the relation:

$$E = -\frac{\Delta V}{\Delta \mathrm{r}}$$

According to the relation, the electric field is negative gradient of electric potential. If the electric potential is constant throughout given region of space, then change in electric potential $\Delta V = 0$, hence $E = 0$.

Q # 2. Suppose that you follow an electric field line due to a positive point charge. Do electric field and the potential increases or decreases.

Ans. If we follow an electric field line due to a positive point charge, then it means that we are moving await from point charge. Thus the distance from the charge increases. Due to increase of distance from positive charge, both electric field intensity and electric potential decreases as:

$$E \propto \frac{1}{r^2} \text{ and } V \propto \frac{1}{r}$$

Q # 3. How can you identify that which plate of capacitor is positively charged?

Ans. The presence of charge on a body is detected by a device called gold leaf electroscope. The leaves of gold leaf electroscope are diverged by giving them negative charge.

- If the disc is touched with any plate of the charged capacitor and the divergence of the leaves increases, the plate of capacitor is negatively charged
- If the divergence of leaves decreases, then that plate of capacitor is positively charged.

Q # 4. Describe the force or forces on a positive point charge when placed between parallel plates:

i. **With similar and equal charges**
ii. **With opposite and equal charges**

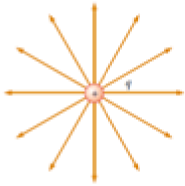
Ans. When a positive point charge is placed between parallel plates with similar and equal charges, then the electric field intensity due to one plate is equal in magnitude but opposite in direction of electric intensity due to other plate. So the value of resultant electric field intensity E is zero. Hence the net force on the positive point charge is zero. Thus it will remain at rest.

When a positive point charge is placed between parallel plates with opposite but equal amount of charge, then electric field intensity due to one plate is equal in magnitude but in same direction of the electric field intensity due to other plate. So the value of resultant electric field intensity is non zero. Hence the point charge will be accelerated towards negative plate.

Q # 5. Electric lines of force never cross. Why?

Electric lines of force never cross each other. This is because of the reason that electric field intensity has only one direction at any given pint. If the lines cross, electric intensity could have more than one direction which is physically not correct.

Q # 6. If a point charge of mass m is released in a non-uniform electric field with field lines in the same direction pointing, will it make a rectilinear motion.



Ans. A non-uniform field of a positive point charge is shown in the figure:

If a point charge q of mass m is placed at any point in the field, it will follow straight or rectilinear path along the field line due to repulsive force.

Q # 7. Is E necessarily zero inside a charged rubber balloon if the balloon is spherical. Assume that charge is distributed uniformly over the surface.

Ans. Yes, E is necessarily zero inside a charged rubber balloon if balloon is spherical. If the Gaussian surface is imagined inside charged balloon, then it does not contain any charge i.e., q=0.

Applying Gausses law:

$$\Phi_e = \frac{q}{\varepsilon_0} = 0 \quad \text{----------} \quad (1)$$

Also, $\Phi_e = E.A$ ----------- (2)

Comparing (1) and (2), we have:

$$E.A = 0$$

As $A \neq 0$, therefore, $E = 0$

Hence electric field intensity will be zero inside a spherical balloon.

Q # 8. Is it true that Gauss's law states that the total number of lines of force crossing any closed surface in the outward direction is proportional to the net positive charge enclosed within surface?

Ans. Yes, the above statement is true.

Electric flux is defined as the measure of number of electric lines of force passing through a certain area. According to Gauss's law, the flux through any close surface is $\frac{1}{\varepsilon_0}$ times the total charged enclosed in it.

Electric flux = $\frac{1}{\varepsilon_0}$ (Total Charge Enclosed)

Electric flux = constant (Total Charge Enclosed)

Electric flux $\propto$ (Total Charge Enclosed)

Q # 9. Do electrons tends to go to region of high potential or of low potential?

Ans. The electrons being negatively charge particle when released in electric field moves from a region of lower potential (negative end) to a region of high potential (positive end).

EXERCISE SHORT QUESTIONS

CHAPTER # 13: CURRENT ELECTRICITY

Q # 1. A potential difference is applied across the ends of a copper wire. What is the effect on the drift velocity of free electrons by

i. **Increasing the potential difference**

ii. **Decreasing the length and the temperature of the wire.**

Ans. The drift velocity V_d of electrons in a conductor is described by the formula:

$$V_d = \frac{\Delta V}{ne\rho L}$$

Where ΔV is the potential difference between the ends of conductor, L is the length of conductor and ρ is the resistivity of wire. From equation, it is clear that

i. Drift velocity of electron increases with increase in potential difference

ii. Drift velocity of electron also increases by decreasing the length and temperature of wire.

Q # 2. Do bends in a wire affect its electrical resistance? Explain.

Ans. The resistance of the conductor is described by the formula:

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

Where L is the length and A is the cross-section area of conductor. ρ the electrical resistivity of the material which depends upon the nature of conductor.

Hence the resistance of conductor depends upon the geometry and nature of conductor. Hence the bends in conducting wires don't affect its electrical resistance.

Q # 3. What are the resistances of the resistors given in the figure A and B. What is the tolerance of each? Explain what is meant by the tolerance.

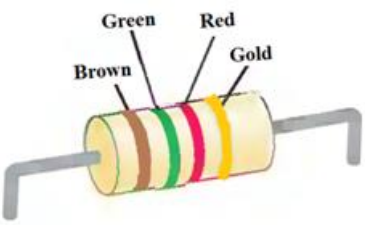


Fig. A

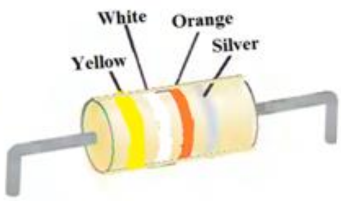


Fig. B

For figure A. The color codes for figure A are as follows: Brown 1 (First Digit) Green 5 (Second Digit) Red 2 (Number of Zero) Therefore Resistance = 1500 Ω And Tolerance = T = 5%	For figure B. The color codes for figure B are as follows: Yellow 4 (First Digit) White 9 (Second Digit) Orange 3 (Number of Zero) Therefore Resistance = 49000 Ω And Tolerance = T = 10%

Tolerance:

Tolerance means the possible variation in the value of resistance from the marked value. For example, a 1000 Ω resistance with a tolerance of 10% can have an actual resistance between 900 Ω and 1100 Ω.

Q # 4. Why does the resistance of conductor rise with temperature?

Ans. The resistance offered by a conductor to the flow of electric current is due to collisions which the free electrons encounter with atoms of the lattice. As the temperature of the conductor rises, the amplitude of vibration of atoms increases and hence the probability of their collision with free electrons also increases which result increase of resistance of conductor.

Q # 5. What are the difficulties in testing whether the filament of a lighted bulb obeys ohm's law?

Ans. Ohm's law states that the current flowing through the conductor is directly proportional to the potential difference applied across its ends provided that the temperature of the conductor remains constant. In case of a lighted bulb, the temperature of the filament increases with the passage of current through it. Hence the Ohm's law can't be applied to filament bulb.

Thus the main difficulty in testing whether the filament of a lighted bulb obeys ohm's law is the change in temperature with the flow of current in it.

Q # 6. Is the filament resistance lower or higher in a 500 W, 220 V bulb than in a 100 W, 220 V bulb?

Ans. We know that

$$P = \frac{V^2}{R} \Longrightarrow R = \frac{V^2}{P}$$

The resistance of filament of 500 W, 220 V bulb is:

$$R = \frac{V^2}{P} = \frac{(220)^2}{500} = 98.6\ \Omega$$

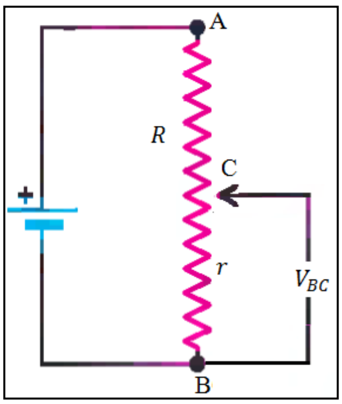
The resistance of filament of 100 W, 220 V bulb is:

$$R = \frac{V^2}{P} = \frac{(220)^2}{100} = 484\ \Omega$$

It is clear that the filament resistance is lowered in a 500 W, 220 V bulb than 100 W, 220 V bulb.

Q # 7. Describe a circuit which will give a continuously varying potential.

Ans. To use rheostat as potential divider, potential difference V is applied across the fixed ends A and B of rheostat with the help of a battery. If R is the resistance of the wire AB, the current I passing through is given by:



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

The potential difference between the portion BC of the wire AB is given by:

$$V_{BC} = current\ \times resistance$$

$$V_{BC} = \frac{V}{R} \times r = \frac{r}{R} V$$

Where r is the resistance of the portion BC of wire. The equation shows that this circuit can provide potential difference at output terminal varying from zero to the full potential difference of the battery depending on the position of sliding contact.

