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CHANDIGARH REGION

CLASS XII

PHYSICS

INDEX

Chapter 1: Electric Charges and Fields

Gist of lesson:

Electric charges , Conservation of charge, Coulomb's law force between two point charges, Forces between multiple charges, superposition principle & continuous charge distribution, Electric field, Electric field due to point charge, Electric field lines, electric dipole, Electric field due to a dipole, torque on dipole in uniform electric field, Electric flux, Statement of Gauss's theorem & its applications to find field due to infinitely long straight wire, uniformly charged infinite plane sheet

Expressions / Formulas used in Chapter

1. Quantization of charge, $q = \pm ne$
2. Coulomb's law

   $F_{vac} = \frac{1}{4\pi\varepsilon 0} \frac{q1q2}{r2}$

   $F_{med} = 1/4\pi\varepsilon \frac{q1q2}{r2}$

3. Electric field, $E = F/q$
4. Electric field of a point charge

   $E = \frac{1}{4\pi\varepsilon 0} \frac{q}{r2}$

5. Dipole moment, $p = q(2a)$ where 2a is length of dipole
6. Electric field at a point on the axial line of dipole at a distance r from the centre of dipole

   $E_{axial} = \frac{1}{4\pi\varepsilon 0} \frac{2pr}{(r2-a2)2}$

   When r>> a

   $E_{axial} = \frac{1}{4\pi\varepsilon 0} \frac{2p}{r3}$

7. Electric field at a point on the equitorial line of dipole at a distance r from the centre of dipole

   $E_{equa} = \frac{1}{4\pi\varepsilon 0} \frac{p}{\frac{(r2+a2)3}{2}}$

   When r>> a

$E_{equa} = \frac{1}{4\pi\varepsilon0}\frac{p}{r3}$

8. Torque on a dipole, $\tau = p\,E\,Sin\theta$
9. Electric flux through a plane surface area S

   $\Phi_E = ES\cos\theta$,

   where θ is the angle which the outward drawn normal to surface area S makes with the electric field E
10. According to Gauss Theorem the total electric flux through a closed surface S enclosing a charge is

$\Phi_E = \oint \vec{E}.\vec{ds} = q/\varepsilon_0$

11. Electric field of a long straight wire at distance r

    $E = \frac{\lambda}{2\pi\varepsilon0r}$
12. Electric field of an infinite plane sheet of charge density σ

    $E = \frac{\sigma}{2\varepsilon0}$

MULTIPLE CHOICE QUESTIONS

1. A glass road acquires charge by rubbing it with silk cloth. The charge on the glass road is due to

   a) Friction b) conduction

   c) Induction d) radiation
2. Two charged spheres are separated by 2mm. Which of the following would yield the greatest attractive force

   a) +2q and -2q b) +2q and +2q

   c) -2q and -2q d) -1q and -4q
3. A cylindrical conductor is placed near another positively charged conductor. The net charge acquired by the cylindrical conductor will be

   a) Positive only b) negative only

   c) zero d) either positive or negative
4. When 1019 electrons are removed from a neutral metal plate, the electric charge on it is

   a) -1.6 C b) +1.6C

c) 10^{+19} C
d) 10^{-19} C

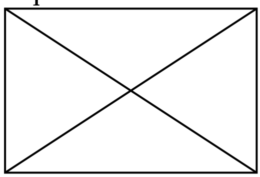
5. The process of charging, the mass of the negatively charged body
   a) increases
   b) decreases
   c) remains constant
   d) is not related to the charging process
6. Identify the wrong statement in the following, Coulomb's law correctly describes the electric force that
   a) binds the electrons of an atom to its nucleus
   b) binds the protons & neutrons in the nucleus of an atom
   c) binds atoms together to form molecules
   d) binds atoms & molecules to form solids
7. Two charges 3×10-5 C & 5× 104 C are placed at a distance 10 cm from each other. The value of electrostatic force acting between them is
   a) 13.5×10^{11} N
   b) 40×10^{11}N
   b) 180×10^{9} N
   c) 13.5×10^{10} N
8. Two charges of equal magnitudes & at a distance r exert a force F on each other. If charges are halved & distance between them is doubled, the net force acting on each charge is
   a)`F/8
   b) F/4
   c) 4F
   c) F/16
9. Each of two point charges are doubled & their distance is halved. Force of interaction becomes n times, where n is
   a) 4
   b) 1
   b) 18
   d) 16
10. The minimum value of force acting between two point charges placed between two point charges placed 1m a apart from one another is
   a) ke^2
   b) ke
   b) ke/4
   d) $ke^2/2$

11. A & B are two identical spherical charged bodies which repel each other with a force F, kept at a finite distance. A third uncharged sphere of the same size is brought in contact with sphere B & removed. it is then kept at midpoint of A & B. Find the magnitude of force on C

a) F/2 b) F/8
c) F d) Zero

12. Four charges are arranged at the corners of a square ABCD as shown in the fig. The force on charge kept at the point of intersection of diagonals is

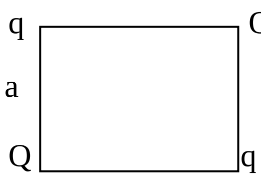
A +q B+2q



D-2Q C +Q

a) zero b) along the diagonal BD
c) along the diagonal AC d) perpendicular to side AB

13. Four charges as shown in fig. are placed at the corners of a square of side length a. What is the ratio of Q/q if net force on Q is zero



a) $\frac{1}{2\sqrt{2}}$ b) $-2\sqrt{2}$
c) ½ c) $1/\sqrt{2}$

14. The physical quantity that has the unit newton / coulomb is

a) electric charge b) electric field

c) electric force d) electric potential

15. The electric field required to keep a water drop of mass m just to remain suspended, when charged with one electron is
    a) mg b) mg/e
    c) emg d) em/g
16. A charge of magnitude 3e & mass 2m is moving in an electric field E. The acceleration imparted to the charge is
    a) 2Ee/3m b) 3Ee/ 2m
    c) 2m / 3Ee d) 3m / 2Ee
17. A particle of mass m & charge q is placed at rest in a uniform electric field E & then released , the kinetic energy attained by by the particle after moving a distance y will be
    a) q^2Ey b) qEy
    c) qE^2y c) qEy^2
18. A charged particle of mass m & charge q initially at rest is released in an electric field of magnitude E. Its kinetic energy after time t will be
    a) $2E^2t^2/mq$ b) $E^2q^2t^2/2m$
    c) $Eq^2m/ 2t^2$ d) Eqm/2t
19. Two charges +5µc & +10µc are placed 20 cm a part. The electric field at the midpoint between the two charges is
    a) 4.5×10^6 N/C towards +5µc
    b) 13.5×10^6 N/C towards +5µc
    c) 4.5×10^6 N/C towards +10µc
    d) 13.5×10^6 N/C towards +10µc
20. Two small charged spheres A & B have charges 10µc & 40µc respectively & are held at a separation of 90 cm

from each other. At what distance from A electric intensity would be zero

a) 22.5 cm b) 18 cm
b) 36 cm d) 30 cm

21. If σ = surface charge density, ε = electric permittivity, the dimension of σ / ε are same as

a) electric force b) electric field intensity
c) pressure d) electric charge

22. What will be value of electric field at the centre of the electric dipole

a) Zero
b) Equal to the electric field due to one charge at the centre
c) Twice the electric field due to each charge
d) Half the value of electric field due to one charge at centre

23. If r is the distance of a point from the centre of a short dipole, then the electric field intensity due to the short dipole remains proportional to

a) r^2 b) r^3 c) r^{-2} d) r^{-3}

24. An electric dipole of moment p is placed in a uniform electric E. The maximum torque experienced by the dipole is

a) pE b) p/E c) E/p d) None of the above

25. Two equal & opposite charges of 2×10^{-10} C are placed at a distance of 1cm forming a dipole & are placed in an electric field of 2×10^5 N/ C

a) $2\sqrt{2}\times 10^{-6}$ Nm
b) 8×10^8 Nm

c) 4×10^{-9} Nm
d) 4×10^{-7} Nm

26. Out of the following is not property of field lines
    a) Field lines are continuous curves without any breaks
    b) Two field lines cannot cross each other
    c) Field lines start at +ve charges & end at – ve charges
    d) they form closed loops
27. Electric field lines contact lengthwise, it shows
    a) repulsion between same charges
    b) attraction between opposite charges
    c) no relation between force & contraction
    d) electric field lines do not move on straight path
28. What is the SI unit of electric flux
    a) Nm^2/c b) nm^2
    c) NC/m^2 d) N^2C^2/m^2
29. Gauss's law is valid for
    a) any closed suface
    b) only regular closed surfaces
    c) any open surface
    d) only irregular open sufaces
30. Four charges 8C, -3C, 5C & -10C are kept inside a closed surface. What will be outgoing flux through the surface
    a) 26 Vm b) 0 Vm c) 10 Vm d) 8 Vm
31. The charge q is first kept in a sphere of radius 5cm & then it is kept in a cube of side 5 cm. The outgoing flux
    a) will be more in case of sphere
    b) will be more in case of cube

c) will be same in both cases
d) cannot be determined

32. The electric charges are distributed in a small volume. The flux of the electric field through a spherical surface of radius 10 cm surrounding the total charge is 20 Vm. The flux over a concentric sphere of radius 20 cm will be

a) 20 Vm b) 25 Vm
c) 40 Vm d) 200 Vm

33. According to Gauss Law electric field of an infinitely long straight wire is proportional to

a) r b) $1/r^2$ c) $1/r^3$ d) 1/r

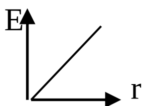
34. Above an infinitely large plane carrying charge density σ, the electric field points up & is equal to $\sigma / 2\varepsilon_0$. What is the magnitude & direction of the electric field below the plane

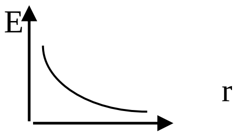
a) $\sigma / 2\varepsilon_{0,}$ down b) $\sigma / 2\varepsilon_{0,}$ up
c) $\sigma / \varepsilon_{0,}$ down d) $\sigma / \varepsilon_{0,}$ up

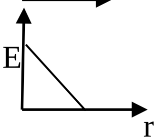
35. A body has a charge of -2μ C . If it has 2.5×10^{13} protons, then how many electrons the body has

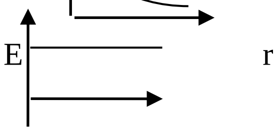
a) 1.25×10^{13} b) 2.5×10^{13}
c) 3.75×10^{13} d) none of these

36. For a point charge the graph between electric field E versus distance r is given by

a) 

b) 

c) 

d) 

37. Which quantity is a vector quantity among the following

a) Electric flux b) Electric charge
c) Electric field d) Electric potential

38. What is the force of repulsion between two charges of 1C each, kept 1m a part in vacuum
a) $F = 9 \times 10^9$ N b) $F = 5 \times 10^9$ N
c) $F = 27 \times 10^9$ N d) $F = 9 \times 10^{-9}$ N

39. How does the coulomb force between two point charges depend upon the dielectric constant of the medium
a) F_{med} α 1/ k b) F_{med} α k
c) F_{med} α 4Πε/ k d) none of the above

40. Two fixed point charges +4e & +e are separated by a distance a. Where should a third q be placed between +4e & +e for it to be in equilibrium
a) 2a/3 b) 2a c) 3a/2 d) 5a/2

41. A proton is placed in a uniform electric field directed along + ve x- axis in which direction will it tend to move
a) Along the direction of electric field
b) opposite the direction of electric field
c) both a) & b)
d) none of the above

42. What is the electric flux through a cube of side 1 cm which encloses a dipole
a) Zero b) q/ε_0 c) q2/ε0 d) none of the above

43. How does the electric flux due to a point charge enclosed by a spherical Gaussian surface get affected when its radius is increased
a) Unchanged b) become double
c) decreases d) none of the above

44. A charge q is placed at the centre of a cube of side l. What is the electric flux passing through two opposite faces of cubea) $q/3\varepsilon_0$b) $q/6\varepsilon_0$c) Zerod) 2 q/ε_0

45. Charges of magnitudes -3Q & +2Q are located at points (a.0) & (4a, 0) respectively. What is the electric flux due to these charges through a sphere of radius 5a with its centre at orgin. a) $-Q/\varepsilon_0$b) Q/ε_0c) $-6Q^2/\varepsilon_0$ d) None of the above
46. Is the force acting between two point electric charges q_1 & q_2 kept at some distance in air , attractive or repulsive when i) $q_1q_2>0$ ii) $q_1\ q_2 <0$.a) repulsive, attractive b) attractive, repulsivec) repulsive. repulsived) attractive, attractive
47. What is the SI unit of electric permittivity of free space
    a) $C^2N^{-1}m^{-2}$ b)$C^{-2}N^{-1}m^{-2}$
    c) $C^2N^1m^{-2}$ d) none of the above
48. The force between two charges placed in vacuum is F. What happens to the force if two charges are dipped in kerosene oil of dielectric constant k=2
    a)F/2 b) F/4
    c) 3F/4 d) none of the above
49. An electric dipole of dipole moment 4×10^{-5}Cm is placed in a uniform electric field of $10^{-3}NC^{-1}$making an angle of 30^0 with the direction of the field. Determine the torque exerted by the electric field on the dipole.
    a) 2×10^{-8} Nm b)4×10^{-8}Nm
    c) 2×10^{-10} Nm d) 8×10^{-8} Nm
50. An electric dipole is placed at an angle of 30^0 to a non uniform electric field. The dipole will experience
    a) a torque as well as translational force
    b) a torque only
    c) a translational force only in the direction of the field
    d) a translational force only in the direction normal to the direction of the field

ASSERTION & REASON QUESTIONS

Two statements are given- one labelled Assertion & other labelled Reason. Select the correct answer to these questions from the codes (a), (b), (c), (d) are given below

(a) Both A & R are true & R is the correct explanation of A

(b) Both A & R are true & R is not the correct explanation of A

(c) A is true but R is false

(d) A is false but R is alsofalse

1. Assertion(A) : If there exists coulomb attraction between two bodies, both of them may not be charged

   Reason(R) : In coulomb attraction two bodies are oppositely charged
2. Assertion(A) : No two electric lines of force can intersect each other

   Reason(R) : Tangent at any point of electric lines of force gives the direction of electric field.
3. Assertion(A): Electric force acting on a proton & an electron moving in a uniform electric field is same, where as acceleration of electron is 1836 times that of a proton

   Reason(R) : Electron is lighter than proton
4. Assertion(A): As force is a vector quantity hence electric field intensity is also a vector quantity

   Reason(R) : The unit of electric field intensity is newton per coulomb
5. Assertion (A): Sharper is the curvature of spot on a charged body lesser will be the surface charge density at that point

Reason(R) : Electric field in non –zero inside a charged conductor

6. Assertion (A): The surface densities of two spherical conductors of different radii are equal. Then the electric field intensities near their surface are equal
   Reason(R) : surface density is equal to charge per unit area
7. Assertion (A): Three equal charges are situated on a circle of radius r such that they form an equilateral triangle, then the electric field intensity at the centre is zero
   Reason(R) : The force per unit positive charge at the centre, due to three equal charges are represented by three sides of a triangle taken in the same order. Therefore electric field intensity at the centre is zero
8. Assertion (A): The electric lines of force diverges from a positive charge & converge at a negative charge
   Reason(R) : A charged particle free to move in an electric field always move along an electric lines of force
9. Assertion (A): Charging is due to transfer of electrons.
   Reason(R) : Mass of a body decreases slightly when it is negatively charged.
10. Assertion (A): Range of Coulomb force is infinite.
    Reason(R) : Coulomb force acts between two charged particles
11. Assertion (A): A small metal ball is suspended in a uniform electric field with an insulated thread, If high energy X ray beam falls on the ball, the ball will be deflected in the electric field
    Reason(R) : X- rays emits photoelectron & metal becomes negatively charged
12. Assertion (A): If a point charge be rotated in a circle around a charge, the work done will be zero.

Reason(R) : Work done is equal to dot product of force & distance

13. Assertion (A): A point charge is lying at the centre of a cube of each side. The electric flux emanating from each surface of the cube is 1/6 th of total flux

    Reason(R) : According to Gauss theorem, total electric flux through a closed surface enclosing a charge is equal to $1/\varepsilon_0$ times the magnitude of the charge enclosed
14. Assertion (A): A point charge is brought in an electric field. The field at a nearby point is increase, whatever be the nature of the charge.

