Chapter One

ELECTRIC CHARGES AND FIELDS

MCQ I

1.1 In Fig.1.1, two positive charges q_2 and q_3 fixed along the y axis, exert a net electric force in the + x direction on a charge q_1 fixed along the x axis. If a positive charge Q is added at (x, 0), the force on q_1

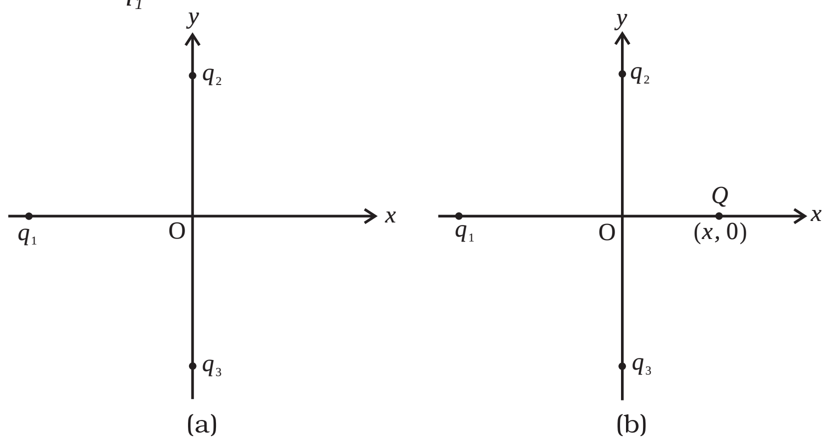


Fig. 1.1

(a) shall increase along the positive x-axis.
(b) shall decrease along the positive x-axis.
(c) shall point along the negative x-axis.
(d) shall increase but the direction changes because of the intersection of Q with q_2 and q_3.

1.2 A point positive charge is brought near an isolated conducting sphere (Fig. 1.2). The electric field is best given by

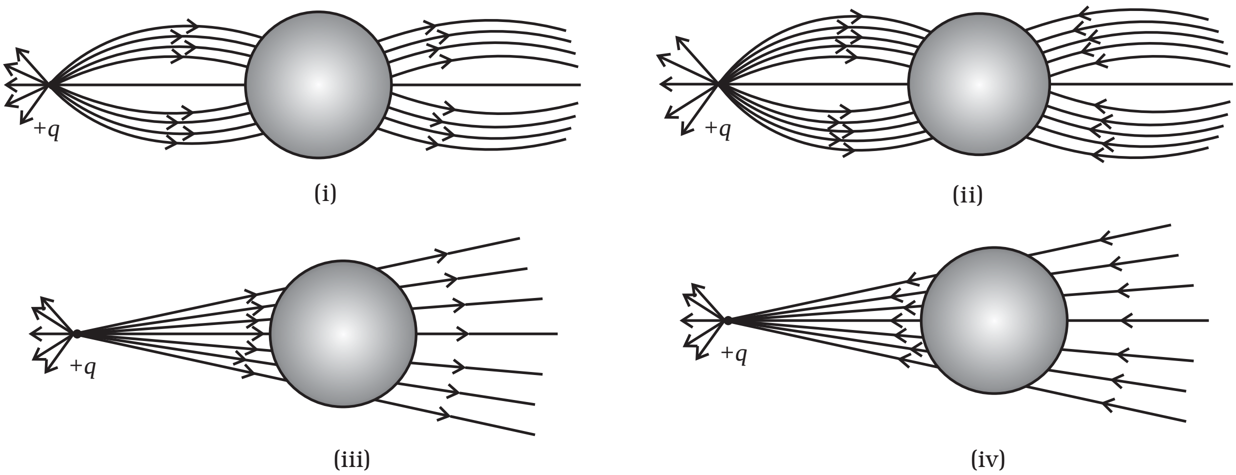


Fig. 1.2

(a) Fig (i) (c) Fig (iii)
(b) Fig (ii) (d) Fig (iv)

1.3 The Electric flux through the surface

(a) in Fig.1.3 (iv) is the largest.
(b) in Fig. 1.3 (iii) is the least.
(c) in Fig. 1.3 (ii) is same as Fig. 1.3 (iii) but is smaller than Fig. 1.3 (iv)
(d) is the same for all the figures.

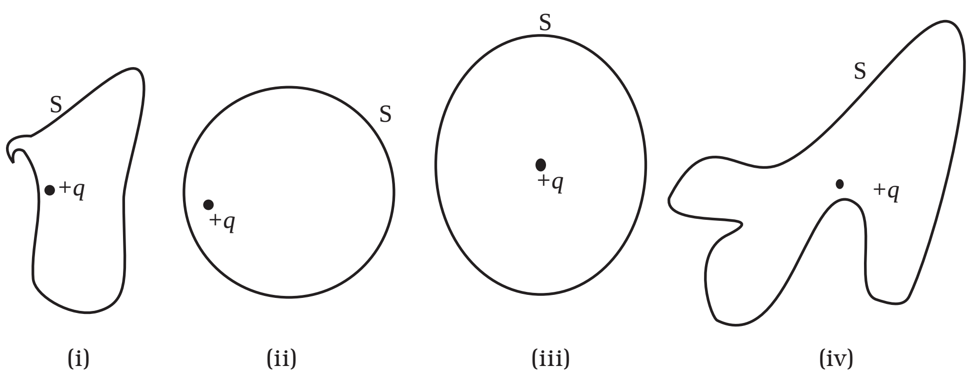


Fig. 1.3

Electric Charges and Fields

1.4 Five charges q_1, q_2, q_3, q_4, and q_5 are fixed at their positions as shown in Fig. 1.4. S is a Gaussian surface. The Gauss's law is given by

$$\oint_S \mathbf{E}.d\mathbf{s} = \frac{q}{\varepsilon_0}$$

Which of the following statements is correct?

(a) **E** on the LHS of the above equation will have a contribution from q_1, q_5 and q_3 while q on the RHS will have a contribution from q_2 and q_4 only.

(b) **E** on the LHS of the above equation will have a contribution from all charges while q on the RHS will have a contribution from q_2 and q_4 only.

(c) **E** on the LHS of the above equation will have a contribution from all charges while q on the RHS will have a contribution from q_1, q_3 and q_5 only.

(d) Both **E** on the LHS and q on the RHS will have contributions from q_2 and q_4 only.

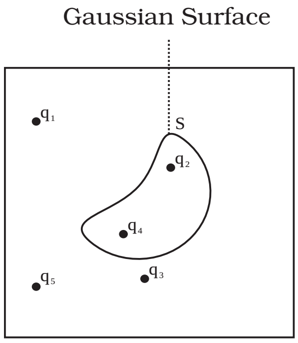


Fig. 1.4

1.5 Figure 1.5 shows electric field lines in which an electric dipole **p** is placed as shown. Which of the following statements is correct?

(a) The dipole will not experience any force.

(b) The dipole will experience a force towards right.

(c) The dipole will experience a force towards left.

(d) The dipole will experience a force upwards.

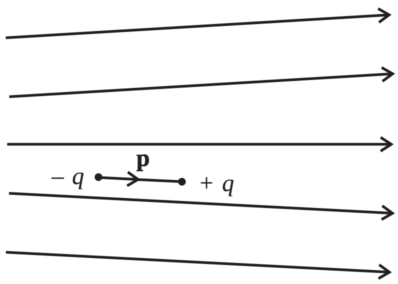


Fig. 1.5

1.6 A point charge $+q$, is placed at a distance d from an isolated conducting plane. The field at a point P on the other side of the plane is

(a) directed perpendicular to the plane and away from the plane.

(b) directed perpendicular to the plane but towards the plane.

(c) directed radially away from the point charge.

(d) directed radially towards the point charge.

1.7 A hemisphere is uniformely charged positively. The electric field at a point on a diameter away from the centre is directed

(a) perpendicular to the diameter

(b) parallel to the diameter

(c) at an angle tilted towards the diameter

(d) at an angle tilted away from the diameter.

MCQ II

1.8 If $\oint_s \mathbf{E}.d\mathbf{S} = 0$ over a surface, then

(a) the electric field inside the surface and on it is zero.
(b) the electric field inside the surface is necessarily uniform.
(c) the number of flux lines entering the surface must be equal to the number of flux lines leaving it.
(d) all charges must necessarily be outside the surface.

1.9 The Electric field at a point is

(a) always continuous.
(b) continuous if there is no charge at that point.
(c) discontinuous only if there is a negative charge at that point.
(d) discontinuous if there is a charge at that point..

1.10 If there were only one type of charge in the universe, then

(a) $\oint_s \mathbf{E}.d\mathbf{S} \neq 0$ on any surface.

(b) $\oint_s \mathbf{E}.d\mathbf{S} = 0$ if the charge is outside the surface.

(c) $\oint_s \mathbf{E}.d\mathbf{S}$ could not be defined.

(d) $\oint_s \mathbf{E}.d\mathbf{S} = \frac{q}{\varepsilon_0}$ if charges of magnitude q were inside the surface.

1.11 Consider a region inside which there are various types of charges but the total charge is zero. At points outside the region
(a) the electric field is necessarily zero.
(b) the electric field is due to the dipole moment of the charge distribution only.

(c) the dominant electric field is $\propto \frac{1}{r^3}$, for large r, where r is the distance from a origin in this region.
(d) the work done to move a charged particle along a closed path, away from the region, will be zero.

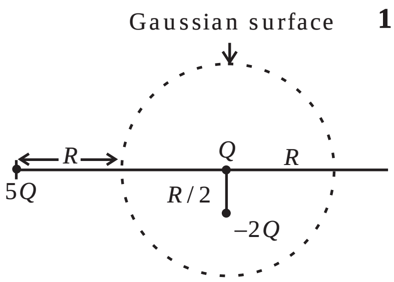


Fig. 1.6

1.12 Refer to the arrangement of charges in Fig. 1.6 and a Gaussian surface of radius R with Q at the centre. Then

(a) total flux through the surface of the sphere is $\frac{-Q}{\varepsilon_0}$.

(b) field on the surface of the sphere is $\frac{-Q}{4\pi\varepsilon_0 R^2}$.

(c) flux through the surface of sphere due to $5Q$ is zero.
(d) field on the surface of sphere due to $-2Q$ is same everywhere.

1.13 A positive charge Q is uniformly distributed along a circular ring of radius R. A small test charge q is placed at the centre of the ring (Fig. 1.7). Then

(a) If $q > 0$ and is displaced away from the centre in the plane of the ring, it will be pushed back towards the centre.
(b) If $q < 0$ and is displaced away from the centre in the plane of the ring, it will never return to the centre and will continue moving till it hits the ring.
(c) If $q < 0$, it will perform SHM for small displacement along the axis.
(d) q at the centre of the ring is in an unstable equilibrium within the plane of the ring for $q > 0$.

