Chapter 12 (Electrostatics)
Short Answers

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

Ans. The electric field E is zero. As electric field is given by the relation $E = -\Delta V / \Delta r$

Since potential is constant, i.e. $\Delta V = 0$ so $E = -0/\Delta r = 0$

Q. 2 Suppose that you follow an electric field line due to a positive point charge. Do electric field and the potential increase or decrease?

Ans. Both electric field and potential decreases. To follow electric field line for +ve charge means to move away from the charge. So distance increases, electric field and potential decreases as given from the following relations.

$$E = Kq/r^2 \quad \text{or} \quad E \propto 1/r^2$$

$$V = Kq/r \quad \text{or} \quad V \propto 1/r$$

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

Ans. Bring a positively charged body near to the capacitor plate. If the charged body is repelled by the capacitor plate then it is positively charged plate and other is negatively charged plate. If the plate is attracted by the capacitor plate then it s negatively charged plate and other is positively charged plate.

Q. 4 Describe the force or forces on a positive point charge when placed between parallel plates (a) with similar and equal charges (b) with opposite and equal charges

Ans. a) With similar and equal charges, the net force will be zero because both the plates will repel/attract the charge with equal and opposite force.

$$F = qE + q(-E) = 0$$

For both +ve equal charges will repel from both sides and –ve equal charges attract from both sides with equal force so net force will be zero.

b) It will accelerate towards –ve plate due to repulsion from +ve plate and attraction from –ve plate.

$$F = qE + qE = 2qE$$

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

Ans. Since E has only one direction at any given point, therefore, if the electric lines cross each other then at the point of intersection E would have more than one direction. This is physical not possible. Hence electric lines can never cross each other.

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

Ans. It will make a rectilinear motion, because the field lines pointing in the same direction means their directions are not changing. The charge q has to follow the field lines so its motion will also be along the same lines.

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

Ans. Yes, E is zero inside a spherical charged rubber balloon due spherical symmetry. If we consider Gaussian surface inside the charged rubber balloon then charged enclosed by this surface is zero.

As $\varphi = q/\varepsilon_0$ since $q = 0$ hence $\varphi = 0/\varepsilon_0 = 0$ -------------(1)

Also $\varphi =$ **E.A** ----------(2) comparing equation (1) and (2) we get **E.A** = 0 since A cannot be zero hence electric intensity will be zero

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

Ans. Yes, it is true.

Electric flux is the measure of number of lines of force passing through the area (closed surface), in outward direction due to +ve charge. Lines of force will be radially moving outward containing the charge. $\varphi \propto Q$ or $\varphi = \text{constant}\ (Q)$

Inserting $1/\epsilon_o$ as constant of proportionality from the given condition

$$\varphi = 1/\epsilon_o\,(Q), \text{ which is Gauss's law.}$$

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

Ans. The positive potential is considered to be the high potential and negative potential is considered to be low potential. Electrons being the negatively charged particles will be repelled by the negative potential and will be attracted by the positive potential. Hence electrons will tend to go from low to high potential.

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Chapter 13 (Current Electricity)
Short Answers

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. **Drift velocity**:

The velocity gained by free electrons in an electrical conductor upon the application of electric field is called drift velocity.

i) When potential difference is increased then the rate of flow of charges increases. Hence drift velocity of free electrons will increase.

ii) By decreasing the length and temperature of the copper wire its resistance will decrease. Hence the drift velocity of the free electrons will increase.

Q. 2 **Do bends in a wire affect the electrical resistance? Explain**.

Ans. No, bends in a wire does not affect its electrical resistance.

$$R = \rho\, L/A$$

R depends upon the dimensions (L & A) and bends do not change dimensions. Hence resistance remains constant

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

Ans. A) Brown Green Red and Gold

$R = 15\,00\ \Omega$; tolerance $\pm 5\ \%$, hence $R = (1500 \pm 75)\ \Omega$

B) Yellow White Orange and Silver

$R = 49000\ \Omega$; tolerance $\pm 10\ \%$, hence $R = (49000 \pm 4900)\ \Omega$

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

Ans. Due to collisions of the free electrons with atoms of the conductor, the resistance of a conductor rises with temperature. As amplitude of vibration of atoms of a conductor increases so probability of their collision also increases due to which resistance will increase. Also $R_t = R_0\,(1+\alpha\, t)$, it means change in resistance is directly proportional to temperature i.e. $\Delta R\ \alpha\ t$. Therefore when temperature will increase the resistance will increase.

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

Ans. Ohm's law [V = IR] is applicable only when physical conditions of the conductor remains same i.e. its temperature remains constant. When small potential difference is applied to the lighted bulb then its temperature remains constant and its resistance also remains constant. Therefore light bulb obeys Ohm's law. When potential difference is increased then due increase of temperature its resistance is also increased. Hence now light bulb does not Obey Ohm's law.

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

Ans. We have the relation for electrical power as

$$P = V^2 / R \text{ or } R = V^2 / P$$

Since potential difference for both of the lighted bulbs is constant, hence resistance is inversely proportional to power. Therefore resistance in a 500 W bulb will be lower than 100 W bulb.

Alternate method

$P_1 = 500$ W $\qquad V = 220$ V

$R_1 = V^2 / P_1 = (220)^2/500 = 96.8\ \Omega$

$P_2 = 100$ W $\qquad V = 220$ V

$R_2 = V^2 / P_2 = (220)^2/100 = 484.0\ \Omega$

Hence 500 W bulb has low resistance.

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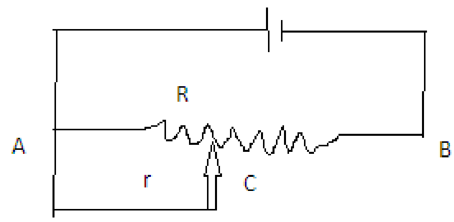
Q. 7 **Describe a circuit which will give a continuously varying potential.**

Ans. Potential divider is a circuit which gives us continuously varying potential. The examples of the potential divider are Rheostat and Potentiometer.



In the circuit battery of emf E is connected across the resistance R. According to Ohm's law

$E = IR$ so $I = E/R$

Let potential difference across AC is V.

$V = I r = E r/R$

$V = E r/R$ In this equation E and R are constant but r varies with slider C. Hence we can get variable potential difference across AC.