    Reason(R) : The electric field is independent of the nature of charge
15. Assertion (A): For charge to be in equilibrium, sum of the forces on charge due to rest of the two charges must be zero

    Reason(R) : A charge is lying at the centre of the line joining two similar charges each other are fixed. The system will be in equilibrium if that charge is one fourth of the similar charges
16. Assertion (A): If a conducting medium is placed between two charges, the electric force between them becomes zero

    Reason(R) : Reduction in a force due to introduced material is inversely proportional to its dielectric constant
17. Assertion (A): In electrostatics, electric lines of force can never be closed loops, as a line can never start & end on the same charge

    Reason(R) : The number of electric lines of force originating or terminating on a charge is proportional to the magnitude of charge

18. Assertion (A): If a point charge q is placed in front of an infinite grounded conducting plane surface, the point charge will experience a force
    Reason(R) : This force is due to induced charge on the conducting surface which is at zero potential.
19. Assertion (A): Charge is quantized
    Reason(R) : Charge which is less than 1C is not possible
20. Assertion (A): The electric flux emanating out & entering a closed surface are 8× 103 & 2 × 103 V m respectively. The charge enclosed by the surface is 0.053 μC.
    Reason(R) : Gauss theorem in electrostatics may be applied to verify
21. Assertion (A): Acceleration of charged particle in non-uniform electric field does not depend on velocity of charged particle
    Reason(R) : Charge is an invariant quantity. That is the amount of charge on particle does not depend upon on frame of reference
22. Assertion (A): Net electric field inside a conductor is zero
    Reason(R) : Total +ve charge equals to total – ve charge in a charged conductor
23. Assertion (A): All the charges in a conductor get distributed on whole of its outer surface
    Reason(R) : In a dynamic system charges try to keep their potential energy minimum
24. Assertion (A): The Coulomb force is the dominating force in the universe
    Reason(R) : The Coulomb force is weaker than gravitational force
25. Assertion (A): The entire charge on a conductor can not be transferred to another isolated conductor

Reason(R) : The total transfer of charge from one conductor to another conductor is impossible

26. Assertion (A): on going away from a point charge or a small electric dipole, electric field decreases at the same rate in both the cases
    Reason(R) : Electric field is inversely proportional to the square of the distance
27. Assertion (A): If a conducting medium is placed between two charges, then electric force between them becomes zero
    Reason(R) : Reduction in force is due to introduced medium is proportional to its dielectric strength
28. Assertion (A): The electric field lines diverge from a positive charge & converge at a negative charge
    Reason(R) : A charged particle free to move in an electric field always moves along an electric field line
29. Assertion (A): On moving a distance two times the initial distance away from an infinitely long straight uniformly charged wire the electric field reduces to one third of the initial value
    Reason(R) : The electric field is inversely proportional to the distance from an infinitely long straight uniformly charged wire
30. Assertion (A): If a conductor is given charge then no excess inner charge appears
    Reason(R) : Electric field inside conductor is zero

CASE STUDY BASED QUESTIONS

1) Coulomb's law states that the electrostatic force of attraction or repulsion acting between two stationary point charges is given by

$$F = \frac{1}{4\pi\varepsilon 0} \frac{q1q2}{r2}$$

Where F denotes the force between two charges q1 & q2 separated by a distance r in free space, ε_0 is a constant known as permittivity of free space. Free space is vacuum & may be taken to be air practically

If free space is replaced by a medium then ε_0 is replaced by (ε_0k) or (ε_0 ε_r) where k is known as dielectric constant or relative permittivity

i) In coulomb's law F = k $\frac{q1q2}{r2}$, then on which of the following factors does the proportionality constant k depends

a) electrostatic force acting between the two charges
b) nature of the medium between the two charges
c) magnitude of the two charges
d) distance between the two charges

ii) Dimensional formula of $\varepsilon 0$

a) $[ML^{-3}T^{4}A^{2}]$ b) $[M^{-1}L^{3}T^{2}A^{2}]$
b) $[M^{-1}L^{-3}T^{4}A^{2}]$ c) $[ML^{-3}T^{4}A^{-2}]$

iii) The force of repulsion between two charges of 1C each, kept 1m apart in vaccum is

a) $1/ 9\times10^{9}$ N b) 9×10^{9} N
c) 9×10^{9} N d) $1/ 9\times10^{12}$ N

iv) Two identical charges repel each other with a force equal to 10mgwt when they are 0.6 m a part in air(g = $10ms^{-2}$). The value of each charge is

a) 2mC b) 2×10^{-7} mC
c) 2 nC d) 2 μC

v) Coulomb's law for force between electric charges most closely resembles with

a) Law of conservation of energy
b) Newton's law of gravitation
c) Newton's second law of motion
d) law of conservation of charge

2) Smallest charges that can exist in nature is the charge of an electron. During friction it is only the transfer of electrons which makes the body charged. Hence net charge on any

body is an integral multiple of charge of an electron ($1.6\times10\text{-}^{19}$C) i. e.

Q = ± ne   n = 1,2,3,4,------------

Hence no body can have a charge represented as 1.1e, 2.7e, 3/5e etc.

Recently it has been discovered that elementary particles such as protons or neutrons are composed of more elemental units called quarks

i) Which of the following properties is not satisfied by an electric charge

a) total charge conservation   b) quantization of charge
c)two types of charges   c) circular line of force

ii) Which one of the following charges are possible

a) 5.8×10^{-18}C   b) 3.2×10^{-18}C
c) 4.5×10^{-19}C   c) 8.6×10^{-19}C

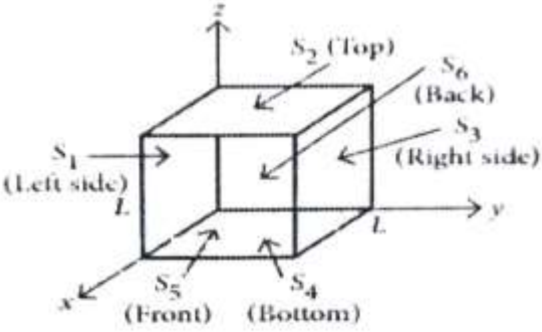
iii) If a charge on a body is 1 nC , then how many electrons are present in the body

a) 6.25×10^{27} b) 1.6×10^{19}
c) 6.25×10^{28} d) 6.25×10^{9}

iv) If a body gives out 10^9 electrons every second how much time is required to get a total charge of 1 C from it

a) 190.19 years   b) 150.12years
c) 198.19 years   d) 188.21

3) Net electric flux through a cube is the sum of fluxes through its six faces. Consider a cube as shown in figure having sides of length L= 10 cm The electric field is uniform has magnitude E = 4×10^3 N/C & IS parallel to the xy planeat an angle of 370 measured from the + x – axis towards +y axis



i) electric flux passing through surface S_6 is

a) $-24Nm^2C^{-1}$ b) $24Nm^2C^{-1}$
c) $32Nm^2C^{-1}$ d) $-32Nm^2C^{-1}$

ii) electric flux passing through surface S_1 is

a) $-24Nm^2C^{-1}$ b) $24Nm^2C^{-1}$
c) $32Nm^2C^{-1}$ d) $-32Nm^2C^{-1}$

iii) The surfaces that have zero flux are

a) S_1 & S_3 b) S_5 & S_6
c) S_2 & S_4 d) S_1 & S_2

iv) The total net electric flux through all faces of the cube is

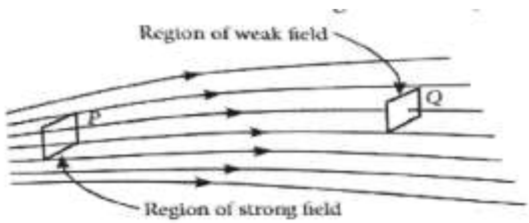
a) $8Nm^2C^{-1}$ b) $-8Nm^2C^{-1}$
c) $24Nm^2C^{-1}$ d) zero

4) Gauss Law and Coulomb's law although expressed in different forms, are equivalent ways of describing the relations between charge and electric field in static conditions. Gauss's law is $\varepsilon_0\Phi = q_{encl}$, when q_{encl} is the net charge inside an imaginary closed surface called Gaussian Surface. $\Phi = \oint E.dA$ Gives electric flux through the Gaussian surface. The two equations hold only when the net charge is in vacuum or air

i) if there is only one type of charge in the universe, then (E- Electric field, ds area vector)

a) $\oint E.ds$ is not zero on any surface
b) $\oint E.ds$ could not be defined
c) $\oint E.ds$ equals infinity if charge is inside
d) $\oint E.ds = 0$ if charge is outside, $\oint E.ds = q/\varepsilon_0$ if charge is inside

(ii) What is the nature of Gaussian Surface involved in the Gauss Law of Electrostatic ?
a) Magnetic b) Scalar c) Vector d) Electrical
(iii)The electric flux through a closed surface area S enclosing charge Q is Φ . If surface area is doubled then the electric flux is
a) 2 Φ b) Φ/2
c) Φ /4 d) Φ
(iv) A Gaussian Surface encloses a dipole. The electric flux through this surface is
a) q / ε_0 b) $2q/ \varepsilon_0$ c) $q/2 \varepsilon_0$ d) zero
5) Electric field strength is proportional to the density of lines of force i.e. electric field strength at a point is proportional to the number of lines of force cutting a unit area element placed normal to the field at that point. As illustrated in the given fig. The electric field at point P is stronger that at Q



i) Electric lines of force about a positive point charge are
a) radially outwards b) circular clockwise
c) radially inwards d) parallel straight lines

ii) Which one of the following is false for electric lines of force

a) they always start from positive charges & terminate on negative charges

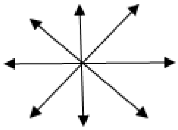
b) they are always perpendicular to the surface of a charged conductor

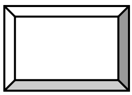
c) they always form closed loops

d) they are parallel & equally spaced in a region of uniform electric field

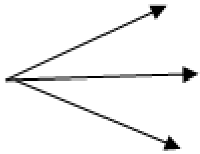
iii) Which one of the following pattern of electric lines of force is not possible in field due to stationary charges

a) 

b) 



c)



d)

iv) Electric lines of force are curved

a) in the field of a single positive or negative charge

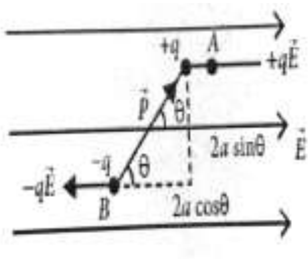
b) in the field of a two equal & opposite charges

c) in the field of a two like charges

d) both (b) & (c)

6) When electric dipole is placed in uniform electric field, its two charges experience equal & opposite forces, which cancel each other & hence net force on electric dipole in uniform electric field is zero. However these forces are not collinear so they give rise to some torque on the dipole.

Since net force on electric dipole in uniform electric field is zero, so no work is done in moving the electric dipole in uniform electric field. However some work is done in rotating the dipole against the torque acting on it.



i) The dipole moment of a dipole in a uniform external field E is p. Then the torque (τ) acting on the dipole is

a) τ = pE sinθ b) τ = pE cosθ

c) τ = 2pE sinθ d) τ = p + E

ii) An electric dipole consists of two opposite charges each of magnitude 1.0 μC separated by a distance of 2.0 cm. The dipole is placed in an external field of 105 NC^{-1}. The maximum torque on the dipole is

a) 0.2×10^{-3} Nm b) 1×10^{-3} Nm

c) 2×10^{-3} Nm d) 4×10^{-3} Nm

iii) Torque on a dipole in uniform electric field is minimum when θ is equal to

a) 0^0 b)90^0

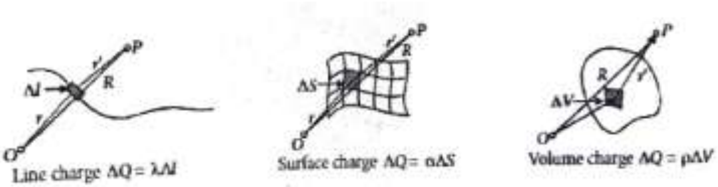
c) 180^0 d) both a) & c)

iv) When an electric dipole is held at an angle in a uniform electric field, the net force F & torque τ on the dipole are

a) F=0, τ =0 b) F≠ 0, τ ≠ 0

c) F=0 ,$\tau \neq 0$ d) F$\neq$ 0, $\tau = 0$

7) In practice we deal with charges much greater in magnitude than the charge on an electron, so we can ignore the quantum nature of charges & imagine that charge is spread in a region in a continuous manner. Such a charge distribution is known as continuous charge distribution. There are three types of continuous charge distribution: line charge distribution, surface charge distribution, volume charge distribution as shown in fig.



i) Statement1: Gauss law can not be used to calculate electric field near an electric dipole

Statement 2 : Electrical dipole don't have symmetrical charge distribution

a) Statement 1 & Statement 2 are true

b) Statement 1is false but Statement 2 is true

c) Statement 1is true but Statement 2 is false

d) both statements are false

ii) An electric charge of 8.85×10^{-13}C is placed at the centre of a sphere of radius 1 m. The electric flux through the sphere is

a) 0.2 $NC^{-1}m^2$ b) 0.1 $NC^{-1}m^2$ c) 0.3 $NC^{-1}m^2$ d) 0.01 $NC^{-1}m^2$

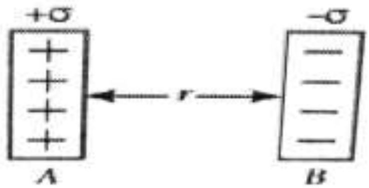
iii) What charge would be required to electrify a sphere of radius 25 cm so as to get a surface charge density of 3/π C m^{-2}

a)0.75C b)7.5C c) 75 C d) zero

iv) The SI unit of linear charge density is

a) C m b) C m^{-1} c) C m^{-2} d) C m^{-3}

8) Surface charge density is defined as charge per unit surface area of surface charge distribution i. e. $\sigma = dq/ds$. Two large, thin metal plates are parallel & close to each other. On their inner faces the plates have surface charge densities of opposite signs having magnitude of 17.0×10^{-22} Cm^{-2} as shown. The intensity of electric field at a point is $E = \sigma/\varepsilon_0$, where ε_0 is permittivity of free space



i) E in the outer region of first plate is

a) 17×10^{-22} N/C b) 1.5×10^{-25} N/C

c) 1.9×10^{-10} N/C d) zero

ii) E in the outer region of second plate is

a) 17×10^{-22} N/C b) 1.5×10^{-25} N/C

c) 1.9×10^{-10} N/C d) zero

iii) E between the plates is

a) 17×10^{-22} N/C b) 1.5×10^{-25} N/C

c) 1.9×10^{-10} N/C d) zero

iv) In order to estimate the electric field due to a thin finite plane metal plate, the Gaussian surface considered is

a) spherical b) cylindrical

c) straight line d) none of these

9) An electric line of force may be defined as the curve along which a small positive charge would tend to move when free to do so in an electric field & the tangent to which at any point gives the direction of the electric field at that point

The lines of force are imaginary lines. The field which they represent is real

i) Do the electric lines of force really exist

a) yes b) no c) none of the above

ii) Two point charges q1 & q2 placed a distance d apart are such that there is no point where the field lines vanishes. What can be concluded from this

a) The point charges q1 & q2 are equal & opposite

b) The point charges q1 & q2 are equal & are of same kind

c) q1 > q 2

d) q1 < q 2

iii) A proton is placed in a uniform electric field directed along the positive x-axis. In which direction will it tend to move

a) + ve x- axis b) –ve x-axis c) + y – axis d) none of the above

iv) Which characteristics of electric field lines , explain the repulsion between two similar charges

a) Tendency to contract lengthwise

b) Tendency to expand laterally

c) both a) & b)

d) non of the above

10. Coulomb's law states that the force of attraction or repulsion between two stationary point charges is directly proportional to the product of the magnitudes of the two charges & inversely proportional to the square of the distance between them. This force acts along the line joining the two charges

q1*-----------r----------------* q2

$F = k\, q_1 q_2 / r^2$

i) If the distance between two equal point charges is doubled & their individual charges are also doubled, what would happen to force between them

a) no change   b) increases by two times

c) decreases by two times   d) none of the above

ii) How is the Coulomb force between two charges affected by the presence of third charge

a) no effect   b) increases

c)decreases   d) none of the above

iii) F is the force between two point charges kept at a distance d apart in air. If these charges are kept at same distance in water , how does the electric force between the change

a) no effect   b) increases

c) decreases   d) none of the above

11. A pair of equal & opposite charges separated by a small distance is called electric dipole

Dipole moment (p) measure the strength of an electric dipole

-q* ——————2a——————→ * +q

p

Electric field at an axial point of a short dipole

$$E_{axial} = \frac{1}{4\pi\varepsilon 0}\frac{2p}{r3}$$

Electric field at an equitorial point of a short dipole

$$E_{equa} = \frac{1}{4\pi\varepsilon 0}\frac{p}{r3}$$

i) SI unit of electric dipole moment

a) C m b) Cm^{-1} c) Cm^2 d) none of the above

ii) Is electric dipole moment a scalar or vector quantity

a) scalar b) vector c) neither scalar nor vector

iii) An electric dipole is placed in a uniform electric field. What is the net force acting on it

a) zero b) $F = k\ q_1q_2/\ r^2$ c) $F = -\ q_1q_2/\ r^2$ d) neither of the above