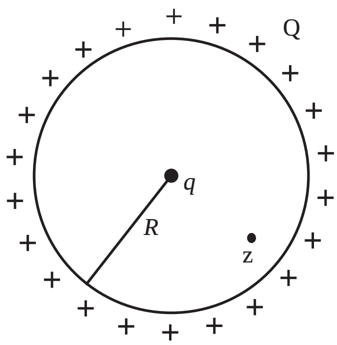


Fig. 1.7

Chapter Two

ELECTROSTATIC POTENTIAL AND CAPACITANCE

MCQ I

2.1 A capacitor of 4 μ F is connected as shown in the circuit (Fig. 2.1). The internal resistance of the battery is 0.5 Ω. The amount of charge on the capacitor plates will be

(a) 0
(b) 4 μ C
(c) 16 μ C
(d) 8 μ C

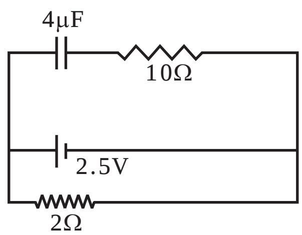


Fig. 2.1

2.2 A positively charged particle is released from rest in an uniform electric field. The electric potential energy of the charge

(a) remains a constant because the electric field is uniform.
(b) increases because the charge moves along the electric field.
(c) decreases because the charge moves along the electric field.
(d) decreases because the charge moves opposite to the electric field.

2.3 Figure 2.2 shows some equipotential lines distributed in space. A charged object is moved from point A to point B.

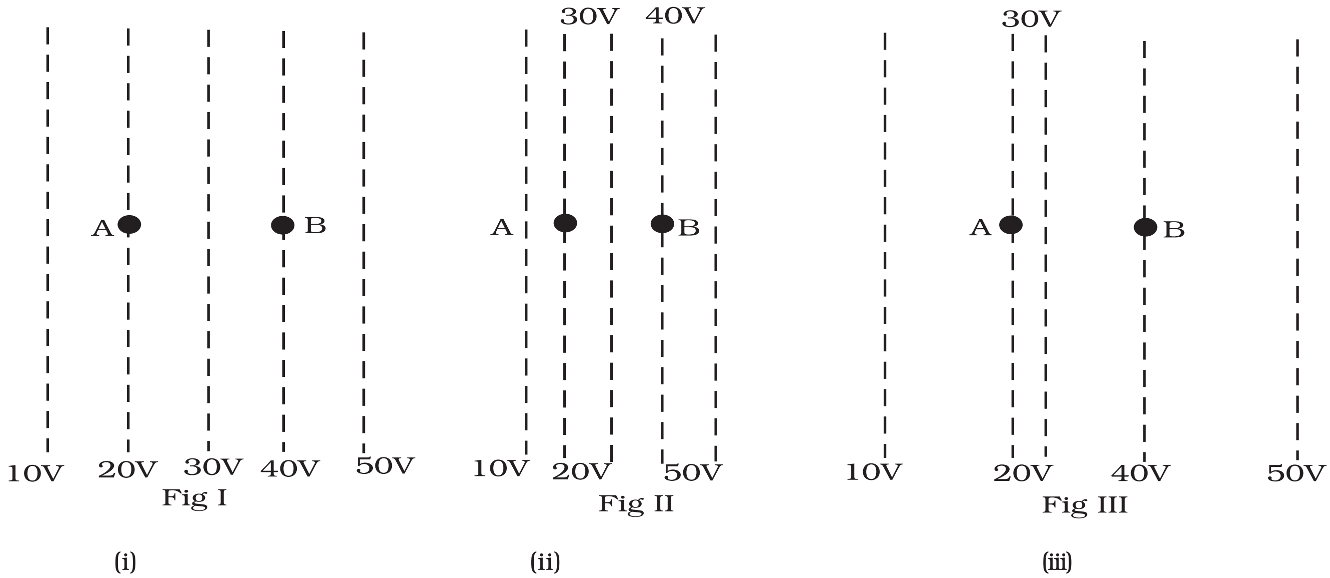


Fig. 2.2

(a) The work done in Fig. (i) is the greatest.
(b) The work done in Fig. (ii) is least.
(c) The work done is the same in Fig. (i), Fig. (ii) and Fig. (iii).
(d) The work done in Fig. (iii) is greater than Fig. (ii)but equal to that in Fig. (i).

2.4 The electrostatic potential on the surface of a charged conducting sphere is 100V. Two statments are made in this regard:

S_1 : At any point inside the sphere, electric intensity is zero.
S_2 : At any point inside the sphere, the electrostatic potential is 100V.

Which of the following is a correct statement?

(a) S_1 is true but S_2 is false.
(b) Both S_1 & S_2 are false.
(c) S_1 is true, S_2 is also true and S_1 is the cause of S_2.
(d) S_1 is true, S_2 is also true but the statements are independant.

2.5 Equipotentials at a great distance from a collection of charges whose total sum is not zero are approximately

(a) spheres.
(b) planes.
(c) paraboloids
(d) ellipsoids.

2.6 A parallel plate capacitor is made of two dielectric blocks in series. One of the blocks has thickness d_1 and dielectric constant k_1 and the other has thickness d_2 and dielectric constant k_2 as shown in Fig. 2.3. This arrangement can be thought as a dielectric slab of thickness d (= d_1+d_2) and effective dielectric constant k. The k is

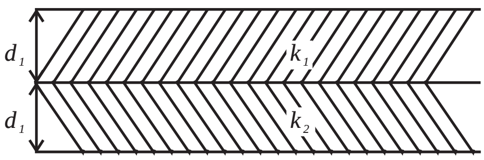


Fig. 2.3

(a) $\dfrac{k_1d_1+k_2d_2}{d_1+d_2}$ (b) $\dfrac{k_1d_1+k_2d_2}{k_1+k_2}$ (c) $\dfrac{k_1k_2(d_1+d_2)}{(k_1d_1+k_2d_2)}$ (d) $\dfrac{2k_1k_2}{k_1+k_2}$

MCQ II

2.7 Consider a uniform electric field in the $\hat{\mathbf{z}}$ direction. The potential is a constant

(a) in all space.
(b) for any x for a given z.
(c) for any y for a given z.
(d) on the x-y plane for a given z.

2.8 Equipotential surfaces

(a) are closer in regions of large electric fields compared to regions of lower electric fields.
(b) will be more crowded near sharp edges of a conductor.
(c) will be more crowded near regions of large charge densities.
(d) will always be equally spaced.

2.9 The work done to move a charge along an equipotential from A to B

(a) cannot be defined as $-\int_A^B \mathbf{E}.d\,\mathbf{l}$
(b) must be defined as $-\int_A^B \mathbf{E}.d\,\mathbf{l}$
(c) is zero.
(d) can have a non-zero value.

2.10 In a region of constant potential

(a) the electric field is uniform
(b) the electric field is zero
(c) there can be no charge inside the region.
(d) the electric field shall necessarily change if a charge is placed outside the region.

2.11 In the circuit shown in Fig. 2.4. initially key K_1 is closed and key

K_2 is open. Then K_1 is opened and K_2 is closed (order is important).
[Take Q_1' and Q_2' as charges on C_1 and C_2 and V_1 and V_2 as voltage respectively.]

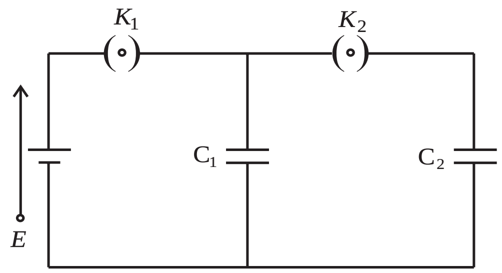


Fig. 2.4

Then

(a) charge on C_1 gets redistributed such that $V_1 = V_2$
(b) charge on C_1 gets redistributed such that $Q_1' = Q_2'$
(c) charge on C_1 gets redistributed such that $C_1V_1 + C_2V_2 = C_1 E$
(d) charge on C_1 gets redistributed such that $Q_1' + Q_2' = Q$

2.12 If a conductor has a potential $V \neq 0$ and there are no charges anywhere else outside, then

(a) there must be charges on the surface or inside itself.
(b) there cannot be any charge in the body of the conductor.
(c) there must be charges only on the surface.
(d) there must be charges inside the surface.

2.13 A parallel plate capacitor is connected to a battery as shown in Fig. 2.5. Consider two situations:

A: Key K is kept closed and plates of capacitors are moved apart using insulating handle.
B: Key K is opened and plates of capacitors are moved apart using insulating handle.

Choose the correct option(s).
(a) In A : Q remains same but C changes.
(b) In B : V remains same but C changes.
(c) In A : V remains same and hence Q changes.
(d) In B : Q remains same and hence V changes.

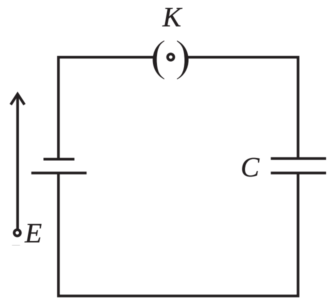


Fig. 2.5

Chapter Three

CURRENT ELECTRICITY

MCQ I

3.1 Consider a current carrying wire (current I) in the shape of a circle. Note that as the current progresses along the wire, the direction of **j** (current density) changes in an exact manner, while the current I remain unaffected. The agent that is *essentially* responsible for is

(a) source of emf.

(b) electric field produced by charges accumulated on the surface of wire.

(c) the charges just behind a given segment of wire which push them just the right way by repulsion.

(d) the charges ahead.

3.2 Two batteries of emf ε_1 and ε_2 ($\varepsilon_2 > \varepsilon_1$) and internal resistances r_1 and r_2 respectively are connected in parallel as shown in Fig 3.1.

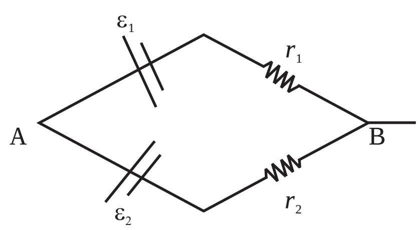


Fig 3.1

(a) The equivalent emf ε_{eq} of the two cells is between ε_1 and ε_2, i.e. $\varepsilon_1 < \varepsilon_{eq} < \varepsilon_2$.

(b) The equivalent emf ε_{eq} is smaller than ε_1 .
(c) The ε_{eq} is given by $\varepsilon_{eq} = \varepsilon_1 + \varepsilon_2$ always.
(d) ε_{eq} is independent of internal resistances r_1 and r_2.

3.3 A resistance R is to be measured using a meter bridge. Student chooses the standard resistance S to be 100Ω. He finds the null point at l_1 = 2.9 cm. He is told to attempt to improve the accuracy. Which of the following is a useful way?

(a) He should measure l_1 more accurately.
(b) He should change S to 1000Ω and repeat the experiment.
(c) He should change S to 3Ω and repeat the experiment.
(d) He should give up hope of a more accurate measurement with a meter bridge.

3.4 Two cells of emf's approximately 5V and 10V are to be accurately compared using a potentiometer of length 400cm.

(a) The battery that runs the potentiometer should have voltage of 8V.
(b) The battery of potentiometer can have a voltage of 15V and R adjusted so that the potential drop across the wire slightly exceeds 10V.
(c) The first portion of 50 cm of wire itself should have a potential drop of 10V.
(d) Potentiometer is usually used for comparing resistances and not voltages.

3.5 A metal rod of length 10 cm and a rectangular cross-section of $1\text{cm} \times \frac{1}{2}$ cm is connected to a battery across opposite faces. The resistance will be

(a) maximum when the battery is connected across 1 cm × $\frac{1}{2}$ cm faces.
(b) maximum when the battery is connected across 10 cm × 1 cm faces.
(c) maximum when the battery is connected across 10 cm × $\frac{1}{2}$ cm faces.
(d) same irrespective of the three faces.

3.6 Which of the following characteristics of electrons determines the current in a conductor?

(a) Drift velocity alone.
(b) Thermal velocity alone.
(c) Both drift velocity and thermal velocity.
(d) Neither drift nor thermal velocity.