Q # 8. Explain why the terminal potential difference of a battery decreases when current drawn from it is increases.

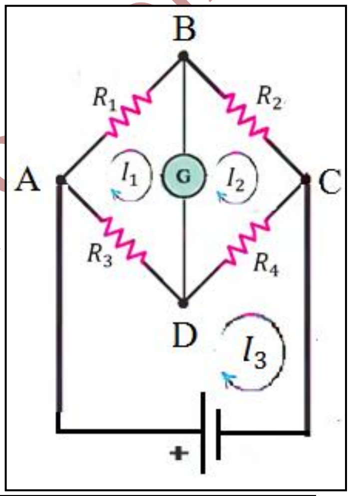
Ans. The terminal potential difference V_t of the battery of emf ε is described by the formula:

$$V_t = \varepsilon - Ir$$

Where r is the internal resistance of the battery and I is the current flowing through outer circuit.

It is clear from equation that when I is large, the factor Ir becomes large and V_t becomes small. Hence terminal potential difference of a battery decreases when current drawn from it is increased.

Q # 9. What is Wheatstone bridge? How can it be used to determine an unknown resistance?



Ans. It is an electrical circuit which can be used to find the unknown resistance of a wire. The circuit of Wheatstone bridge is shown in the figure.

It consist of four resistance connected in the form of a mesh, galvanometer, battery and a switch. When the bridge is balanced, it satisfies the following relation:

$$\frac{R_1}{R_2} = \frac{R_3}{R_4} \Longrightarrow R_4 = \frac{R_2 \times R_3}{R_1}$$

If the values of R_1, R_2, R_3 are known, then R_4 can be calculated, provided the bridge is balanced.

EXERCISE SHORT QUESTIONS

CHAPTER # 14: ELECTROMAGNETISM

Q # 1. A plane conducting loop is located in a uniform magnetic field that is directed along the x-axis. For what orientations of the loop, is the flux maximum? For what orientation, is the flux minimum?

Ans. The magnetic flux through a conducting loop can be find out by the expression:

$$\Delta\varphi = \mathbf{B}.\mathbf{A} = BA\cos\theta$$

Here **B** is the magnetic field strength and A is vector area whose direction is perpendicular to the plane of the loop.

Case 1. When vector area of the conducting loop is in the direction of magnetic field strength i.e., $\theta = 0°$, then the magnetic flux:

$$\Delta\varphi = \mathbf{B}.\mathbf{A} = BA\cos 0° = BA \qquad \text{as } \cos 0° = 1$$

Thus the magnetic flux through the coil is maximum, when the vector area of the conducting loop is parallel to magnetic field strength.

Case 2. When vector area of the conducting loop is perpendicular to magnetic field strength i.e., $\theta = 90°$, then the magnetic flux:

$$\Delta\varphi = \mathbf{B}.\mathbf{A} = BA\cos 90° = BA \qquad \text{as } \cos 90° = 0$$

Thus the magnetic flux through the coil is minimum, when the vector area of the conducting loop is perpendicular to magnetic field strength.

Q # 2. A current in a conductor produce a magnetic field, which can be calculated using Ampere's Law. Since current is defined as the rate of flow of charge. What can you conclude about the magnetic field due to stationary charges? What about moving charges?

Ans. A stationary charges cannot produce any magnetic field. In case of stationary charges, the rate of flow of charges is zero(i.e. current = 0), so there will be no magnetic field.

As the moving charges produce current, so the magnetic field produced around the path of its motion similar to the magnetic field produced around a current carrying conductor.

Q # 3. Describe the charge in the magnetic field inside a solenoid carrying steady current I, if (a) the length of the solenoid is doubled but the number of turns remains the same and (b) the number of turns are doubled, but the length remains the same.

Ans. The magnetic field strength **B** inside a current carrying conductor can be find out by the expression:

$$B = \frac{\mu_0 NI}{L}$$

where I is the current flowing through conductor and N is the number of turn of solenoid having length L. Thus

(a) When Length of solenoid is doubled by keeping the number of turns constant, then magnetic field strength: $B' = \frac{\mu_0 NI}{2L} \Longrightarrow B' = \frac{B}{2}$

Thus on doubling the length of solenoid by keeping the turns constant, the magnetic field strength becomes one half of its original value.

(b) When number of turns of solenoid is doubled by keeping the length of solenoid constant, then magnetic field strength:

$$B'' = \frac{\mu_0(2N)I}{L} \Longrightarrow B'' = 2B$$

Thus on doubling the number of turns of solenoid by keeping its length constant, the magnetic field strength becomes doubled of its original value.

Q # 4. At a given instant, a proton moves in the positive x-direction in the region where there is magnetic field in the negative z-direction. What is the direction of the magnetic force? Will the proton continue to move in the positive x-direction? Explain.

Ans. As the proton is moving in the positive x-direction and magnetic field is directed into the plane of paper, then the magnetic force on proton can be find out using expression:

$$\mathbf{F} = q(\mathbf{v} \times \mathbf{B})$$

According to right hand rule, the magnetic force is directed along y-axis.

No, the proton will not continue to move in the positive x-direction. Since the magnetic force is acting at the right angle to motion of conductor, therefore it will move along a circular path in xy-plane.

Q # 5. Two charged particles are projected into a region where there is a magnetic field perpendicular to their velocities. If the charge are deflected in opposite directions, what can you say about them?

Ans. When a charge particle is projected in a magnetic field, it will experience the magnetic force given by:

$$\mathbf{F} = q(\mathbf{v} \times \mathbf{B})$$

The magnetic force is a deflecting force. Thus if the charged particles are deflected in opposite direction, then particles are oppositely charged. i.e., one particle is positively charged and the other is negatively charged.

Q # 6. Suppose that a charge q is moving in a uniform magnetic field with a velocity v. Why is there no work done by the magnetic force that acts on the charge?

Ans. The magnetic force on a charge particle will act normal to the direction of motion of the particle, so the work done by the force is given by:

$$W = \mathbf{F}.\mathbf{d} = Fd\cos\theta$$

Where θ is the angle between the magnetic force and displacement of charge particle. For present case: $\theta = 90°$. Therefore:

$$W = Fd\cos 90° = 0$$

Thus we can say that magnetic force is a deflecting force and it cannot do any work.

Q # 7. If a charge particle moves in a straight line through some region of space, can you say that the magnetic field in the region is zero.

Ans. The magnitude of magnetic force on a charge particle can be expressed as:

$$F = qvB\sin\theta$$

Where θ is the angle between **B** and **v**. So if the particle moves in a straight line through some region of space then it means that the charge particle is not experiencing magnetic force which might be due to one of the following reasons:

- **i.** Magnetic field strength B in the region is zero
- **ii.** Magnetic field is parallel or anti-parallel to the direction of motion.

Q # 8. Why does the picture on a TV screen become distorted when a magnet is brought near the screen?

Ans. The picture on a TV is formed when moving electrons strike the florescent screen. As magnet is brought close to the TV screen, the path of electrons is distorted due to the magnetic force on them. So the picture on the screen of TV is distorted.

Q # 9. Is it possible to orient a current loop in a uniform magnetic field such that the loop will not tend to rotate? Explain.

Ans. A current carrying loop when placed in magnetic field will experience a torque given by:

$$\tau = BINA\cos\alpha$$

Where B is the magnetic field strength, I is current flowing through coil, N is number of turns in a coil, A is the area of the coil and α is the angle between plane of the coil and magnetic field.

It is clear from expression that when plane of the coil makes and angle of 90° with magnetic field, the torque on the coil will be zero. In this condition, the coil will not tend to rotate.

Q # 10. How can a current loop be used to determine the presence of a magnetic field in a given region of space?

Ans. When a current carrying loop is placed in a uniform magnetic field, a torque is produced in the loop is given by:

$$\tau = BINA\cos\alpha$$

If the loop is deflected in a given region, then it confirms the presence of magnetic field, otherwise not.

Q # 11. How can you use a magnetic field to separate isotopes of chemical element?

Ans. If the ions of isotopes of an element are projected in a magnetic field of known strength B, the ions move in circular path of radius r. The e/m of the ion is given by the expression:

$$\frac{e}{m} = \frac{v}{Br} \Longrightarrow r = \frac{v}{B} \times \frac{m}{e}$$

If v, B and e of the ions are constant, then

$$r \propto m$$

So the ions of different mass will have different radii of curvature and hence they can be separated in magnetic field.

Q # 12. What should be the orientation of a current carrying coil in a magnetic field so that torque acting upon the coil is (a) maximum (b) minimum?

Ans. A current carrying loop when placed in magnetic field will experience a torque given by:

$$\tau = BINA\cos\alpha$$

Where B is the magnetic field strength, I is current flowing through coil, N is number of turns in a coil, A is the area of the coil and α is the angle between plane of the coil and magnetic field.