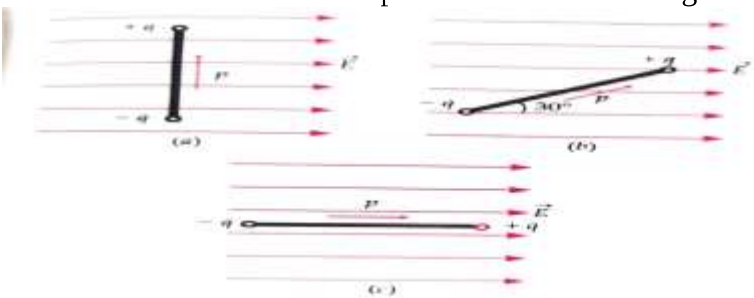
iv) What is the angle between the directions of electric field at any i) axial point and ii) equatorial point due to an electric dipole

a) 0^0 b) 180^0 c) 90^0 d) none of the above

12) Torque experienced by a dipole consisting of two equal & opposite charges –q & +q separated by a distance 2a placed in a uniform electric field E at an angle ɵ is given by

$\vec{\tau} = \vec{p} \times \vec{E}$ where p = q(2a) dipole moment of dipole

Different orientation of the dipole are shown in the fig



i) In which orientation the torque is maximum

A) a B) b

C) c D) none of the above

ii) In which orientation the torque is half the maximum

A) a B) b

C) c D) none of the above

iii) In which orientation the torque is half the maximum

A) a B) b

C) c D) none of the above

iv) Identify two pairs of perpendicular vetors

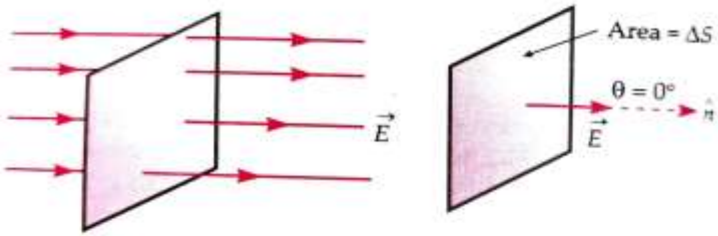
A) (τ , p) & (τ , E) B) (τ , p) & (p , E)

C) (p , E) & (τ , E)

13) The term flux implies some kind of flow. Flux is the property of any vector field. The electric flux is the property of electric field.

The electric flux through a given area held inside an electric field is the measure of total no. of electric field lines passing normally through the area

As shown in fig. If an electric field E passes normally through an area element ΔS, then the electric flux through this area is $\Delta\Phi_E = E\,\Delta S$



i) If electric field is given by E = 8i +4j + 3k N/C, calculate the electric flux through a surface of area 100 m^2 lying in X-Y plane

a) 300 Nm^2C^{-1} b) 200 Nm^2C^{-1}

c) -300 Nm^2C^{-1} d) -200 Nm^2C^{-1}

ii) Is electric flux scalar or vector

a) scalar b) vector c) neither scalar nor vector

iii) SI unit of electric flux is

a) N^2mC^{-1} b) Vm c) V/m d) Vm^2

iv) Consider a uniform electric field E = 3× 103 i NC^{-1}. Calculate the flux of this field through a square surface of area $10cm^2$ when normal to its plane makes a 60^0 angle with x- axis

a) 25 Nm^2C^{-1} b) 10 Nm^2C^{-1} c) zero d) 15 Nm^2C^{-1}

14.Gauss's theorem gives a a relationship between the total flux passing through any closed surface & net charge enclosed within the surface

It states that total flux through a closed surface is 1/ε0 the net charge enclosed by the closed surface.

Mathematically it can be expressed as

$$\Phi_E = \oint \vec{E}.\vec{ds} = q/\varepsilon_0$$

Electric field due to infinitely long charged wire

$E = \lambda / 2\pi\, \varepsilon_0 r$ where λ is linear charge density, r is distance from line charge

i) A cylinder of large length carries a charge of 2×10^{-8} C m^{-1} . Find the electric field at a distance of 0.2 m from it

a) 1200 Vm^{-1} b) 800 Vm^{-1}

c) 1400 Vm^{-1} d) 1800 Vm^{-1}

ii) An arbitrary surface encloses a dipole. What is the electric flux through this surface

a) 1 b) q^2/ε_0

c) zero d) -1

iii) How much is the electric flux through a closed surface due to a charge q lying outside the closed surface

a) q/ε_0 b) ε_0

c) zero d) none of the above

iv) Give the SI unit of surface integral of an electric field

a) Nm^2C^{-1} b) Vm

c) both a) & b)　　d) Vm^{-1}

15) A charge is a property associated with the matter due to which it experiences & produces an electric & magnetic field. Charges are scalar in nature & they add up like real numbers. Also total charge of an isolated system is always conserved. When the objects rub against each other charges acquired by them must be equal & opposite

i) The cause of charging is

a) the actual transfer of protons

b) the actual transfer of electrons

c) the actual transfer of neutrons

d none of the above

ii) Pick the correct statement

a) The glass rod gives protons to silk when they are rubbed against each other

b) The glass rod gives electrons to silk when they are rubbed against each other

c) The glass rod gains protons from silk when they are rubbed against each other

d) The glass rod gains electrons from silk when they are rubbed against each other

iii) A charge is a property associated with the matter due to which it produces &experiences

a) electric effect only　　b) magnetic effect only

c) both electric & magnetic field　　d) none of these

iv) The cause of quantization of charge is

a) transfer of integral no. of neutrons　b) transfer of integral no. of protons

c) transfer of integral no. of electrons　d) none of these

16) Electric charge is the physical property of matter that causes it to experience a force when placed in an electromagnetic field. There are two types of charges positive & negative charges. Also like charges repel each other whereas unlike charges attract each other

i) How many electronic charges form one coulomb of charge

a) 6.25×10^{-18} C b) 6.25×10^{18} C

c) -6.25×10^{-17} C d) 6.25×10^{-17} C

ii) Calculate the charge on an alpha particle. charge on a proton is 1.6×10^{-19}C

a) 3.2×10^{-19}C b) -3.2×10^{-19}C

c) 6.4×10^{-19}C d) -6.4×10^{-19}C

iii) When glass rod is rubbed with silk, both acquires charges. What is the source of their electrification

a) electrons b) protons

c) neutrons d) none of the above

iv) How does a positively charged glass rod attract a neutral piece of a paper

a) by inducing –ve charge on the closer end & +ve charge on the farther end of the paper

b) by inducing +ve charge on the closer end & -ve charge on the farther end of the paper

c) by inducing no charge

d) none of the above

17) Permittivity is the property of the medium which determines the electric force between two charges situated in a medium. e. g. Force between two charges located some distance a part in water is about 1/80 th of the force between them when they are separated by same distance in air. This is because the absolute permittivity of water is 80 times greater than the absolute permittivity of free space

$\frac{Fvac}{Fmed} = \varepsilon/\varepsilon_0 = k$ or ε_r

Ratio of $\varepsilon/\varepsilon_0$ is called relative permittivity (ε_r) or dielectric constant of the medium

i) Force between two point charges kept at a distance d apart in air is F.If these charges are kept at same distance in water, how does the electric force between them change

a) F/80 b) F/ 40

c) no change d) none of the above

ii) The dielectric constant of water is 80. What is its permittivity

a) $7.083\times10^{-10}\ C^2N^{-1}m^{-2}$ b) $8.854\times10^{-12}\ C^2N^{-1}m^{-2}$

c) $5.083\times10^{-10}\ C^2N^{-1}m^{-2}$ d) $6.854\times10^{-12}\ C^2N^{-1}m^{-2}$

iii) Two point charges placed at a distance r in air exert a force F on each other. At what distance will these charges experience the same force F in a medium of dielectric constant k

a) $\frac{r}{\sqrt{k}}$ b) $\frac{r}{2\sqrt{k}}$ c) $\frac{2r}{\sqrt{k}}$ d) none of the above

iv) A force F is acting between two charges placed some distance a part in vacuum. If brass rod is placed between these two charges, how does the force change

a) zero b) 1

c) infinite d) none of the above

18) The electric field intensity at a point at a distance r from a charge q is

$E = \frac{1}{4\pi\varepsilon0}\frac{q}{r2}$, $E = F/q$ $F = \frac{1}{4\pi\varepsilon0}\frac{q1q2}{r2}$

Such a field is called spherically symmetric or radial field

i) Two point charges +4μ C & +1μ C are separated by a distance of 2m in air. Find the point on the line joining charges at which the net electric field of system is zero

a) 4/3m to the right of +4μ C b)4/3m to the left of +4μ C

c) 4m c) 2/3m to the right of +4μ C

ii) A charge q is placed at the centre of the line joining two charges Q. Find the value of q at which three charges will be in equilibrium

a) q= - Q/4 b) q= Q/4 c) q= 4/Q c) q = -4/Q

iii) Two point charges of charge value Q & q are placed at distances x & x/2 respectively from a third charge of charge value 4q, all charges being in the same straight line. At what value of Q the net force experienced by charge q is zero

a) -4q b) 4q c) 1/-4q d) 1/4q

iv) Assuming that the charge on an atom is uniformly distributed in a sphere of radius 10^{-10} m. What will be the electric field at the surface of the gold atom. For gold Z = 79

a) 1.5×10^{15} N/C b) 4.5×10^{-15} N/C

c) 1.138×10^{13} N/C d) -1.138×10^{-13} N/C

19) Law of Conservation of Charge states that

1. The total charge of an isolated system remains constant.

2. The electric Charges can neither be created nor be destroyed, they can only be transferred from one body to another.

(i) When glass rod is rubbed with silk. What is the net charge of the system after rubbing them.

(a) -1 (b) 0 (c)1 (d) 2

(ii) In the following pair production phenomenon

ϒ →electron + positron , whether there is conservation of charge or not.

(a) yes (b)no

(c) neither yes nor no (d) none of the above

(iii) a glass rod when rubbed with silk cloth, acquires a charge of

1.6×10^{-13} C.What is the charge on silk cloth?

(a)0 (b) -1.6×10^{-13} C

(c) -1.6×10^{13} C (d) 1.6×10^{13} C

(iv) is total charge of the conserved?

(a) yes (b)no

(c) neither yes nor no (d) none of the above

20) Charge is additive in nature, i.e total charge on a body is the sum of all the charges distributed in body. Total Mass of the body is always positive, whereas the total charge on a body maybe +ve or -ve or zero.

(i)both charges and mass are scalars and hence, got the additive property, however in adding charges it is not enough to just add the amount of charges because

(a) charges are of two different kinds
(b) above statement is wrong
(c) charges are of similar kinds
(d) none of the above

(ii) Charge is strictly conserved but mass is not conserved because

(a) mass may get changed into energy
(b) energy may get changed into mass
(c) both a and b
(d) none of the above

(iii) Consider the statements

(1)A charged body always possesses some mass.
(2) A body possessing mass may not have any net charge.

(a) both statements are true
(b) statement 1 is true but statement2 is false
(c) statement 2 is true but statement1 is false
(d) both statements are false

(iv) Consider the statements

(1) Charge on a body does not depend on its speed
(2) Mass of a body increases with its speed

(a) both statements are true
(b) statement 1 is true but statement2 is false
(c) statement 2 is true but statement1 is false
(d) both statements are false

Chapter 2. Electrostatic potential and capacitance

GIST OF LESSON

1. Electrostatic Potential The electrostatic potential at any point in an electric field is equal to the amount of work done per unit positive test charge or in bringing the unit positive test charge from infinite to that point, against the electrostatic force without acceleration.

$$\text{Electrostatic potential, } V = \frac{\text{Work done } (W)}{\text{Charge } (q)}$$

Its SI unit is volt (V) and 1 V = 1 J/C and its dimensional formula is $[ML^2T^{-3}A^{-1}]$.
It is a scalar quantity.

NOTE: Electrostatic potential is a state dependent function as electrostatic forces are conservative forces. 2. Electrostatic Potential Difference The electrostatic potential difference between two points in an electric field is defined as the amount of work done in moving a unit positive test charge from one point to the other point against of electrostatic force without any acceleration (i.e. the difference of electrostatic potentials of the two points in the electric field).

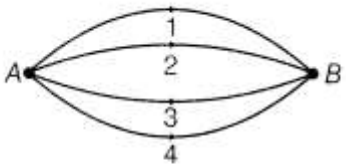
$$V_B - V_A = \frac{W_{AB}}{q_0}$$

where, is work done in taking charge q0 from A to B against of electrostatic force. Also, the line integral of electric field from initial position A to final position B along any path is termed as potential difference between two points in an electric field, i.e.

$$V_B - V_A = -\int_A^B \mathbf{E} \cdot d\mathbf{l}$$

NOTE: As, work done on a test charge by the

electrostatic field due to any given charge configuration is independent of the path, hence potential difference is also same for any path.
For the diagram given as below, potential difference between points A and B will be same for any path.



3. Electrostatic potential due to a point charge q at any point P lying at a distance r from it is given by

$$V = \frac{1}{4\pi\varepsilon_0} \cdot \frac{q}{r}$$

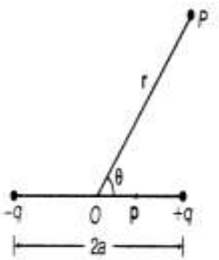
4. The potential at a point due to a positive charge is positive while due to negative charge, it is negative.
5. When a positive charge is placed in an electric field, it experiences a force which drives it from points of higher potential to the points of lower potential. On the other hand, a negative charge experiences a force driving it from lower potential to higher.
6. Electrostatic potential due to an electric dipole at any point P whose position vector is r w.r.t. mid-point of dipole is given by

$$V = \frac{1}{4\pi\varepsilon_0} \cdot \frac{p\cos\theta}{r^2}$$

or

$$V = \frac{1}{4\pi\varepsilon_0} \cdot \frac{\mathbf{p}\cdot\hat{\mathbf{r}}}{|\mathbf{r}|^2}$$

where, θ is the angle between **r** and **p**.



7. The electrostatic potential on the perpendicular

bisector due to an electric dipole is zero.
8. Electrostatic potential at any point P due to a system of n point charges $q_1, q_2, \ldots\ldots, q_n$ whose position vectors are $r_1, r_2, \ldots, r_n$ respectively, is given by

$$V = \frac{1}{4\pi\varepsilon_0} \sum_{i=1}^{n} \frac{q_i}{|\mathbf{r} - \mathbf{r}_i|}$$

where, r is the position vector of point P w.r.t. the origin.
9. Electrostatic potential due to a thin charged spherical shell carrying charge q and radius R respectively, at any point P lying

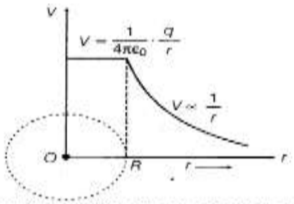
(i) inside the shell is $V = \frac{1}{4\pi\varepsilon_0} \cdot \frac{q}{R}$

(ii) on the surface of shell is $V = \frac{1}{4\pi\varepsilon_0} \cdot \frac{q}{R}$

(iii) outside the shell is $V = \frac{1}{4\pi\varepsilon_0} \cdot \frac{q}{r}$ for $r > R$

where, r is the distance of point P from the centre of the shell.

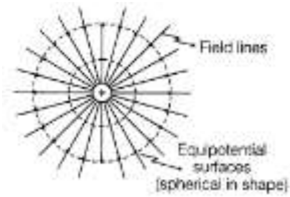
10. Graphical representation of variation of electric potential due to a charged shell at a distance r from centre of shell is given as below:



Variation of potential due to charged shell with distance r from its centre

11 Equipotential Surface A surface which have same electrostatic potential at every point on it, is known as equipotential surface.
The shape of equipotential surface due to
(i) line charge is cylindrical.
(ii) point charge is spherical as shown along side:

(a) Equipotential surfaces do not intersect each other as it gives two directions of electric field E at intersecting point which is not possible.
(b) Equipotential surfaces are closely spaced in the region of strong electric field and vice-versa.
(c) Electric field is always normal to equipotential surface at every point of it and directed from one equipotential surface at higher potential to the equipotential surface at lower potential.
(d) Work done in moving a test charge from one point of equipotential surface to other is zero.