Exemplar Problems–Physics

MCQ II

3.7 Kirchhoff's junction rule is a reflection of

(a) conservation of current density vector.
(b) conservation of charge.
(c) the fact that the momentum with which a charged particle approaches a junction is unchanged (as a vector) as the charged particle leaves the junction.
(d) the fact that there is no accumulation of charges at a junction.

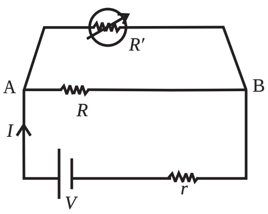


Fig 3.2

3.8 Consider a simple circuit shown in Fig 3.2. stands for a variable resistance R'. R' can vary from R_0 to infinity. r is internal resistance of the battery ($r<<R<<R_0$).

(a) Potential drop across AB is nearly constant as R' is varied.
(b) Current through R' is nearly a constant as R' is varied.
(c) Current I depends sensitively on R'.
(d) $I \geq \dfrac{V}{r+R}$ always.

3.9 Temperature dependence of resistivity $\rho(T)$ of semiconductors, insulators and metals is significantly based on the following factors:

(a) number of charge carriers can change with temperature T.
(b) time interval between two successive collisions can depend on T.
(c) length of material can be a function of T.
(d) mass of carriers is a function of T.

3.10 The measurement of an unknown resistance R is to be carried out using Wheatstones bridge (see Fig. 3.25 of NCERT Book). Two students perform an experiment in two ways. The first students takes $R_2 = 10\Omega$ and $R_1 = 5\Omega$. The other student takes $R_2 = 1000\Omega$ and $R_1 = 500\Omega$. In the standard arm, both take $R_3 = 5\Omega$.

Both find $R = \dfrac{R_2}{R_1} R_3 = 10\Omega$ within errors.

(a) The errors of measurement of the two students are the same.
(b) Errors of measurement do depend on the accuracy with which R_2 and R_1 can be measured.
(c) If the student uses large values of R_2 and R_1, the currents through the arms will be feeble. This will make determination of null point accurately more difficult.
(d) Wheatstone bridge is a very accurate instrument and has no errors of measurement.

3.11 In a meter bridge the point D is a neutral point (Fig 3.3).

(a) The meter bridge can have no other neutral point for this set of resistances.

(b) When the jockey contacts a point on meter wire left of D, current flows to B from the wire.

(c) When the jockey contacts a point on the meter wire to the right of D, current flows from B to the wire through galvanometer.

(d) When R is increased, the neutral point shifts to left.

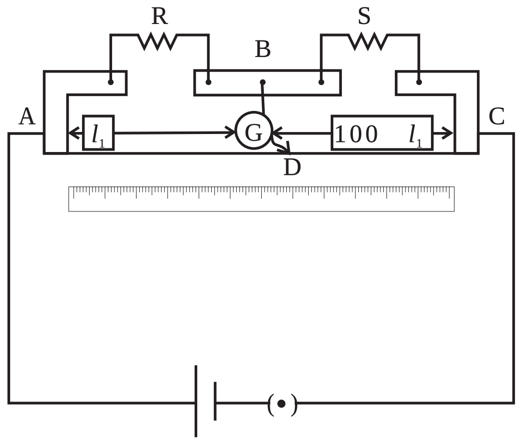


Fig 3.3

Chapter Four

MOVING CHARGES AND MAGNETISM

MCQ I

4.1 Two charged particles traverse *identical* helical paths in a completely opposite sense in a uniform magnetic field $\mathbf{B} = B_0 \hat{\mathbf{k}}$.

(a) They have equal z-components of momenta.
(b) They must have equal charges.
(c) They necessarily represent a particle-antiparticle pair.
(d) The charge to mass ratio satisfy : $\left(\frac{e}{m}\right)_1 + \left(\frac{e}{m}\right)_2 = 0$.

4.2 Biot-Savart law indicates that the moving electrons (velocity **v**) produce a magnetic field **B** such that

(a) $\mathbf{B} \perp \mathbf{v}$.
(b) $\mathbf{B} \parallel \mathbf{v}$.
(c) it obeys inverse cube law.
(d) it is along the line joining the electron and point of observation.

Moving Charges and Magnetism

4.3 A current carrying circular loop of radius R is placed in the x-y plane with centre at the origin. Half of the loop with $x > 0$ is now bent so that it now lies in the y-z plane.

(a) The magnitude of magnetic moment now diminishes.
(b) The magnetic moment does not change.
(c) The magnitude of **B** at $(0.0.z)$, $z >>R$ increases.
(d) The magnitude of **B** at $(0.0.z)$, $z >>R$ is unchanged.

4.4 An electron is projected with uniform velocity along the axis of a current carrying long solenoid. Which of the following is true?

(a) The electron will be accelerated along the axis.
(b) The electron path will be circular about the axis.
(c) The electron will experience a force at 45° to the axis and hence execute a helical path.
(d) The electron will continue to move with uniform velocity along the axis of the solenoid.

4.5 In a cyclotron, a charged particle

(a) undergoes acceleration all the time.
(b) speeds up between the dees because of the magnetic field.
(c) speeds up in a dee.
(d) slows down within a dee and speeds up between dees.

4.6 A circular current loop of magnetic moment M is in an arbitrary orientation in an external magnetic field **B**. The work done to rotate the loop by 30° about an axis perpendicular to its plane is

(a) MB.
(b) $\sqrt{3}\dfrac{MB}{2}$.
(c) $\dfrac{MB}{2}$.
(d) zero.

MCQ II

4.7 The gyro-magnetic ratio of an electron in an H-atom, according to Bohr model, is

(a) independent of which orbit it is in.
(b) negative.
(c) positive.
(d) increases with the quantum number n.

4.8 Consider a wire carrying a steady current, I placed in a uniform magnetic field **B** perpendicular to its length. Consider the charges inside the wire. It is known that magnetic forces do no work. This implies that,

(a) motion of charges inside the conductor is unaffected by **B** since they do not absorb energy.

(b) some charges inside the wire move to the surface as a result of **B**.

(c) if the wire moves under the influence of **B**, no work is done by the force.

(d) if the wire moves under the influence of **B**, no work is done by the magnetic force on the ions, assumed fixed within the wire.

4.9 Two identical current carrying coaxial loops, carry current I in an opposite sense. A simple amperian loop passes through both of them once. Calling the loop as C,

(a) $\oint_c \mathbf{B}.\mathbf{dl} = \mp 2\mu_0 I$.

(b) the value of $\oint_c \mathbf{B}.\mathbf{dl}$ is independent of sense of C.

(c) there may be a point on C where **B** and **dl** are perpendicular.

(d) **B** vanishes everywhere on C.

4.10 A cubical region of space is filled with some uniform electric and magnetic fields. An electron enters the cube across one of its faces with velocity **v** and a positron enters via opposite face with velocity - **v**. At this instant,

(a) the electric forces on both the particles cause identical accelerations.

(b) the magnetic forces on both the particles cause equal accelerations.

(c) both particles gain or loose energy at the same rate.

(d) the motion of the centre of mass (CM) is determined by **B** alone.

4.11 A charged particle would continue to move with a constant velocity in a region wherein,

(a) $\mathbf{E} = 0$, $\mathbf{B} \neq 0$.

(b) $\mathbf{E} \neq 0$, $\mathbf{B} \neq 0$.

(c) $\mathbf{E} \neq 0$, $\mathbf{B} = 0$.

(d) $\mathbf{E} = 0$, $\mathbf{B} = 0$.

Chapter Five

MAGNETISM AND MATTER

MCQ I

5.1 A toroid of n turns, mean radius R and cross-sectional radius a carries current I. It is placed on a horizontal table taken as x-y plane. Its magnetic moment **m**

(a) is non-zero and points in the z-direction by symmetry.

(b) points along the axis of the tortoid ($\mathbf{m} = m\hat{\phi}$).

(c) is zero, otherwise there would be a field falling as $\frac{1}{r^3}$ at large distances outside the toroid.

(d) is pointing radially outwards.

5.2 The magnetic field of Earth can be modelled by that of a point dipole placed at the centre of the Earth. The dipole axis makes an angle of 11.3° with the axis of Earth. At Mumbai, declination is nearly zero. Then,

(a) the declination varies between 11.3° W to 11.3° E.

(b) the least declination is 0°.

(c) the plane defined by dipole axis and Earth axis passes through Greenwich.
(d) declination averaged over Earth must be always negative.

5.3 In a permanent magnet at room temperature

(a) magnetic moment of each molecule is zero.
(b) the individual molecules have non-zero magnetic moment which are all perfectly aligned.
(c) domains are partially aligned.
(d) domains are all perfectly aligned.

5.4 Consider the two idealized systems: (i) a parallel plate capacitor with large plates and small separation and (ii) a long solenoid of length $L >> R$, radius of cross-section. In (i) **E** is ideally treated as a constant between plates and zero outside. In (ii) magnetic field is constant inside the solenoid and zero outside. These idealised assumptions, however, contradict fundamental laws as below:

(a) case (i) contradicts Gauss's law for electrostatic fields.
(b) case (ii) contradicts Gauss's law for magnetic fields.
(c) case (i) agrees with $\oint \mathbf{E}.d\mathbf{l} = 0$.
(d) case (ii) contradicts $\oint \mathbf{H}.d\mathbf{l} = I_{en}$

5.5 A paramagnetic sample shows a net magnetisation of 8 Am^{-1} when placed in an external magnetic field of 0.6T at a temperature of 4K. When the same sample is placed in an external magnetic field of 0.2 T at a temperature of 16 K, the magnetisation will be

(a) $\frac{32}{3}\ Am^{-1}$
(b) $\frac{2}{3}\ Am^{-1}$
(c) $6\ Am^{-1}$
(d) $2.4\ Am^{-1}$.

MCQ II

5.6 *S* is the surface of a lump of magnetic material.

(a) Lines of **B** are necessarily continuous across *S*.
(b) Some lines of **B** must be discontinuous across *S*.
(c) Lines of **H** are necessarily continuous across *S*.
(d) Lines of **H** cannot all be continuous across *S*.

5.7 The primary origin(s) of magnetism lies in

(a) atomic currents.
(b) Pauli exclusion principle.
(c) polar nature of molecules.
(d) intrinsic spin of electron.

5.8 A long solenoid has 1000 turns per metre and carries a current of 1 A. It has a soft iron core of $\mu_r = 1000$. The core is heated beyond the Curie temperature, T_c.

(a) The **H** field in the solenoid is (nearly) unchanged but the **B** field decreases drastically.

(b) The **H** and **B** fields in the solenoid are nearly unchanged.

(c) The magnetisation in the core reverses direction.

(d) The magnetisation in the core diminishes by a factor of about 10^8.

5.9 Essential difference between electrostatic shielding by a conducting shell and magnetostatic shielding is due to

(a) electrostatic field lines can end on charges and conductors have free charges.
(b) lines of **B** can also end but conductors cannot end them.
(c) lines of **B** cannot end on any material and perfect shielding is not possible.
(d) shells of high permeability materials can be used to divert lines of **B** from the interior region.

5.10 Let the magnetic field on earth be modelled by that of a point magnetic dipole at the centre of earth. The angle of dip at a point on the geographical equator

(a) is always zero.
(b) can be zero at specific points.
(c) can be positive or negative.
(d) is bounded.

