Self Study Series

Short Answers to Questions

of the Textbook

PHYSICS XII

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PREFACE

This book is prepared especially from examination point of view. Sometimes in the question paper short answers to the questions are being asked.

In writing an answer, it should be to the point. And that should be specific as required by the key words of the question.

The answers are written in such a brief form that intelligent as well as less intelligent student can take help from it. Answers are written short and to the point. These can be elaborated according to student's individual capacity. However, I must confess that few answers are long, as the demand of certain questions were to write detailed answer.

It is hoped that it will be helpful for F. Sc. Students. Comments for improvement are invited.

October 31, 2004. Ross Nazir Ullah

How to use this book

Dear students you should follow the following seven steps for complete utilization of this book.

1. Read and try to understand the question.

2. Try to find answer in your mind.

3. Try to find key word and single sentence for the answer.

4. Arrange your answer in your mind.

5. Start writing (may be wrong) your answer.

6. Consult this book, 'Short Answers to Questions'.

7. Compare both answers and finally make your own answer.

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Chapter 12 (Electrostatics)

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. **Zero,** the E is zero, since potential (ΔV) is constant, i.e. $\Delta V = 0$

so $E = -\Delta V / \Delta r = 0$

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. **Decrease.** To follow electric field line for +ve charge, means to move away. So distance increases and electric field decreases, see from following relations.

$$E = \frac{1}{4\pi\in_o}\frac{q}{r^2} \quad \text{or} \quad E \propto \frac{1}{r^2}$$

$$V = \frac{1}{4\pi\in_o}\frac{q}{r} \quad \text{or} \quad V \propto \frac{1}{r}$$

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

Ans. Just touch or bring a positively charged body to the capacitor plate. The capacitor plate which will repel, will be 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) The net force will be **zero.**

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

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. As repulsion from +ve plate and attraction from –ve plate

$F = qE + qE = 2qE$

The net force will be from +ve to –ve plates.

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

Ans. Because E has only one direction at any given point. If the lines cross, E could have more than one direction. Which is incorrect.

Q. 6 ***If a point charge q of mass m is released in a non-uniform electric field, will it make a rectilinear motion ?***

Ans. Rectilinear motion, in a field due to isolated charge. It will follow the path along the field line.

Move in curved path, in the electric field due to combined charges.

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 charges balloon. There is no charge inside so the flux is zero.

$\phi_e = q / \in_o = 0$ [because $q = 0$]

& $\phi_e = E \cdot A = 0$ [because $= \phi_e = 0$]

A is not zero. So E is 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 the area (closed surface), in outward direction due to +ve charge.
Lines of force will be radially moving outward containing the charge.

$$Q \propto \phi \quad \text{or} \quad \phi \propto Q$$

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

$$\phi = 1/\in_o \times Q \text{ , which is Gauss's law.}$$

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

Ans. To high potential. Electric potential increases towards +ve end. Electrons being –ve charged will be attracted towards higher (+ve) potential.

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. **Drift velocity:**

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

When charge passes through a conductor, we have

$$I = nAqv \quad \text{or} \quad v = I / nAq$$

For free electrons,

$$v_D = I / nAe \qquad [V = IR \text{ or } I = V/R]$$

$$\text{or} \quad v_D = V / nAeR \quad \Rightarrow \quad v_D \propto V \qquad \ldots\ldots (1)$$

$$v_D = VxA / nAe\rho L \qquad [R = \rho L / A]$$

$$v_D = V / ne\rho L \quad \Rightarrow \quad v_D \propto 1/L \qquad \ldots\ldots(2)$$

from relation (1) $\qquad [R \propto T \text{ or } R = \text{const x } T]$

$$v_D = V / nAe\,(\text{const})T \quad \Rightarrow \quad v_D \propto 1/T \qquad \ldots\ldots(3)$$

i) from the relation (1), v_D will increase with increasing potential difference.

ii) from relations (2) & (3), drift velocity will increase with decreasing the length and temperature.

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). Bends do not change dimensions.

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 = 1 5 00 Ω ; tolerance $\pm$ 5 % (indication of gold)

brown green red

B = 4 9 00 Ω ; tolerance $\pm$ 10 % (indication of silver)

yellow white orange

tolerance means that the actual resistance may be any value within 5% (10%) of the nominal value.