12. Relationship between electric field and potential gradient

$$E = -\frac{dV}{dr}$$

i.e. $$E_x = -\frac{\partial V}{\partial x}, E_y = -\frac{\partial V}{\partial y}, E_z = -\frac{\partial V}{\partial z}$$

where, negative sign indicates that the direction of electric field is from higher potential to lower potential, i.e. in the direction of decreasing potential.
NOTE: (i) Electric field is in the direction of which the potential decreases steepest.
(ii) Its magnitude is given by the change in the magnitude of potential per unit displacement normal to the equipotential surface at the point.
13. Electrostatic Potential Energy The work done against electrostatic force gets stored as potential

energy. This is called electrostatic potential energy. $\Delta U = U_B - U_A = W_{AB}$

14. The work done in moving a unit positive test charge over a closed path in an electric field is zero. Thus, electrostatic forces are conservative in nature.

15. Electrostatic potential energy of a system of two point charges is given by

$$U = \frac{1}{4\pi\varepsilon_0} \cdot \frac{q_1 q_2}{r}$$

Putting the values of charge with their signs.

16. Electrostatic potential of a system of n point charges is given by

$$U = \frac{1}{4\pi\varepsilon_0} \sum_{j=1}^{n} \sum_{i=1}^{n} \frac{q_j q_i}{r_{ji}} \quad j \neq i \text{ and } ij = ji$$

17. Potential Energy in an External Field

(i) Potential Energy of a single charge in external field

Potential energy of a single charge q at a point with position vector r, in an external field is qV(r), where V(r) is the potential at the point due to external electric field E.

(ii) Potential Energy of a system of two charges in an external field

$$U = q_1 V(\mathbf{r}_1) + q_2 V(\mathbf{r}_2) + \frac{q_1 q_2}{4\pi\varepsilon_0 \mathbf{r}_{12}}$$

where, q_1 and q_2 = two point charges at position vectors $\mathbf{r}_1$ and $\mathbf{r}_2$, respectively

$V(\mathbf{r}_1)$ = potential at $\mathbf{r}_1$ due to the external field

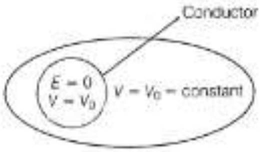
$V(\mathbf{r}_2)$ = potential at $\mathbf{r}_2$ due to the external field

18. Potential energy of a dipole in a uniform electric field E is given by

Potential energy= -p.E

19. Electrostatic Shielding The process which involves the making of a region free from any electric field is

known as electrostatic shielding.



It happens due to the fact that no electric field exist inside a charged hollow conductor. Potential inside a shell is constant. In this way we can also conclude that the field inside the shell (hollow conductor) will be zero.

- Conductors:- Conductors are those substance through which electric charge easily.
- Insulators:- Insulators (also called dielectrics) are those substances through which electric charge cannot pass easily.
- Capacity:- The capacity of a conductor is defined as the ratio between the charge of the conductor to its potential

  $C = Q/V$

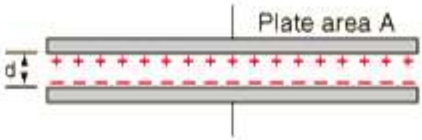
  Units:-

  S.I – farad (coulomb/volt)

  C.G.S – stat farad (stat-coulomb/stat-volt)

  Dimension of C:- $[M^{-1}L^{-2}T^{4}A^{2}]$
- Capacity of an isolated spherical conductor:-

  $C = 4\pi\varepsilon_0 r$
- Capacitor:- A capacitor or a condenser is an arrangement which provides a larger capacity in a smaller space.
- Capacity of a parallel plate capacitor:-



$C_{air} = \varepsilon_0 A/d$

$C_{med} = K\varepsilon_0 A/d$

Here, A is the common area of the two plates and d is the distance between the plates.

- Effect of dielectric on the capacitance of a capacitor:-

  $C = \varepsilon_0 A/[d-t+(t/K)]$

  Here d is the separation between the plates, t is the thickness of the dielectric slab A is the area and K is the dielectric constant of the material of the slab.

  If the space is completely filled with dielectric medium (t=d), then,

  $C = \varepsilon_0 KA/ d$

- Capacitance of a sphere:-

  (a) $C_{air} = 4\pi\varepsilon_0 R$

  (b) $C_{med} = K (4\pi\varepsilon_0 R)$

- Potential energy of a charged capacitor (Energy stored in a capacitor):-

  $W = ½ QV = ½ Q^2/C = ½ CV^2$

- Energy density of a capacitor:-

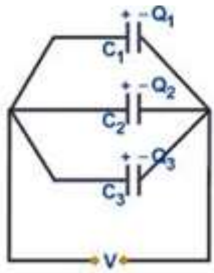
  $U = ½ \varepsilon_0 E^2 = ½ (\sigma^2/ \varepsilon_0)$

  This signifies the energy density of a capacitor is independent of the area of plates of distance between them so long the value of E does not change.

- Grouping of Capacitors:-

  (a)

  (i) Capacitors in parallel:- $C = C_1+C_2+C_3+\ldots..+C_n$?



The resultant capacity of a number of capacitors, connected in parallel, is equal to the sum of their individual capacities.

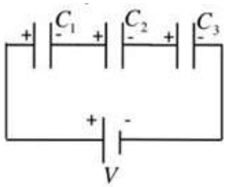
(ii)$V_1 = V_2 = V_3 = V$

(iii) $q_1 = C_1V$, $q_2 = C_2V$, $q_3 = C_3V$

(iv) Energy Stored, $U = U_1+U_2+U_3$

(b)

(i) Capacitors in Series:- $1/C = 1/C_1 + 1/C_2 + \ldots\ldots + 1/C_n$



?

The reciprocal of the resultant capacity of a number of capacitors, connected in series, is equal to the sum of the reciprocals of their individual capacities.

(ii) $q_1 = q_2 = q_3 = q$

(iii) $V_1 = q/C_1$, $V_2 = q/C_2$, $V_3 = q/C_3$

(iv) Energy Stored, $U = U_1+U_2+U_3$

- Energy stored in a group of capacitors:-

  (a) Energy stored in a series combination of capacitors:-

  $W = ½ (q^2/C_1) + ½ (q^2/C_2) + ½ (q^2/C_3) = W_1+W_2+W_3$

Thus, net energy stored in the combination is equal to the sum of the energies stored in the component capacitors.

(b) Energy stored in a parallel combination of capacitors:-

$W = ½\ C_1V^2 + ½\ C_2V^2 + ½\ C_3V^2 = W_1+W_2+W_3$

The net energy stored in the combination is equal to sum of energies stored in the component capacitors.

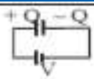
- Common potential when two capacitors are connected:-

  $V = [C_1V_1+ C_2V_2] / [C_1+C_2] = [Q_1+Q_2]/ [C_1+C_2]$
- Charge transfer when two capacitors are connected:-

  $\Delta Q = [C_1C_2/C_1+C_2]\ [V_1-V_2]$
- Energy loss when two capacitors are connected:-

  $\Delta U = ½\ [C_1C_2/C_1+C_2]\ [V_1-V_2]^2$

EFFECT OF FILLING A DIELECTRIC IN A CAPACITOR AFTER DISCONNECTION OF BATTERY

		
Capacitance	C_0	$C = KC_0$
Charge	Q_0	$Q = Q_0$
P.D	$V_0 = \frac{Q_0}{C_0}$	$V = \frac{Q_0}{C} = \frac{V_0}{K}$
Potential energy	$U_0 = \frac{1}{2}C_0V_0^2$	$U = \frac{1}{2}KC_0\left(\frac{V_0}{K}\right)^2 = \frac{U_0}{K}$

IMPORTANT FORMULAE

1. **Electrostatic force between two charges**
   $F = K.\frac{q_1q_2}{r^2} = \frac{1}{4\pi\epsilon_0\epsilon_r}.\frac{q_1q_2}{r^2}$
   For air, $\epsilon_r = 1$
   Fair = $\frac{1}{4\pi\epsilon_0}.\frac{q_1q_2}{r^2} = 9\times10^9\,\frac{q_1q_2}{r^2}$
2. **Electric field intensity due to a point charge,** $\vec{E} = \lim_{q_0\to0}\frac{\vec{F}}{q_o}$
3. **Electric field intensity due to infinite linear charge density (λ)**
   $E = \frac{1}{4\pi\epsilon_0}.\frac{2\lambda}{r}$
4. **Electric field intensity near an infinite thin sheet of surface charge density** σ
   $E = \frac{\sigma}{2\epsilon_0}$
   For thick sheet = $\frac{\sigma}{\epsilon_0}$.
5. **Electric potential,** $V = \lim_{q_0\to0}\frac{W}{q_o}$
   Electric potential due to a point charge, $V = \frac{1}{4\pi\epsilon_0}.\frac{q}{r}$
6. **Relation between electric field and potential** $E = -\frac{dV}{dr} = \frac{V}{r}$ **(numerically)**
7. **Dipole moment,** $\vec{P} = q.2\vec{l}$
8. **Torque on a dipole in uniform electric field,** $\vec{\tau} = \vec{p}\times\vec{E}$.
9. **Potential energy of dipole,** U= $-\vec{p}.\vec{E} = -pE\cos\theta$
10. **Work done in rotating the dipole in uniform electric field from orientation** Q_1 **to** Q_2 **is**
    $W = U_2 - U_1 = pE(\cos\theta_1 - \cos\theta_2)$
11. **Electric field due to a short dipole**
    (i) at axial point, $E_{axis} = \frac{1}{4\pi\epsilon_0}.\frac{2p}{r^3}$
    (ii) at equatorial point, $E_1 = \frac{1}{4\pi\epsilon_0}.\frac{p}{r^3}$
12. **Electric potential due to a short dipole**
    (i) At axial point, $V_{axis} = \frac{1}{4\pi\epsilon_0}.\frac{p}{r^2}$
    (ii) At equatorial point, $V = 0$.
13. **Dielectric constant,** $K = \frac{\epsilon}{\epsilon_0} = \frac{C_{med}}{C_{air}}$
14. **Capacitance of parallel plate capacitor**
    (i) $C = \frac{A\epsilon_0K}{d}$, in medium of dielectric constant K
    (ii) $C = \frac{A\epsilon_0}{d-t(1-\frac{1}{K})}$; if space between plate partially filled with dielectric of thickness t.
15. **Combination of capacitors :-**
    (i) In series, $\frac{1}{C} = \frac{1}{C_1}+\frac{1}{C_2}+\frac{1}{C_3}$, $q_1 = q_2 = q_3$, $V = V_1+V_2+V_3$
    (ii) In parallel, C= $C_1+C_2+C_3$, $q = q_1+q_2+q_3$, $V_1 = V_2 = V_3 = V$

MULTIPLE CHOICE QUESTIONS:

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

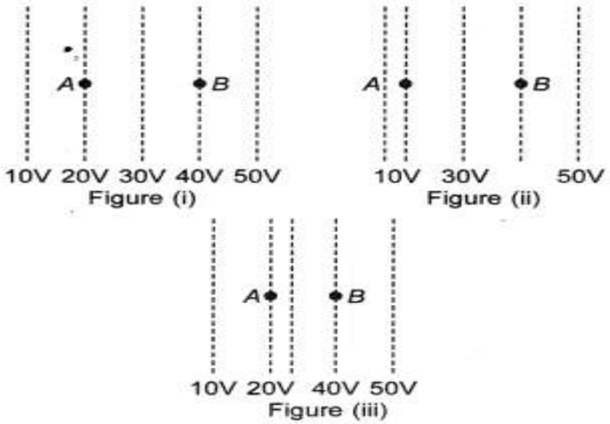
(a) remains a constant because the electric field is uniform.

(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. Figures show some equipotential lines distributed in space. A charged object is moved from point A to point B. [NCERT Exemplar]



(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).

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

[NCERT Exemplar]

(a) spheres (b) planes

(c) paraboloids (d) ellipsoids

4. Two small spheres each carrying a charge q are placed r metre apart. If one of the spheres is taken around the other one in a circular path of radius r, the work done will be equal to

(a) force between them × r (b) force between them × 2πr

(c) force between them/2πr (d) zero

5. The electric potential V at any point O (x, y, z all in meters) in space is given by $V = 4x^2$ volt. The electric field at the point (1 m, 0, 2 m) in volt/metre is

(a) 8 along negative x-axis (b) 8 along positive x-axis

(c) 16 along negative x-axis (d) 16 along positive z-axis

6. If a unit positive charge is taken from one point to another over an equipotential surface, then

(a) work is done on the charge.

(b) work is done by the charge.

(c) work done is constant.

(d) no work is done.

7. A hollow metal sphere of radius 5 cm is charged so that the potential on its surface is 10 V. The potential at the centre of the sphere is

(a) 0 V

(b) 10 V

(c) Same as at point 5 cm away from the surface

(d) Same as at point 25 cm away from the surface

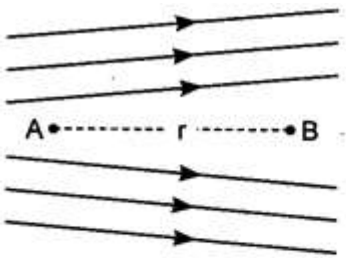
8. The electrostatic force between the metal plates of an isolated parallel plate capacitor C having a charge Q and area A, is

(a) proportional to the square root of the distance between the plates.

(b) linearly proportional to the distance between the plates.

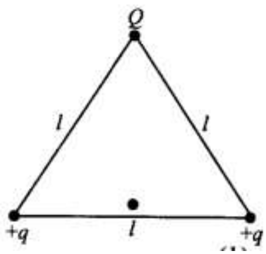
(c) independent of the distance between the plates.
(d) inversely proportional to the distance between the plates.

9. A capacitor is charged by a battery. The battery is removed and another identical uncharged capacitor is connected in parallel. The total electrostatic energy of resulting system
(a) increases by a factor of 4. (b) decreases by a factor of 2
(c) remains the same. (d) increases by a factor of 2.
10. A conductor with a positive charge
(a) is always at +ve potential.
(b) is always at zero potential.
(c) is always at negative potential.
(d) may be at +ve, zero or -ve potential.
11 v Figure shows the electric lines of force emerging from a charged body. If the electric field at A and B are EA and EB respectively and if the displacement between A and B is r then

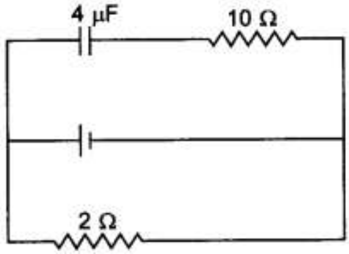


(a) $E_A > E_B$ (b) $E_A < E_B$
(c) $E_A = E_B/r$ (d) $E_A = E_B/r^2$
12. Which of the following options are correct? If a conductor has a potential V 4- 0 and there are no charges anywhere else outside, then [NCERT Exemplar]
(a) there must not be charges on the surface or inside itself.
(b) there cannot 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.

13. Which of the following options is correct? In a region of constant potential [NCERT Exemplar]
(a) the electric field is uniform. (b) the electric field is zero.
(c) there can be charge inside the region.
(d) the electric field shall necessarily change if a charge is placed outside the region.
14. 64 drops each having the capacity C and potential V are combined to form a big drop. If the charge on the small drop is q, then the charge on the big drop will be
(a) 2q (b) 4q
(c) 16q (d) 64q
15. The radii of two metallic spheres A and B are r_1 and r_2 respectively ($r_1 > r_2$). They are connected by a thin wire and the system is given a certain charge. The charge will be greater
(a) on the surface of the sphere B.
(b) on the surface of the sphere A.
(c) equal on both.
(d) zero on both.
16. A parallel plate condenser is connected with the terminals of a battery. The distance between the plates is 6mm. If a glass plate (dielectric constant K = 9) of 4.5 mm is introduced between them, then the capacity will become
(a) 2 times. (b) the same. (c) 3 times. (d) 4 times.
17. Three charges Q, +q and +q are placed at the vertices of an equilateral triangle of side l as shown in the figure. If the net electrostatic energy of the system is zero, then Q is equal to



(a) -q
(b) +q
(c) zero
(d) $-\frac{q}{2}$
18. Two metal plates form a parallel plate capacitor. The distance between the plates is d. A metal sheet of thickness $\frac{d}{2}$ and of the same area is introduced between the plates.
What is the ratio of the capacitance in the two cases?
(a) 2 : 1 (b) 3 : 1 (c) 2 : 1 (d) 5 : 1
19. Acapacitor of 4 pF is connected as shown in the circuit. The internal resistance of the battery is 0.5 Q. The amount of charge on the capacitor plates will be [NCERT Exemplar]



(a) 0 (b) 4 (c) 16 μC (d) 8 μC
20. A capacitor is charged by using a battery which is then disconnected. A dielectric slab then slipped between the plates, which results in
(a) reduction of charge on the plates and increase of potential difference across the plates.
(b) increase in the potential difference across the plate, reduction in stored energy, but no change in the charge on the plates.
(c) decrease in the potential difference across the plates, reduction in the stored energy, but no change in the charge on the plates.
(d) none of these

21. Which of the following statement is true?
(a) Electrostatic force is a conservative force.
(b) Potential at a point is the work done per unit charge in bringing a charge from any point to infinity.
(c) Electrostatic force is non-conservative
(d) Potential is the product of charge and work.