Chapter Six

ELECTROMAGNETIC INDUCTION

MCQ 1

6.1 A square of side L meters lies in the x-y plane in a region, where the magnetic field is given by $\mathbf{B} = B_o(2\,\hat{\mathbf{i}} + 3\hat{\mathbf{j}} + 4\,\hat{\mathbf{k}})\,\mathrm{T}$, where B_o is constant. The magnitude of flux passing through the square is

(a) $2\,B_o\,L^2$ Wb.
(b) $3\,B_o\,L^2$ Wb.
(c) $4\,B_o\,L^2$ Wb.
(d) $\sqrt{29}\,B_o\,L^2$ Wb.

6.2 A loop, made of straight edges has six corners at A(0,0,0), B(L,O,0) C(L,L,0), D(0,L,0) E(0,L,L) and F(0,0,L). A magnetic field $\mathbf{B} = B_o\,(\hat{\mathbf{i}} + \hat{\mathbf{k}})\,\mathrm{T}$ is present in the region. The flux passing through the loop ABCDEFA (in that order) is

(a) $B_o\,L^2$ Wb.
(b) $2\,B_o\,L^2$ Wb.
(c) $\sqrt{2}\,B_o\,L^2$ Wb.
(d) $4\,B_o\,L^2$ Wb.

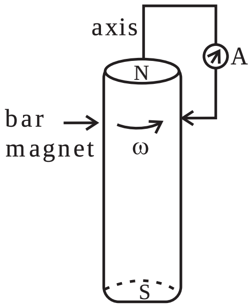


Fig. 6.1

6.3 A cylindrical bar magnet is rotated about its axis (Fig 6.1). A wire is connected from the axis and is made to touch the cylindrical surface through a contact. Then

(a) a direct current flows in the ammeter A.
(b) no current flows through the ammeter A.
(c) an alternating sinusoidal current flows through the ammeter A with a time period $T=2\pi/\omega$.
(d) a time varying non-sinosoidal current flows through the ammeter A.

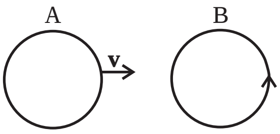


Fig. 6.2

6.4 There are two coils A and B as shown in Fig 6.2. A current starts flowing in B as shown, when A is moved towards B and stops when A stops moving. The current in A is counterclockwise. B is kept stationary when A moves. We can infer that

(a) there is a constant current in the clockwise direction in A.
(b) there is a varying current in A.
(c) there is no current in A.
(d) there is a constant current in the counterclockwise direction in A.

6.5 Same as problem 4 except the coil A is made to rotate about a vertical axis (Fig 6.3). No current flows in B if A is at rest. The current in coil A, when the current in B (at $t = 0$) is counterclockwise and the coil A is as shown at this instant, t = 0, is

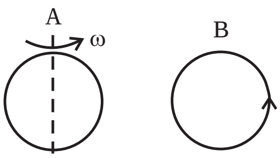


Fig. 6.3

(a) constant current clockwise.
(b) varying current clockwise.
(c) varying current counterclockwise.
(d) constant current counterclockwise.

6.6 The self inductance L of a solenoid of length l and area of cross-section A, with a fixed number of turns N increases as

(a) l and A increase.
(b) l decreases and A increases.
(c) l increases and A decreases.
(d) both l and A decrease.

MCQ II

6.7 A metal plate is getting heated. It can be because

(a) a direct current is passing through the plate.
(b) it is placed in a time varying magnetic field.

(c) it is placed in a space varying magnetic field, but does not vary with time.
(d) a current (either direct or alternating) is passing through the plate.

6.8 An e.m.f is produced in a coil, which is not connected to an external voltage source. This can be due to

(a) the coil being in a time varying magnetic field.
(b) the coil moving in a time varying magnetic field.
(c) the coil moving in a constant magnetic field.
(d) the coil is stationary in external spatially varying magnetic field, which does not change with time.

6.9 The mutual inductance M_{12} of coil 1 with respect to coil 2

(a) increases when they are brought nearer.
(b) depends on the current passing through the coils.
(c) increases when one of them is rotated about an axis.
(d) is the same as M_{21} of coil 2 with respect to coil 1.

6.10 A circular coil expands radially in a region of magnetic field and no electromotive force is produced in the coil. This can be because

(a) the magnetic field is constant.
(b) the magnetic field is in the same plane as the circular coil and it may or may not vary.
(c) the magnetic field has a perpendicular (to the plane of the coil) component whose magnitude is decreasing suitably.
(d) there is a constant magnetic field in the perpendicular (to the plane of the coil) direction.

Chapter Seven

ALTERNATING CURRENT

MCQ 1

7.1 If the rms current in a 50 Hz ac circuit is 5 A, the value of the current 1/300 seconds after its value becomes zero is

(a) $5\sqrt{2}$ A

(b) $5\sqrt{3/2}$ A

(c) 5/6 A

(d) $5/\sqrt{2}$ A

7.2 An alternating current generator has an internal resistance Rg and an internal reactance Xg. It is used to supply power to a passive load consisting of a resistance Rg and a reactance X_L. For maximum power to be delivered from the generator to the load, the value of X_L is equal to

(a) zero.

(b) X_g.

(c) $-X_g$.

(d) R_g.

Alternating Current

7.3 When a voltage measuring device is connected to AC mains, the meter shows the steady input voltage of 220V. This means

(a) input voltage cannot be AC voltage, but a DC voltage.

(b) maximum input voltage is 220V.

(c) the meter reads not v but $<v^2>$ and is calibrated to read $\sqrt{<v^2>}$.

(d) the pointer of the meter is stuck by some mechanical defect.

7.4 To reduce the reasonant frequency in an LCR series circuit with a generator

(a) the generator frequency should be reduced.
(b) another capacitor should be added in parallel to the first.
(c) the iron core of the inductor should be removed.
(d) dielectric in the capacitor should be removed.

7.5 Which of the following combinations should be selected for better tuning of an *LCR* circuit used for communication?

(a) $R = 20\ \Omega$, $L = 1.5$ H, $C = 35\mu$F.
(b) $R = 25\ \Omega$, $L = 2.5$ H, $C = 45\mu$F.
(c) $R = 15\ \Omega$, $L = 3.5$ H, $C = 30\mu$F.
(d) $R = 25\ \Omega$, $L = 1.5$ H, $C = 45\mu$F.

7.6 An inductor of reactance 1 Ω and a resistor of 2 Ω are connected in series to the terminals of a 6 V (rms) a.c. source. The power dissipated in the circuit is

(a) 8 W.
(b) 12 W.
(c) 14.4 W.
(d) 18 W.

7.7 The output of a step-down transformer is measured to be 24 V when connected to a 12 watt light bulb. The value of the peak current is

(a) $1/\sqrt{2}$ A.
(b) $\sqrt{2}$ A.
(c) 2 A.
(d) $2\sqrt{2}$ A.

MCQ II

7.8 As the frequency of an ac circuit increases, the current first increases and then decreases. What combination of circuit elements is most likely to comprise the circuit?

(a) Inductor and capacitor.
(b) Resistor and inductor.
(c) Resistor and capacitor.
(d) Resistor, inductor and capacitor.

7.9 In an alternating current circuit consisting of elements in series, the current increases on increasing the frequency of supply. Which of the following elements are likely to constitute the circuit ?

(a) Only resistor.
(b) Resistor and an inductor.
(c) Resistor and a capacitor.
(d) Only a capacitor.

7.10 Electrical energy is transmitted over large distances at high alternating voltages. Which of the following statements is (are) correct?

(a) For a given power level, there is a lower current.
(b) Lower current implies less power loss.
(c) Transmission lines can be made thinner.
(d) It is easy to reduce the voltage at the receiving end using step-down transformers.

7.11 For an *LCR* circuit, the power transferred from the driving source to the driven oscillator is $P = I^2Z \cos \phi$.

(a) Here, the power factor $\cos \phi \geq 0$, $P \geq 0$.
(b) The driving force can give no energy to the oscillator ($P = 0$) in some cases.
(c) The driving force cannot syphon out ($P < 0$) the energy out of oscillator.
(d) The driving force can take away energy out of the oscillator.

7.12 When an AC voltage of 220 V is applied to the capacitor *C*

(a) the maximum voltage between plates is 220 V.
(b) the current is in phase with the applied voltage.
(c) the charge on the plates is in phase with the applied voltage.
(d) power delivered to the capacitor is zero.

Alternating Current

7.13 The line that draws power supply to your house from street has

(a) zero average current.
(b) 220 V average voltage.
(c) voltage and current out of phase by 90°.
(d) voltage and current possibly differing in phase ϕ such that

$|\phi| < \frac{\pi}{2}$.

Chapter Eight

ELECTROMAGNETIC WAVES

MCQ I

8.1 One requires 11eV of energy to dissociate a carbon monoxide molecule into carbon and oxygen atoms. The minimum frequency of the appropriate electromagnetic radiation to achieve the dissociation lies in

(a) visible region.
(b) infrared region.
(c) ultraviolet region.
(d) microwave region.

8.2 A linearly polarized electromagnetic wave given as $\mathbf{E} = E_o \hat{\mathbf{i}} \cos(kz - \omega t)$ is incident normally on a perfectly reflecting infinite wall at $z = a$. Assuming that the material of the wall is optically inactive, the reflected wave will be given as

(a) $\mathbf{E}_r = -E_o \hat{\mathbf{i}} \cos(kz - \omega t)$.

(b) $\mathbf{E}_r = E_o \hat{\mathbf{i}} \cos(kz + \omega t)$.

(c) $\mathbf{E}_r = -E_o \hat{\mathbf{i}} \cos(kz + \omega t)$.

(d) $\mathbf{E}_r = E_o \hat{\mathbf{i}} \sin(kz - \omega t)$.

8.3 Light with an energy flux of 20 W/cm^2 falls on a non-reflecting surface at normal incidence. If the surface has an area of 30 cm^2. the total momentum delivered (for complete absorption) during 30 minutes is

(a) 36×10^{-5} kg m/s.
(b) 36×10^{-4} kg m/s.
(c) 108×10^{4} kg m/s.
(d) 1.08×10^{7} kg m/s.

8.4 The electric field intensity produced by the radiations coming from 100 W bulb at a 3 m distance is E. The electric field intensity produced by the radiations coming from 50 W bulb at the same distance is

(a) $\frac{E}{2}$.
(b) $2E$.
(c) $\frac{E}{\sqrt{2}}$.
(d) $\sqrt{2}E$.

8.5 If **E** and **B** represent electric and magnetic field vectors of the electromagnetic wave, the direction of propagation of electromagnetic wave is along

(a) **E**.
(b) **B**.
(c) **B** × **E**.
(d) **E** × **B**.

8.6 The ratio of contributions made by the electric field and magnetic field components to the intensity of an EM wave is

(a) $c : 1$
(b) $c^2 : 1$
(c) $1 : 1$
(d) $\sqrt{c} : 1$

8.7 An EM wave radiates outwards from a dipole antenna, with E_0 as the amplitude of its electric field vector. The electric field E_0 which transports significant energy from the source falls off as

(a) $\frac{1}{r^3}$

(b) $\frac{1}{r^2}$

(c) $\frac{1}{r}$

(d) remains constant.