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

Ans. **Due to collisions**, which the free electrons encounter with atoms of the lattice, resistance of a conductor rise with temperature. As amplitude of a conductor increases so probability of their collision increases.

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 for constant temperature. The change in temperature of the lighted bulb will change the resistance and the condition of the Ohm's law will not be applicable.

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

Ans. $P = V^2 / R$ or $R = V^2 / P$

i) $(220)^2 / 500 = 96.8\ \Omega$--lower

ii) $(220)^2 / 100 = 484\ \Omega$

The filament resistance of 500W, 220V light bulb is **lower.**

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

Ans. Potentiometer or potential divider is a circuit, which can give a continuously varying potential. This instrument is used for measuring voltage by balancing two opposing potentials so that no current flows through a galvanometer.

In fig. (b) $I = E / R$ .....(1)

Potential drop between A & C:

$V = r I$ .....(2)

From equations (1) and (2) we have

$V = r E/R$

As C is moved from A to B, r varies from 0 to R and potential drop between A & C changes from 0 to E.

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

Ans. The relation for terminal potential difference.

$E = IR + Ir$ or $IR = E - Ir$; where IR is terminal potential difference.

From the above relation, terminal potential difference will deceases as I increases.

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 so as to form a mesh, used for accurate measurement of electrical resistance. If we connect three known resistances, after no deflection in galvanometer, calculating unknown resistance from

$R_1 / R_2 = R_3 / R_4$

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 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.

$\Delta\phi = B \cdot A = BA\cos\theta = BA\cos 0^o = BA$ (maximum)

The flux is minimum when plane of the loop is parallel to X-axis and vector area will be perpendicular to B.

$\Delta\phi = B \cdot A = BA\cos\theta = BA\cos 90^o = 0$ (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. **No** magnetic field due to stationary charges. (They produce only electric field) There is magnetic field around moving charges. And they produce 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.

$B = \mu_o nI = \mu_o N/l\, I$ [$n = N / l$]

or $B = \mu_o N / 2l\, I = \frac{1}{2} (\mu_o N/l\, I)$ [for $l = 2l$]

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

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

$B = \mu_o nI = \mu_o N/l\, I$ [for N = 2N]

or $B = \mu_o 2N / l\, I = 2 (\mu_o N/l\, I) = 2B$

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. The proton will move in +y direction

(from R. H. rule)

$F = q (v \times B) = qvB\sin\theta$

No, the proton will move along curved path in X-Y plane.

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 particles are oppositely charged, one is positively charged and the other is negatively charged.

They will experience a force in the magnetic field

$F = q (v \times B)$

or $F = -e(v \times B)$ & $F = +e (v \times B)$

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 follow a circular path under the action of magnetic force

$$F = q (v \times B) = qvB\sin\theta$$

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

$$W = F \bullet d = Fd\cos 90^o \qquad [\theta = 90^o]$$
$$= 0$$

so the work done by the magnetic force is zero.

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. Three possibilities:

i) Magnetic field is not present.

ii) The magnetic field is parallel or anti-parallel to the direction of motion

$$F = qvB\sin 0^o = 0 \quad \text{[for parallel]}$$
$$F = qvB\sin 180^o = 0 \quad \text{[for anti-parsallel]}$$

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

iii) The magnetic field B is balanced by an electric field E

$$F = qE, \; F = qv \times B$$

if balanced, $qE = qvB$ or $v = E/B$

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

Ans. The direction of striking electrons will change due to magnetic field of this magnet. The electrons move towards the screen from the picture tube, which pass through the balanced magnetic fields. This balance of magnetic fields is disturbed by bringing external magnet and the striking electrons are deflected, making distorted picture.

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. When plane of the coil is placed perpendicular to the magnetic field.

$$\tau = IBA\cos\alpha$$

for angle between B and plane of the loop, $\alpha = 90^o$

$$\tau = IBA\cos 90^o = 0$$

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. The deflection of current carrying loop will indicate the presence of magnetic field. A torque is produced due to current in a loop placed in a magnetic field.

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

Ans. e/m = v/Br or r = mv/eB
Isotopes of different m will follow different radius r, and can be separated in the magnetic field. Just as in mass spectrograph.