Q. 8 **Explain why the terminal potential difference of a battery decreases when the current drawn from it is increased?**

Ans. The relation between terminal potential difference and emf is given by

$E = V_t + I r$ or

$V_t = E - Ir$; where V_t is terminal potential difference, E is emf and r is internal resistance of battery.

From the above relation it is clear when current drawn from the battery 'I' will increase the terminal potential difference Vt will decease.

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

Ans. Wheatstone bridge is a circuit consisting of four resistances connected in such a way to form a loop. It is used for accurate measurement of electrical resistance of a wire. If we connect three known resistances and then balance the bridge, the fourth unknown resistance can be calculated from the relation:

$$R_1 / R_2 = R_3 / R_4 \quad \text{or} \quad R_4 = R_1 R_3 / R_2$$

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Chapter 14 (Electromagnetism)

Short Answers

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

Ans. The flux is maximum when plane of the loop is perpendicular to x-axis and vector area will be parallel to B i.e. $\theta = 0$.

$\Delta\varphi = \mathbf{B} \cdot \mathbf{A} = B\,A\cos\theta = B\,A\cos 0^{o} = BA$ (maximum)

The flux is minimum when plane of the loop is parallel to x-axis and vector area will be perpendicular to B i.e. $\theta = 90^{o}$.

$\Delta\varphi = \mathbf{B} \cdot \mathbf{A} = B\,A\cos\theta = BA\cos 90^{o} = 0$ (minimum)

Q. 2 **A current in a conductor produces 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. Since stationary charges do not produce current hence no magnetic field is produced due to stationary charges. They produce only electric field. Moving charges produce current and hence magnetic field will be produced around conductor carrying this current.

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

Ans. a) When the length of solenoid doubled, the magnetic field B will be halved.

$B = \mu o\, nI = \mu o\,(N/L)\, I$ since $n = N / L$

When $L' = 2L$

$B' = \mu o\,(N / 2L)\, I = 1/2\,(\mu o\, N/L\, I) = 1/2\, B$

b) When number of turns doubled, the magnetic field B will be doubled.

$B = \mu o\, nI = \mu o\, N/l\, I$

When $N' = 2N$

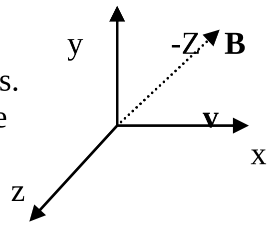
$B' = \mu o\, 2N / l\, I = 2\,(\mu o\, N/l\, I) = 2B$

Q. 4 **At a given instant, a proton moves in the positive x direction in a 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 $\mathbf{F} = q\,(\mathbf{v} \times \mathbf{B})$

According to the right hand rule, magnetic force will act along + y-axis.

No proton will not continue to move along +x-axis rather its will move in a circular path around +y-axis.



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

Ans. The charged particles are deflected in opposite directions due magnetic force given by the relation $\mathbf{F} = q\,(\mathbf{v} \times \mathbf{B})$. They will experience a force in the magnetic field

$\mathbf{F} = -e(\mathbf{v} \times \mathbf{B})$ on electron & $\mathbf{F} = +e\,(\mathbf{v} \times \mathbf{B})$ one proton

This shows that particles are oppositely charged, one 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 q?**

Ans. The charge q follows a circular path under the action of magnetic force $F = qvB\sin\theta$

The force F always acts perpendicular to the direction of motion of charge. The angle between F and displacement d is 90^{o}.

$W = \mathbf{F} \bullet \mathbf{d} = Fd\cos 90^{o} = 0$ so the work done by the magnetic force is zero. It is only deflecting force and changes the direction of moving charge particle.

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

Ans. There are two possibilities:

i) Magnetic field is not present i.e. B = 0

ii) The magnetic field is parallel or anti-parallel to the direction of motion of charge particle. If charge particle moves parallel to the magnetic field then $\theta = 0$ hence $F = qvB \sin 0^o = 0$. Similarly if charge particle moves anti-parallel to the magnetic field then $\theta = 180^o$ hence $F = qvB \sin 180^o = 0$.

In both the above cases the force F is zero and the particle move in a straight line.

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

Ans. The picture is formed on the TV screen when beam of electrons from picture tube strike on the TV screen. When magnet is brought near the TV screen the electrons being charged particles are deflected by the magnetic field of this magnet and cannot reach the TV screen. Due to this the picture 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. Yes it is possible. When plane of the current carrying loop is held perpendicular to the magnetic field, i.e. $\alpha = 90^o$ then torque acting on the loop will be zero.

$$\tau = NIBA \cos\alpha = NIBA \cos 90^o = NIBA \times 0 = 0$$

Hence it will experience no torque and do not 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. A current loop is rotated in that region of space. If at any orientation, torque acts on it then magnetic field is present there. But if current carry loop does not experience any torque then magnetic field is not present. As torque is given by the relation $\tau = NIBA \cos\alpha$.

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

Ans. Isotopes of an element in the ions form are projected into the magnetic filed. They will be deflected into circular paths of different radii by the magnetic force. Since $\mathbf{r \propto \sqrt{m}}$ where r is the radius of path of charge particle and m is its mass. The isotopes have different masses hence they will in paths having different radii. Hence isotopes are separated by measuring the radii of their paths.

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)** For maximum torque, the plane of the current carrying coil must be parallel to the magnetic field B. i.e. $\alpha = 0^o$, therefore $\tau_{max} = NIBA \cos\alpha = NIBA\cos 0^o = NIBA$

b) For minimum torque, the plane of the current carrying coil must be perpendicular to the magngtic field B. i.e. $\alpha = 90^o$, therefore $\tau_{min} = NIBA \cos 90^o = NIBA \times 0 = 0$

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

Ans. As the plane of loop of wire if parallel to the pole faces, its plane is perpendicular to the magnetic field B. i.e. $\alpha = 90^o$, therefore, $\tau = NIBA \cos 90^o = 0$. It means no torque will act on the loop of wire. Hence loop of wire will remain stationary for both alternating current and direct current.

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

Ans. Since ammeter is connected in series in a circuit to measure the maximum current. Its resistance is kept very low so that it should not disturb (reduce) the current in the circuit and measure it accurately. If its resistance is high then it will disturb the circuit current and it will not measure the current accurately.

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

Ans. We connect voltmeter parallel to the circuit to measure the maximum potential difference because potential difference in parallel remains same. The resistance of voltmeter is kept very high because minimum current should flow through voltmeter and maximum current should flow through the circuit. In this way the potential difference across the resistor is measured accurately.