22. 1 volt is equivalent to
(a) $\frac{\text{newton}}{\text{second}}$ (b) $\frac{\text{newton}}{\text{coulomb}}$
(c) $\frac{\text{joule}}{\text{coulomb}}$ (d) $\frac{\text{joule}}{\text{second}}$

23. The work done in bringing a unit positive charge from infinite distance to a point at distance x from a positive charge Q is W. Then the potential at that point is
(a) $\frac{WQ}{x}$ (b) W
(c) $\frac{W}{x}$ (d) WQ

24. Consider a uniform electric field in the z-direction. The potential is a constant
(a) for any x for a given z (b) for any y for a given z
(c) on the x-y plane for a given z (d) all of these

25. 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 always be equally spaced.
(d) both (a) and (b) are correct.

26. 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) both (b) and (c) are correct.

27. A test charge is moved from lower potential point to a higher potential point. The potential energy of test charge will

(a) remain the same (b) increase
(c) decrease (d) become zero

28. An electric dipole of moment $\vec{p}$ is placed in a uniform electric field $\vec{E}$. Then

(i) the torque on the dipole is $\vec{p} \times \vec{E}$

(ii) the potential energy of the system is $\vec{p}.\vec{E}$

(iii) the resultant force on the dipole is zero. Choose the correct option.

(a) (i), (ii) and (iii) are correct
(b) (i) and (iii) are correct and (ii) is wrong
(c) only (i) is correct
(d) (i) and (ii) are correct and (iii) is wrong

29. 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 in¬side itself.
(b) there cannot be any charge in the body of the conductor.
(c) there must be charges only on the surface.
(d) both (a) and (b) are correct.

30. Which of the following statements is false for a perfect conductor?
(a) The surface of the conductor is an equipoten-tial surface.
(b) The electric field just outside the surface of a conductor is perpendicular to the surface.
(c) The charge carried by a conductor is always uniformly distributed over the surface of the conductor.
(d) None of these.

31. Dielectric constant for a metal is
(a) zero (b) infinite (c) 1 (d) 10

32. When air is replaced by a dielectric medium of constant K, the maximum force of attraction between two charges separated by a distance

(a) increases K times (b) remains unchanged

(c) decreases K times (d) increases K^{-1} times

33. In a parallel plate capacitor, the capacity increases if

(a) area of the plate is decreased.

(b) distance between the plates increases.

(c) area of the plate is increased.

(d) dielectric constantly decreases.

34. A parallel plate air capacitor is charged to a potential difference of V volts. After disconnecting the charging battery the distance between the plates of the capacitor is increased using an insulating handle. As a result the potential difference between the plates

(a) increases (b) decreases

(c) does not change (d) becomes zero

35. Two identical capacitors are joined in parallel, charged to a potential V, separated and then connected in series, the positive plate of one is connected to the negative of the other. Which of the following is true?

(a) The charges on the free plated connected to-gether are destroyed.

(b) The energy stored in ths system increases.

(c) The potential difference between the free plates is 2V.

(d) The potential difference remains constant.

36. A capacitor has some dielectric between its plates, and the capacitor is connected to a dc source. The battery is now disconnected and then the dielectric is removed, then

(a) capacitance will increase.

(b) energy stored will decrease.

(c) electric field will increase.

(d) voltage will decrease.

37. Two spherical conductors each of capacity C are charged to potential V and -V. These are then connected by means of a fine wire. The loss of energy is

(a) zero (b) $\frac{1}{2}CV^2$ (c) CV^2 (d) 2 CV^2

38. Consider a uniform electric field in the z-direction. The potential is a constant

(a) for any x for a given z (b) for any y for a given z

(c) on the x-y plane for a given z (d) all of these

Answer: d

39. 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 always be equally spaced.

(d) both (a) and (b) are correct.

Answer: d

40. 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) both (b) and (c) are correct.

41. A test charge is moved from lower potential point to a higher potential point. The potential energy of test charge will

(a) remain the same (b) increase

(c) decrease (d) become zero

42. An electric dipole of moment $\vec{p}$ is placed in a uniform electric field $\vec{E}$. Then

(i) the torque on the dipole is $\vec{p} \times \vec{E}$

(ii) the potential energy of the system is $\vec{p} . \vec{E}$

(iii) the resultant force on the dipole is zero. Choose the correct option.

(a) (i), (ii) and (iii) are correct

(b) (i) and (iii) are correct and (ii) is wrong

(c) only (i) is correct
(d) (i) and (ii) are correct and (iii) is wrong
43. 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 in¬side itself.
(b) there cannot be any charge in the body of the conductor.
(c) there must be charges only on the surface.
(d) both (a) and (b) are correct.
44. Which of the following statements is false for a perfect conductor?
(a) The surface of the conductor is an equipoten-tial surface.

(b) The electric field just outside the surface of a conductor is perpendicular to the surface.
(c) The charge carried by a conductor is always uniformly distributed over the surface of the conductor.
(d) None of these.
45. Dielectric constant for water is
(a) zero (b) infinite (c) 1 (d) 81
46. When air is replaced by a dielectric medium of constant K, the maximum force of attraction between two charges separated by a distance.
(a) increases K times (b) remains unchanged
(c) decreases K times (d) increases K^{-1} times
47. In a parallel plate capacitor, the capacity increases if
(a) area of the plate is decreased.
(b) distance between the plates increases.
(c) area of the plate is increased.
(d) dielectric constantly decreases.
48. A parallel plate air capacitor is charged to a potential difference of V volts. After disconnecting the charging battery the distance between the plates of the capacitor is increased using an insulating handle. As a result the

potential difference between the plates
(a) increases (b) decreases
(c) does not change (d) becomes zero

49. Two identical capacitors are joined in parallel, charged to a potential V, separated and then connected in series, the positive plate of one is connected to the negative of the other. Which of the following is true?
(a) The charges on the free plated connected together are destroyed.
(b) The energy stored in ths system increases.
(c) The potential difference between the free plates is 2V.
(d) The potential difference remains constant.

50. A capacitor has some dielectric between its plates, and the capacitor is connected to a dc source. The battery is now disconnected and then the dielectric is removed, then
(a) capacitance will increase.
(b) energy stored will decrease.
(c) electric field will increase.
(d) voltage will decrease.

Assertion and Reasoning

For question numbers 1 to 30, two statements are given-one labelled Assertion

(A) and the other labelled Reason

(R). Select the correct answer to these questions from the codes

(a), (b), (c) and (d) as given below.

a) Both A and R are true and R is the correct explanation of A

b) Both A and R are true but R is NOT the correct explanation of A

c) A is true but R is false

d) A is false and R is also false

1. Assertion(A): No work is done in moving a test charge from one point to another over an equipotential surface.
Reason(R): Electric field is always normal to the equipotential surface at every point

2.Assertion(A): No work is done in moving a point charge Q around a circular arc of radius $'r'$ at the Centre of which another point charge $'q'$ is located.
Reason(R): No work is done in moving a test charge from one point to another over an equipotential surface.

3.Assertion(A): A metal plate is introduced between the plates of a charged parallel plate capacitor, its capacitance increased.
Reason(R): A metal plate is introduced between the plates of a charged parallel plate capacitor, the effective separation between the plates is decreased.

4.Assertion(A): In the presence of external electric field the net electric field within the conductor becomes zero.
Reason(R): In the presence of external electric field the free charge carriers move and charge distribution in the conductor adjusts itself.

5.Assertion (A): Sensitive instruments can protect from outside electrical influence by enclosing them in a hollow conductor.
Reason(R): Potential inside the cavity is zero.

6.Assertion(A): Earthing provides a safety measure for electrical circuits and appliances.
Reason(R): When we bring a charged body in contact with the earth, all the excess charge on the body disappears by

causing a momentary current to pass to the ground through the connecting conductor.

7.Assertion(A): The total amount of charge on a body equal to 4X10-19 C is not possible.

Reason(R): Experimentally it is established that all free charges are integral multiples of a basic unit of charge denoted by e. Thus, charge q on a body is always given by q = ne

8.Assertion(A): The net force on a dipole in a uniform electric dipole is zero.

Reason(R): Electric dipole moment is a vector directed from –q to +q.

9.Assertion(A): Electrostatic forces are conservative in nature.

Reason(R): Work done by electrostatic force is path dependent.

10.Assertion(A) The field intensity in between such sheets having equal and opposite uniform surface densities of charge become constant.

Reason(R): The field intensity does not depend upon the distance between the thin sheet.

11.Assertion(A): Work done by the electrostatic force in bringing the unit positive Charge form infinity to the point P is positive.

Reason(R): The force on a unit positive test charge is attractive, so that the electrostatic force and the displacement (from infinity to P) are in the same direction.

12.Assertion(A): The interior of a conductor can have no excess charge in the static situation Reason(R): Electrostatic potential is constant throughout the volume of the conductor and has the same value (as inside) on its surface.

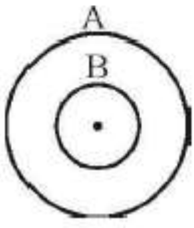
Q.13. Assertion : If the distance between parallel plates of a capacitor is halved and dielectric constant is three times, then the capacitance becomes 6 times.
Reason : Capacity of the capacitor does not depend upon the nature of the material.

Q.14 Assertion : A parallel plate capacitor is connected across battery through a key. A dielectric slab of dielectric constant K is introduced between the plates. The energy which is stored becomes K times.
Reason : The surface density of charge on the plate remains constant or unchanged.

Q.15 Assertion : The total charge stored in a capacitor is zero.
Reason : The field just outside the capacitor is σ/ε_0 . (σ is the charge density).

Q.16 Assertion : The electrostatic force between the plates of a charged isolated capacitor decreases when dielectric fills whole space between plates.
Reason : The electric field between the plates of a charged isolated capacitance increases when dielectric fills whole space between plates.

Q.17. Assertion : Two concentric charged shells are given. The potential difference between the shells depends on charge of inner shell.
Reason : Potential due to charge of outer shell remains same at every point inside the sphere.



Q.18. Assertion : Two equipotential surfaces cannot cut each other.
Reason : Two equipotential surfaces are parallel to each other.
Q.19. Assertion: The potential difference between any two points in an electric field depends only on initial and final position.
Reason: Electric field is a conservative field so the work done per unit positive charge does not depend on path followed.
Q.20. Assertion : Electric field inside a conductor is zero.
Reason: The potential at all the points inside a conductor is same.
Q21. Assertion : Electric field is discontinuous across the surface of a spherical charged shell.
Reason : Electric potential is continuous across the surface of a spherical charged shell.
22. Assertion : Work done in moving a charge between any two points in an electric field is independent of the path followed by the charge, between these points.
Reason: Electrostatic force is a non conservative force.
Q.21. Assertion : Two adjacent conductors of unequal dimensions, carrying the same positive charge have a potential difference between them.
Reason : The potential of a conductor depends upon the charge given to it.
Q.22. Assertion : Electric potential and electric potential energy are different quantities.

Reason : For a system of positive test charge and point charge electric potential energy = electric potential.

Answer(c) Potential and potential energy are different quantities and cannot be equated.

Q.23. Assertion : For a non-uniformly charged thin circular ring with net charge is zero, the electric field at any point on axis of the ring is zero.

Reason : For a non-uniformly charged thin circular ring with net charge zero, the electric potential at each point on axis of the ring is zero.

Q.24. Assertion : For a charged particle moving from point P to point Q, the net work done by an electrostatic field on the particle is independent of the path connecting point P to point Q.

Reason : The net work done by a conservative force on an object moving along a closed loop is zero.

Q.25. Assertion : Polar molecules have permanent dipole moment.

Reason : In polar molecules, the centres of positive and negative charges coincide even when there is no external field.

Q.26. Assertion : Dielectric polarisation means formation of positive and negative charges inside the dielectric.
Reason: Free electrons are formed in this process.

Q.27. Assertion : In the absence of an external electric field, the dipole moment per unit volume of a polar dielectric is zero.

Reason : The dipoles of a polar dielectric are randomly oriented.

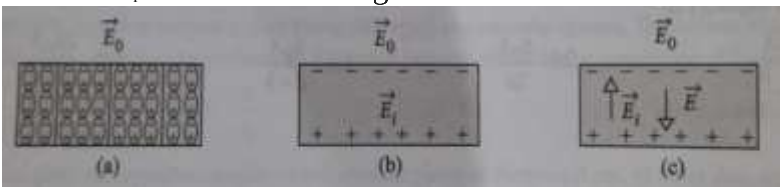
Q.28. Assertion : For a point charge, concentric spheres centered at a location of the charge are equipotential surfaces.

Reason : An equipotential surface is a surface over which potential has zero value.

Q.29. Assertion : Electric energy resides out of the spherical isolated conductor.
Reason : The electric field at any point inside the conductor is zero.
Q.30. Assertion : Two equipotential surfaces cannot cut each other.
Reason : Two equipotential surfaces are parallel to each other.

CASE STUDY QUESTIONS

1. When an insulator is placed in an external field, the dipoles become aligned. Induced surface charges on the insulator establish a polarization field $\bar{E}_i$ in its interior. The net field $\bar{E}$ in the insulator is the vector sum of $\bar{E}$, and $\bar{E}_i$ as shown in the figure.



On the application of external electric field, the effect of aligning the electric dipoles in the insulator is called polarisation and the field $\bar{E}$; is known as the polarisation field.
The dipole moment per unit volume of the dielectric is known as polarisation (P).
For linear isotropic dielectrics, P =χE, where χ = electrical susceptibility of the dielectric medium.
(i) Which among the following is an example of polar molecule?
(a) O_2 (b) H (c) N_2 (d) HCI
(ii) When air is replaced by a dielectric medium of constant K, the maximum force of attraction between two charges separated by a distance
(a) increases K times (b) remains unchanged

(c) decreases K times (d) increases 2K times.

(iii) Which of the following is a dielectric?

(a) Copper (b) Glass

(c) Antimony (Sb) (d) None of these

(iv) For a polar molecule, which of the following statements is true ?

(a) The centre of gravity of electrons and protons coincide.

(b) The centre of gravity of electrons and protons do not coincide.

(c) The charge distribution is always symmetrical.

(d) The dipole moment is always zero.

(v) When a comb rubbed with dry hair attracts pieces of paper. This is because the

(a) comb polarizes the piece of paper

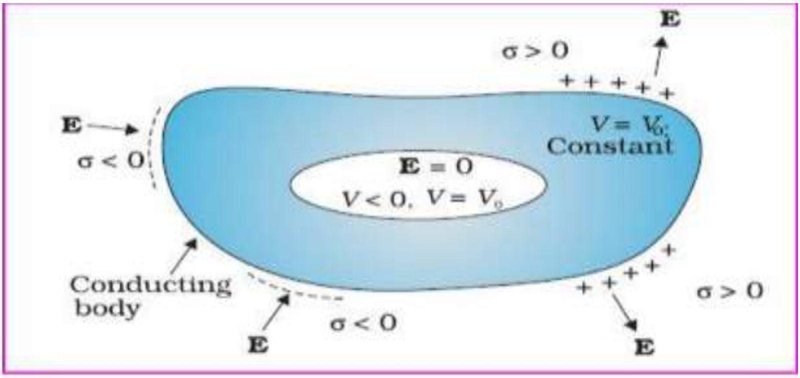
(b) comb induces a net dipole moment opposite to the direction of field

(c) electric field due to the comb is uniform

(d) comb induces a net dipole moment perpendicular to the direction of field

2. The electric field inside the cavity is zero, whatever be the size and shape of the cavity and whatever be the charge on the conductor and the external fields in which it might be placed. The electric field inside a charged spherical shell is zero. But the vanishing of electric field in the (charge free) cavity of a conductor is, as mentioned above, a very general result. A related result is that even if the conductor is charged or charges are induced on a neutral conductor by an external field, all charges reside only on the outer surface of a conductor with cavity. The proofs of the results noted in Fig. are omitted here, but we note their important implication. Whatever be the charge

and field configuration outside, any cavity in a conductor remains shielded from outside electric influence: the field inside the cavity is always zero. This is known as electrostatic shielding. The effect can be made use of in protecting sensitive instruments from outside electrical influence.