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 coil in the magnetic field should be parallel. $\tau = IBA\cos\alpha = IBA\cos 0^o = IBA$
b) for minimum torque, the plane of the coil should be perpendicular;
$\tau = IBA\cos 90^o = 0$

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. For d..c. , the coil will turn in one direction. A torque acts on the coil which rotates it. For a.c., it will oscillate with a.c. frequency.

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

Ans. So that maximum current can flow through galvanometer. As we put galvanometer in series with the circuit. So low resistance do not disturb the current in the circuit.

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

Ans. So that minimum current will flow through voltmeter, as we put voltmeter parallel to the circuit. With high resistance in the voltmeter, obstruct the current to flow from the voltmeter and circuit current will not disturb.

Chapter 15 (Electromagnetic Induction)

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; $\varepsilon = -N\,\Delta\phi/\Delta t$
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 a 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

$$\Delta\phi / \Delta t = 0$$

$\varepsilon = -N\,\Delta\phi / \Delta t = -N \times 0 = 0$; 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. In clockwise direction, current will flow in ring, when viewed from above. In the light of Lenz's law and applying R.H. rule, induced current is such that it opposes motion of the ring. Thus N-pole must produce towards the face of the ring opposite to N-pole of magnet. It will be due to clockwise direction of induced current in ring.

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. As the induced current will flow in anticlockwise direction.
b) The direction of current is from right to left when the switch is opened. As the current flows in opposite direction, in clockwise direction.

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

Ans. No. from Lenz's Law, the induced emf opposes the cause producing it. If magnetic flux in a circuit increases then emf acts to decrease the magnetic flux. If magnetic flux decreases then emf acts to increase the magnetic flux.

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) Why? Describe what would happen to the ring if battery polarity were reversed?***

Ans. From establishment of current, induced magnetic flux will be produced in the cylinder. From Lenz's law an opposing emf in the ring will be produced. The face of the ring opposite to coil develops similar pole of magnet and experiences repulsion, which makes it to jump upward.
The ring will jump upward in the same manner, if the battery polarity is reversed. The same process will happen as mentioned above.

Q. 7 ***The Fig. 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. Around X-axis, if the coil is rotated, will generate an emf and a current 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. Positioning plane of the loop parallel to the field. When the coil is held parallel to the direction of B, then the angle between vector area A and B will be 90^o .

$$\phi_B = B \bullet A = BA\cos 90^o = 0$$

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. [At the two magnetic poles, the direction of the earth's magnetic field is vertical. At north magnetic pole it is downward into the ground, at south magnetic pole, it is upward out of the ground. Here on both places, the compass needle does not indicate any particular direction along the ground.]

Left wingtip will be positively charged. The electrons in the wing experience the magnetic force [F = -e(vxB)] From R.H. rule, the electrons will move towards right, (the direction of conventional current is left). Due to it left wingtip (West side) will be positively charged.

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

Ans. Units of ε

$$\varepsilon = -vBL = \frac{m}{S} \times \frac{Wb}{m^2} \times m = \frac{Wb}{S} = Wb\, S^{-1} \qquad .....(1)$$

& units of $\frac{\Delta\phi}{\Delta t} = \frac{B \bullet A}{\Delta t} = \frac{Wb}{m^2} \times \frac{m^2}{S} = \frac{Wb}{S} = Wb\, S^{-1}$ .....(2)

from the above we see that ε and $\Delta\phi / \Delta t$ have 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. **Yes** it also acts as a generator. When the electric motor is running, due to rotation of its coil, an emf is induced in it. It is called back emf, which produces opposing current. It increases with speed of motor. This means that it also acts as a generator.

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.
To change it, needs some arrangement to rotate the armature. Disconnect the brushes of the commutator from d. c. supply and connect it with some external circuit.

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; $\Delta\phi = B \bullet A$

B and A are inversely proportional to each other. If the area of the loop and magnetic field passing through the loop are changed in such a way to make product constant, then no induced emf will be produced.

Secondly, if plane of the coil is parallel to the magnetic field, changing in area and the field will not induce any emf in the loop.

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. Perpetual motion machine is not possible according to law of conservation of energy.