Chapter 15 (Electromagnetic Induction)
Short Answers

Q. 1 **Does the induced emf in a circuit depend on the resistance of the circuit? Does the induced current depend on the resistance of the circuit?**

Ans. The induced emf does not depend upon the resistance of the circuit. It depends upon rate of change of magnetic flux as given by relation $\varepsilon = -N\, \Delta\varphi/\Delta t$

The induced current depends upon the resistance of the circuit. If resistance increases, current will decrease from the relation; $\varepsilon = IR$ or $I = \varepsilon / R$

Q. 2 **A square loop of wire is moving through a uniform magnetic field. The normal to the loop is oriented parallel to magnetic field. Is an emf induced in the loop? Give reasons**.

Ans. No emf will induce in the loop. From the relation $\varepsilon = -vBL\sin\theta$. As normal to the loop and **v** is parallel to **B**, so $\theta = 0$, $E = -vBL\sin 0^o = 0$

Also there is no change of flux due to parallel motion, so $\Delta\varphi / \Delta t = 0$

$\varepsilon = -N\, \Delta\varphi / \Delta t = -N \times 0 = 0$; so no emf will produce.

Q. 3 **A light metallic ring is released from above in to a vertical bar magnet (in the fig). Viewed for above, does the current flow clockwise or anticlockwise in the ring?**

Ans. When viewed from above, current in ring will flow in clockwise direction. According to Lenz's law induced current is such that it opposes motion of the ring. Thus N-pole of the magnetic field produced due to the induce current in the ring must face to N-pole of bar magnet. It is only possible when induced current in ring will flow clockwise direction.

Q. 4 **What is the direction of the current through resistor R in the fig? When switch S is; (a) closed (b) opened**

Ans. a) The direction of current is left to right when switch is closed. The induced current must flow in anticlockwise direction according to Lenz's law.

b) The direction of current is from right to left when the switch is opened. The induced current must flow in clockwise direction according to Lenz's law.

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

Ans. No induced emf does not always act to decrease the magnetic flux through a circuit. According to Lenz's Law it acts to maintain magnetic flux by opposing any change in it. Thus if magnetic flux decreases it tends to increase the magnetic flux and if magnetic flux increases it tends to decrease it.

Q. 6 **When the switch in the circuit is closed a current established in the coil and the metal ring jumps upward (see the fig. in book) Why? Describe what would happen to the ring if battery polarity were reversed?**

Ans. When switch is closed then current will increase from zero to maximum in the coil. This will induce the emf in the metallic ring. Due to induce current in the ring magnetic field will be produced around the ring which will oppose the magnetic field of the coil according to Lenz's law. Due to this opposition the ring jumps in the upward direction. In this case the S-poles of both the magnetic fields will face each other. The ring will jump upward in the same manner, if the battery polarity is reversed. In this case the N-poles of both the magnetic fields will face each other.

Q. 7 **The Fig. in book 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. If the coil is rotated around X-axis then emf and a current is generated in the coil due to change of magnetic flux passing through 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 plane of the loop is parallel to the magnetic field, then angle between vector area **'A'** and magnetic field '**B**' will be 90^o then flux will be zero according to the equation

$\Delta\varphi = \mathbf{\Delta B \cdot A} = BA\cos 90^o = 0$ Hence no emf will be induced as given by the relation

$\varepsilon = -N\, \Delta\varphi / \Delta t = -N \times 0 = 0$

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

Ans. According to right hand rule, the direction of the magnetic force will be from East to West. This force will move the positive charges to the West wing tip. Hence West wingtip will be positively charged.

Q.10 **Show that ε and $\Delta\Phi / \Delta t$ have the same units.**

Ans. As $\varepsilon = W/q$

Units of ε = J/C …..(1)

As $\Delta\varphi / \Delta t = \Delta B\, A / \Delta t$

Hence Units of $\Delta B\, A/ \Delta t = N\, A^{-1}\, m^{-1}\, m^2 / s = N\, m /A\, s = J / C$ …..(2)

From equation (1) and (2) ε and $\Delta\Phi / \Delta t$ 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. An electric motor produces induced emf due to its rotation inside the magnetic field which is also the property of the generator. Hence in this sense we can say that it acts like a generator. According to Lenz's Law the induce emf will reduce the speed of electric motor.

Q.12 **Can a D.C. motor be turned into a D.C. generator? What changes required to be done**?

Ans. Yes a d.c. motor can be turned into a d.c. generator. For this purpose, two changes are required; (i) some arrangement should be made to rotate the armature (ii). disconnect the voltage source and use these terminals for output of d.c. generator.

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 flux remains constant. From the equation; $\Delta\varphi = \mathbf{\Delta B \bullet \Delta A}$. If we increase the area and equally decrease magnetic field and vice versa so that product remains constant.

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

Ans. No. An electric motor cannot be used to drive an electric generator. It is against the law of conservation of energy as it becomes self perpetuating machine.

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

Ans. The metal plate produces an induced emf due to oscillations in the suspended magnet. This induced emf produces current, which produces its own magnetic field that will oppose the motion of the suspended magnet. So oscillations are strongly damped.

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

Ans. We will separate primary and secondary coils with ohmmeter by checking their continuity. Connecting primary coil with a.c. supply of known voltage V_p we will measure the voltage induced V_s by voltmeter. Then we can calculate turns ratio from the formula; $V_s / V_p = N_s / N_p$

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) No. A step up transformer cannot increase the power level. As for ideal case;

Power input = Power out

It can increase or decrease alternating voltage but power, P = VI, will remain same.

b) Primary and secondary coils are connected magnetically but not electrically. Therefore power is transferred due to induced emf.

Q.18 **When the primary of a transformer is connected to a.c. 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) The output power is zero, if the secondary circuit is open. Hence a very small current is drawn by the primary coil from a.c. mains.

b) When output circuit is closed then output power will increase and primary coil has to draw a larger current from the a.c. mains to equalize the power output as we know that

Power input = Power output

Chapter 16 (Alternating Current)
Short Answers

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

Ans. $I_{rms} = I_o / \sqrt{2}$

or $I_o = \sqrt{2}\, I_{rms}$

$= \sqrt{2} \times 10 = 14.14$ A

Q. 2 **Name the device 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) i) Inductor permits flow of direct current but oppose the flow of alternating current due to its inductive reactance. As $X_L = 2\pi f L$, for D.C, f = 0 hence $X_L = 2\pi (0) L = 0$ Hence inductive reactance for d.c. becomes zero.

b) Capacitor permits flow of alternating current but not the direct current. As $X_C = 1/2\pi f L$, for D.C, f = 0 hence $X_C = \infty$ for direct current.