(1) A metallic shell having inner radius R1 and outer radii R2 has a point charge Q kept inside cavity. Electric field in the region R1 < r < R2 where r is the distance from the centre is given by

(a) depends on the value of r

(b) Zero

(c) Constant and nonzero everywhere

(d) None of the above

(2) The electric field inside the cavity is depend on

(a) Size of the cavity

(b) Shape of the cavity

(c) Charge on the conductor

(d) None of the above

(3) Electrostatic shielding is based

(a) electric field inside the cavity of a conductor is less than zero

(b) electric field inside the cavity of a conductor is zero

(c) electric field inside the cavity of a conductor is greater than zero

(d) electric field inside the cavity of a plastic is zero

(4) During the lightning thunderstorm, it is advised to stay

(a) inside the car

(b) under trees

(c) in the open ground

(d) on the car

(5) Which of the following material can be used to make a Faraday cage (based on electrostatic shielding)

(a) Plastic

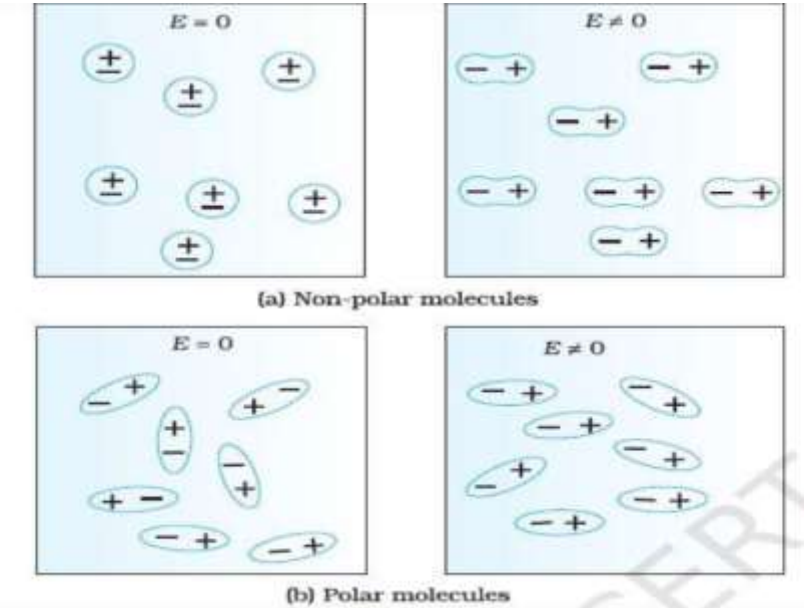
(b) Glass

(c) Copper

(d) Wood

3. Dielectric with polar molecules also develops a net dipole moment in an external field, but for a different reason. In the absence of any external field, the different permanent dipoles are oriented randomly due to thermal agitation; so the total dipole moment is zero. When an external field is applied, the individual dipole moments tend to alignwith the field. When summed overall the molecules, there is then a net dipole moment in the direction of the external field, i.e., the dielectric is polarised. The extent of polarisation depends on the relative strength of two factors: the dipole potential energy in the external field tending to align the dipoles mutually opposite with the field and thermal energy tending to disrupt the alignment. There may be, in addition, the

'induced dipole moment' effect as for non-polar molecules, but generally the alignment effect is more important for polar molecules. Thus in either case, whether polar or non-polar, a dielectric develops a net dipole moment in the presence of an external field. The dipole moment per unit volume is called polarization.



(1) The best definition of polarisation is

(a) Orientation of dipoles in random direction

(b) Electric dipole moment per unit volume

(c) Orientation of dipole moments

(d)Change in polarity of every dipole

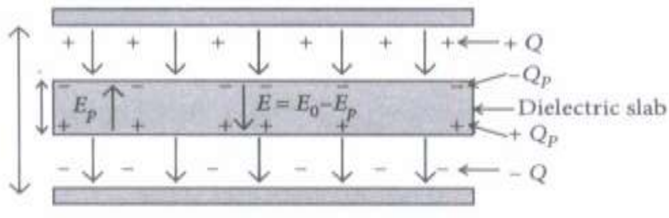
(2) Calculate the polarisation vector of the material which has 100 dipoles per unit volume in a volume of 2 units.

(a) 200 (b) 50

(c) 0.02 (d) 100

(3) The total polarisation of a material is the
(a) Product of all types of polarisation
(b) Sum of all types of polarisation
(c)Orientation directions of the dipoles
(d)Total dipole moments in the material
(4) Dipoles are created when dielectric is placed in ____________
(a) Magnetic Field
(b) Electric field
(c) Vacuum
(d) Inert Environment
(5) Identify which type of polarisation depends on temperature.
(a)Electronic
(b)Ionic
(c) Orientational
(d) Interfacial

4. A dielectric slab is a substance which does not allow the flow of charges through it but permits them to exert electrostatic forces on one another. When a dielectric slab is placed between the plates, the field E_o polarises the dielectric. This induces charge $-Q_p$ on the upper surface and $+ Q_p$ on the lower surface of the dielectric. These induced charges set up a field E_p inside the dielectric in the opposite direction of $\vec{E}$ 0E→0 as shown.



(I) In a parallel plate capacitor, the capacitance increases from 4μF to 80μF on introducing a dielectric medium between the plates. What is the dielectric constant of the medium?

(a) 10 (b) 20 (c) 50 (d) 100

(ii) A parallel plate capacitor with air between the plates has a capacitance of 8 pF. The separation between the plates is now reduced half and the space between them is filled with a medium of dielectric constant 5.

Calculate the value of capacitance of the capacitor in second case.

(a) 8pF (b) 10pF (c) 80pF (d)100pF

(iii) A dielectric introduced between the plates of a parallel plate condenser

(a) decreases the electric field between the plates
(b) increases the capacity of the condenser
(c) increases the charge stored in the condenser
(d) increases the capacity of the condenser

(iv) A parallel plate capacitor of capacitance 1 pF has separation between the plates is d. When the distance of separation becomes 2d and wax of dielectric constant x is inserted in it the capacitance becomes 2 pF. What is the value of x?

(a) 2 (b) 4 (c) 6 (d) 8

(v) A parallel plate capacitor having area A and separated by distance d is filled by copper plate of thickness b. The new capacity is

(a) ε0Ad+b2 (b) ε0A2d
(c) ε0Ad−b (d) 2ε0Ad+b2

CURRENT ELECTRICITY

GIST OF THE CHAPTER

Electric Current (I)

The rate of flow of charge through any cross-section of a wire is called electric current flowing through it.
Electric current (I) = q / t. Its SI unit is ampere (A).
The conventional direction of electric current is the direction of motion of positive charge.
The current is the same for all cross-sections of a conductor of non-uniform cross-section. Similar to the water flow, charge flows faster where the conductor is smaller in cross-section and slower where the conductor is larger in cross-section, so that charge rate remains unchanged.
If a charge q revolves in a circle with frequency f, the equivalent current, i = qf
(In a metallic conductor current flows due to motion of free electrons while in electrolytes and ionized gases current flows due to electrons and positive ions.)

Types of Electric Current

According to its magnitude and direction electric current is of two types

(i) Direct Current (DC) Its magnitude and direction do not change with time. A ceil, battery or DC dynamo are the sources of direct current.

(ii) Alternating Current (AC) An electric current whose magnitude changes continuously and changes its direction periodically is called alternating current. AC dynamo is source of alternating current.

Current Density

The electric current flowing per unit area of cross-section of conductor is called current density.
Current density (J) = I / A

Its S1 unit is ampere metre^{-2} and dimensional formula is [AT^{-2}].

It is a vector quantity and its direction is in the direction of motion positive charge or in the direction of flow of current.

Thermal Velocity of Free Electrons

Free electrons in a metal move randomly with a very high speed of the order of 10^5 ms-1. This speed is called thermal velocity of free electron.

Average thermal velocity of free electrons in any direction remains zero.

Drift Velocity of Free Electrons

When a potential difference is applied across the ends of a conductor, the free electrons in it move with an average velocity opposite to direction of electric field. which is called drift velocity of free electrons.

Drift velocity $v_d = eE\tau / m = eV\tau / ml$ where, τ = relaxation time, e = charge on electron, E = electric field intensity, 1 = length of the conductor, V = potential difference across the ends of the conductor m = mass of electron.

Relation between electric current and drift velocity is given by $v_d = I / An\,e$ Mobility

The drift velocity of electron per unit electric field applied is mobility of electron.

Mobility of electron (μ) = v_d / E

Its SI unit is $m^2s^{-1}V^{-1}$ and its dimensional formula is [$M^{-1}T^2A$].

Ohm's Law

If physical conditions of a conductor such as temperature remains unchanged, then the electric current (I) flowing through the conductor is directly proportional to the potential difference (V) applied across its ends.

$I \propto V$

or V = IR where R is the electrical resistance of the conductor and R = $Ane^2 \tau / ml$.

Electrical Resistance

The obstruction offered by any conductor in the path of flow of current is called its electrical resistance.

Electrical resistance, R = V / I

Its SI unit is ohm (Ω) and its dimensional formula is $[ML^2T^{-3}A^{-2}]$.

Electrical resistance of a conductor R = ρl / A

where, l = length of the conductor, A = cross-section area and ρ = resistivity of the material of the conductor.

Resistivity

Resistivity of a material of a conductor is given by ρ = m / $n^2 \tau$ where, n = number of free electrons per unit volume.

Resistivity of a material depend on temperature and nature of the material.

It is independent of dimensions of the conductor, i.e., length, area of cross-section etc. Resistivity of metals increases with increase in temperature as $\rho_t = \rho_o (1 + \alpha t)$ where ρ_o and ρ_t are resistivity of metals at O°C and t°C and α temperature coefficient of resistivity of the material.

For metals α is positive, for some alloys like nichrome, manganin and constantan, α is positive but very low.

For semiconductors and insulators. α is negative.

Resistivity is low for metals, more for semiconductors and very high alloys like nichrome, constantan etc.

(In magnetic field the resistivity of metals increases. But resistivity of ferromagnetic materials such as iron, nickel, cobalt etc decreases in magnetic field.)

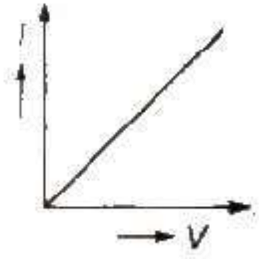
Electrical Conductivity

The reciprocal of resistivity is called electrical conductivity.

Electrical conductivity (σ) = 1 / ρ = 1 / RA = $ne^2 \tau / m$ Its SI units is $ohm^{-1} m^{-1}$ or mho m^{-1} or siemen m^{-1}.
Relation between current density (J) and electrical conductivity (σ) is given by
J = σ E where, E = electric field intensity.

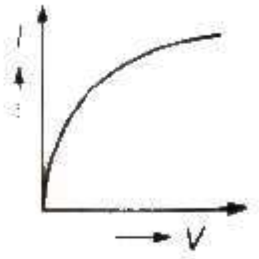
Ohmic Conductors

Those conductors which obey Ohm's law, are called ohmic conductors e.g., all metallic conductors are ohmic conductor.
For ohmic conductors V – I graph is a straight line.



Non-ohmic Conductors

Those conductors which do not obey Ohm's law, are called non-ohmic conductors. e.g., diode valve, triode valve, transistor , vacuum tubes etc.
For non-ohmic conductors V – I graph is not a straight line.



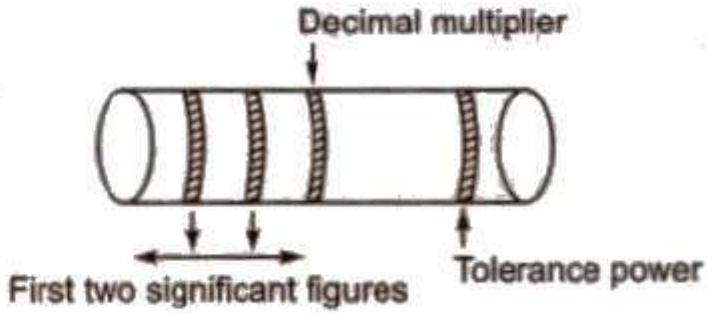
Superconductors

When few metals are cooled, then below a certain critical temperature their electrical resistance suddenly becomes zero. In this state, these substances are called superconductors and this phenomena is called super conductivity.

Mercury become superconductor at 4.2 K, lead at 7.25 K and niobium at 9.2 K

Colour Coding of Carbon Resistors

The resistance of a carbon resistor can be calculated by the code given on it in the form of coloured strips.



Colour coding

Colour	Figure
Black	0
Brown	1
Red	2
Orange	3
Yellow	4
Green	5
Blue	6
Violet	7
Grey	8
White	9

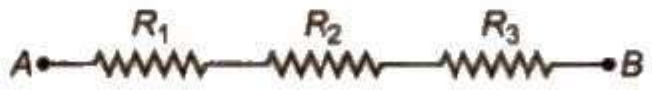
Tolerance power

Colour	Tolerance
Gold	5%
Silver	10%
No colour	20%

This colour coding can be easily learned in the sequence “B B ROY Great Bratain Very Good Wife”.

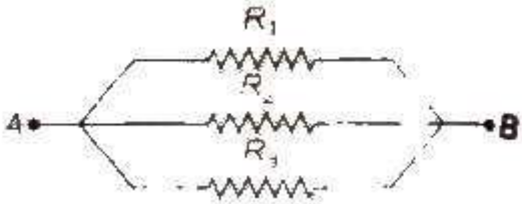
Combination of Resistors1.In Series

(i) Equivalent resistance, $R = R_1 + R_2 + R_3$ (ii) Current through each resistor is same. (iii) Sum of potential differences across individual resistors is equal to the potential difference, applied by the source.



In ParallelEquivalent resistance

$1 / R = 1 / R_1 + 1 / R_2 + 1 / R_3$



Potential difference across each resistor is same.
Sum of electric currents flowing through individual resistors is equal to the electric current drawn from the source.

Electric Cell

An electric cell is a device which converts chemical energy into electrical energy.
Electric cells are of two types

(i) Primary Cells Primary cells cannot be charged again. Voltaic, Daniel and Leclanche cells are primary cells.

(ii) Secondary Cells Secondary cells can be charged again and again. Acid and alkali accumulators are secondary cells.

Electro – motive – Force (emf) of a Cell

The energy given by a cell in flowing unit positive charge throughout the circuit completely one time, is equal to the emf of a cell.

Emf of a cell (E) = W / q.

Its SI unit is volt.

Terminal Potential Difference of a Cell

The energy given by a cell in flowing unit positive charge through till outer circuit one time from one terminal of the cell to the other terminal of the cell.

Terminal potential difference (V) = W / q.

Its SI unit is volt.

Internal Resistance of a Cell

The obstruction offered by the electrolyte of a cell in the path of electric current is called internal resistance (r) of the cell. Internal resistance of a cell

(i) Increases with increase in concentration of the electrolyte.

(ii) Increases with increase in distance between the electrodes.

(iii) Decreases with increase in area of electrodes dipped in electrolyte.