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. Separate primary and secondary coils by ohmmeter. Connect primary coil with a.c. supply of known voltage V_p . measure the voltage induced Vs by voltmeter. Calculate turns ratio from; $V_s / V_p = N_s / N_p$

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 voltage or current but power, P = VI, will remain same.

b) Due to induced emf, power is transferred.
There is no transfer of charge, but the change of flux in one coil is linked with the other coil and emf is produced.

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, very small current is drawn by the primary coil from a.c. mains.
b) Output power will increase, when the secondary circuit is closed.
Power input = Power output
Greater current is needed in primary for equalizing power in the secondary coil.

Chapter 16 (Alternating Current)

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—permit flow of direct current but oppose the flow of alternating current.
ii) Semiconductor devices, e.g., semiconductor diode.

b) Capacitor—permit flow of alternating current but not the direct current.

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

Ans. 100 times in one second. In a.c. cycle, the current becomes maximum two times, for +ve half and for –ve half cycle of 50 Hz a.c. supply.

$2f = 2 \times 540 = 100$ times

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. Energy is stored in the magnetic field of the inductor, due to induced emf. When switch is opened, a spark jumps due to stored energy in the inductor.

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

Ans. a) for inductor: $f = 2f$

$X_L = 2\pi fL = 2\pi\, 2f\, L = 2 \times 2\pi fL = 2X_L$

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 become 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 π /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 (Resistance)
With the addition of variable capacitor, the reactance of capacitor $X_C = 1/\omega C$ will be balanced with the inductor having reactance $X_L = \omega L$, and can be adjusted for normal brilliance, since inductance and capacitance behave oppositely as a function of frequency.

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

Ans. Electromagnetic waves are generated when electric or magnetic flux is changing through a certain region of space. Also accelerated electrical charges will generate a wave by moving field. So they can be produced either accelerating a charged particle in a potential difference or oscillating it by connecting to an a.c. source.

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

Ans. The reception is selected by adjusting the value of the capacitor to that of natural frequency of L-C circuit of the transmitting station. Then the circuit will resonate under driving action of the antenna and will be tuned.

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

Ans. A.M. means, Amplitude modulation—variation of a carrier wave by changes in the amplitude of the wave.
F.M. means, Frequency modulation—variation of a carrier wave by changes in the frequency of the wave.

Chapter 17 (Physics of Solids)

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

Ans. Crystalline solids:
Solids with a definite, fixed melting point, having a regular arrangement of particles.
Amorphous solids:
Solids having a random arrangement of particles.
Polymeric solids:
Solids having large molecules consisting of repeated units.
Distinctions:
Regular arrangement of particles constitute a crystal, random arrangement of particles make an amorphous, and having large molecules with repeated units make a polymer.

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 distorting force per unit area set up inside the body. SI unit is N/m^2 called Pascal.
Strain:
The change produced in the dimensions of a body under a system of forces. It is dimensionless and has no units.
Tensile stress:
The stress tending to stretch a body.
Compressive stress:
It is an overall force per unit area (pressure) applied.
Shear stress:
It is a stress tending to produce an angular deformation. It is the tangential force per unit area.
Tensile strain:
It is the change in length divided by the original length ($\Delta d/l$). It applies to the stretching of a body.
Compressive strain:
The strain produced as a result of compressive stress.
Shear strain:
It occurs when an angular deformation occurs, and 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.***

Ans. Modulus of elasticity:
The ratio of the stress on a body to the strain produced. It has three kinds.
Young's modulus: Linear elasticity, or elasticity of length.
Bulk modulus: Elasticity of volume, corresponding to volume strain.
Shear modulus: The ratio of the shear stress on a body to the shear strain produced.

$$\text{Units of } E = \frac{\text{units of stress}}{\text{units of strain}} = \frac{\text{units of stress}}{\text{dimensionless}} = \text{units of stress}$$

So units of modulus of elasticity and units of stress are same, as units of strain have no units.

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. Elastic limit:
Point above the proportional limit where the material no longer obeys Hooke's law.
Yield point:
The point at which the material begins to 'flow', i.e. the strain increases with time up to breaking point without further increase in the stress.
Ultimate tensile stress:
The maximum stress that a material can withstand; regarded as the normal strength of the material.