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

Ans. The lamp will reach maximum brilliance for 100 times in one second. In an a.c. cycle, the current becomes maximum twice, once for +ve half and once for –ve half cycle of 50 Hz a.c. source .

Therefore 2f = 2 x 50 = 100 times /second

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

Ans. When switch is closed the current increases from zero to maximum and when switch is reopened then current decreases to zero from maximum. So when the switch is reopend then current is maximum due to which a spark jumps across the switch.

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

Ans. a) for inductor: f = 2f

$X'_L = 2\pi f L = 2\pi * 2f L = 2 * 2\pi f L = 2X_L$

The inductive reactance will become double.

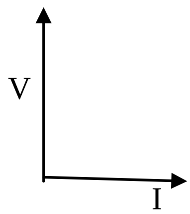
b) for capacitor: f = 2f

$X'_C = 1 / 2\pi fC = 1 / 2\pi * 2f C = \frac{1}{2} \times 1 / 2\pi fC = \frac{1}{2} X_C$

The capacitive reactance becomes half.

Q. 6 **In a R-L circuit, will the current lag or lead the voltage? Illustrate your answer by a vector diagram.**

Ans. In R-L circuit, the current lags behind the voltage by 90^o or $\pi/2$



Q. 7 **A choke coil placed in series with an electric lamp in an A.C. 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. Lamp becomes dim due to large inductive reactance to the flow of current which decreases the current. With the addition of variable capacitor, the reactance of capacitor $X_C = 1/\omega C$ will be adjusted in a way that electrical resonance occurs and it becomes equal to the inductive reactance $X_L = \omega L$. Since X_C and X_L beahve oppositley as a function of frequency so they cancel each other effect. The impedance of the circuit becomes minimum hence maximum current flows through it due to which lamp start glowing with nornal brilliance.

Q. 8 **Explain the conditions under which electromagnetic waves are produced from a sourc.**

Ans. Electromagnetic waves are generated when electric or magnetic flux is changing through a certain region of space. This can be done by oscillating electrical charges. The oscillation can be produced by LC circuit or waving the conductor in space or by continuously reversing the polarity of attached voltage source.

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

Ans. The formula for the resonance frequency is given by

$$f_r = 1/(2\pi\sqrt{LC})$$

We continuously change the value of variable capacitor provided in the oscillator circuit (LC circuit) of our radio set with the help of a knob which changes frequency of this circuit. When this frequency matches the frequency of radio station then resonance takes place and that particular radio station is selected on our radio set.

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

Ans. **A.M. means Amplitude Modulation**: This is the type of modulation in which amplitude of the carrier waves is increased or dimnished as the amplitue of modulating signal increases or decreases but the frequency of the carrier waves is kept constant. The A.M. transmission frequencies ranges from 540 kHz to 1600 kHz. These are long range waves and less effected by the obstacles like hills and large buildings. Their quality of signal is not good.

F.M. means Frequency Modulation: This is the type of modulation in which frequency of the carrier waves is increased or diminished as the modulating signal amplitude increases or decreases but the amplitude of the carrier waves remains constant. The F.M. transmission frequencies has range from 88 MHz to 108 MHz. Frequency modulated radio waves are less effected by the electrical interference, that is why their signal quality is good. These are short range waves.

Chapter 17 (Physics of Solids)
Short Answers

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

Ans. **Crystalline solids**:

Solids which have a regular arrangement of molecules are called crystalline solids. Due to their regular structure they have fixed melting point. All metals like copper, iron, aluminum etc. are crystalline solids.

Amorphous solids:

Solids having a random arrangement of particles are called amorphous or glassy solids. Due to their random structure they donot have a fixed melting point. They are like liquids which are suddenly frozen. Examples are wood, glasss etc.

Polymeric solids:

Solids whose structure is in between crystalline and amorphous solids are called pollymeric solids. They consist of long chain carbon molecules due chemical reaction called polymerization. Examples are ceramics and 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 applied force per unit area to change the length volume or shape of the object is called stress.

$\sigma = F/A$ S.I units of stress are N/m^2 or pascal.

Strain:

The change produced in the length, volume or shape of a body due to applied stress is called strain.

$\varepsilon = \Delta L / L$ It is dimensionless and has no units.

Tensile stress:

The stress applied on a body to change its length is called tensile stress.

Volumetric stress:

It is appled stress which changes the volume of the object.

Shear stress:

It is a stress which changes the shpae of the object.

Tensile strain:

It is the change in length divided by the original length of an object.

$\varepsilon = \Delta L / L$

Volumetric strain:

The strain produced as a result of volumetic stress is called volumetric strain. It is equal to change in volume per unit original volume.

Compressive Strain = $\Delta V/V$

Shear strain:

The strain produced in the body due shear stress is called shear strain.

Shear Strain = $\Delta a/a$

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

Ans. **Modulus of elasticity**:

The ratio of the stress on a body to the strain produced in it is called modulus of elasticity. Mathematically it can be written as

Modulus of elasticity = Stress / Strain

Units of stress and modulus of elasticity

Since $\sigma = F/A$ so its units are N/m^2

As the strain is dimensionless quantity and it has no units. Hence the units of modulus of elasticity is also N/m^2 which are same as units of stress.

Three Kinds of Modulus of Elasticity

i. Young's Modulus

The ratio of tensile stress to the tensile strain is called Young's modulus. Mathematically, $Y = (F/A)/(\Delta L/L)$

ii. Bulk Modulus

The ratio of volumetic stress to the volumetic strain is callled Bulk modulus. Mathematically, $K = (F/A)/(\Delta V/V)$

iii. Shear Modulus

The ratio of shear stress to the shear strain is callled Shear modulus. Mathematically,

$K = (F/A)/\tan\theta$

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

Ans. See the long article in book for stress strain curve.

Elastic Limit: It is the greatest stress that a material can endure without any permanent change in its shape or dimension.

Yield Point: It is the point on the stress strain curve beyond which a material is permanently de-shaped.

Ultimate Tensile Stress: It is the maximum stress which a material can withstand without breaking.