(a) When plane of the coil is parallel to magnetic field, $\alpha = 0$ and the torque acting on the coil will be maximum given by: $\tau = BINA\cos 0° = BINA$

(b) When plane of the coil is perpendicular to magnetic field, $\alpha = 90°$ and the torque acting on the coil will be minimum, given by: $\tau = BINA\cos 90° = 0$.

Q # 13. A loop of wire is suspended between the pools of a magnet with its plane parallel to the pole faces. What happens if a direct current is put through the coil? What happens if an alternating current is used instead?

Ans. As the plane of the coil is parallel to the pole faces, therefore, it is perpendicular to the magnetic field, i.e. α = 90°. Torque acting on coil $\tau = BINA\cos 90° = 0$**.** Therefore, for both A.C. and D.C., the coil will not rotate.

Q # 14. Why the resistance of an ammeter should be very low?

Ans. An ammeter is connected in series with a circuit to measure the current. It is connected in series so that total current passing through the circuit should pass through it. If the resistance of the ammeter will be large, it will alter the current of the circuit to great extent and the measurement of current will not be accurate.

Q # 15. Why the voltmeter should have a very high resistance?

Ans. A voltmeter is connected in parallel to the resistor to measure potential difference across it. It should have very high resistance so that practically, a very little current should pass through it and the current of the circuit should almost remain constant, so that it might measure the potential difference across a resistor accurately.

EXERCISE SHORT QUESTIONS

CHAPTER # 15: ELECTROMAGNETIC INDUCTION

Q # 1. Does the inducted emf in circuit depend on the resistance of the circuit? Does the induced current depend on the resistance of the circuit?

Ans. The expression for induced emf is given by

$$\boldsymbol{\varepsilon = -N\frac{\Delta\phi}{\Delta t}}$$

The relation shows that the induced emf in a coil only depend upon the rate of change of magnetic flux and number of turns but does not depend upon the resistance of the coil.

As the induced current flowing through a coil is given by:

$$I = \frac{\varepsilon}{R}$$

this expression shows that the value of current depends upon the resistance of the coil. The smaller the value of the resistance of the coil, greater will he the value of current.

Q # 2. A square loop of wire is moving through a uniform magnetic field. The normal to the loop is oriented parallel to the magnetic field. Is a emf induced in the loop? Give a reason for your answer.

Ans. The induce emf in a wire is given by:

$$\varepsilon = vBL\sin\theta$$

Where θ the angle between "v" and "B".

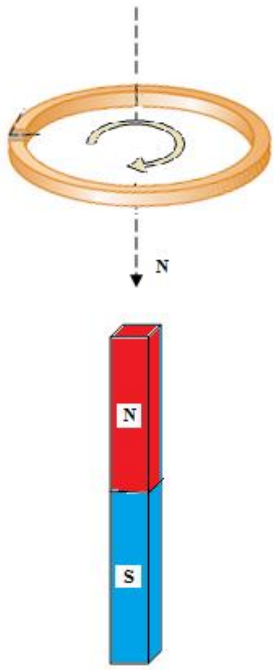
When normal to the loop is parallel to the field, the velocity vector "v" of side of loop is also parallel to field "B", so $\theta = 0$. Therefore,

$$\varepsilon = vBL\sin 0$$

$$\Longrightarrow \varepsilon = vBL(0)$$

$$\Longrightarrow \varepsilon = 0$$

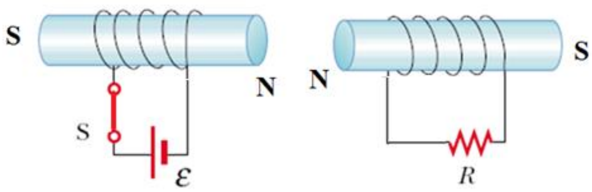
Thus, emf induced in the loop is zero.



Q # 3. A light metallic ring is released from above into a vertical bar magnet as shown in the figure. Viewed from above, does the current flow clockwise or anti-clockwise in the ring?

Ans. According to Lenz's law, the direction of the induced current is opposite to the cause which produces it. So, the side of the ring facing north pole of magnet must be north pole of the induced magnetic field.

When viewed from above, the current in the ring is clockwise.



Q # 4. What is the direction of the current through resistor R as shown in the figure? As the switch S is (a) closed (b) open.

Ans. When switch S is closed, then the current in the primary coil increases from zero to maximum. During this time interval, magnetic flux through the secondary coil increases from zero to maximum and induced current produce in it. According to Lenz's law, the current through the secondary should flow in anti-clockwise direction. And current through resistor will be from left to right.

(b) However, if the switch is opened, the induced current through secondary should flow in clockwise direction. So the current through resistor R will flow from right to left.

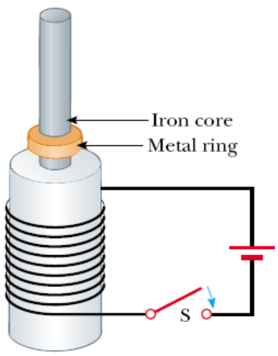
Q # 5. Does the induced emf always act to decrease the magnetic flux through a circuit?

Ans. The induced emf always opposes the cause that produces it.

- If the magnetic flux through the circuit through the circuit is increasing, then induced emf acts to decrease the magnetic flux.
- If the magnetic flux through the circuit through the circuit is decreasing, then induced emf acts to increase the magnetic flux.

Hence, the induced emf does not always act to decrease the magnetic flux through the circuit.

Q # 6. When the switch in the circuit is closed, a current is established in the coil and the metal ring jumps upward. Why? Describe what would happen to the ring if the battery polarity were reversed?



Ans. When the switch in the circuit is closed, the current is set up in the coil which establish magnetic field in it.

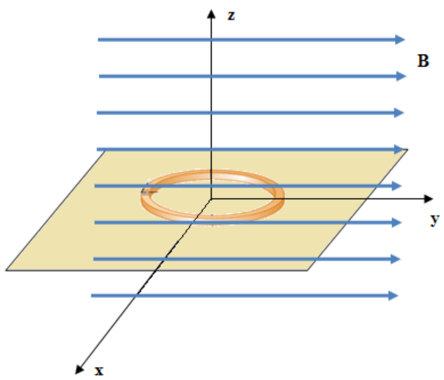
This result in change of magnetic flux through the metallic ring and hence an induced emf is produced in it.

The induced magnetic field in the ring opposes the magnetic field of the coil (according to Lenz's law). Therefore the ring experience a force of repulsion and jumps up.

The same event occurs even if the polarity of the battery is reversed.

Q # 7. Figure shows a coil of wire in the xy-plane with a magnetic field directed along the y-axis. Around which of the three coordinate axes should the coil be rotated in order to generate an emf and a current in the coil?

Ans.



- The coil must be rotated along x-axis to get change of magnetic flux and an induced current through it.
- If the coil is rotated about y-axis, the flux passing through the coil zero because plane of the coil remains parallel to magnetic field B all the times.
- If the coil is rotated about z-axis then no change of magnetic flux takes place through coil.

Hence if the coil is rotated about x-axis, then there is a change of magnetic flux passing through a coil. So only in this case, an emf is induced in the coil.

Q # 8. How would you position a flat loop of wire in a changing magnetic field so that there is no emf induced in the loop?

Ans. If the plane of loop of wire is placed parallel to changing magnetic field i.e., $\theta = 0$, then no flux through it will change. Hence no emf will be induced through the loop as:

$$\varepsilon = \omega AB \sin\theta$$

$$\varepsilon = \omega AB \sin 0 = \omega AB(0)$$

$$\varepsilon = 0$$

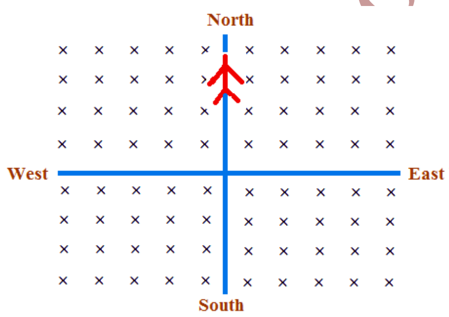
Q # 9. In a certain region, the earth's magnetic field point vertically down. When a plane flies due north, which wing tip is positively charged?

Ans. The magnetic force on electrons in the wing is given by:

$$\mathbf{F} = -e(\mathbf{v} \times \mathbf{B})$$

When the plane flies due north in the earth magnetic field directed vertically downward, then electrons will experience force in east direction.

Thus west wingtip of the plane is positively charged.



Q # 10. Show that $\boldsymbol{\varepsilon}$ and $\frac{\Delta\varphi}{\Delta t}$ have the same units.