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

Ans. Strain energy:
It is the potential energy stored in the body because of an elastic deformation, which is equal to work done to produce this deformation.
In force-extension graph, F is the force applied and Δx is the extension produced, then

energy stored = work done

= area of ΔOAB = ½ OA x AB = ½ l_1 x F_1

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. An energy band is formed due to closely spaced and discrete energy levels. Within these permissible energy levels taken in groups called energy bands, the levels are very close and they appear to be continuous.
In conductors, the valence and conduction bands largely overlap each other.
Insulators having; i) an empty conduction band ii) a full valence band and iii) a large energy gap between them.
Semiconductors at room temperature have
i) partially filled conduction band ii) partially filled valence band
iii) a very narrow forbidden energy gap between conduction and valence bands.

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. In it the concentrations of negative charge carriers (electrons) and positive charge carriers (holes) are the same.
Extrinsic semiconductor
Such material in which certain impurities are added. Its conductivity increases considerably depending strongly on the type and concentration of the impurity.
From pure silicon N-type substance is obtained by adding impurity like a pentavalent element phosphorous $_{15}P$.
Four valence electrons of As form covalent bonds with valence electrons of Si atoms, but one electron is left unbounded. It is called free electron.
From pure silicon, P-type substance is obtained by adding an impurity of trivalent element like $_{31}Ga$. Three valence electrons of surrounding $_{14}Si$, but one bond is not completed because no electron is available. This vacancy of electron is called a hole.

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 hole move towards the negative end of the semiconductor.

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

Ans. Superconductors

In some substance have the property that in them there is effective disappearance of electrical resistance, when they are cooled close to absolute zero. Currents in induced in circuits of such materials have persisted for several years with no measurable change.

In these materials resistivity becomes zero below a certain temperature Tc called critical temperature.

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 ($YBa_2Cu_3O_7$) 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 magnets.

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 the atoms cooperate with each other in such a way so as to exhibit a strong magnetic effect.

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 of magnetization of ferromagnetic material behind the magnetizing force), when the magnetic material is subjected to cyclic changes of magnetization. The magnetic materials for which the area of hysteresis loss is small and dissipation will also be small, are suitable for construction of a transformer.

Chapter 18 (Electronic)

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. Electrons actually move in n-type substances, as majority carriers moving from –ve to +ve terminal.
The holes appear to be mobile in p-type substance as majority carriers moving from +ve to –ve side. When a broken covalent bond left a hole then another electron fill the hole and the hole made shift to the next and so on.

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. Doping only increase their conductivity. 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. Reverse biased for Si & Ge. When the energy is not sufficient to overcome the potential barrier [0.7 V for Si, 0.3V for Ge], the current cannot flow. In this state p-n-junction cannot be forward biased.

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. 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 depletion region is **narrowed**. In reverse biasing, the depletion region is **widened.**

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

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

$$E = hf,\ f = E / h$$

$$\lambda = c/f = c \times h / E \quad [E = 0.7eV$$

$$= \frac{3\times10^{8} \times 6.63\times10^{-34}}{0.7\times1.6\times10^{-19}} = 1.776 \times 10^{-6}\ m$$

Photons emitted from Si having $\lambda = 1.776\times10^{-6}$ m are $>$ visible light ($\lambda = 10^{-7}$ m)
So they lie in infrared region and not visible.

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

Ans. Due to almost negligible reverse current, photodiode is operated in reverse biased, which is increased with intensity of light upon the exposure of p-n junction from light.

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

Ans. Since the base is extremely thin ~ 10^{-6} m, very few electrons manage to recombine with holes and escape out of the base.

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, batteries V_{BB} and V_{CC} are connected forward biased for emitter-base junction and collector-base junction is reverse biased.
For common-emitter circuit input signal voltage is applied to the base and output is taken out from the collector and the emitter is grounded and made common between input and output.

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

Ans. According to principle of virtual ground, when non-inverting terminal (+) is grounded, and since A_{OL} is very high so

$$V_+ - V_- \cong 0 \quad \text{or} \quad V_+ \approx V_o$$

So V_- is virtually (not actually) at ground potential.