Q. 5 **What ismeant by strain energy? How can it be determined from force-extension graph?**

Ans. See long article in book

Q.6 **Describe the formation of energy bands in solids. Explain difference amongst electrical behaviour of conductors, insulators and semiconductors in terms of energy band theory.**

Ans. See long article in book

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**.

Ans. **Intrinsic semiconductor**

A Pure semiconductor material is called intrinsic semicondutor. In it the concentrations of negative charge carriers (electrons) and positive charge carriers (holes) are the same. e.g. pure silicon, germanium etc.

Extrinsic semiconductor

The semiconductor material in which certain impurities are added is called extrinsic semiconductor. This addition of impurities is called doping. In pure silicon if we add pentavalent impurities like phosphorus it becomes n-type semiconductor material. In pure silicon if we add trivalent impurities like aluminum then it becomes p-type semiconductor material.

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

Ans. A pure semiconductor element consists of holes (+ve charge carriers) and free electrons (-ve charge carriers; electrons). They are equal in number and move at random but in opposite direction. When some voltage is applied across the ends of the semiconductor, then free electrons move towards the positive end and the holes move towards the negative end of the semiconductor.

Q. 9 **Write a note on superconductors**.

Ans. **Superconductors**

The substances whose resistivity becomes zero at certain low temperature are called superconductors. The temperature at which resistivity of material becomes zero is called critical temperature represented by Tc. The first superconductor was discovered in 1911 by Kmaerlingh Ornes. He observed that electrical resistance of mercury disappears at 4.2 K. Some other metals such as Al, Sn and Pb also become superconductor at very low temperatures. In 1986 a new class of ceramic materials was discovered that become superconductors at 125 K. Recently Yttrium barium copper oxide (Yba2 Cu3 O7) have been reported to become superconductor at 163 K. Superconductors have many applications., e.g.magnetic resonance imaging (MRI), magnetic levitation trains and faster computer chips.

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

Ans. **Paramagnetic substances**:

The substances in which, the orbits and the spin axes of the electrons in the atom are so oriented that their fields support each other and the atoms behave like a tiny magnet. They are feebly attracted by a strong magnet e.g. Na and K.

Diamagnetic substances: The substances in whose atoms, there is no resultant field as the magnetic fields produced by both orbital and spin motions of the electrons might add up to zero. They are feebly repelled by a strong magnet, e.g. Cu, Bi & Sb.

Ferromagnetic substances: The substances in which domains cooperate with each other in such a way so as to exhibit a strong magnetic effect on the application of external magnetic field or passing current through the ferromagnetic substances. They are strongly attracted by a magnet, e.g. Fe, Co & Ni.

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

Ans. **Hysteresis loss**:

The dissipation of energy that occurs due to magnetic hysteresis (The lagging behind of magnetization of ferromagnetic material behind the magnetizing current), when the magnetic material is subjected to cyclic changes of magnetization is called hysteresis loss. The magnetic materials for which the area of hysteresis loop is small the dissipation of energy will also be small. These are called soft magnetic materials like soft iron. That is why soft iron is very useful material for making the core of transformer.

Chapter 18 (Electronic)
Short Answers

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

Ans.
- i. Electrons are more mobile than holes.
- ii. Electrons move from low potential to high potential i.e. from –ve to +ve terminal. The holes move from high potential to the low potential i.e. from +ve to –ve terminal.
- iii. Current produced due to flow of electrons is called electronic current and due to flow of holes is called conventional current.

Q. 2 What is the net charge on a n-type or p-type substance?

Ans. The net charge is zero on a n-type or p-type substance. Net charge only appears when their are excess or deficiency of electrons in an atom. Doping only increases their conductivity and does not create deficiency or excess of electrons. Hence both types are electrically neutral.

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

Ans. Yes it is forward bias because anode is at higher potential as compared to the cathode. The p-type of diode is connected with positive terminal of battery and n-type is connected with negative terminal of the battery. This is the condition for forward bias. Hence diode is forward bias under the given condition.

Q. 4 Why charge carriers are not present in the depletion region?

Ans. Since free electrons in the n-region diffuse into the p-region near the junction. As a result of this diffusion no charge carriers are found in the depletion region.

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

Ans. In forward biasing, the charge carriers are pushed towards the junction by the battery. Hence width of depletion region decreases. In reverse biasing, the charge carriers are pulled away from the junction by the opposite terminals of the battery. Therefore width of depletion region decreases.

Q. 6 Why ordinary silicon diodes do not emit light?

Ans. The ordinary silicon diodes have low value of forward bias potential as compared to LED, so visible light do not emit.

$$E = hf,\ f = E / h$$
$$\lambda = c / f = c \times h / E\ [E = 0.7\ \text{eV For silicon}]$$
$$= 3 \times 108 \times 6.63\text{x}10^{-34} = 1.776 \times 10^{-6}\ \text{m}$$

Photons emitted from Si having λ=1.776x10^{-6} > visible light (λ =10 $^{-7}$m)

So they lie in infrared region and not visible.

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

Ans. Photo diode is used to detect the light. In reverse biased condition, the current is negligible small and can not be detected. But when light falls on p-n junction then current increases with intensity of light which can be easily detected.

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

Ans.
- i. Since the base is extremely thin ~ 10^{-6} m, so very few electrons manage to recombine with holes and escape out of the base.
- ii. Most of the electrons due to high $V_{CC,}$ cross the base and enter the collector making the collector current large and base current small.
- iii. The impurity concentration in the base is less due which base current remains less.

Q. 9 What is the biasing requirement of the junctions of a transistor for its normal operation? Explain how these requirements are met in a common emitter amplifier?

Ans. For normal operation of the transistor, the input junction is forward biased and output junction is reverse biased. For common-emitter amplifier, the emitter is common between base and collector. Therefore, the emitter-base junction is forward biased and collector- base junction is reverse biased.

Q.10 What is the principle of virtual ground? Apply it to find the gain of an inverting amplifier.

Ans. Since the open loop gain of the amplifier is very high (10^5) so when non-inverting input terminal (+) is grounded, then same voltage appears at the inverting terminal (-). Therefore potential difference between the two input terminals is approximately zero i.e.

$$V_+ - V_- \approx 0 \text{ or } V_+ \approx V_-$$

So V_- is virtually at ground potential. This is called principal of virtual ground.

(For second part see long question in the book.)

Q. 11 The inputs of a gate are 1 and 0, Identify the gate if its output is (a) 0, (b) 1

Ans. a) NOR gate or AND gate or XNOR gate

b) OR gate, or NAND gate or XOR gate.