Ans. As we know that:

- $\varepsilon = \frac{W}{q}$

$$\Rightarrow unit\ of\ \varepsilon = \frac{unit\ of\ Work}{unit\ of\ charge} = \frac{joule}{coulomb} = volt \quad \text{----------} \quad (1)$$

- $\frac{\Delta\varphi}{\Delta t} = \frac{B\Delta A}{\Delta t}$

$$\Rightarrow unit\ of\ \frac{\Delta\boldsymbol{\varphi}}{\Delta\boldsymbol{t}} = \frac{(unit\ of\ B)(unit\ of\ \Delta A)}{unit\ of\ \Delta\boldsymbol{t}} = \frac{(NA^{-1}m^{-1})(m^2)}{s}$$

$$\Rightarrow unit\ of\ \frac{\Delta\boldsymbol{\varphi}}{\Delta\boldsymbol{t}} = \frac{N \times m}{A \times s}$$

As $N \times m = J\ (joule)$ and $A \times s = C\ (coulomb)$

$$\Rightarrow unit\ of\ \frac{\Delta\boldsymbol{\varphi}}{\Delta\boldsymbol{t}} = \frac{joule}{coulomb} = volt \quad \text{----------} \quad (2)$$

Hence from (1) and (2), it is proved that both $\boldsymbol{\varepsilon}$ and $\frac{\Delta\varphi}{\Delta t}$ have the same units.

Q # 11. When an electric motor, such as an electric drill, is being used, does it also act as a generator? If so what is the consequences of this?

Ans. When a motor like drill machine is working, its armature (coil) is revolving in a uniform magnetic field by a potential difference V. The revolving armature of the motor experiences change in flux, which produces emf, known as back emf of the motor. Hence, a drill machine (or a motor) is also operating like a generator whose generated emf is known as back emf.

Q # 12. Can a DC motor be turned into a DC generator? What changes are required to be done?

Ans. Yes, a DC motor be turned into a DC generator.

In order to convert DC motor into a DC generator, two changes are to be done:

- The magnetic field must be supplied by the permanent magnet and not by electromagnet.
- An arrangement to rotate the coil armature should be provided.

Q # 13. Is it possible to change both the area of the loop and the magnetic field passing through the loop and still not have an induced emf in the loop?

Ans. Yes. If the plane of the loop is kept parallel to the direction of the magnetic field, no emf will be induced in the loop either by changing its area or by changing the magnetic field.

Q # 14. Can an electric motor be used to drive an electric generator with output from the generator being used to operate the motor?

Ans. No it is not possible. Because if it is possible, it will be a self operating system without getting energy from some external source and this is against the law of conservation of energy.

Q # 15. A suspended magnet is oscillating freely in a horizontal plane. The oscillations are strongly damped when a metal plate is placed under the magnet. Explain why this occurs?

Ans. the oscillating magnet produces change of magnetic flux close to it. The metal plate placed below it experiences the change of magnetic flux. As the result, eddy current are produced inside metal. According to Lenz's law, these eddy current oppose the cause which produce it. So, the oscillations of magnet are strongly damped.

Q # 16. Four unmarked wires emerge from a transformer. What steps would you take to determine the turn ratio?

Ans. By checking continuity of the coils, the coils are separated as primary and secondary coils. An alternating voltage of known value V_P is connected to one coil (primary coil), the output voltage V_S across the ends of the other coil (secondary coil) is measured. The turn ratio of the coil is determined by using relation:

$$\frac{V_S}{V_P} = \frac{N_S}{N_P}$$

Q # 17. (a) Can a step-up transformer increase the power level?

(b) In a transformer, there is no transfer of charge from the primary to the secondary. How is, then the power transferred?

Ans.

(a). In case of an ideal transformer, the power output is equal to the power input. In actual transformer, due of dissipation of energy in the coil, the output power is always less than input power. Therefore, a step-up transformer can't increase power level.

(b). The two coils of transformer are magnetically linked i.e., the change of flux through one coil is linked with the other coil.

Q # 18. When the primary of a transformer is connected to AC mains, the current in it

(a) Is very small if the secondary circuit is open, but

(b) Increases when the secondary circuit is closed. Explain these facts.

Ans. (a). If the secondary circuit is open, then output power will be zero. Because output power is always slightly smaller than the output power, therefore a very small value of current is being drawn by a primary coil of transformer form AC mains.

(b). When the secondary circuit is closed, the output power increases. To produce this power, transformer will draw large current from the A.C. mains to increase its primary power (V_pI_p).

EXERCISE SHORT QUESTIONS

CHAPTER # 16: ALTERNATING CURRENT

Q # 1. A sinusoidal current has rms value of 10 A. What is the maximum or peak value?

Ans.

$RMS\ value\ of\ current\ = I_{rms} = 10\ A$

$Peak\ Value\ (maximum\ value) = I_0 = ?$

Using formula:

$$I_{rms} = \frac{I_0}{\sqrt{2}}$$

$$\Rightarrow I_0 = \sqrt{2}\ \ I_{rms}$$

$$\Rightarrow I_0 = \sqrt{2}(10\ A)$$

$$\Rightarrow I_0 = 14.14\ A$$

Thus, the maximum value of the current is $14.14\ A$.

Q # 2. Name the devices that will

(a) Permit flow of direct current but oppose the flow of alternating current

(b) Permit flow of alternating current but not the direct current.

Ans.

(a) An inductor (choke) is a device which permits flow of direct current but opposes the flow of alternating current.

(b) A capacitor is a device which permits flow of alternating current but not the direct current.

Q # 3. How many times per second will an incandescent lamp reaches maximum brilliance when connected to a 50 Hz source?

Ans. The brilliance of the lamp will become maximum twice in one AC cycle because the current also becomes maximum two times in a cycle (i.e., for +ve half cycle and –ve half cycle).

As the frequency "f" of AC cycle is 50 Hz.

$$So\ maximum\ brilliance\ shown\ by\ lamp\ per\ second\ = Twice\ the\ frequency\ of\ AC\ source$$

$$So\ maximum\ brilliance\ shown\ by\ lamp\ per\ second\ = 2f = 2 \times 50 = 100\ times$$

Hence, the brilliance will be maximum 100 time in one second.

Q # 4. A circuit contains an iron-cored inductor, a switch and a DC sources arranged in series. The switch is closed and after an interval reopened. Explain why a spark jumps across the switch contacts?

Ans. When a switch of circuit containing iron cored inductor is closed, current increases from zero to maximum value. This changing current produce change of magnetic flux and hence emf is produced.

After an interval, when switch is reopened, the current changes from maximum to zero. Again emf is developed across the coil. This is back emf. This produces spark across the switch contacts.

Q # 5. How does doubling the frequency affect the reactance of (a) an inductor (b) capacitor?

Ans.

	Formula for Reactance	Doubling frequency	Result
Inductor	$X_L = \omega L$	$X_L' = 2\omega L = 2X_L$	Inductive Reactance will become double
Capacitor	$X_C = \frac{1}{\omega C}$	$X_C' = \frac{1}{2\omega C} = \frac{1}{2}X_C$	Capacitive Reactance will becomes half

Hence by doubling the frequency, the inductive reactance will become double, while capacitive reaction remains half.

Q # 6. In a RL circuit, will the current lag or lead the voltage? Illustrate your answer by a vector diagram.

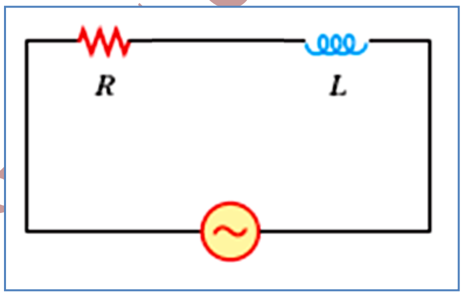
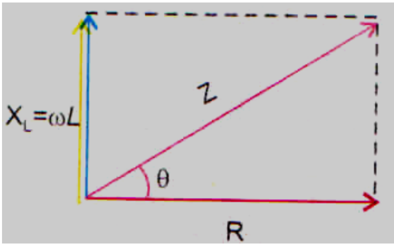


Figure shows an RL series circuit excited by an AC source. The potential difference across resistor 'IR' would be in phase with current I.

Taking the current as the reference, the potential difference across the resistor is represented by the line along the current line because the potential difference is in phase with current.



The potential difference across the inductor $V_L = I_{RMS}(\omega L)$. As the current lags the voltage by 90°, so the line representing vector ωL is drawn at right angle to the current line.

Figure shows that the current and the applied voltage are not in phase. The phase θ by which the current leads the voltage is given by the expression:

$$\theta = \tan^{-1}\left(\frac{\omega L}{R}\right)$$

Q # 7. A choke coil placed in series with an electric lamp in an AC circuit causes the lamp to become dim. Why is it so? A variable capacitor added in series in this circuit may be adjusted until the lamp glows with normal brilliance. Explain, how this is possible?