To find gain:
Current through $R_1 = I_1 = V_1 / R_1$
& current through $R_2 = I_2 = V_o / R_2$
from Kirchhoff's 1st rule

$$\sum I = 0 \text{ or } I_1 + I_2 = 0$$
$$\text{or } I_1 = - I_2$$
$$\text{or } V_1 / R_1 = - V_o / R_2$$
$$\text{or } V_o / V_1 = - R_2 / R_1 = \text{Gain}$$

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
The truth table for the above is
A = 1 , B = 0 & output = 0
b) OR gate, or NAND gate or XOR gate.
The truth table for the above three gates is
A = 1, B = 0 & output = 1

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. D_2 and D_4 b. D_1 and D_3

c. D_2 and D_3 d. D_1 and D_4

(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)

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

Ans. When experimenters observe what is going on in their own frame of reference, the same experiment gives identical observations.

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. No change for its own frame of reference.

$$t = \frac{t_o}{\sqrt{1 - v^2/c^2}}$$

for example: for $v = 0.9c$

$$t = \frac{t_o}{\sqrt{1 - (.9c)^2/c^2}} = \frac{t_o}{\sqrt{1 - .81c^2/c^2}} = \frac{t_o}{\sqrt{0.19}} \cong 2\,t_o$$

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 observe 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 reduced to classical results;

$m = m$, $l = l$, $t = t$, but energy will become infinite.

$$m = \frac{m_o}{\sqrt{1 - v^2/\infty}} = \frac{m_o}{\sqrt{1 - 0}} = m_o$$

$$l = l_o \sqrt{1 - v^2/\infty} = l_o \sqrt{1 - 0} = l_o$$

$$t = \frac{t_o}{\sqrt{1 - v^2/\infty}} = \frac{t_o}{\sqrt{1 - 0}} = t_o$$

$E = m(\infty)^2 \Rightarrow$ E is infinity

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. From classical point of view the mass remain same. According to theory of relativity, change of mass is due to relative motion and not due to position.

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 red.

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

Ans. $E = \sigma T^4$; For $T = 2T$; $E = \sigma (2T)^4 = 16\sigma T^4 = 16E$

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 constant

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

The above relation shows that greater wavelength have more number of photons. So Red beam 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 $f_B > f_G > f_R$

So photons of blue light carrier the most energy.

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

as $\lambda_R > \lambda_G > \lambda_B$ so $p_R < p_G < p_B$

this means that the photons of blue light carries the most momentum.

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

Ans. Radiowaves 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 frequency of photons Brightness is linked with energy. And high frequency photons have more energy.

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. Due to less frequency of infrared light. For the emission of visible light, photons of frequency higher than threshold frequency f_o are needed.

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

Ans. **Yes**. Emission of electrons are directly proportional to intensity of light, according to the law of photoelectric emission.

So bright light will eject more electrons than dimmer light of same colour.

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

Ans. **Yes**. Higher frequency of light will eject greater number of electrons, if its frequency is greater than the threshold frequency of the metal.

If its $f < f_o$, than no emission of electrons.

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

Ans. **Yes**, due to collision of photons of light with the electrons of the metal surface. Although, greater portion of the incident light is reflected, but still 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. It gives necessary provision for film development. If the frequency of red light is less than the threshold frequency of the photographic film and paper then less damage will occur.

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. $p = E / c$ or $E = pc$

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

$E_B = 2E_A = 2p_A c$

or $p_B c = 2 p_A c \Rightarrow p_A / p_B = ½$

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

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

Ans. Visible light has less frequency. Compton effect is observed with X-rays and γ-rays photons having necessary frequency for this phenomenon.

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

Ans. **No**. Pair production takes place in the electric field in the vicinity of a heavy nucleus. It cannot take place in vacuum.

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 is 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 will be observed. And there will be no interference pattern seen on the screen, if electrons behave like particles in double slit experiment.

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

Ans. $p = mv = h/\lambda$

or $v = h / m\lambda$

for same λ & h , and λ being constant $v \propto 1 / m$

as $m_e < m_p$ so $v_e > v_p$

Above relation shows that the speed of electron is greater than that of proton.

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

Ans. $$\lambda = \frac{h}{mv} = \frac{6.63 \times 10^{-34}}{0.16 \times 90} \approx 4.6 \times 10^{-35} \text{ m}$$

This wavelength of cricket ball is so small that it is not measurable or detectable by any of its effects.