Q. 12 Tick (√) the correct answer

(i) A diode characteristic curve is a plot between

(a) current and time (b) voltage and time

(c) voltage and current (d) forward voltage and reverse voltage

(ii) The colour of light emitted by a LED depends on

(a) its forward bias (b) its reverse bias

(c) the amount of forward current **(d) the type of semi-conductor material used**

(iii) In a half-wave rectifier the diode conducts during

a. both halves of the input cycle

b. a portion of the positive half of the input cycle

c. a portion of the negative half of the input cycle

d. one half of the input cycle

(iv) In a bridge rectifier of Fig. Q.18.1 when V is positive at point B with respect to point A, which diodes are ON.

a. D2 and D4 b. D1 and D3

c. D2 and D3 d. D1 and D4

(v) The common emitter current amplification factor β is given by

a. I_C / I_E b. I_C / I_B c. I_E / I_B d. I_B / I_E

(vi) Truth table of logic function

a. summarizes its output values

b. tabulates all its input conditions only

c. display all its input/output possibilities

d. is not based on logic algebra

(vii) The output of a two inputs OR gate is 0 only when its

a. both inputs are 0 b. either input is 1

c. both inputs are 1 d. either input is 0

(viii) A two inputs NAND gate with inputs A and B has an output 0 if

a. A is 0 b. B is 0

c. both A and B are zero d. both A and B are 1

(ix) The truth table shown below is for

a. XNOR gate

b. OR gate

c. AND gate

d. NAND gate

Ans. i) c—voltage and current

ii) d—the type of semi-conductor material used

iii) b—a portion of the positive half of the input cycle

iv) a—D_2 and D_4

v) b—I_C / I_B

vi) c—display all its input/output possibilities

vii) a—both inputs are 0

viii) d—both A and B are 1

ix) a—XNOR gate

Chapter 19 (Dawn of Modern Physics)

Short Answers

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

Ans. Two observers in relative motion will always agree on the speed of light and all non relativistic quantities such as temperature and mass number etc.

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

Ans. According to time dilation, time really passes more slowly in moving system, relative to stationary system as it is experimentally verified. For example a pion (π-meson) when stationary decays in 26 ns but it requires 83 ns when moving at a speed of 0.95c.

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

Ans. a) No difference in the pulse rate, as observing in its own frame of reference.

b) Pulse rate of people on Earth will decrease, as it is observed from other reference frame.

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

Ans. Three equations of special theory of relativity reduce to

$m = \frac{m_o}{\sqrt{1-v^2/c^2}}$ If c = ∞ then $m = \frac{m_o}{\sqrt{1-v^2/\infty}} = m_0$

$t = \frac{t_o}{\sqrt{1-v^2/c^2}}$ If c = ∞ then $t = \frac{t_o}{\sqrt{1-v^2/\infty}} = t_0$

$l = l_0\left(\sqrt{1-v^2/c^2}\right)$ If c = ∞ then $l = l_0\left(\sqrt{1-v^2/\infty}\right) = l_0$

$E = m\,c^2$ If c = ∞ then $E = m\,x\infty = \infty$

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

Ans. No because the increase in mass takes place at relativistic speeds. In the present case compression or extension in the spring does not involve the relativistic speed. Hence mass of the compressed spring will remain constant.

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

Ans. Red colour has less frequency (or energy) as compared to blue. At low temperature a body emits radiation that is of long wavelength.The longest visible wavelength is of red colour. That is why when a solid is heated it first appear red.

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

$E = \sigma T^4$ When $T' = 2T$; $E' = \sigma (2T)^4 = 16\,\sigma T^4 = 16\,E$

So when T is doubled, total radiation from a black body increased by 16 times.

Q. 8 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. $E = nhf$, $c = f\lambda$ or $f = c/\lambda$

$E = nhc/\lambda$ or $n = E\lambda/hc$

Since energies of Red light and Blue light are same, so h, c & E are constants therefore,

$n = \text{const.} \times \lambda$ or $n \propto \lambda$

The above relation shows that greater wavelength have more number of photons. So red beam of light contains greater number of photons.

Q. 9 Which photon, red, green, or blue carries the most (a) energy and (b) momentum?

Ans. a) $E = hf$ or $E \propto f$

As frequency of Blue photon > frequency of Green photon > frequency of Red photon

Therefore, photons of blue light carry the most energy.

b) $p = h/\lambda$ or $p \propto 1/\lambda$

As wavelength of red photon >wavelength of green photon > wavelength of blue photon

This means that the photons of blue light carry the most momentum.

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Q.10 Which has the lower energy quanta? Radiowaves or X-rays

Ans. Radio waves have lower energy quanta, as frequency of radiowaves is less than X-rays.

$E = nhf$ or $E \propto f$

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

Ans. Primarily brightness of a beam of light depends on the intensity. The intensity of light is directly proportional to the number of photons. Hence if number of photons is greater then the brightness of the beam of light will be greater.

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

Ans. When ultraviolet light falls on certain dyes some of its energy is absorbed and rest is emitted in the form of visible light. Infrared light has less energy therefore when it falls on the same dyes some of their energy is also absorbed and rest is emitted which fall in the far-infrared region and cannot be seen.

Q.13 **Will bright light eject more electrons from a metal surface than dimmer light of the same colour?**

Ans. Yes. Number of photoelectrons emitted from the metallic surface is directly proportional to intensity of light falling on its surface according to photoelectric effect. Greater the intensity brighter will be the light. Hence more electrons will be ejected with brighter light as compared to the dimmer light.

Q.14 Will higher frequency light ejects greater number of electrons than low frequency light?

Ans. The energy of ejected electrons depends on the frequency of light falling on the metal surface. But number of ejected electrons depends on the intensity of light. Therefore number of ejected electrons does not depend on the frequency of light so higher frequency or lower frequency will not change the number of ejected electrons.

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

Ans. Yes. Since momentum is quantity of motion contained in a body so when photons of light will collide with the electrons of the metal surface they will transfer their momentum. Although greater portion of the incident light is reflected, but still a part of it is absorbed by the shiny surface.

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

Ans. Because red light has less frequency as compared to blue or white light therefore it does not interact with the photographic film. Due this reason it will not destroy the image developed on the photographic film.