Ans. Let an electric lamp connected to a source of alternating voltage V in AC circuit. When there is no inductance or capacitance in the circuit, the impedance is equal to the resistance of the circuit, say R. it means that the current flowing through the lamp is

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

(a) When a choke coil is connected in series with an electric lamp

If, now, a choke coil of inductive reactance X_L is placed in series with the electric lamp, the new impedance of the circuit will be:

$$Z_1 = \sqrt{R^2 + X_L^2}$$

Therefore, the current flowing through the circuit in this case will be:

$$I_1 = \frac{V}{Z_1} = \frac{V}{\sqrt{R^2 + X_L^2}}$$

From the comparison of both currents, we see that I_1 is smaller than I and that is why the electric lamp is dimmed on placing a choke coil in the circuit.

(b) A Variable capacitor added in series with an electric lamp

When a variable capacitor also is in series with the circuit, its capacitive reactance X_C opposes X_L and thus the impedance of the circuit is

$$Z_2 = \sqrt{R^2 + (X_L - X_C)^2}$$

Therefore, the current flowing through the circuit in this case will be:

$$I_2 = \frac{V}{Z_2} = \frac{V}{\sqrt{R^2 + (X_L - X_C)^2}}$$

If the $X_L = X_C$, then $I_2 = \frac{V}{Z_2} = \frac{V}{\sqrt{R^2+(0)^2}} = \frac{V}{R} = I$

Hence, the current I_2 becomes equal to the current I for $X_L = X_C$, as if there is no reactance in the circuit and hence the lamp glow with normal brilliance.

Q # 8. Explain the condition under which electromagnetic waves are produced from a source.

Ans. When alternating voltage is applied across the ends of a metallic antenna, and oscillating electric field comes into existence which accelerates the electrons again and again as the polarities of the antenna changes after half a cycle.

The accelerated electrons radiate energy carried by changing electric field. A changing electric field creates a magnetic field and a changing magnetic field creates electric field. Thus each field will generate the other and the whole package of electric and magnetic fields will move along propelling itself through space.

Q # 9. How the reception of a particular radio station is selected on your radio set?

Ans. A particular radio station can be selected on a radio set by tuning it. When the frequency of the LC-oscillator in the radio set is equal to the frequency of the radio wave from a particular radio station, a resonance is produced. The current of this signal becomes maximum and can detected and amplified.

Q # 10. What is meant by A.M and F.M?

Ans. Amplitude Modulation: In this type of modulation, the amplitude of the carrier wave is increased or diminished as the amplitude of the superposing modulating signal increases or decreases.

Frequency Modulation: In this type of modulation, the frequency of the carrier wave is increased or diminished as the amplitude of the superposing modulating signal increases or decreases. But the carrier wave amplitude remains constant.

EXERCISE SHORT QUESTIONS

CHAPTER # 17: PHYSICS OF SOLIDS

Q # 1. Distinguish between crystalline, amorphous and polymeric solids.

Crystalline Solids

The solids in which the atoms, ions and molecules are arranged periodically are called crystalline solids. Metals such as copper, zinc, iron etc., Ionic compounds such as sodium chloride and Ceramics such as zirconia are the examples of crystalline solids.

Amorphous Solids

The word amorphous means shapeless. Thus in amorphous solids, there is no regular arrangement of molecules like that in crystalline solids. The ordinary glass is an example of amorphous solids.

Polymeric Solids

Polymeric solids are more or less solid materials with a structure between order and disorder. Natural rubber which is in pure state composed of Hydrocarbons. Polythene, Polystyrene and Nylon are examples of synthetic polymers.

Q # 2. Define stress and strain. What are their SI units? Differentiate between tensile, compressive and shear modes of stress and strain.

Ans. Stress

The force applied on unit area to produce any change in the shape, volume or length of a body is called stress. Mathematically, it is described as:

$$Stress\,(\sigma) = \frac{Force\ (F)}{Area\ \ (A)}$$

The SI unit of stress is newton per square meter, which is given the name pascal (Pa).

Strain: It is defined as the fractional change in length, volume or shape of a body when stress is applied on it. It has no unit.

Tensile Stress: When a stress changes length it is called tensile stress.

Tensile Strain: It is defined as the fractional change in length on applying stress.

Compressive Stress: The stress which causes change in volume of the body is called compressive stress.

Compressive Strain: This is the strain produced as a result of compressive stress.

Shear Stress: The stress tending to produce an angular deformation or change in the shape is called shear stress.

Shear Strain: This is the strain caused by angular deformation. It is equal to the angular displacement produced.

Q # 3. Define modulus of elasticity. Show that the units of modulus of elasticity and stress are the same. Also discuss its three kinds.

Modulus of Elasticity

The ratio of stress to strain is a constant for a given material, provided the external applied force is not too great, called modulus of elasticity. Mathematically, it is described as:

$$Modulus\ of\ \ Elasticity = \frac{Stress}{Strain}$$

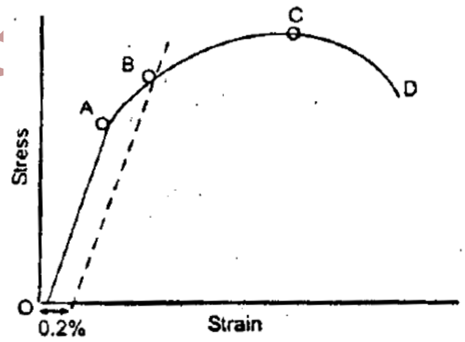
Since the strain is a dimensionless quantity, the units of modulus of elasticity are the same as that of stress, i.e., Nm^{-2} or Pa.

Young's modulus is the ratio of tensile stress to tensile strain.

Bulk modulus is the ratio of volume stress to volume strain.

Shear modulus is the ratio of shear stress to shear strain of a body.

Q # 4. Draw a stress-strain curve for a ductile material, and then define the terms: Elastic limit, Yield point and Ultimate tensile stress.



Elastic Limit: It is defined as the maximum stress a material can endure without any permanent deformation.

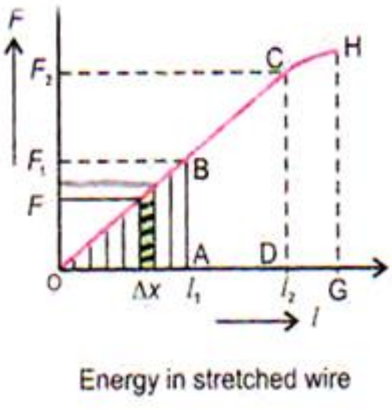
Yield Point: The stress at which the material start to be permanently deformed is called Yield Point.

Ultimate Tensile Stress: It is defined as the maximum stress a material can withstand.

Q # 5. What is meant by strain energy? How can it be determined from the force-extension graph?

Ans. The amount of P.E stored in a material due to displacement of its molecule from its equilibrium position, under the action of stress, is called strain energy.

Consider a wire whose one end is attached to a fixed support, is stretched vertically by connecting a weight at its lower end. The work done for extension l_1 by a certain force F_1 will be equal to the area under force –extension curve, which is equal to the area of triangle OAB. Therefore,



Energy in stretched wire

Work Done = Area of triangle OAB

$$\text{Work Done} = \frac{1}{2}(\text{base})(\text{altitude})$$

$$\text{Work Done} = \frac{1}{2}(\overline{OA})(\overline{AB})$$

$$\text{Work Done} = \frac{1}{2}(l_1)(F_1)$$

This work done is appeared as strain energy inside the wire. So

$$\text{Strain Energy} = \frac{1}{2}(l_1)(F_1)$$

Q # 6. Describe the formation of energy bands in solids. Explain the difference among electrical behavior of conductors, insulators and semi-conductors in terms of energy band theory.

Ans. Energy Band

When the numbers of atoms are brought together, as in a crystal, they interact with one another. As the result, each energy level splits up into several sub-levels. A group of such energy sub-levels are called an energy band.

Conductors

In conductors, valence and conduction bands largely overlap each other. There is no physical distinction between the two bands which ensures the availability of a large number of free electrons.

Insulators

In insulators, valence electrons are tightly bound to their atoms and are not free to move. An insulator has an empty conduction band, a full valence band and a large energy gap in between them.

Semi-conductors

At room temperature, the semiconductors have partially filled conduction band, partially filled valence band and very narrow forbidden gap between valence and conduction band.

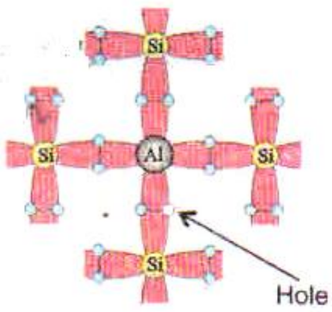
Q # 7. Distinguish between intrinsic and extrinsic semi-conductors. How would you obtain n-type and p-type material from pure silicon? Illustrate it by schematic diagram.

Intrinsic semi-conductors

A semiconductor in its extremely pure form is known as intrinsic semiconductors.

Extrinsic semi-conductors

The doped semi-conducting materials are called extrinsic semi-conductors.