Relation between E,V and r

V= E when cell is in open circuit

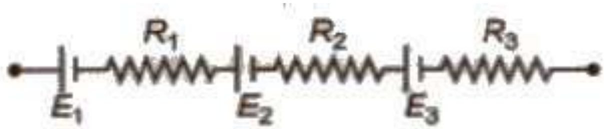
V = E –I R when cell is discharging

If cell is in charging state, then

E = V – Ir

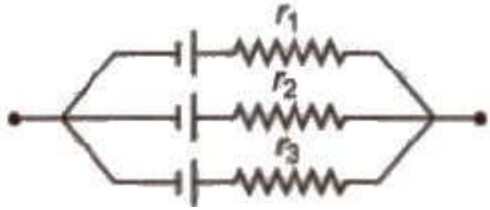
Grouping of Cells

(i) In Series If n cells, each of emf E and internal resistance r are connected in series to a resistance R. then equivalent emf



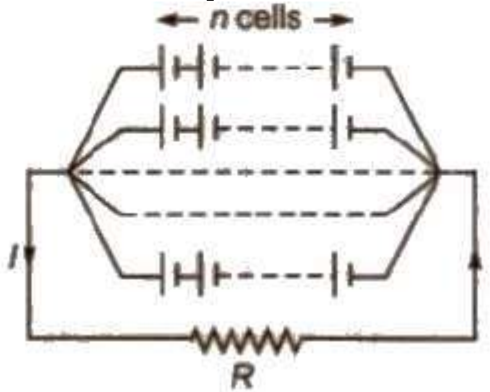
$E_{eq} = E_1 + E_2 + ... + E_n = nE$
Equivalent internal resistance $r_{eq} = r_1 + r_2 + ... + r_n = nr$
Current In the circuit $I = E_{eq} / (R + r_{eq}) = nE / (R + nr)$

(ii) In Parallel If n cells. each of emf E and internal resistance r are connected to in parallel. then equivalent emf.
$E_{eq} = E$
Equivalent internal resistance



$1 / r_{eq} = 1 / r_1 + 1 / r_1 + ... + 1 / r_n = n / r$ or $r_{eq} = r / n$
Current In the circuit $I = E / (R + r / n)$

(iii) Mixed Grouping of Cells If n cells, each of emf E and internal resistance r are connected in series and such m rows are connected in parallel, then



Equivalent emf, E_{eq}
Equivalent Internal resistance r_{eq}

Current in the circuit, $I = nE / (R + nr / m)$ or $I = mnE / mR + nr$

Note Current in this circuit will be maximum when external resistance is equal to the equivalent internal resistance, i.e.,
$R = nr / m \Rightarrow mR = nr$

Kirchhoff's Laws

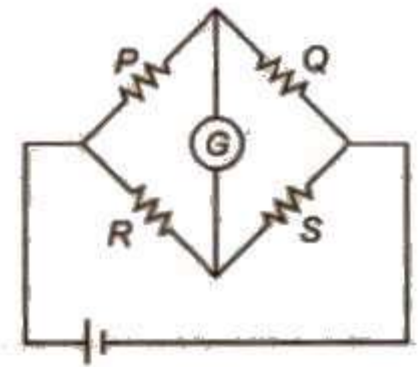
There are two Kirchhoff's laws for solving complicated electrical circuits

(i) Junction Rule The algebraic sum of all currents meeting at a junction in a closed circuit is zero, i.e., $\Sigma I = 0$.
This law follows law of conservation of charge.

(ii) Loop Rule The algebraic sum of all the potential differences in any closed circuit is zero, i.e.,
$\Sigma V = 0 \Rightarrow \Sigma E = \Sigma IR$
This law follows law of conservation of energy.

Balanced Wheatstone Bridge

Wheatstone bridge is also known as a metre bridge or slide wire bridge.
This is an arrangement of four resistance in which one resistance is unknown and rest known. The Wheatstone bridge as shown in figure. The bridge is said to be balanced when deflection in galvanometer is zero, i.e., $i_g = 0$.



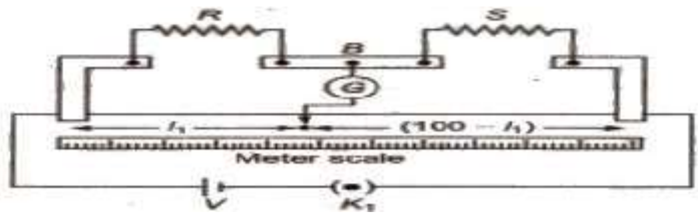
Principle of Wheatstone Bridge

P / Q = R / S

The value of unknown resistance S can found. as we know the value of P,Q and R. It may be remembered that the bridge is most sensitive, when all the four resistances are of the same order.

Meter Bridge

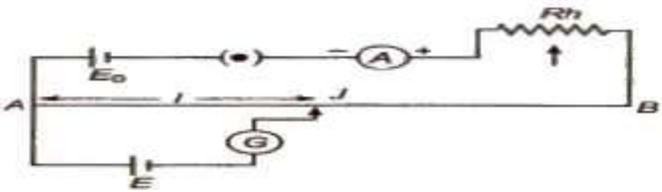
This is the simplest form of Wheatstone bridge and is specially useful for comparing resistance more accurately.



$R / S = l_1 / (100 – l_1)$ where l_1 is the length of wire from one end where null point is obtained.

Potentiometer

Potentiometer is an ideal device to measure the potential difference between two points. It consists of a long resistance wire AB of uniform cross section in which a steady direct current is set up by means of a battery.



If R be the total resistance of potentiometer wire L its total length, then potential gradient, i.e., fall in potential per unit length along the potentiometer will be

$K = V / L = IR / L = E_o R / (R_o + R)L$

where, E_o = emf of battery and R_o = resistance inserted by means of rheostat Rh.

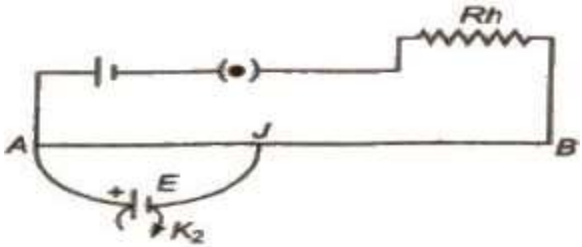
Determination of emf of a Cell using Potentiometer

If with a cell of emf E on sliding the contact point we obtain zero deflection in galvanometer G when contact point is at J at a length I from the end where positive terminal of cell have been joined. then fall in potential along length i is just balancing the emf of cell. Thus, we have E = Kl

or $E_1 / E_2 = l_1 / l_2$

Determination of Internal Resistance of a Cell using Potentiometer

The arrangement is shown in figure. If the cell E is in open circuit and balancing length l_1, then $E = Kl_1$



But if by inserting key K_2 circuit of cell is closed, then potential

$V = Kl_2$

Internal resistance of cell $r = (l_1 / l_2 - 1) \times R$

Important Points

- Potentiometer is an ideal voltmeter.
- Sensitivity of potentiometer is increased by increasing length of potentiometer wire.

- If n identical resistances are first connected in series and then in parallel. the ratio of the equivalent resistance.

IMPORTANT FORMULAE

- Electric current $I = q/t$
- Drift velocity $qE\tau / m$
  For electron drift velocity is given by
  $v_d = eE\tau / m = eV\tau / ml$ where, τ = relaxation time, e = charge on electron,
  E = electric field intensity, l = length of the conductor, V = potential
  Difference
- $I = n A e v_d$ where n is number density ofelectrons , A is area of cross section of conductor
- Ohms law $V= IR$
- $R = ml/ ne^2 \tau A$
- $R = \rho l/A$, where ρ is specific resistance or resistivity
- Current density $J = I /A$
- Conductance $G = 1/R$
- Conductivity $\rho = 1/ \rho$
- $J = \rho E$
- Mobility $\mu = v_d /E$
-
- Resistances in series $Rs = R_1 + R_2 + R_3$
- Resistances in parallel $1/R_p = 1/ R_1 + 1/ R_2 + 1/ R_3$
- Terminal potential difference $V = E – I r$, where r is internal resistance of cell.
- Internal resistance $r = (E/V-1)/ x R$
- KIrchoffs first rule ., $\Sigma I = O$.

- KIrchoffs second rule $\Sigma V = 0 \Rightarrow \Sigma E = \Sigma IR$
- Wheat stone balance condition $P/Q = R/S$
- Comparing the emf of two primary cells using potentiometer $E_1/E_2 = l_1/ l_2$
- For finding internal reistance of a cell $r = (l_1/l_2 \ -1)$ R
- For finding unknown resistance using meter bridge $S = (100-l)/l \times R$
- Variation of resistance with temperature is :

$$R = R_0 (1 + \alpha t)$$

Where R_0 is resistance at 0° C and t is rise in temperature .

Multiple choice questions

1. Drift velocity of free electrons in a conductor is v when a current i is flowing in it. If both the radius and current are doubled, then drift velocity will be

2. If a power of 100 watt is being supplied across a potential difference of 200 V, current flowing is

(a) 2 A (b) 0.5 A

(c) 1 A (d) 20 A

3. A steady current flows in a metallic conductor of non-uniform cross-section. The quantities/quantity constant along the length of the conductor is/are

(a) Current, electric field and drift speed

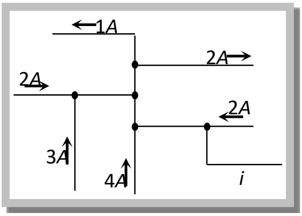
(b) Drift speed only

(c) Current and drift speed

(d) Current only

4. The figure here shows a portion of a circuit. What are the magnitude and direction of the current in the lower right hand wire

(a) 8A, left ward
(b) 8A, right ward
(c) 9A right ward
(d) 9A, left ward



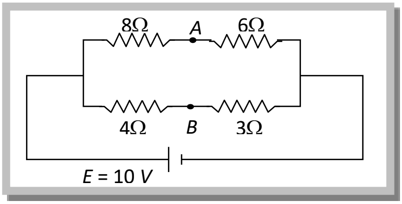
5. The electric resistance of a certain wire of iron is R. If its length and radius are both doubled, then
(a) The resistance will be halved and the specific resistance will be doubled
(b) The resistance and the specific resistance, will both remain unchanged
(c) The resistance will be doubled and the specific resistance will be halved
(d) The resistance will be halved and the specific resistance will remain unchanged

6. A carbon resistance is having a following coding green, orange, black, gold. The resistance of resistor is
(a) $53 \times 10^0 \pm 5\%$ (b) $53 \times 10^1 \pm 5\%$
(c) $53 \times 10^0 \pm 10\%$ (d) $53 \times 10 \pm 10\%$

7. By increasing the temperature, the specific resistance of a conductor and semiconductor [AIEEE 2002]
(a) Increases for both
(b) Decreases for both
(c) Increases, decreases
(d) Decreases for both

8. At what temperature will the resistance of a copper wire become three times its value at 0^oC? (Temperature coefficient of resistance for copper = 4×10^{-3} per^oC)
(a) 400^oC
(b) 450^oC
(c) 500^oC
(d)550^oC

9. The potential difference between point A and B is



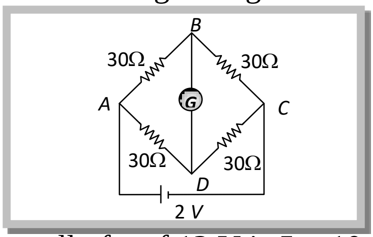
(a) $\frac{20}{7}V$

(b) $\frac{40}{7}V$

(c) $\frac{10}{7}V$

(d) 0

10. In the following figure current flowing through BD is



(a) 0
(b) 0.033 A
(c) 0.066 A
(d) None of these

11. The internal resistance of a cell of emf 12 V is 5×10^{-2} Ω. It is connected across an unknown resistance. Voltage across the cell, when a current of 60 A is drawn from it, is

(a) 15 V (b) 12 V
(c) 9 V (d) 6 V

12. Kirchoff's first and second laws in the electricity are the laws respectively of

(a) Energy and Momentum conservation
(b) Momentum and charge conservation
(c) Mass and charge conservation
(d)Charge and energy conservation

13. A cell of emf E is connected with an external resistance R, then p.d. across cell is V. The internal resistance of cell will be

(a) $\frac{(E-V)R}{E}$ (b) $\frac{(E-V)R}{V}$

(c) $\frac{(V-E)R}{V}$ (d) $\frac{(V-E)R}{E}$

14. Two wires of the same material are given. The first wire is twice as long as the second and has twice the diameter of the second. The resistance of the first will be [MP PMT 1993]

(a) Twice of the second (b) Half of the second
(c) Equal to the second (d) Four times of the second

15. For a metallic wire, the ratio V/i (V = the applied potential difference, i = current flowing) is

(a) Independent of temperature
(b) Increases as the temperature rises
(c) Decreases as the temperature rises
(d) Increases or decreases as temperature rises, depending upon the metal

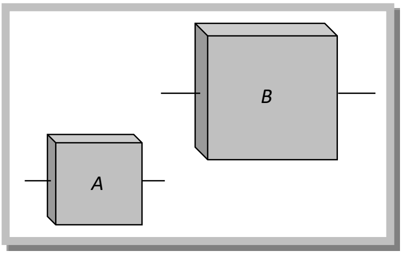
16. Calculate the amount of charge flowing in 2 minutes in a wire of resistance 10 Ω when a potential difference of 20 V is applied between its ends

(a) 120 C (b) 240 C
(c) 20 C (d) 4C

17. The drift velocity does not depend upon

(a) Cross-section of the wire
(b) Length of the wire
(c) Number of free electrons
(d) Magnitude of the current

18. A and B are two square plates of same metal and same thickness but length of B is twice that of A. Ratio of resistances of A and B is



(a) 4 : 1
(b) 1 : 4

19. In a Wheatstone's bridge all the four arms have equal resistance R. If the resistance of the galvanometer arm

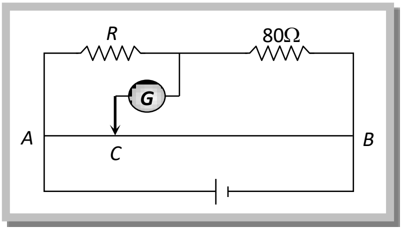
is also R, the equivalent resistance of the combination as seen by the battery is

(a) $\frac{R}{2}$ (b) R

(c)2R (d) $\frac{R}{4}$

20. s AB is a wire of uniform resistance. The galvanometer G shows no current when the length AC = 20 cm and $CB = 80\ cm$. The resistance R is equal to [RPET 2001; MP PMT 1995]

(a) 2 Ω
(b) 8 Ω
(c) 20 Ω
(d) 40 Ω

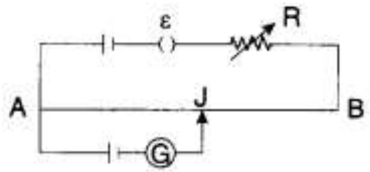


21. An electric heater is connected to the voltage supply. After few seconds, current gets its steady value then its initial current will be
(a) equal to its steady current
(b) slightly higher than its steady current
(c) slightly less than its steady current
(d) zero
22. In parallel combination of n cells, we obtain
(a) more voltage
(b) more current
(c) less voltage
(d) less current
23. If n cells each of emf e and internal resistance r are connected in parallel, then the total emf and internal resistance will be

(a) $\varepsilon, \frac{r}{n}$ (b) ε, nr

(d) $n\varepsilon, \frac{r}{n}$ (d) $n\varepsilon, nr$

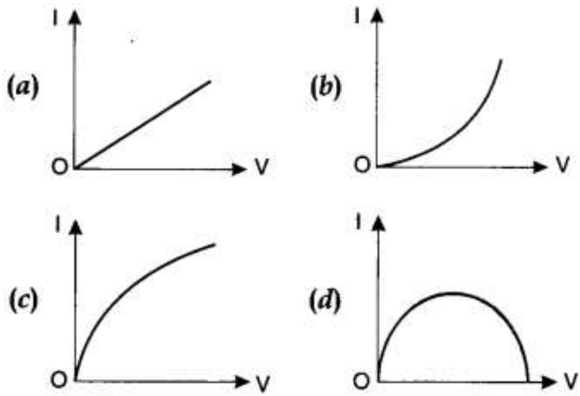
24. In a Wheatstone bridge if the battery and galvanometer are interchanged then the deflection in galvanometer will
(a) change in previous direction
(b) not change
(c) change in opposite direction
(d) none of these.
25. When a metal conductor connected to left gap of a meter bridge is heated, the balancing point
(a) shifts towards right
(b) shifts towards left
(c) remains unchanged
(d) remains at zero
26. In a potentiometer of 10 wires, the balance point is obtained on the 7^{th} wire. To shift the balance point to 9th wire, we should
(a) decrease resistance in the main circuit.
(b) increase resistance in the main circuit.
(c) decrease resistance in series with the cell whose emf is to be measured.
(d) increase resistance in series with the cell whose emf is to be determined.
27. AB is a wire of potentiometer with the increase in the value of resistance R, the shift in the balance point J will be



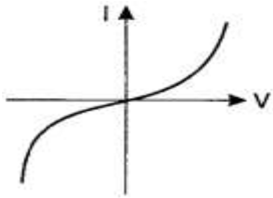
(a) towards B

(b) towards A
(c) remains constant
(d) first towards B then back towards A.