MCQ II

8.8 An electromognetic wave travels in vacuum along z direction: $\mathbf{E} = \left(E_1\hat{\mathbf{i}} + E_2\hat{\mathbf{j}}\right)\cos(kz - \omega t)$. Choose the correct options from the following:

(a) The associated magnetic field is given as $\mathbf{B} = \frac{1}{c}\left(E_1\hat{\mathbf{i}} - E_2\hat{\mathbf{j}}\right)\cos(kz\text{-}\omega t)$.

(b) The associated magnetic field is given as $\mathbf{B} = \frac{1}{c}\left(E_1\hat{\mathbf{i}} - E_2\hat{\mathbf{j}}\right)\cos(kz\text{-}\omega t)$.

(c) The given electromagnetic field is circularly polarised.

(d) The given electromagnetic wave is plane polarised.

8.9 An electromagnetic wave travelling along z-axis is given as: $\mathbf{E} = \mathbf{E}_0 \cos(kz - \omega t.)$. Choose the correct options from the following;

(a) The associated magnetic field is given as $\mathbf{B} = \frac{1}{c}\hat{\mathbf{k}} \times \mathbf{E} = \frac{1}{\omega}(\hat{\mathbf{k}} \times \mathbf{E})$.

(b) The electromagnetic field can be written in terms of the associated magnetic field as $\mathbf{E} = c\,(\mathbf{B} \times \hat{\mathbf{k}})$.

(c) $\hat{\mathbf{k}}.\mathbf{E} = 0,\ \hat{\mathbf{k}}.\mathbf{B} = 0$.

(d) $\hat{\mathbf{k}} \times \mathbf{E} = 0, \hat{\mathbf{k}} \times \mathbf{B} = 0$.

8.10 A plane electromagnetic wave propagating along x direction can have the following pairs of **E** and **B**

(a) E_x, B_y.

(b) E_y, B_z.

(c) B_x, E_y.

(d) E_z, B_y.

Chapter Nine

RAY OPTICS AND OPTICAL INSTRUMENTS

MCQ I

9.1 A ray of light incident at an angle θ on a refracting face of a prism emerges from the other face normally. If the angle of the prism is 5° and the prism is made of a material of refractive index 1.5, the angle of incidence is

(a) 7.5°.
(b) 5°.
(c) 15°.
(d) 2.5°.

9.2 A short pulse of white light is incident from air to a glass slab at normal incidence. After travelling through the slab, the first colour to emerge is

(a) blue.
(b) green.
(c) violet.
(d) red.

9.3 An object approaches a convergent lens from the left of the lens with a uniform speed 5 m/s and stops at the focus. The image

(a) moves away from the lens with an uniform speed 5 m/s.
(b) moves away from the lens with an uniform accleration.
(c) moves away from the lens with a non-uniform acceleration.
(d) moves towards the lens with a non-uniform acceleration.

9.4 A passenger in an aeroplane shall

(a) never see a rainbow.
(b) may see a primary and a secondary rainbow as concentric circles.
(c) may see a primary and a secondary rainbow as concentric arcs.
(d) shall never see a secondary rainbow.

9.5 You are given four sources of light each one providing a light of a single colour – red, blue, green and yellow. Suppose the angle of refraction for a beam of yellow light corresponding to a particular angle of incidence at the interface of two media is 90°. Which of the following statements is correct if the source of yellow light is replaced with that of other lights without changing the angle of incidence?

(a) The beam of red light would undergo total internal reflection.
(b) The beam of red light would bend towards normal while it gets refracted through the second medium.
(c) The beam of blue light would undergo total internal reflection.
(d) The beam of green light would bend away from the normal as it gets refracted through the second medium.

9.6 The radius of curvature of the curved surface of a plano-convex lens is 20 cm. If the refractive index of the material of the lens be 1.5, it will

(a) act as a convex lens only for the objects that lie on its curved side.
(b) act as a concave lens for the objects that lie on its curved side.
(c) act as a convex lens irrespective of the side on which the object lies.
(d) act as a concave lens irrespective of side on which the object lies.

9.7 The phenomena involved in the reflection of radiowaves by ionosphere is similar to

(a) reflection of light by a plane mirror.
(b) total internal reflection of light in air during a mirage.
(c) dispersion of light by water molecules during the formation of a rainbow.
(d) scattering of light by the particles of air.

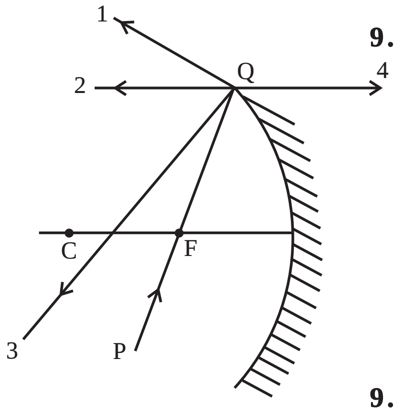


Fig. 9.1

9.8 The direction of ray of light incident on a concave mirror is shown by PQ while directions in which the ray would travel after reflection is shown by four rays marked 1, 2, 3 and 4 (Fig 9.1). Which of the four rays correctly shows the direction of reflected ray?

(a) 1
(b) 2
(c) 3
(d) 4

9.9 The optical density of turpentine is higher than that of water while its mass density is lower. Fig 9.2. shows a layer of turpentine floating over water in a container. For which one of the four rays incident on turpentine in Fig 9.2, the path shown is correct?

(a) 1
(b) 2
(c) 3
(d) 4

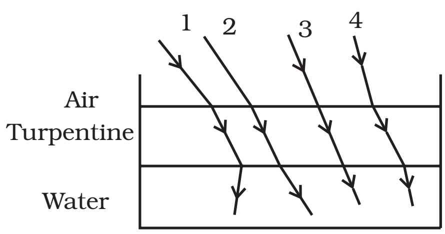


Fig. 9.2

9.10 A car is moving with at a constant speed of 60 km h^{-1} on a straight road. Looking at the rear view mirror, the driver finds that the car following him is at a distance of 100 m and is approaching with a speed of 5 km h^{-1}. In order to keep track of the car in the rear, the driver begins to glance alternatively at the rear and side mirror of his car after every 2 s till the other car overtakes. If the two cars were maintaining their speeds, which of the following statement (s) is/are correct?

(a) The speed of the car in the rear is 65 km h^{-1}.
(b) In the side mirror the car in the rear would appear to approach with a speed of 5 km h^{-1} to the driver of the leading car.
(c) In the rear view mirror the speed of the approaching car would appear to decrease as the distance between the cars decreases.
(d) In the side mirror, the speed of the approaching car would appear to increase as the distance between the cars decreases.

9.11 There are certain material developed in laboratories which have a negative refractive index (Fig. 9.3). A ray incident from air (medium 1) into such a medium (medium 2) shall follow a path given by

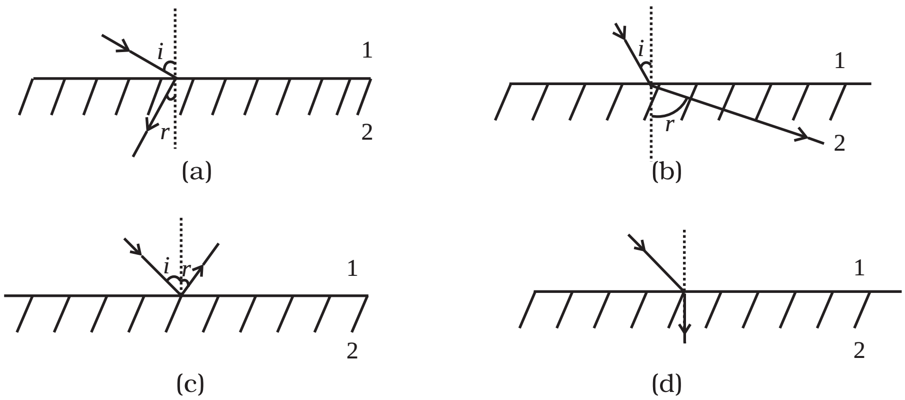


Fig. 9.3

MCQ II

9.12 Consider an extended object immersed in water contained in a plane trough. When seen from close to the edge of the trough the object looks distorted because

(a) the apparent depth of the points close to the edge are nearer the surface of the water compared to the points away from the edge.

(b) the angle subtended by the image of the object at the eye is smaller than the actual angle subtended by the object in air.

(c) some of the points of the object far away from the edge may not be visible because of total internal reflection.

(d) water in a trough acts as a lens and magnifies the object.

9.13 A rectangular block of glass ABCD has a refractive index 1.6. A pin is placed midway on the face AB (Fig. 9.4). When observed from the face AD, the pin shall

(a) appear to be near A.

(b) appear to be near D.

(c) appear to be at the centre of AD.

(d) not be seen at all.

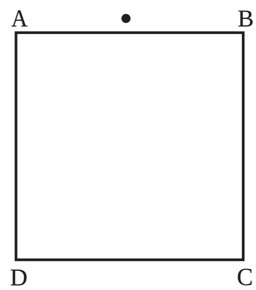


Fig. 9.4

9.14 Between the primary and secondary rainbows, there is a dark band known as Alexandar's dark band. This is because

(a) light scattered into this region interfere destructively.

(b) there is no light scattered into this region.

(c) light is absorbed in this region.
(d) angle made at the eye by the scattered rays with respect to the incident light of the sun lies between approximately 42° and 50°.

9.15 A magnifying glass is used, as the object to be viewed can be brought closer to the eye than the normal near point. This results in

(a) a larger angle to be subtended by the object at the eye and hence viewed in greater detail.
(b) the formation of a virtual erect image.
(c) increase in the field of view.
(d) infinite magnification at the near point.

9.16 An astronomical refractive telescope has an objective of focal length 20m and an eyepiece of focal length 2cm.

(a) The length of the telescope tube is 20.02m.
(b) The magnification is 1000.
(c) The image formed is inverted.
(d) An objective of a larger aperture will increase the brightness and reduce chromatic aberration of the image.

Chapter Ten

WAVE OPTICS

MCQ I

10.1 Consider a light beam incident from air to a glass slab at Brewster's angle as shown in Fig. 10.1.

A polaroid is placed in the path of the emergent ray at point P and rotated about an axis passing through the centre and perpendicular to the plane of the polaroid.

(a) For a particular orientation there shall be darkness as observed through the polaoid.

(b) The intensity of light as seen through the polaroid shall be independent of the rotation.

(c) The intensity of light as seen through the Polaroid shall go through a minimum but not zero for two orientations of the polaroid.

(d) The intensity of light as seen through the polaroid shall go through a minimum for four orientations of the polaroid.

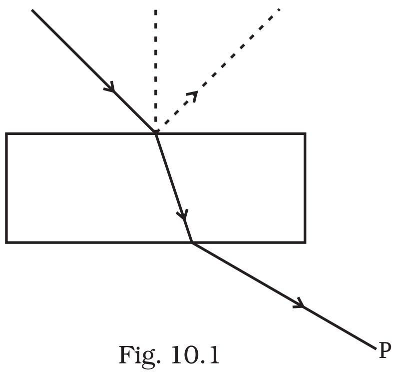


Fig. 10.1

10.2 Consider sunlight incident on a slit of width 10^4 A. The image seen through the slit shall

Wave Optics

(a) be a fine sharp slit white in colour at the center.
(b) a bright slit white at the center diffusing to zero intensities at the edges.
(c) a bright slit white at the center diffusing to regions of different colours.
(d) only be a diffused slit white in colour.