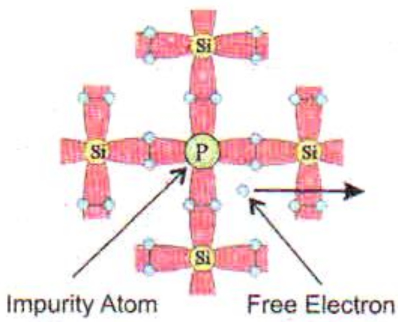


P-type

These materials are obtained by doping semi-conductor with atoms of a trivalent impurity such as Aluminium. It creates a vacancy of an electron called a hole.

N-type

The N-type materials are obtained by doping semi-conductor with atoms of a pentavalent impurity such as Phosphorous. It leaves a free electron.



Q # 8. Discuss the mechanism of electrical conduction by holes and electrons in a pure semi-conductor element.

Ans. In a pure (or intrinsic) semi-conductor, the number of holes and free electrons is equal and both contribute to the flow of current through it. When voltage is applied across the semi-conductor, an electric field is produced. Due to this electric field, electrons get a drift velocity opposite to the electric field and holes in the direction of the electric field. The electronic current and the hole current add up together to give the current through semiconducting material.

Q # 9. Write a note on superconductors.

Ans. The materials whose resistivity becomes zero below a certain temperature are called superconductors. And the temperature at which the resistivity of a material falls to zero is called critical temperature.

Any superconductor having a critical temperature above 77K (the boiling point of liquid nitrogen) is referred as high temperature superconductor. Superconductors can be used in Magnetic Resonance Imaging (MRI), Magnetic Levitation Trains, Powerful but small electric motors and in Fast computer chips.

Q # 10. What is meant by para, dia and ferromagnetic substances? Give examples for each.

Paramagnetic Substances

If the spin and orbital axis of electrons in an atom are oriented in such a way that their fields support each other and the atom behaves like a tiny magnet. Such substances are called Paramagnetic substances. e.g., Manganese, Aluminium, Platinium etc.

Diamagnetic Substances

The substances in which the magnetic field produced by orbital and spin motion of the electrons may cancel each others effects are called Diamagnetic substances. e.g., the atoms of water, Copper (Cu), Bismuth (Bi), Antimony (Sb).

Ferromagnetic Substances

Ferromagnetic substances are those substances in which atoms co-operate with each other in such a way as to show strong magnetic effects e.g., Iron (Fe), Cobalt (Co), Nickel (Ni), Chromium dioxide and Alnico.

Q # 11. What is meant by hysteresis loss? How is it used in the construction of a transformer?

Ans. The area of hysteresis loop is the measure of energy required to magnetize and demagnetize a substance. This energy is dissipated in form of heat, which is called hysteresis loss. The materials, for which hysteresis loss is small, are used to form the core of transformers.

EXERCISE SHORT QUESTIONS

CHAPTER # 18: ELECTRONICS

Q # 1: How does the motion of an electron in n-type substance differ from the motion in a p-type substance?

Ans. In n-type material, the electrons are the majority carriers. They move from lower potential to higher potential.

In p-type materials, the holes are the majority carriers. They move from higher potential to lower potential.

Q # 2: What is the net charge on an n-type or p-type substance?

Ans. The penta-valent or trivalent impurity atoms bombard on intrinsic semiconductor, to form it n-type or p-type material, are neutral. Therefore, an n-type or p-type substance is an electrically neutral substance.

Q # 3: The anode of a diode is 0.2 V positive with respect to its cathode. Is it forward biased?

Ans. A junction diode is said to be forward biased if its P-type region is connected to the positive terminal and N-type region is connected to the negative terminal of the battery. Since anode (p-type) is at positive potential 0.2 V with respect to its cathode (n-type), so it satisfied the condition of forward biased.

But the potential barrier of Ge and Si are 0.3 V and 0.7 V respectively, so such small value of voltage can't produce forward current.

Q # 4: Why charge carries are not present in the depletion region?

Ans. When a p-type semiconductor is brought close an n-type to form a PN-junction, and then the free electrons near the junction in the n region begin to diffuse across the junction into the p-type region where they combine with holes near the junction, and neutralize holes in p-type. As a result, a charge less region is formed across the junction in which charge carriers are not present. This region is known as depletion region.

Q # 5: What is the effect of forward and reverse biasing of diode on the width of depletion region?

Ans. When the diode is forward biased, the width of depletion region is decreased. When the diode is reversed biased, the width of depletion region is increased.

Q # 6: Why ordinary silicon diodes don't emit light?

Ans. The potential barrier across the pan-junction of Si is 0.7 V. so in forward biased condition, when electron recombine with the hole, a photon of light having 0.7 eV energy is released. As the energy of emitted photon lies in infrared region of electromagnetic spectrum. That's why we don't observe light emission from Si diode.

Q # 7: Why a photo diode is operated in reverse biased state?

Ans. Photo diode is used for detection of light. It is operated in the reverse biased condition.

- When no light is incident on the junction, the reverse current is almost negligible.
- When a photo diode is exposed to light, the reverse current increases with intensity of light.

Thus the reverse biased condition of a photo diode is useful to detection of light.

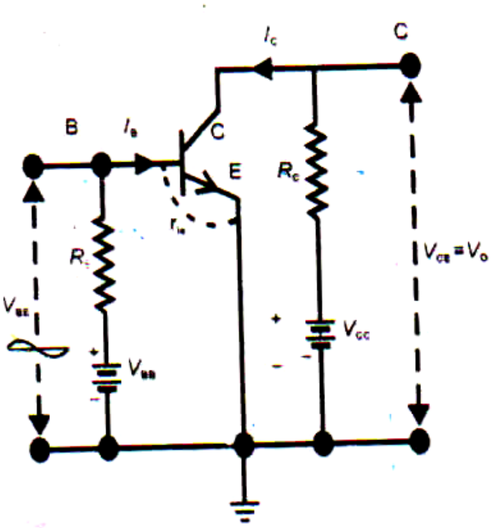
Q # 8: Why is the base current in a transistor very small?

Ans. The base of a transistor is kept thin so that a very few charge carriers (electrons or holes)from emitter may combine with electrons or holes of base. This result in larger collector current, hence larger current and power gain to transistor become possible.

Q # 9: What are the biasing requirements of the junction of a transistor for its normal operation? Explain how these requirements are met in a common emitter amplifier?

Ans. For the normal operation of transistor, the EB (emitter-base) junction of transistor is forward biased and CB (collector-base) junction of transistor is reversed.

In npn-transistor in common emitter configuration, the EB-junction is forward biased by V_{BB}battery and CB-junction is reversed biased by V_{CC} battery, as shown in the figure.



EXERCISE SHORT QUESTIONS

CHAPTER # 19: DAWN OF MODERN PHYSICS

Q # 1. What are the measurements on which two observers in relative motion will always agree upon?

Ans. The measurement on which two observers in relative motion will always agree upon is speed of light.

Q # 2. Does the dilation means that time really passes more slowing in moving system or that it only seems to pass more slowly?

Ans. According to the time dilation formula $= \frac{t_0}{\sqrt{1-\frac{v^2}{c^2}}}$, time is not constant. It is relative.

- Time passes normally for any observer within his own system.
- Time seems to pass more slowly when an observer in one system in relativistic motion takes the time measurement of the other system.

Q # 3. If you are moving in a space ship at very high speed relative to the earth, would you notice a difference (a) in your pulse rate (b) in pulse rate of people on earth?

Ans. The pulse rate of a person who is travelling in a spaceship is not changed with respect to clock inside the spaceship. But the person in spaceship will experience the change in pulse rate of the people on earth, according to the relation $t = \frac{t_0}{\sqrt{1-\frac{v^2}{c^2}}}$.

Q # 4. If the speed of light were infinite, what would the equations of special theory of relativity reduce to?

Ans. If we take speed of light c as infinity, then the equations of special theory of relativity reduce to:

- **Time dilation formula:** $t = \frac{t_0}{\sqrt{1-\frac{v^2}{c^2}}} = \frac{t_0}{\sqrt{1-\frac{v^2}{\infty^2}}} = \frac{t_0}{\sqrt{1-0}} = t_0$, i.e., Time in motion=Proper Time
- **Length contraction formula:** $L = L_0\sqrt{1-\frac{v^2}{c^2}} = L_0\sqrt{1-\frac{v^2}{\infty^2}} = L_0\sqrt{1-0} = L_0$, i.e., Length in motion = Proper Length
- **Mass increment formula:** $m = \frac{m_0}{\sqrt{1-\frac{v^2}{c^2}}} = \frac{m_0}{\sqrt{1-\frac{v^2}{\infty^2}}} = \frac{m_0}{\sqrt{1-0}} = m_0$, i.e., Mass in motion=Rest Mass

Q # 5. Since mass is form of energy, can we conclude that a compressed spring has more mass than the same spring when it is not compressed?