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

Ans. We knot that $E = pc$

$E_A = p_A c$ & $E_B = p_B c$

$E_A = 2E_B = 2\, p_B c$

or $p_A c = 2\, p_B c$ or $p_A / p_B = 2/1$

So the ratio between the momentum of photon A and B is 2:1

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

Ans. In Compton effect some portion of energy of the incident photon is given to the electron and rest is carried by the scattered photon. Therefore incident photon must have sufficient energy (X-rays) to produce the Compton effect. Visible light has less frequency and therefore less energy and Compton effect is not observed with this light.

Q.19 Can pair production take place in vacuum? Explain.

Ans. No, pair production cannot take place in vacuum. It takes place in the electric field in the vicinity of a heavy nucleus. The presence of heavy nucleus is necessary because it takes the recoil energy so that energy and momentum are conserved.

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

Ans. No. It is not possible to create single electron from energy. For charge conservation in the universe, creation of two particles with equal and opposite charges is essential. Electron and positron (an anti-particle of electron) are created in pair production.

Q.21 If electrons behaved only like particles, what pattern would you expect on the screen after the electrons passes through the double slit?

Ans. No diffraction and interference will be observed because the diffraction and interference are wave phenomena. Therefore with particle nature of electrons there will be no interference pattern seen on the screen.

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

Ans. $p = m v = h / \lambda$

or $v = h / m\lambda$

Since h is a constant so if λ is also constant for electron and proton then

$v \propto 1/m$

As $m_e < m_p$ so speed of electron > speed of proton

Q.23 We do not notice the de Broglie wavelength for a pitched cricket ball. Explain why?

Ans. $\lambda = h/mv$

Since the speed of pitched cricket ball is very small and its mass is relatively larger as compared to electron. So its wavelength is so small that it is not measurable and it shows no effect.

Q.24 If the following particles have the same energy, which has the shortest wavelength? Electron, alpha particle, neutron, proton.

Ans. From the relation

$\lambda = h/mv$

For same energy v & h are constants, so $\lambda \propto 1/m$

This means wavelength is inversely proportional to mass. Therefore greater mass shorter will be the wavelength. As α-particle has greatest mass, so it has shortest wavelength.

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

Ans. In diffraction, interference and polarization light behave as a wave. In photoelectric effect, Compton effect and pair production, it behaves as a particle.

Q.26 What advantages an electron microscope has over an optical microscope?

Ans.
a. Electron microscope has high resolution of 0.5 to 1 nm as compared to best optical microscope which has resolution 0.2 µm.
b. Electron microscope gives inner details of the specimen whereas optical microscope gives surface details only.
c. Electron microscope gives three dimensional image whereas optical microscope gives two dimensional image.

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

Ans. No. According to Uncertainty principle, position and momentum of a particle cannot both be measured simultaneously with perfect accuracy. For a precise position of an electron, the momentum becomes uncertain and vice versa.

$\Delta x \bullet \Delta p \approx h$ or $\Delta p \approx h/\Delta x$

for precise measurement of position $\Delta x = 0$,

$\Delta p \approx h/0$

or $\Delta p \approx h/0 \approx \infty$

We cannot measure precisely and simultaneously the momentum of an electron.

Chapter 20 (Atomic Spectra)
Short Answers

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

Ans. First two postulates contradict classical physics; According to Bohr's 1st postulate, an electron in the allowed orbits does not radiate energy. But according to classical theory, an accelerated electron radiates energy due to its circular motion around the nucleus. Bohr's 2nd postulate states that only those stationary orbits are allowed for which orbital angular momentum is an integral multiple of $h/2\pi$. But in classical theory the idea of continuity of energy is found instead of discreteness.

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

Ans. A spectrum, consisted of sharply defined spectral lines emitted from an isolated atom, is called line spectrum. Each line in it represents a transition between two of its energy levels. As the differences between energy levels of the atom do not resemble with those of the atom of any other element, hence it can be used for identification purposes.

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

Ans. Yes. 13.6 eV is the minimum energy required for ionization of hydrogen atom in its ground state. An electron in the ground state can absorb a photon of energy equal to ionization energy. Any extra amount of energy will become the K.E energy of the escaping electron.

Q. 4 How can the spectrum of hydrogen contain so many lines when hydrogen contains one electron?

Ans. There are infinite energy levels around the nucleus of hydrogen atom. Although hydrogen atom contains one electron but its transition can take place from different energy levels. For each transition the electron will emit a spectral line which will have different energy from other spectral line.

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

Ans. Yes, energy is conserved when an atom emits a photon of light. When an atom is excited, the electron from some external source absorbs the energy. The same energy is emitted in the form of photon when it de-excites.

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

Ans. The gas can absorb or emit only those wavelengths whose corresponding energies match the difference between any two of its energy levels. So it will not absorb any wavelength whose energy does match with difference between any two of its energy levels. Hence it will be transparent to all other wavelength.

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

Ans. Actually, when electron absorbs energy it goes to the higher energy level. This electron is called as excited electron. Since electron is the part of atom hence we can say that atom is excited.

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

Ans. Yes. They are high energy electromagnetic waves. Since reflection, refraction, diffraction and polarization are wave phenomena. Hence X-rays will reflect, refract, diffract, and polarize just like any other electromagnetic radiation, if suitable conditions are provided.

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

Ans. The laser light is more intense, monochromatic, unidirectional and coherent. The ordinary light lacks these properties. Hence, a laser beam is more power full than an ordinary light beam.

Q.10 Explain why laser action could not occur without population inversion between atomic levels?

Ans. With out population inversion all the incident photons will used in raising the electrons from their ground states to the metastable states. So there will be no photons for induced emission which is the basis of laser action. Hence laser action will not occur with out population inversion between the atomic levels.

Chapter 21 (Nuclear Physics)
Short Answers

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

Ans. **Isotopes**: Nuclei of elements having same atomic number but different mass number are called isotopes. They have same number of protons but numbers of neutrons are different. They have same chemical properties but different physical properties e.g., hydrogen has three isotopes like $_1H^1$, $_1H^2$ and $_1H^3$.

Q. 2 Why are heavy nuclei unstable?

Ans. Heavy nuclei are unstable because their binding energy per nucleon is less. Also due to weak nuclear forces as the neutrons are not tightly bound.

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. **Half life:** Time required to decay an element into half of its original quantity is called half life.

The half-life is linked with the aggregate quantity (total number of nuclei). Its definition does not deal with a single nucleus. A single nucleus may or may not decay.