10.3 Consider a ray of light incident from air onto a slab of glass (refractive index n) of width d, at an angle θ. The phase difference between the ray reflected by the top surface of the glass and the bottom surface is

(a) $\frac{4\pi d}{\lambda}\left(1-\frac{1}{n^2}\sin^2\theta\right)^{1/2}+\pi$

(b) $\frac{4\pi d}{\lambda}\left(1-\frac{1}{n^2}\sin^2\theta\right)^{1/2}$

(c) $\frac{4\pi d}{\lambda}\left(1-\frac{1}{n^2}\sin^2\theta\right)^{1/2}+\frac{\pi}{2}$

(d) $\frac{4\pi d}{\lambda}\left(1-\frac{1}{n^2}\sin^2\theta\right)^{1/2}+2\pi$.

10.4 In a Young's double slit experiment, the source is white light. One of the holes is covered by a red filter and another by a blue filter. In this case

(a) there shall be alternate interference patterns of red and blue.
(b) there shall be an interference pattern for red distinct from that for blue.
(c) there shall be no interference fringes.
(d) there shall be an interference pattern for red mixing with one for blue.

10.5 Figure 10.2 shows a standard two slit arrangement with slits S_1, S_2. P_1, P_2 are the two minima points on either side of P (Fig. 10.2).

At P_2 on the screen, there is a hole and behind P_2 is a second 2- slit arrangement with slits S_3, S_4 and a second screen behind them.

(a) There would be no interference pattern on the second screen but it would be lighted.
(b) The second screen would be totally dark.

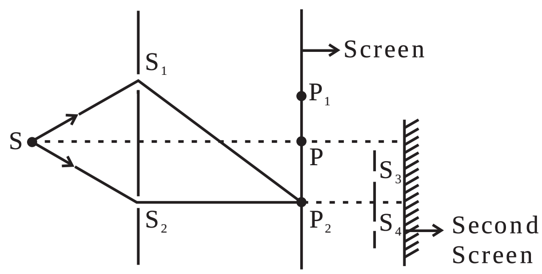


Fig. 10.2

(c) There would be a single bright point on the second screen.
(d) There would be a regular two slit pattern on the second screen.

MCQ II

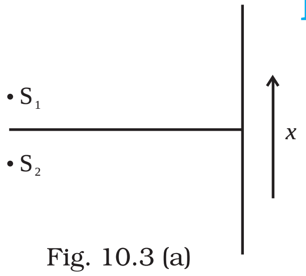


Fig. 10.3 (a)

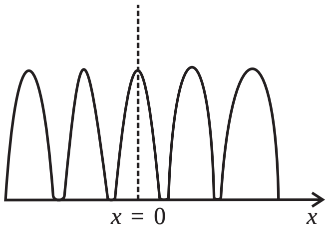


Fig. 10.3 (b)

10.6 Two source S_1 and S_2 of intensity I_1 and I_2 are placed in front of a screen [Fig. 10.3 (a)]. The patteren of intensity distribution seen in the central portion is given by Fig. 10.3 (b).

In this case which of the following statements are true.

(a) S_1 and S_2 have the same intensities.
(b) S_1 and S_2 have a constant phase difference.
(c) S_1 and S_2 have the same phase.
(d) S_1 and S_2 have the same wavelength.

10.7 Consider sunlight incident on a pinhole of width 10^3A. The image of the pinhole seen on a screen shall be

(a) a sharp white ring.
(b) different from a geometrical image.
(c) a diffused central spot, white in colour.
(d) diffused coloured region around a sharp central white spot.

10.8 Consider the diffraction patern for a small pinhole. As the size of the hole is increased

(a) the size decreases.
(b) the intensity increases.
(c) the size increases.
(d) the intensity decreases.

10.9 For light diverging from a point source

(a) the wavefront is spherical.
(b) the intensity decreases in proportion to the distance squared.
(c) the wavefront is parabolic.
(d) the intensity at the wavefront does not depend on the distance.

Chapter Eleven

DUAL NATURE OF RADIATION AND MATTER

MCQ I

11.1 A particle is dropped from a height H. The de Broglie wavelength of the particle as a function of height is proportional to

(a) H
(b) $H^{1/2}$
(c) H^0
(b) $H^{-1/2}$

11.2 The wavelength of a photon needed to remove a proton from a nucleus which is bound to the nucleus with 1 MeV energy is nearly

(a) 1.2 nm
(b) 1.2×10^{-3} nm
(c) 1.2×10^{-6} nm
(d) 1.2×10^{1} nm

11.3 Consider a beam of electrons (each electron with energy E_0) incident on a metal surface kept in an evacuated chamber. Then

Dual Nature of Radiation and Matter

(a) no electrons will be emitted as only photons can emit electrons.
(b) electrons can be emitted but all with an energy, E_0.
(c) electrons can be emitted with any energy, with a maximum of $E_0 - \phi$ (ϕ is the work function).
(d) electrons can be emitted with any energy, with a maximum of E_0.

11.4 Consider Fig. 11.7 in the NCERT text book of physics for Class XII. Suppose the voltage applied to A is increased. The diffracted beam will have the maximum at a value of θ that

(a) will be larger than the earlier value.
(b) will be the same as the earlier value.
(c) will be less than the earlier value.
(d) will depend on the target.

11.5 A proton, a neutron, an electron and an α-particle have same energy. Then their de Broglie wavelengths compare as

(a) $\lambda_p = \lambda_n > \lambda_e > \lambda_\alpha$
(b) $\lambda_\alpha < \lambda_p = \lambda_n > \lambda_e$
(c) $\lambda_e < \lambda_p = \lambda_n > \lambda_\alpha$
(d) $\lambda_e = \lambda_p = \lambda_n = \lambda_\alpha$

11.6 An electron is moving with an initial velocity $\mathbf{v} = v_0\hat{\mathbf{i}}$ and is in a magnetic field $\mathbf{B} = B_0\hat{\mathbf{j}}$. Then it's de Broglie wavelength

(a) remains constant.
(b) increases with time.
(c) decreases with time.
(d) increases and decreases periodically.

11.7 An electron (mass m) with an initial velocity $\mathbf{v} = v_0\hat{\mathbf{i}} (v_0 > 0)$ is in an electric field $\mathbf{E} = -E_0\hat{\mathbf{i}} (E_0 = \text{constant} > 0)$. It's de Broglie wavelength at time t is given by

(a) $\dfrac{\lambda_0}{\left(1 + \dfrac{eE_0}{m}\dfrac{t}{v_0}\right)}$

(b) $\lambda_0\left(1 + \dfrac{eE_0 t}{m v_0}\right)$

(c) λ_0
(d) $\lambda_0 t$.

11.8 An electron (mass m) with an initial velocity $\mathbf{v} = v_0\hat{\mathbf{i}}$ is in an electric field $\mathbf{E} = E_0\hat{\mathbf{j}}$. If $\lambda_0 = h/mv_0$, it's de Breoglie wavelength at time t is given by

(a) λ_0

(b) $\lambda_0\sqrt{1+\frac{e^2E_0^2t^2}{m^2v_0^2}}$

(c) $\frac{\lambda_0}{\sqrt{1+\frac{e^2E_0^2t^2}{m^2v_0^2}}}$

(d) $\frac{\lambda_0}{\left(1+\frac{e^2E_0^2t^2}{m^2v_0^2}\right)}$

MCQ II

11.9 Relativistic corrections become neccssary when the expression for the kinetic energy $\frac{1}{2}mv^2$, becomes comparable with mc^2, where m is the mass of the particle. At what de Broglie wavelength will relativistic corrections become important for an electron?

(a) $\lambda = 10$nm
(b) $\lambda = 10^{-1}$nm
(c) $\lambda = 10^{-4}$nm
(d) $\lambda = 10^{-6}$nm

11.10 Two particles A_1 and A_2 of masses m_1, m_2 ($m_1 > m_2$) have the same de Broglie wavelength. Then

(a) their momenta are the same.
(b) their energies are the same.
(c) energy of A_1 is less than the energy of A_2.
(d) energy of A_1 is more than the energy of A_2.

11.11 The de Broglie wavelength of a photon is twice the de Broglie wavelength of an electron. The speed of the electron is $v_e = \frac{c}{100}$. Then

(a) $\frac{E_e}{E_p} = 10^{-4}$

(b) $\frac{E_e}{E_p} = 10^{-2}$

(c) $\frac{p_e}{m_e c} = 10^{-2}$

(d) $\frac{p_e}{m_e c} = 10^{-4}$.

11.12 Photons absorbed in matter are converted to heat. A source emitting n photon/sec of frequency ν is used to convert 1kg of ice at 0°C to water at 0°C. Then, the time T taken for the conversion

(a) decreases with increasing n, with ν fixed.
(b) decreases with n fixed, ν increasing
(c) remains constant with n and ν changing such that $n\nu$ = constant.
(d) increases when the product $n\nu$ increases.

11.13 A particle moves in a closed orbit around the origin, due to a force which is directed towards the origin. The de Broglie wavelength of the particle varies cyclically between two values λ_1, λ_2 with $\lambda_1 > \lambda_2$. Which of the following statement are true?

(a) The particle could be moving in a circular orbit with origin as centre

(b) The particle could be moving in an elliptic orbit with origin as its focus.

(c) When the de Broglie wave length is λ_1, the particle is nearer the origin than when its value is λ_2.

(d) When the de Broglic wavelength is λ_2, the particle is nearer the origin than when its value is λ_1.

Atoms

Chapter Twelve

ATOMS

MCQ I

12.1 Taking the Bohr radius as a_0 = 53pm, the radius of Li^{++} ion in its ground state, on the basis of Bohr's model, will be about

(a) 53 pm
(b) 27 pm
(c) 18 pm
(d) 13 pm

12.2 The binding energy of a H-atom, considering an electron moving around a fixed nuclei (proton), is $B = -\dfrac{me^4}{8n^2\varepsilon_0^2h^2}$. ($m$ = electron mass).

If one decides to work in a frame of reference where the electron is at rest, the proton would be moving arround it. By similar arguments, the binding energy would be

$$B = -\frac{Me^4}{8n^2\varepsilon_0^2h^2} \quad (M = \text{ proton mass})$$

This last expression is not correct because
(a) n would not be integral.
(b) Bohr-quantisation applies only to electron
(c) the frame in which the electron is at rest is not inertial.
(d) the motion of the proton would not be in circular orbits, even approximately.

12.3 The simple Bohr model cannot be directly applied to calculate the energy levels of an atom with many electrons. This is because

(a) of the electrons not being subject to a central force.
(b) of the electrons colliding with each other
(c) of screening effects
(d) the force between the nucleus and an electron will no longer be given by Coulomb's law.

12.4 For the ground state, the electron in the H-atom has an angular momentum = $\hbar$, according to the simple Bohr model. Angular momentum is a vector and hence there will be infinitely many orbits with the vector pointing in all possible directions. In actuality, this is not true,

(a) because Bohr model gives incorrect values of angular momentum.
(b) because only one of these would have a minimum energy.
(c) angular momentum must be in the direction of spin of electron.
(d) because electrons go around only in horizontal orbits.

12.5 O_2 molecule consists of two oxygen atoms. In the molecule, nuclear force between the nuclei of the two atoms

(a) is not important because nuclear forces are short-ranged.
(b) is as important as electrostatic force for binding the two atoms.
(c) cancels the repulsive electrostatic force between the nuclei.
(d) is not important because oxygen nucleus have equal number of neutrons and protons.