Ans. According to the theory of relativity, Mass is form of energy. As compressed spring has greater potential energy, so there would be increase in mass of compressed spring according to the relation: $\Delta m = \frac{\Delta E}{c^2}$. However, this increase in mass is slightly greater than original mass (negligibly small).

Q # 6. As a solid is heated and begins to glow, why does it first appear red.

Ans. At lower temperature, a body emits radiation of low energy (longer wavelength). Since longest visible wavelength is red, so it appears red first.

Q # 7. What happens to total radiation from a black body if its absolute temperature is doubled?

Ans. According to Stephen Boltzmann law: $E = \sigma T^4$

- When absolute temperature is doubled, then: $E' = \sigma (2T)^4 = 16\sigma T^4 = 16E$

Thus if absolute temperature is doubled, the total radiation emitted by black body increases 16 times.

Q # 8. Which photon, red, green or blue carry the most (a) energy and (b) momentum?

Energy: According to relation: $E = hf = \frac{hc}{\lambda}$, the photons of blue light having shorter wavelength must have larger energy as compared to photons of red or green color light.

Momentum: According to relation: $p = \frac{h}{\lambda}$, the photons of blue light having shorter wavelength must have larger momentum as compared to photons of red or green color light.

Q # 9. Which have the low energy quanta? Radio waves or X-rays.

Ans. According to relation: $E = hf = \frac{hc}{\lambda}$, the quanta of X-rays having shorter wavelength must have larger energy as compared to quanta of radio waves.

Q # 10. A beam of red light and a beam of blue light have exactly the same energy. Which beam contains the greater number of photons?

Ans. As $(Energy\ of\ a\ photon\ of\ blue\ light) > (Energy\ of\ a\ photon\ of\ red\ light)$

Therefore, two color beams having same energy will contain different number of photons.

- The blue light, having photon of comparatively larger energy contains less number of photons
- The red light, having photon of comparatively smaller energy contains greater number of photons

Q # 11. Does the brightness of a beam of light primarily depend on the frequency of photons or the number of photons?

Ans. The brightness of a beam depends upon intensity (number of photons) and not on the frequency of light. Thus brightness increases with intensity of light.

Q # 12. When ultravoilot light falls on certain dyes, visible light is emitted. Why does this not happens when infrared light falls on these dyes?

Ans. UV light consists of photons having energy greater than energy of visible light photons. When UV light falls on dyes, atoms initially become excited and then de-excited by emitting lower energy photons, which may be detectable by normal human eyes.

Infrared light consists of photons having energy lower than energy of visible light photons. When Infrared light falls on dyes, atoms initially become excited and then de-excited by emitting lower energy photons which couldn't lie in visible spectrum of electromagnetic radiation.

Q # 13. Will bright light eject more electrons from metal surface than dimmer light of same color?

Ans. Since "number of electrons" ejected from metal surface depend upon the intensity of light (number of photons). Therefore, bright light being more intense will eject more electrons from a metal surface than dimmer light of same color.

Q # 14. Will higher frequency light eject greater number of electrons than lower frequency light?

Ans. No, the higher frequency light will not eject greater number of electrons than low frequency light. It is because of the reason that number of electrons emitted from metal surface depends upon intensity of light (number of photons) and not frequency of light.

Q # 15. When light shines on a surface, is momentum transferred to the metal surface?

Ans. When light falls on the surface, about 20% of incident light energy is absorbed in each reflection. So both energy and momentum is transferred to the metal surface.

Q # 16. Why can red light be used in photographic dark room when developing films but a blue or white light cannot?

Ans. Since the frequency of red light is less as compared to blue light, so red light has less energy as compared to blue light. Therefore, photographic films an the material concerned are less affected in the presence of red light.

Q # 17. Photon A has twice the energy of photon B. what is the ratio of the momentum to A to that of B.

Ans. Given that the energy of photon A is twice the energy of photon B i.e.,

$$E_A = 2E_B$$

The momentum of photon A = $P_A = \frac{E_A}{c}$

The momentum of photon B = $P_B = \frac{E_B}{c}$

Now, $\frac{P_A}{P_B} = \frac{\left(\frac{E_A}{c}\right)}{\left(\frac{E_B}{c}\right)} = \frac{E_A}{E_B} = \frac{2E_B}{E_B} = 2$

So, photon A has twice the momentum of photon B.

Q # 18. Why don't we observe Compton effect with visible light?

Ans. We don't observe a Compton effect with visible light because photons of visible light have smaller energy and momentum then the photons of X-rays.

Q # 19. Can pair production takes place in vaccum? Explain.

Ans. No, pair production can't take place in vacuum. Because, in vacuum, there is no heavy nucleus present. Pair production always takes place in the presence of a heavy nucleus.

Q # 20. Is it possible to create a single electron from energy? Explain.

Ans. No it is not possible to create a single electron from energy. The creation of single electron from energy is violation of law of conservation of charge. Whenever pair production takes place, the electrons and positrons are created at the same time.

Q # 21. If electrons behaved only light particles, what pattern would you expect on the sucreen after the electron passing through double slit?

Ans. If electron behave only like particles then, after passing through the double slit, only those parts of the screen are affected which are in front of the slits.

Q # 22. If an electron and proton have the same de Broglie wavelength, which particle have greater speed?

Ans. The de Broglie wavelength associated with moving particle is given by expression:

$$\lambda = \frac{h}{mv} \Rightarrow v = \frac{h}{m\lambda}$$

As the wavelength is same for both electron and proton beam, therefore: $v \propto \frac{1}{m}$

As mass of electron is smaller then proton, so electron has greater speed.

Q # 23. We don't notice the de Broglie wavelength for a pitched cricket. Explain. Why?

Ans. The de Broglie wavelength associated with moving particle is given by expression:

$$\lambda = \frac{h}{mv}$$

Due to large mass and small speed, the wavelength associated with moving cricket ball is very small. As the diffraction produced by the ball is also very small. So it is impossible to measure de Broglie wavelength for a pitched cricket ball.

Q # 24. If the following particles all have the same energy, which has the shortest wavelengths? Electrons, α −particle, neutron, proton.

Ans. The de Broglie wavelength associated with moving particle is given by expression:

$$\lambda = \frac{h}{mv} = \frac{h}{m\sqrt{\frac{2E}{m}}} = \frac{h}{\sqrt{2mE}} \qquad \because E = \frac{1}{2}mv^2$$

For same energy of beam of particles, we have: $\lambda \propto \frac{1}{\sqrt{m}}$

Thus the massive particle has shorter wavelength. As mass of alpha particle is greater, so it has the shorter wavelength.

Q # 25. When does light behave as a wave? When does it behave as a particle?

Ans. Light behaves as wave in the phenomenon of:

(i) Interference, (ii) Diffraction, (iii) Polarization

Light behaves as particle in

(i) Photo electric effect, (ii) Compton effect, (iii) Pair production

Q # 26. What advantage an electron microscope has over an optical microscope?

Ans. The resolving power of electron microscope is thousand times greater then an Optical microscope.

The internal structure of an object can also be obtained by electron microscope which is not possible with optical microscope.

Q # 27. If measurement shows a precise position for an electron, can those measurements show precise momentum also? Explain.

Ans. According to Heisenberg's uncertainty principle, it is impossible that measure both position and momentum precisely at the same time. Mathematically:

$$\Delta x \, \Delta p = h$$

Thus if one measurement is precise, then the other is uncertain.

EXERCISE SHORT QUESTIONS

Q # 1. Bohr's theory of hydrogen atom is based upon several assumptions. Do any of these assumptions contradict classical physics?

Ans. Bohr's first postulate disagrees with the classical physics. According to this postulate:

An electron in an orbit revolving around the nucleus doesn't radiate energy by radiation. But according to the classical physics, an accelerated electron radiates energy due to its circular motion around nucleus.

Q # 2. What is meant by line spectrum? Explain, how line spectrum can be used for identification of elements?

Ans. A spectrum which consists of isolated sharp parallel lines, in which each line corresponds to a definite frequency and wavelength, is called line spectra.

Each element gives its own characteristic lines of definite wavelengths. Thus an element can be easily identified by observing its spectrum.

Q # 3. Can the electron in the ground state hydrogen absorb a photon of energy 13.6 eV and greater than 13.6 eV.

Ans. Yes it can absorb a photon of energy 13.6 eV and greater than 13.6 eV.

Since the ionization energy of the electron in the ground state of hydrogen atom is 13.6 eV. So by absorbing a photon having energy greater than 13.6 eV, ionization of H-atom will take place and the surplus energy of photon is taken away by electron as kinetic energy.

Q # 4. How can the hydrogen emission spectrum contain so many lines although it contains one electron only?

Ans. When H-atom de-excites, the electron will come from higher energy level to ground level by several jumps. As the result, photons of different wavelengths are emitted. That's why the spectrum of hydrogen contains so many lines.