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

Ans. From the relation

$\lambda = h / mv$

for same energy (or K.E.) v & h are constant, so $\lambda \propto 1 / m$

for greater mass has shorter wavelength. As α-particle has greatest mass, so the α-particle 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. Electron microscope has high resolution. It can distinguish details not visible with optical microscope.
A resolution of 0.5 to 1 nm is possible with a 50 kV microscope as compared to best optical resolution of 0.2 μm.

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.

$$\Delta x \cdot \Delta p \approx h$$

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

$$0 \cdot \Delta p \approx h$$

$$\text{or} \quad \Delta p \approx h / 0 \approx \infty$$

we cannot measure precisely the momentum of an electron.

Chapter 20 (Atomic Spectra)

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. Line spectrum:
A spectrum consisting of monochromatic slit images having wavelengths characteristic of the atoms present.
Line spectrum is characteristic of an atom. (And band spectrum is characteristic of molecules). The spectrum of certain element contains wavelength that exhibit definite regularities. It makes easy to identify an element.

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**. An electron in the ground state can absorb a photon of energy equal to 13.6 eV, called ionization energy. If the electron absorbs the energy greater than 13.6 eV, it will lift the electron to some higher state known as excitation potential.

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

Ans. When a hydrogen atom is excited from some external source then its electron jump to some high energy level. And when this single electron makes transition to a lower state from its excited state, then other spectral lines are given out.

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-excite.

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. Atoms of a gas has fixed energy levels. It can emit or absorb radiation of specific wavelength.
The transition from higher shell to lower shell will give emission of certain wavelength. It will absorb same wavelength for transition to the same higher shell.
It is the inherited character of every element to emit or absorb radiation of some specific wavelength, that's why it is transparent to other wavelengths.

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

Ans. When the revolving electrons absorb certain energy, they move to higher shell in excited state, so we can say the atom is excited.

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

Ans. Yes. They are part of electromagnetic spectrum. They will reflect, refract, diffract, and polarize, if suitable conditions are provided.

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

Ans. Laser light moves up to greater distance, heat, destroy certain cells, which ordinary light cannot do.
Laser light is well defined being monochromatic, coherent and intense as compared to ordinary light.

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

Ans. For laser action, we need a net absorption of photons due to more atoms in the ground state than in excited state. It is only if the situation is of population inversion, i.e., a net emission of photons can result if there is more number of atoms in the excited state than in the ground state.

Chapter 21 (Nuclear Physics)

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

Ans. **Isotopes:**

Atoms having same atomic number but different mass number.
They have same chemical properties. And physical properties are different, e.g., a certain isotope may be stable and other may be radioactive. They have same number of protons but numbers of neutrons are different.

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.
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, if deal with quantity. It will not decay completely after 2 years.
Un-decayed quantity after 1 year = $\frac{1}{2} N_o$
// // // 2 years = $\frac{1}{4} N_o$
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 time $T_{1/2}$ = 50 %
// // // // // // $2T_{1/2}$ = 50/2 = 25 %
so decayed atoms will be = 100 – 25 = 75 %

Q. 5 ***The radioactive element $_{88}Ra^{226}$ 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 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.
γ-rays after interaction produce photoelectric effect, Compton scattering 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-, β- particles produce ionization in matter.
α- particle attracts an electron and β- particle 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 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 leave 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.

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, 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, operating 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 such 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, need fast moving nuclei, which can be produced from an accelerator.

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:

Less radiation hazards, e.g., only neutron radiation effect—advantage.

Difficult to bring under control—disadvantage.

Pollution:

Less external radiation and contamination. No need for wasteful disposal—advantage.

Needful high energy is taken from fission—disadvantage.

Resources:

We have abundant supply of hydrogen--advantage.

But need of high-energy particles or laser—disadvantage.

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.

Sources:

1- Cosmic rays apparently coming from upper atmosphere.

2- Naturally occurring radiation substances 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 ionization and cause much damage.

β-particles produce less ionization and pass through body as 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 mGy dose to entire body, more energy will deposit in the body.

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

For a) $E_{hand} = 10\ mGy \times m_h$

For b) $E_{body} = 1\ mGy \times m_b$

Since $m_b > 10\ m_h$

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.

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 (P^{32}) 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 (C^{14}) 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. P^{32} is used for skin cancer. Safety precautions are necessary for the hospital persons and the patient.