Secondly:

If instead of nucleus, we deal with quantity then it will not decay completely after 2 years. Un-decayed quantity after 1 year = ½ N_o

Un-decayed quantity after 2 years = ¼ N_o

Therefore three-fourth quantity will decay after 2 years.

Q. 4 What fraction of radioactive sample decays after two half-lives have elapsed?

Ans. Number of un-decayed atoms after first half life time $T_{1/2}$ = 50 %

Number of un-decayed atoms after first half life = ½ N_o

Number of un-decayed atoms after second half life = ¼ N_o

Therefore three-fourth quantity will decay after 2 years.

Q. 5 The radioactive element 88Ra226 has a half life of 1.6 x 10^3 years. Since the Earth is about 5 billion years old, how can you explain why we still find this element in nature?

Ans. After so many half-lives, although the activity falls, the fraction though becomes very small but never reaches zero. For complete decay infinite time is required. So some quantity of $^{88}Ra_{226}$ will be found after 5 billion years.

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

Ans. α , β and γ radiations interact with matter. They penetrate in the matter with different ranges. They produce ionization after interaction from it, we can measure their energy. After striking they produce fluorescence with some substances. Their interactions with matter produce photoelectric effect, Compton effect and pair production.

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

Ans. Due to electrostatic force, after passing through matter, α and β particles produce ionization in matter. α particle being positively charged attracts an electron and β particle being negatively charged repels an electron from the atom. α particle produce intense ionization along its straight path. The ionizing ability of β particle is about 100 times less than α particles. The path of β particle is not straight but straggling or scattering.

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

Ans. It loses much of its energy due to more ionization, and its range in the medium is small so less penetrating.

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

Ans. α- particle leaves thick, straight and continuous tracks due to intense ionization produced by them. β-particles form thin and discontinuous tracks extending in erratic manner showing frequent deflections. γ-rays leave no definite tracks along their paths.

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Q.10 Why must Geiger Muller tube for detecting α -particles have a very thin end window? Why does a Geiger Muller tube for detecting γ-rays not need a window at all?

Ans. According to the range and penetrating power of α- particles, G.M. tube have very thin end window. The range of α-particle is small due to greater mass so if we take thick window sheet then it will be absorbed by the sheet. Due to high penetrating power, γ-rays do not need any window. They can penetrate even through a thick sheet, so it does not matter whether window sheet is there or not.

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. A solid-state detector is a specially designed p-n junction. It operates under a reverse bias in which electron hole pairs are produced by the incident radiation to cause a current pulse to flow through the external circuit. Then the electrical pulse is amplified and recorded.

Q. 12 What do you mean by the term critical mass?

Ans. **Critical mass**: The minimum mass of a material that can sustain a nuclear chain reaction. It is the quantity of mass which is enough to absorb most of neutrons produced in fission chain reaction and to produce large amount of energy.

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

Ans. One kilogram of uranium, when completely utilized in fission reaction, has about the same fuel value as 3×10^6 kg of coal. Nuclear power is an important substitute for world's energy supplies. In fossil fuel generated power plant steam comes from a boiler fired with coal. In nuclear power plant, the steam is generated by heat released from the fission process. Radiation hazards and atmosphere pollution are disadvantages of nuclear power.

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

Ans. High temperature and energy is needed to overcome high repulsive force between nucleons to form a heavy nucleus. To overcome this electrostatic force of repulsion we need fast moving nuclei, which can be produced from an accelerator. Also we can get high energy from fission reaction for fusion reaction.

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

Ans. We have limited resources of energy but have ever increasing demand of energy. Controlled fusion power plants are probably the promising sources of energy for the future. We have abundant supply of hydrogen and fusion is relatively safer and cleaner process compared with the fission reactions.

Safety:

Advantage: Less radiation hazards, e.g., only neutron radiation effect.

Disadvantage: Difficult to bring under control

Pollution:

Advantage: Less external radiation and contamination. No need for wasteful disposal.

Disadvantage: Needful high energy is taken from fission which is also difficult to control.

Resources:

Advantage: We have abundant supply of hydrogen.

Disadvantage: But high-energy particles or laser are needed.

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

Ans. **Background radiation**: The low intensity radiation resulting from the bombardment of the earth by cosmic rays and from the presence of naturally occurring radio-nuclides in rocks, soil, air and building materials are called background radiation.

Sources:

1- Cosmic rays apparently coming from upper atmosphere.

2- Naturally occurring radioactive materials in the earth's crust.

Q. 17 If you swallowed an α -source and a β –source, which would be the more dangerous to you? Explain why?

Ans. Swallowing α-source is more dangerous than β-source. α-particles pass through matter and produce more ionization and cause much damage. β-particles produce less ionization and pass through body as they have high penetrating power.

Q. 18 Which radiation dose would deposit more energy to your body (a) 10 mGy to your hand, or (b) 1 mGy dose to your entire body.

Ans. With 1 m Gy dose to entire body, more energy will deposit in the body as its clear from following relation:

$D = E / m$ or $E = D \times m$

For a) E_{hand} = 10 m Gy x m_{hand}
For b) Ebody = 1 mGy x m_{body}
Since $m_b$ody > 10 m_{hand}
So in second case (b) more energy will be absorbed.

Q. 19 What is a radioactive tracer? Describe one application each in medicine, agriculture and industry.

Ans. **Radioactive tracer**: Radio-isotopes used to trace the path or position of an element through a biological, chemical, or mechanical system is called radioactive tracer.

Medicine:

Diagnosis: By taking radioactive iodine with food, position of iodine can be followed by G.M. counter. So detector tells the position of the food in the digestive system.

Agriculture:

Productivity of food grains: Labeled fertilizer of radio phosphorous (P32) is placed at several depths and distances from plant. The relationship between the root growth and taking of phosphorous from the soil determine percentage productivity of food grains.

Industrial:

Labeling the elements: Labeled radioactive carbon (C14) mixed in certain compound provide a simple test of leaks in pipes and the flow of rates of liquid without effecting the actual flow.

Q. 20 How can radioactivity help in the treatment of cancer?

Ans. Cobalt-60 is often used in the treatment of cancer. Those cells that multiply rapidly absorb more radiation and are more easily destroyed. γ-rays are used for internal imaging of the brain to determine precisely the size and location of a tumour or other parts of body. Iodine-131 is used to cure cancer of thyroid gland. P32 is used for skin cancer. Safety precautions are necessary for the hospital persons and the patient.