12.6 Two H atoms in the ground state collide inelastically. The maximum amount by which their combined kinetic energy is reduced is

(a) 10.20 eV
(b) 20.40 eV
(c) 13.6 eV
(d) 27.2 eV

12.7 A set of atoms in an excited state decays.

(a) in general to any of the states with lower energy.
(b) into a lower state only when excited by an external electric field.

(c) all together simultaneously into a lower state.

(d) to emit photons only when they collide.

MCQ II

12.8 An ionised H-molecule consists of an electron and two protons. The protons are separated by a small distance of the order of angstrom. In the ground state,

(a) the electron would not move in circular orbits.

(b) the energy would be $(2)^4$ times that of a H-atom.

(c) the electrons, orbit would go arround the protons.

(d) the molecule will soon decay in a proton and a H-atom.

12.9 Consider aiming a beam of free electrons towards free protons. When they scatter, an electron and a proton cannot combine to produce a H-atom,

(a) because of energy conservation.

(b) without simultaneously releasing energy in the from of radiation.

(c) because of momentum conservation.

(d) because of angular momentum conservation.

12.10 The Bohr model for the spectra of a H-atom

(a) will not be applicable to hydrogen in the molecular from.

(b) will not be applicable as it is for a He-atom.

(c) is valid only at room temperature.

(d) predicts continuous as well as discrete spectral lines.

12.11 The Balmer series for the H-atom can be observed

(a) if we measure the frequencies of light emitted when an excited atom falls to the ground state.

(b) if we measure the frequencies of light emitted due to transitions between excited states and the first excited state.

(c) in any transition in a H-atom.

(d) as a sequence of frequencies with the higher frequencies getting closely packed.

12.12 Let $E_n = \dfrac{-1}{8\varepsilon_0^2}\dfrac{me^4}{n^2h^2}$ be the energy of the n^{th} level of H-atom. If all the H-atoms are in the ground state and radiation of frequency $(E_2\text{-}E_1)/h$ falls on it,

(a) it will not be absorbed at all

(b) some of atoms will move to the first excited state.
(c) all atoms will be excited to the $n = 2$ state.
(d) no atoms will make a transition to the $n = 3$ state.

12.13 The simple Bohr modle is not applicable to He^4 atom because

(a) He^4 is an inert gas.
(b) He^4 has neutrons in the nucleus.
(c) He^4 has one more electron.
(d) electrons are not subject to central forces.

Chapter Thirteen

NUCLEI

MCQ I

13.1 Suppose we consider a large number of containers each containing initially 10000 atoms of a radioactive material with a half life of 1 year. After 1 year,

(a) all the containers will have 5000 atoms of the material.

(b) all the containers will contain the same number of atoms of the material but that number will only be approximately 5000.

(c) the containers will in general have different numbers of the atoms of the material but their average will be close to 5000.

(d) none of the containers can have more than 5000 atoms.

13.2 The gravitational force between a H-atom and another particle of mass m will be given by Newton's law:

$F = G\dfrac{M.m}{r^2}$, where r is in km and

(a) $M = m_{\text{proton}} + m_{\text{electron}}$.

(b) $M = m_{\text{proton}} + m_{\text{electron}} - \dfrac{B}{c^2}$ $(B = 13.6 \text{ eV})$.

(c) M is not related to the mass of the hydrogen atom.

(d) $M = m_{\text{proton}} + m_{\text{electron}} - \frac{|V|}{c^2}$ ($|V|$ = magnitude of the potential energy of electron in the H-atom).

13.3 When a nucleus in an atom undergoes a radioactive decay, the electronic energy levels of the atom

(a) do not change for any type of radioactivity .
(b) change for α and β radioactivity but not for γ-radioactivity.
(c) change for α-radioactivity but not for others.
(d) change for β-radioactivity but not for others.

13.4 M_x and M_y denote the atomic masses of the parent and the daughter nuclei respectively in a radioactive decay. The Q-value for a β^- decay is Q_1 and that for a β^+ decay is Q_2. If m_e denotes the mass of an electron, then which of the following statements is correct?

(a) $Q_1 = (M_x - M_y)\,c^2$ and $Q_2 = (M_x - M_y - 2m_e)c^2$
(b) $Q_1 = (M_x - M_y)\,c^2$ and $Q_2 = (M_x - M_y)c^2$
(c) $Q_1 = (M_x - M_y - 2m_e)\,c^2$ and $Q_2 = (M_x - M_y + 2\,m_e)c^2$
(d) $Q_1 = (M_x - M_y + 2m_e)\,c^2$ and $Q_2 = (M_x - M_y + 2\,m_e)c^2$

13.5 Tritium is an isotope of hydrogen whose nucleus Triton contains 2 neutrons and 1 proton. Free neutrons decay into $p + \bar{e} + \bar{\nu}$. If one of the neutrons in Triton decays, it would transform into He^3 nucleus. This does not happen. This is because

(a) Triton energy is less than that of a He^3 nucleus.
(b) the electron created in the beta decay process cannot remain in the nucleus.
(c) both the neutrons in triton have to decay simultaneously resulting in a nucleus with 3 protons, which is not a He^3 nucleus.
(d) because free neutrons decay due to external perturbations which is absent in a triton nucleus.

13.6. Heavy stable nucle have more neutrons than protons. This is because of the fact that

(a) neutrons are heavier than protons.
(b) electrostatic force between protons are repulsive.
(c) neutrons decay into protons through beta decay.
(d) nuclear forces between neutrons are weaker than that between protons.

13.7 In a nuclear reactor, moderators slow down the neutrons which come out in a fission process. The moderator used have light nuclei. Heavy nuclei will not serve the purpose because

(a) they will break up.
(b) elastic collision of neutrons with heavy nuclei will not slow them down.
(c) the net weight of the reactor would be unbearably high.
(d) substances with heavy nuclei do not occur in liquid or gaseous state at room temperature.

MCQ II

13.8 Fusion processes, like combining two deuterons to form a He nucleus are impossible at ordinary temperatures and pressure. The reasons for this can be traced to the fact:

(a) nuclear forces have short range.
(b) nuclei are positively charged.
(c) the original nuclei must be completely ionized before fusion can take place.
(d) the original nuclei must first break up before combining with each other.

13.9 Samples of two radioactive nuclides A and B are taken. λ_A and λ_B are the disintegration constants of A and B respectively. In which of the following cases, the two samples can simultaneously have the same decay rate at any time?

(a) Initial rate of decay of A is twice the initial rate of decay of B and $\lambda_A = \lambda_B$.
(b) Initial rate of decay of A is twice the initial rate of decay of B and $\lambda_A > \lambda_B$.
(c) Initial rate of decay of B is twice the initial rate of decay of A and $\lambda_A > \lambda_B$.
(d) Initial rate of decay of B is same as the rate of decay of A at t = 2h and $\lambda_B < \lambda_A$.

13.10 The variation of decay rate of two radioactive samples A and B with time is shown in Fig. 13.1.

Which of the following statements are true?

(a) Decay constant of A is greater than that of B, hence A always decays faster than B.
(b) Decay constant of B is greater than that of A but its decay rate is always smaller than that of A.
(c) Decay constant of A is greater than that of B but it does not always decay faster than B.
(d) Decay constant of B is smaller than that of A but still its decay rate becomes equal to that of A at a later instant.

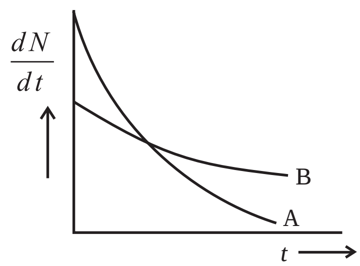


Fig. 13.1

Chapter Fourteen

SEMICONDUCTOR ELECTRONICS

MATERIALS, DEVICES AND SIMPLE CIRCUITS

MCQ I

14.1 The conductivity of a semiconductor increases with increase in temperature because

(a) number density of free current carriers increases.

(b) relaxation time increases.

(c) both number density of carriers and relaxation time increase.

(d) number density of current carriers increases, relaxation time decreases but effect of decrease in relaxation time is much less than increase in number density.

14.2 In Fig. 14.1, V_o is the potential barrier across a p-n junction, when no battery is connected across the junction

(a) 1 and 3 both correspond to forward bias of junction

(b) 3 corresponds to forward bias of junction and 1 corresponds to reverse bias of junction

(c) 1 corresponds to forward bias and 3 corresponds to reverse bias of junction.

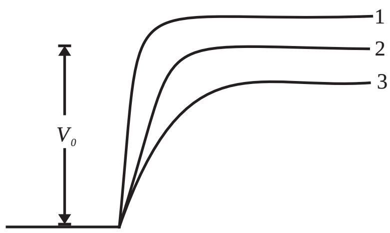


Fig. 14.1

(d) 3 and 1 both correspond to reverse bias of junction.

14.3 In Fig. 14.2, assuming the diodes to be ideal,

(a) D_1 is forward biased and D_2 is reverse biased and hence current flows from A to B

(b) D_2 is forward biased and D_1 is reverse biased and hence no current flows from B to A and vice versa.

(c) D_1 and D_2 are both forward biased and hence current flows from A to B.

(d) D_1 and D_2 are both reverse biased and hence no current flows from A to B and vice versa.

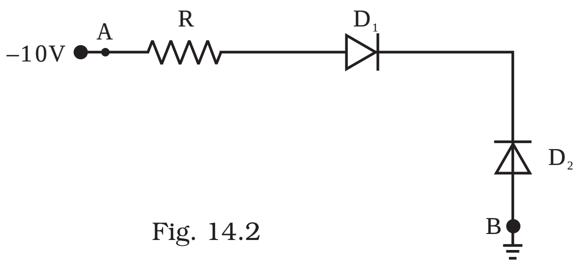
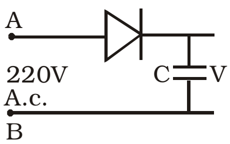


Fig. 14.2

14.4 A 220 V A.C. supply is connected between points A and B . What will be the potential difference V across the capacitor?



(a) 220V.

(b) 110V.

(c) 0V.

(d) $220\sqrt{2}$ V.

14.5 Hole is

(a) an anti-particle of electron.

(b) a vacancy created when an electron leaves a covalent bond.

(c) absence of free electrons.

(d) an artifically created particle.

14.6 The output of the given circuit in Fig. 14.4.

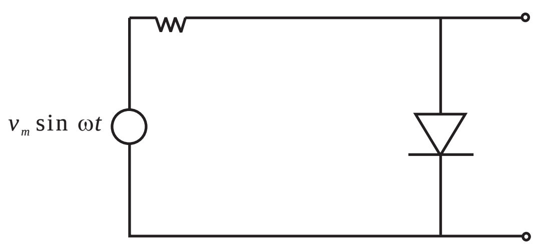


Fig. 14.4

(a) would be zero at all times.

(b) would be like a half wave rectifier with positive cycles in output.

(c) would be like a half wave rectifier with negative cycles in output.

(d) would be like that of a full wave rectifier.