Q # 5. Is energy conserved when an atom emit a photon of light?

Ans. The energy emitted during de-excitation is exactly equal to the energy absorbed by the atom during excitations. So the energy is conserved in this process, i.e., total energy remains the same.

Q # 6. Explain why a glowing gas gives only certain wavelength of light and why that is capable of absorbing the same wavelength? Give a reason why it is transparent to other wavelengths?

Ans. Atoms have fixed energy levels. When electron jumps from higher to lower energy level during de-excitation, photons of particular wavelengths are emitted.

On the other hand, when white light is passed through gas, it absorbs only those photons which have the energy equal to the difference of energy levels in atoms of the gas. All other photons pass through the gas un-absorbed. In other words, gas is transparent for those photons.

Q # 7. Why do you mean when we say that the atom is excited?

Ans. If the certain amount of energy is supplied to the electrons of an atom by an external source, it will be raised up to one of the higher allowed states by absorption of energy. Then the atom is said to be in excited state.

Q # 8. Can X-rays be reflected, refracted, diffracted and polarized just like any other waves? Explain.

Ans. Yes, X-rays can be reflected, refracted, diffracted and polarized as they are also electromagnetic waves of higher frequency and smaller wavelength. Therefore, the X-rays posses the entire properties specific to light waves.

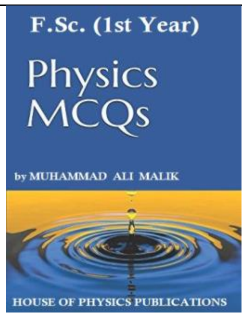
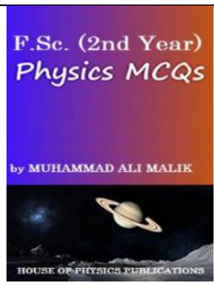
Q # 9. What are the advantages of laser over ordinary light?

Ans. The laser light over ordinary light has following advantages:

- Laser light is monochromatic, while ordinary light has number of wavelengths.
- Laser light is coherent, while ordinary light has no phase coherence.
- Laser light moves in the same direction, while ordinary light spreads in all direction.
- Laser light is much more intense than ordinary light.

Q # 10. Explain why laser action could not occur without pollution inversion between atomic levels.

Ans. In population inversion, more than 50% vacancies in the meta-stable states become filled. Then all the electrons in the meta-stable state simultaneously jump to the ground level, thereby producing a pulse of coherent photons. Without population inversion, laser action could not occur.

F.Sc. Physics, (1^{st} Year), Multiple Choice Questions (MCQs) **CLICK THE LINK TO DOWNLOAD** https://houseofphy.blogspot.com/2017/12/fsc-physics-1st-year-multiple-choice.html	
F.Sc. Physics, (2^{nd} Year), Multiple Choice Questions (MCQs) **CLICK THE LINK TO DOWNLOAD** https://houseofphy.blogspot.com/2017/12/fsc-physics-2nd-year-multiple-choice.html	

EXERCISE SHORT QUESTIONS

CHAPTER # 20: ATOMIC SPECTRA

Q # 1: What are isotopes? What do they have in common and what are their differences?

Ans. Isotopes are those nuclei, which have same atomic number but have different mass number. The isotopes have the same number of protons and have different number of neutrons.

Q # 2: Why are heavy nuclei unstable?

Ans. The heavy nuclei have very small value of their binding energy per nucleon. So they are unstable, and less energy is required to split it.

Q # 3: If a nucleus has a half life of 1 year, does this mean that it will be completely decayed after 2 years? Explain.

Ans. No. As decay rate decreases with the decrease of number of radioactive atoms, so total life is much greater than twice of half life. Total decay is possible after infinite years.

Q # 4: What fraction of a radioactive sample decays after two half lives have elapsed?

Ans. The total un-decayed atoms of an radioactive element N is described by the formula:

$$N = N_0\left(\frac{1}{2}\right)^n$$

where N_0 is the total number of atoms of radioactive element and n is total number of half lives. So,

- Number of un-decayed atoms after two half lives $= N_0\left(\frac{1}{2}\right)^2 = \frac{N_0}{4} = 25\ \%$
- Number of decayed atoms after two half lives $= 75\ \%$

Q # 5: The radioactive element $^{226}_{88}Ra$ has a half-life of 1.6×10^3 years. Since the earth is about 5 billion years old, how can you explain why we still can find this element in nature?

Ans. The half life of $^{226}_{88}Ra$ is 1.6×10^3 years but its total life is equal to infinity. This is common property of all radioactive elements. That's why $^{226}_{88}Ra$ still found on earth while earth's life is 5 billion years.

Q # 6: Describe a brief account of interaction of various types of radiations with matter.

Ans. Electromagnetic radiation interact with matter in three different ways mainly depending upon their energies. These three processes are:

- Photoelectric effect
- Compton effect
- Pair production

Q # 7: Explain how α and β −particles may ionize an atom without directly hitting the electrons? What is the difference in the action of two particles for producing ionization?

Ans. An α −particle is nucleus of helium, it requires electrons. So an energetic α −particle, while passing through matter, ionizes thousands of atoms by attracting their electrons.

But the energetic β −particles ionize the atoms by ejecting their electrons by the force of repulsion.

Q # 8: A particle which produces more ionization is less penetrating. Why?

Ans. A particle with greater ionizing power will loose its whole of energy in a short distance inside a medium. So, its range in that medium is very small.

Q # 9: What information is revealed by the length and shape of the tracks of an incident particle in Wilson cloud chamber?

Ans. In Wilson cloud chamber, the length and shape of the tracks gives the following information.

- The tracks of α −particles are straight, continuous and thicker because these particles have greater mass as well as greater ionizing power.
- The tracks of β −particles are thinner, short and discontinuous tracks because these particles has less mass and less value of ionizing power as compared to α −particles.
- γ −rays have no definite tracks bacuse of high penetrating power and less ionizing power.

Q # 10: Why must a Geiger Muller tube for detecting α −particle have a very thin end window? Why does a Geiger Muller tube for detecting γ − rays not need a window at all?

- The GM tube has a very thin end window for detecting α −particles because this window provides easy way for these low penetrating particles, to enter into the tube.
- For detecting γ −rays, there is no need of such a window because γ −rays are highly penetrating.

Q # 11: Describe the principle of operation of a solid state detector of ionizing radiation in terms of generation and detection of charge carriers.

Ans. Its principle based upon the production of electron-hole pair by getting energy from incident radiation. These generated carriers cause current pulse, which is used for detection purposes.

Q # 12: What do we mean by term critical mass?

Ans. It is the quantity of mass of nuclear fuel, which is enough to absorb most of neutrons for self sustained fission chain reaction.

Q # 13: Discuss the advantages and disadvantages of nuclear power compared to the use of fossil fuel generated power.

Advantages

Nuclear power fossil	Fuel generated fossil
It is cheaper for electricity	It is not cheaper
It is permanent for a given period of time	It is not permanent and not for long period of time
It does not produce smoke	It produces smoke
It is of large amount	It is not of large amount

Disadvantages

Nuclear power has radiation effects which makes it dangerous.

Q # 14: What factors make a fusion reaction difficult to achieve?

Ans. The fusion reaction requires temperature up to million degree centigrade and high energy. These requirements are very difficult to achieve.

Q # 15: Discuss the advantage and disadvantages of fusion power from the point of safety, pollution and resources.

Ans.

Advantage: As the fusion reaction is free from radioactive fossil products, so it is not dangerous. It also gives more energy per nucleon as compared with nuclear fission reaction.

Disadvantage: The fusion reaction requires temperature up to million degree centigrade and high energy. These requirements are very difficult to achieve.

Q # 16: What do you understand by "background radiations"? State the two sources of this radiation.

Ans. The radiation present due to cosmic rays and due to presence of radioactive materials under crest of earth, are called background radiations.

Q # 17: If you swallowed a α −source and β −source, which would be more dangerous to you? Explain why?

Ans. If someone swallowed α −source, then it will damage more blood cells due to its high ionizing power as compare to β −source.

Q # 18: Which radiation does would deposit more energy to your body (a) 10 mGy to your hands or (b) 1 mGy does to your entire body.

Ans. We know that

$$(Absorbed\ Energy) = (Absorbed\ Dose) \times (Mass)$$

As the mass of body is much greater than hand so in second case, more energy will be absorbed.

Q # 19: What is radioactive tracer? Describe on application in medicine, agriculture and industry.

- The use of phosphorous or nitrogen as a tracer has helped to adopt a better mode of fertilizer supply to plants.
- Radioactive iodine can be used to check that a person's thyroid gland is working properly or not. A similar method can be used to study the circulation of blood using sodium-24.

Q # 20: How can radioactivity help in treatment of cancer?

Ans. High energy radiation can penetrate deep into the body and can be used to intentional selective destruction of tissues, such as cancer tumor.