14.7 In the circuit shown in Fig. 14.5, if the diode forward voltage drop is 0.3 V, the voltage difference between A and B is

(a) 1.3 V
(b) 2.3 V
(c) 0
(d) 0.5 V

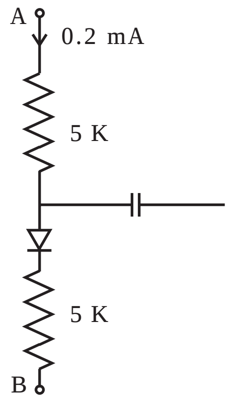


Fig. 14.5

14.8 Truth table for the given circuit (Fig. 14.6) is

(a)

A	B	E
0	0	1
0	1	0
1	0	1
1	1	0

(b)

A	B	E
0	0	1
0	1	0
1	0	0
1	1	1

(c)

A	B	E
0	0	0
0	1	1
1	0	0
1	1	1

(d)

A	B	E
0	0	0
0	1	1
1	0	1
1	1	0

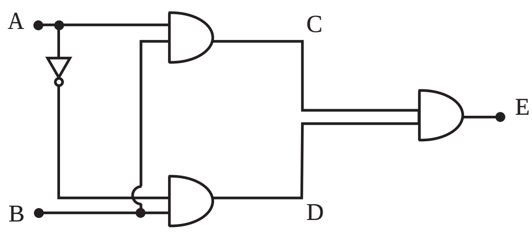


Fig. 14.6

MCQ II

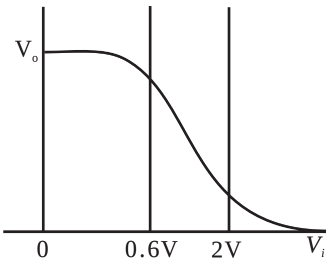
14.9 When an electric field is applied across a semiconductor

(a) electrons move from lower energy level to higher energy level in the conduction band.
(b) electrons move from higher energy level to lower energy level in the conduction band.
(c) holes in the valence band move from higher energy level to lower energy level.
(d) holes in the valence band move from lower energy level to higher energy level.

Exemplar Problems–Physics

14.10 Consider an npn transitor with its base-emitter junction forward biased and collector base junction reverse biased. Which of the following statements are true?.

(a) Electrons crossover from emitter to collector.
(b) Holes move from base to collector.
(c) Electrons move from emitter to base.
(d) Electrons from emitter move out of base without going to the collector.



14.11 Figure 14.7 shows the transfer characteristics of a base biased CE transistor. Which of the following statements are true?

(a) At $V_i = 0.4V$, transistor is in active state.
(b) At $V_i = 1V$, it can be used as an amplifier.
(c) At $V_i = 0.5V$, it can be used as a switch turned off.
(d) At $V_i = 2.5V$, it can be used as a switch turned on.

14.12 In a npn transistor circuit, the collector current is 10mA. If 95 per cent of the electrons emitted reach the collector, which of the following statements are true?

(a) The emitter current will be 8 mA.
(b) The emitter current will be 10.53 mA.
(c) The base current will be 0.53 mA.
(d) The base current will be 2 mA.

14.13 In the depletion region of a diode

(a) there are no mobile charges
(b) equal number of holes and electrons exist, making the region neutral.
(c) recombination of holes and electrons has taken place.
(d) immobile charged ions exist.

14.14 What happens during regulation action of a Zener diode?

(a) The current in and voltage across the Zenor remains fixed.
(b) The current through the series Resistance (R_s) changes.
(c) The Zener resistance is constant.
(d) The resistance offered by the Zener changes.

14.15 To reduce the ripples in a rectifier circuit with capacitor filter

(a) R_L should be increased.
(b) input frequency should be decreased.
(c) input frequency should be increased.
(d) capacitors with high capacitance should be used.

14.16 The breakdown in a reverse biased p–n junction diode is more likely to occur due to

(a) large velocity of the minority charge carriers if the doping concentration is small.
(b) large velocity of the minority charge carriers if the doping concentration is large.
(c) strong electric field in a depletion region if the doping concentration is small.
(d) strong electric field in the depletion region if the doping concentration is large.

Exemplar Problems–Physics

Chapter Fifteen

COMMUNICATION SYSTEMS

MCQ I

15.1 Three waves A, B and C of frequencies 1600 kHz, 5 MHz and 60 MHz, respectively are to be transmitted from one place to another. Which of the following is the most appropriate mode of communication:

(a) A is transmitted via space wave while B and C are transmitted via sky wave.
(b) A is transmitted via ground wave, B via sky wave and C via space wave.
(c) B and C are transmitted via ground wave while A is transmitted via sky wave.
(d) B is transmitted via ground wave while A and C are transmitted via space wave.

15.2 A 100m long antenna is mounted on a 500m tall building. The complex can become a transmission tower for waves with λ

(a) ~ 400 m.
(b) ~ 25 m.

(c) ~ 150 m.
(d) ~ 2400 m.

15.3 A 1 KW signal is transmitted using a communication channel which provides attenuation at the rate of – 2dB per km. If the communication channel has a total length of 5 km, the power of the signal received is [gain in dB $= 10 \log \left(\frac{P_0}{P_i}\right)$]

(a) 900 W.
(b) 100 W.
(c) 990 W.
(d) 1010 W.

15.4 A speech signal of 3 kHz is used to modulate a carrier signal of frequency 1 MHz, using amplitude modulation. The frequencies of the side bands will be

(a) 1.003 MHz and 0.997 MHz.
(b) 3001 kHz and 2997 kHz.
(c) 1003 kHz and 1000 kHz.
(d) 1 MHz and 0.997 MHz.

15.5 A message signal of frequency ω_m is superposed on a carrier wave of frequency ω_c to get an amplitude modulated wave (AM). The frequency of the AM wave will be

(a) ω_m.
(b) ω_C.
(c) $\frac{\omega_c + \omega_m}{2}$.
(d) $\frac{\omega_c - \omega_m}{2}$.

15.6 *I-V* characteristics of four devices are shown in Fig. 15.1

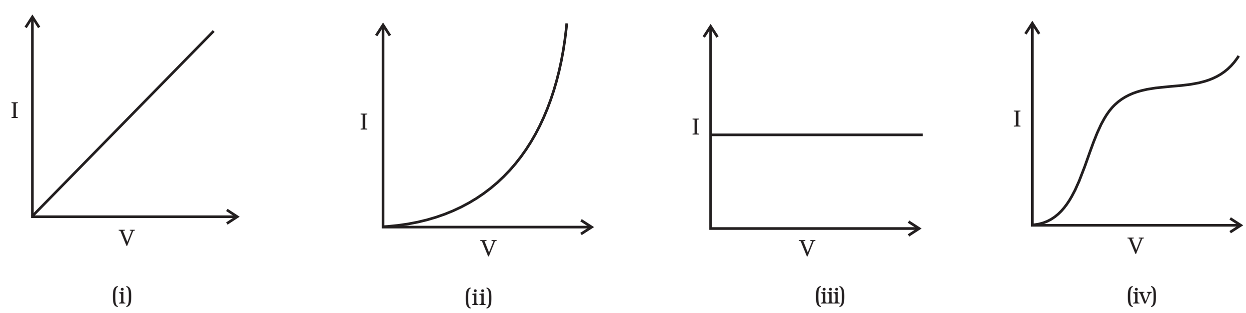


Fig. 15.1

Identify devices that can be used for modulation:

(a) 'i' and 'iii'.
(b) only 'iii'.
(c) 'ii' and some regions of 'iv'.
(d) All the devices can be used.

15.7 A male voice after modulation-transmission sounds like that of a female to the receiver. The problem is due to

(a) poor selection of modulation index (selected $0 < m < 1$)
(b) poor bandwidth selection of amplifiers.
(c) poor selection of carrier frequency
(d) loss of energy in transmission.

15.8 A basic communication system consists of

(A) transmitter.
(B) information source.
(C) user of information.
(D) channel.
(E) receiver.

Choose the correct sequence in which these are arranged in a basic communication system:

(a) ABCDE.
(b) BADEC.
(c) BDACE.
(d) BEADC.

15.9 Identify the mathematical expression for amplitude modulated wave:

(a) $A_c \sin [\{\omega_c + k_1 v_m(t)\}t + \phi]$.
(b) $A_c \sin \{\omega_c t + \phi + k_2 v_m(t)\}$.
(c) $\{A_c + k_2 v_m(t)\} \sin (\omega_c t + \phi)$.
(d) $A_c v_m(t) \sin (\omega_c t + \phi)$.

MCQ II

15.10 An audio signal of 15kHz frequency cannot be transmitted over long distances without modulation because

(a) the size of the required antenna would be at least 5 km which is not convenient.

(b) the audio signal can not be transmitted through sky waves.
(c) the size of the required antenna would be at least 20 km, which is not convenient.
(d) effective power transmitted would be very low, if the size of the antenna is less than 5 km.

15.11 Audio sine waves of 3 kHz frequency are used to amplitude modulate a carrier signal of 1.5 MHz. Which of the following statements are true?

(a) The side band frequencies are 1506 kHz and 1494 kHz.
(b) The bandwidth required for amplitude modulation is 6kHz.
(c) The bandwidth required for amplitude modulation is 3 MHz.
(d) The side band frequencies are 1503 kHz and 1497 kHz.

15.12 A TV trasmission tower has a height of 240 m. Signals broadcast from this tower will be received by LOS communication at a distance of (assume the radius of earth to be 6.4×10^6 m)

(a) 100 km.
(b) 24 km.
(c) 55 km.
(d) 50 km.

15.13 The frequency response curve (Fig. 15.2) for the filter circuit used for production of AM wave should be

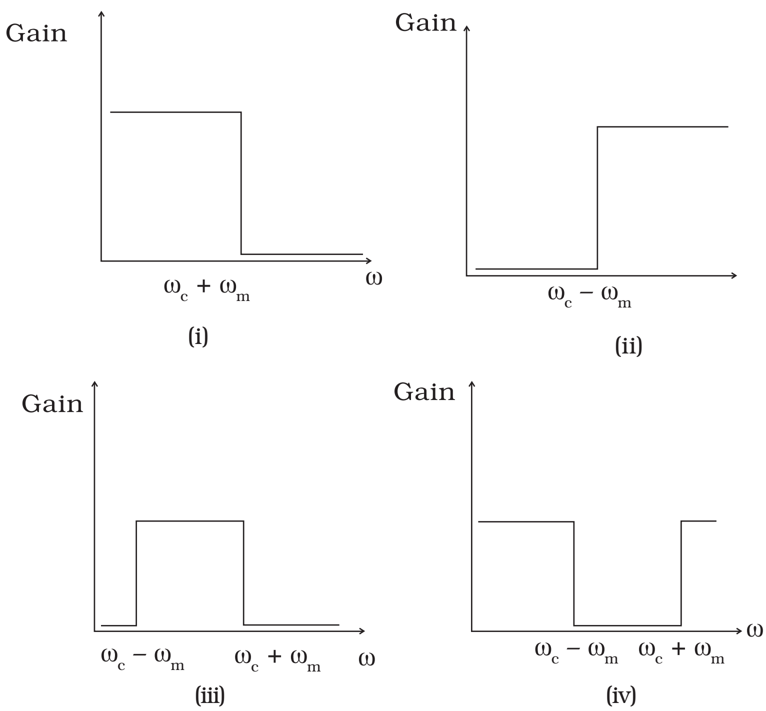


Fig. 15.2

(a) (i) followed by (ii).
(b) (ii) followed by (i).
(c) (iii).
(d) (iv).

15.14 In amplitude modulation, the modulation index m, is kept less than or equal to 1 because

(a) $m > 1$, will result in interference between carrier frequency and message frequency, resulting into distortion.
(b) $m > 1$ will result in overlapping of both side bands resulting into loss of information.
(c) $m > 1$ will result in change in phase between carrier signal and message signal.
(d) $m > 1$ indicates amplitude of message signal greater than amplitude of carrier signal resulting into distortion.