28 Which of the following I-V graph represents ohmic conductors?

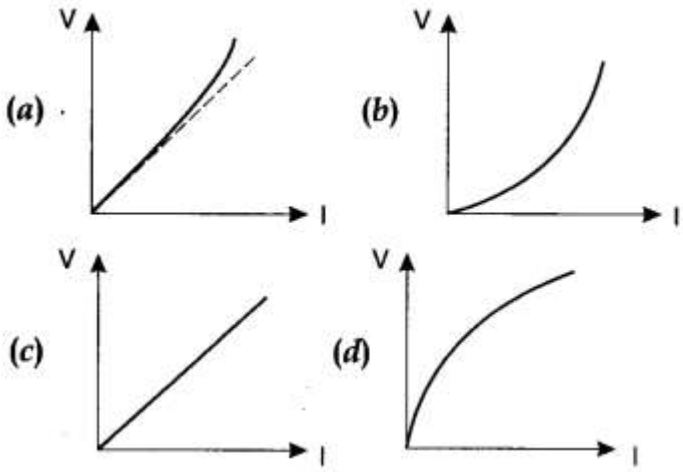


29. The I-V characteristics shown in figure represents



(a) ohmic conductors
(b) non-ohmic conductors
(c) insulators
(d) superconductors

30. Which of the following is correct for V-I graph of a good conductor?



31. The resistivity of alloy manganin is
    (a) Nearly independent of temperature
    (b) Increases rapidly with increase in temperature
    (c) Decreases with increase in temperature
    (d) Increases rapidly with decrease in temperature
32. The example of a non-ohmic resistance is:
    (a) copper wire
    (b) fi lament lamp
    (c) carbon resistor
    (d) diode
33. If a certain piece of copper is to be shaped into a conductor of minimum resistance, its length (L) and cross-sectional area (a) shall respectively be :
    (a) L, 2A
    (b) L/2, 2A
    (c) 2L, 2A
    (d) 2l, A/2
34. A wire of resistance 3 Ω is cut into three pieces, which are then joined to form a triangle. The

equivalent resistance between any corners of the triangle is :
(a) 2/3 Ω
(b) 3/2 Ω
(c) 1/2 Ω
(d) 1/3 Ω

35. The specific resistance of a rod of copper as compared to that of thin wire of copper is :
(a) less
(b) more
(c) same
(d) depends upon the length and area of cross-section of the wire

36. Siemen is the unit of:
(a) resistance
(b) conductance
(c) specific conductance
(d) None of these

37. In an experiment with potentiometer, null point with a cell is found at 240 cm. When the cell is shunted with a resistance 2 Ω, the null point becomes 120 cm internal resistance of cell is :
(a) 4 Ω
(b) 2 Ω
(c) 1 Ω
(d) 12 Ω

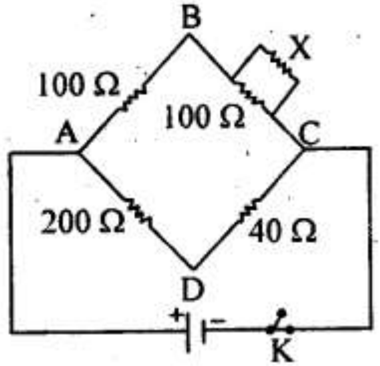
38. Suppose H_1 is the heat generated per second in the filament of a 100 W, 250 V lamp and H_2 is the heat generated in the filament of a 200 W, 250 V lamp. Then H_1/H_2 is equal to:
(a) 1
(b) 2
(c) 1/2
(d) 1/4

39. Two equal resistors are connected in series across a battery and consume a power of P. If these are connected in parallel, then the' power consumed will be:
(a) 2P
(b) 4P
(c) p4
(d) P
40. Kirchhoffs first and second laws for electrical circuits are consequences of:
(a) conservation of energy
(b) conservation of electrical charge and energy respectively
(c) conservation of electric charge
(d) neither conservation of energy nor electric charge
41. A 5 A fuse wire can with stand a maximum power of 1 W in circuit. The resistance of the fuse wire is:
(a) 0.2 Ω
(b) 5 Ω
(c) 0.4 Ω
(d) 0.04 Ω
42. In an experiment with potentiometer, null point with a cell is found at 240 cm. When the cell is shunted with a resistance 2 Ω, the null point becomes 120 cm internal resistance of cell is :
(a) 4 Ω
(b) 2 Ω
(c) 1 Ω
(d) 12 Ω
43. Two conductors of equal length and radii the ratio of 2 : 3 are; connected in parallel the source of electricity. The ratio of the velocity of electrons in the conductor be :
(a) 2 : 3
(b) 4 : 9

(c) 1 : 1
(d) 3 : 2

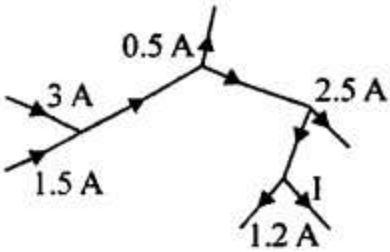
44. The charge flowing in a conductor varies with time as :
$q = \alpha t + 1/2\ \beta t^2 + 16\ \gamma t^3$
Where α, β, γ are positive constants. Then the initial current (l) is given by the condition :
(a) $l = \alpha$
(b) $l = \alpha^2$
(c) $l = \alpha^{-1}$
(d) None of these

45. In the following figure represents a balanced Wheatstone bridge circuit. What is the value of X ?



(a) 15 Ω
(b) 20 Ω
(c) 25 Ω
(d) 30 Ω

46. In following figure shows currents in a part of electrical circuit, then the value of/(in ampere) is given by :



(a) 0.3 A
(b) 0.5 A
(c) 1.3 A
(d) None of these

47. The smallest resistance that can be obtained by the combination of n resistors each resistance r is :
(a) r/n
(b) nr
(c) nr
(d) n^2r

48. Which of the following has a negative temperature coefficient of resistance ?
(a) Tungsten
(b) Carbon
(c) Nichrome
(d) Platinum

49. An electric heating element consumes 500 W, when connected to a 100 V line. If the line voltage becomes 150 V, the power consumed Will be:
(a) 500 W
(b) 750 W
(c) 1000 W
(d) 1125 W

50. A uniform w ire connected across a supply produces heat H per second. If wire is cut into three equal parts and all the parts are connected in parallel across the same supply, the heat produced per second will be :
(a) H/9

(b) 9 H
(c) 3 H
(d) H3

ASSERTION AND REASON TYPE QUESTIONS

Answer: Option (1) when Both Assertion and Reason are correct and Reason is correct explanation of assertion.

Answer: Option (2)when Both Assertion and Reason are correct but Reason is not the correct explanation of Assertion .

Answer: option (3) when : Assertion is true but Reason is wrong.

Answer: option (4) when Both are wrong.

1. Assertion: A potentiometer can act as an ideal voltmeter.
   Reason : An ideal voltmeter has infinite resistance.
2. Assertion : Ohm's law is universally applicable for all conducting elements.
   Reason : All conducting elements show straight line graphic variation on (I–V) plot.
3. Assertion : A low voltage supply, from which high currents are to be withdrawn, must have very low internal resistance.
   Reason : Maximum current drawn from a source is inversely proportional to internal resistance.
4. Assertion : High voltage (high tension) supply must have very large internal resistance
   Reason : If the circuit is accidentally shorted, then the current drawn will not exceed safety limits if internal resistance is high.
5. Assertion : Alloys of metals usually have greater resistivity than that of their constituent metals.

Reason : Alloys usually have much lower thermal coefficient of resistance than pure metals.

6. Assertion : Current density is a vector quantity.

Reason: Electric current, passing through a given area is the flux of current density through that area.

7. Assertion : When two cells of equal EMF and equal internal resistances are connected in parallel with positive plate of one to the positive plate of the other then, the net EMF of the combination will be equal to the EMF of each cell.

Reason : Effective internal resistance of the parallel combination of two identical cells will be half of the internal resistance of each cell.

8. Assertion A: The drift velocity of electrons in a conductor is very small still current in a conductor is established almost instantaneously on closing the switch.

Reason : Electric field in the conductor sets up with speed of light.

9. Assertion: When temperature of a metallic wire is increased, its resistance increases.

Reason : As the temperature is increased, average relaxation time increases.

10. Assertion: The potentiometer wire should have uniform cross sectional area.

Reason : On the potentiometer wire the jockey is gently touched, not pressed hard.

11. Assertion : High voltage (high tension) supply must have very large internal resistance

Reason : If the circuit is accidentally shorted, then the current drawn will not exceed safety limits if internal resistance is high.

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Reason: Electric current, passing through a given area is the flux of current density through that area.

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Reason : Effective internal resistance of the parallel combination of two identical cells will be half of the internal resistance of each cell.

15. Assertion : The drift velocity of electrons in a conductor is very small still current in a conductor is established almost instantaneously on closing the switch.
Reason : Electric field in the conductor sets up with speed of light.

16. Assertion : When temperature of a metallic wire is increased, its resistance increases.
Reason : As the temperature is increased, average relaxation time increases.

17. Assertion : The potentiometer wire should have uniform cross sectional area.
Reason : On the potentiometer wire the jockey is gently touched, not pressed hard.

18. Assertion : In a simple battery circuit, the point of the lowest potential is positive terminal of the battery.
Reason : The current flows towards the point of the higher potential, as it does in such a circuit from the negative to the positive terminal.

19. Assertion : A larger dry cell has higher emf.
Reason : The emf of a dry cell is proportional to its size.

20. Assertion : A current continues to flow in superconducting coil even after switch is off.
Reason : Superconducting coils show Meissner effect.
21. Q.21. Assertion : Voltmeter is connected in parallel with the circuit.
Reason : Resistance of a voltmeter is very large.
22. Assertion : Ohm’s law is applicable for all conducting elements.
Reason : Ohm’s law is a fundamental law.
23. Assertion : An electric bulb becomes dim, when the electric heater in parallel circuit is switched on.
Reason : Dimness decreases after sometime.
24. Assertion. Although there are large number of free electrons yet yet there is no current in the absence of electric field in the metal.
Reason: In the absence of electric field electrons move randomly in all directions.
25. Assertion : The value of temperature coefficient of resistance is positive for metals.
Reason: The temperature coefficient of resistance for insulator is also positive.
26. Assertion: The conductivity of an electrolyte is very low as compared to a metal at room temperature.
Reason: The number density of free ions in electrolyte is much smaller as compared to the number density of free electrons in metals further ions drift much more slowly being heavier.
27. Assertion: An electrical bulb starts glowing instantly as it is switched on.
Reason: Drift speed of electrons in a metallic wire is very large.
28. Assertion: A current flows in a conductor only a conductor only when there is an electric field within the conductor.

Reason: The drift speed of electrons in presence of electric field decreases.

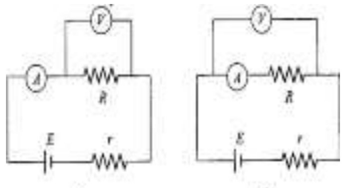
29. Assertion: A ten wire potentiometer is more sensitive than a potentiometer.
Reason : Sensitivity decreases with increase in the length of wire.

30. Assertion: Voltage current graph becomes nonlinear for a metallic wire when it gets heated up.
Reason: Resistance of the metallic wire increases with rise in temperature when wire gets heated up.

CASE STUDY BASED QUESTIONS

1.

Resistance value of an unknown resistor is calculated using the formula $R = V/I$ where V and I are the readings of the voltmeter and the ammeter, respectively. Consider the circuits below. The internal resistances of the voltmeter and the ammeter (R_V and R_G respectively) are finite and non-zero.



(a) (b)

A: The relation between R_A and the actual value of R is

1. R > R_A
2. R < R_A
3. R = R_A
4. Dependent on E and r

B: The relation between R_B and the actual value of R is

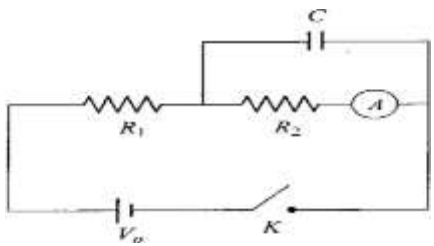
1. R < R_B
2. R > R_B
3. R = R_B
4. Dependent upon E and r

C: If the resistance of the voltmeter is R_V= 1 kilo ohm and that of ammeter is R_G =1 ohm , the magnitude of percentage error in the measurement of R (the value of R is nearly 10 ohm) is

1. Zero in both cases
2. Non-zero but equal in both cases
3. More in circuit A
4. More in circuit B

2.

In the connection shown in the figure, initially the switch K is open and the capacitor is uncharged. Then the switch is closed and the capacitor is charged up to the steady state and the switch is opened again. Determine the values indicated by the ammeter. [Given: $V_0 = 30$ V, $R_1 = 10$ kΩ, $R_2 = 5$ kΩ]



i): Just after closing the switch

A) 2 mA
B) 3 mA
C) 0 mA
D) None of the above

ii) : Long time after the switch is closed

A) 2 mA
B) 3 mA
C) 6 mA
D) None of the above

III) Just after reopening the switch

A) 2 mA
B) 3 mA

C) 6 mA
D) None of the above

3.

Electric fuse is a protective device used in series with an electric circuit or an electric appliance to save it from damage due to overheating produced by strong current in the circuit or application. Fuse wire is generally made from an alloy of lead and tin which has high resistance and low melting point. It is connected in series in an electric installation. If a circuit gets accidentally short-circuited, a large current flows, then fuse wire melts away which causes a break in the circuit. The power through fuse (F') is equal to heat energy lost per unit area per unit time (h) (neglecting heat loses from ends of the wire).

$$P = I^2 R = h \times 2\pi r l \quad \left[R = \frac{\rho l}{\pi r^2} \right]$$

where r and l are the length and radius of fuse wire, respectively.

A battery is described by its e.m.f. (E) and internal resistance (r). Efficiency of a battery (η) is defined as the ratio of the output power to the input power

$$\eta = \frac{\text{Output power}}{\text{Input power}} \times 100\%$$

i): Two fuse wires of same potential material are having length ratio 1:2 and ratio 4:1 Then respective ratio of their current rating will be

A). 8:1
B) . 2:1
C) 1:8
D). 4:1

II): The maximum power rating of a 20.0 ohm fuse wire is 2.0 kW,then this fuse wire can be connected safely to a DC source (negligible internal resistance) of

A) 300 volt
B) 190 volt
C) 250 volt
D) 220 volt

III): Efficiency of a battery when delivering maximum power is

A). 100 %

B). 50 %

C). 90 %

D). 40 %

4. When a conductor does not have a current through it it's conduction electrons Move randomly with no net motion in any direction. When a conductor in our conductor does have a current through it and to throw it these electrons actually actually still move randomly but but now they tend to drift with a With a speed V with a speed V in that direction opposite to the Applied electric field. The drift speed is very small as compared to the it's compared to the speeds in the random motion. For example in copper conductors of household wiring electron speeds 10-5 m/s to 10^{-3} m/s where as in random motion speed is around 10^6 m/s.

i) Electron drift speed is having a small value then why current a current is established almost instantaneously in a circuit because

A) Because electrons travel with the speed of light in the circuit.

B) Because electric field is set up with the speed of light and conduction electrons at every point undergo drift.

C) Current grows gradually in the circuit Electrons move slowly Oppose it to the electric field.

D) None of the above.

ii) When the electrons drift in a metal from lower potential to higher potential does it mean that all free electrons of the metal are moving in same direction.

A)Yes
B) No
C) Nothing can be said.

iii) Drift speed of electrons decreases with increase in temperature because
A) Collision of the electrons with positive irons become more frequent.
B) Collision of the electrons where the positive iron become less frequent
C) Drift speed has no relation with the collision of electrons and positive ions.

5. The resistance offered by the electrolyte of the cell to the flow of current between the electrodes is called internal existence of the cell . Internal resistance of the cell depends upon following factors.
- Nature of the electrolyte
- It is directly proportional to the concentration of the electrolyte
- Directly proportional to that distance between the two electrodes
- It varies inversely as the common area of the electrodes emerged in the electrolyte
- It increases with the decrease in the temperature of electrolyte.

i) Savita prepared a cell P in lab by immersing 10 cm of electrodes in the electrolytic solution but Mohan made the same cell Q by immersing 5cm of electrodes inside solution. Internal resistance of which cell is more?
A)P
B) Q
C) Both have equal internal resistance as they are of same kind.

ii) Resistance of a copper wire increases with rise in temperature .does the same happens with internal resistance.

A) Internal resistance is independent of temperature

B) it increases with rise in temperature

C) It decreases with rise in temperature.

iii) Internal resistance of a freshly prepared cell is less than a used cell because

A) As the chemicals get used up in reaction concentration of electrolytes fall.

B) There is deposition of ions on electrodes.

C) Internal resistance is independent of electrolyte concentration.

6. The flow of electric charge in a particular direction constitutes electric current. Current is measured in ampere A. The electric current in a conductor across an area held perpendicular to the direction of flow of charge is defined as amount of charge that is flowing across that area per unit time. Current density at a point in conductor is the ratio of the current at that point in the conductor to the area of cross section of the conductor at that point.

i) What is the current flowing through a conductor if one million electrons are crossing in 1 milli second through a crosssection of it .

A) 2.5×10^{-10} A B) $1.6x\ 10^{-10}$

C)7.5×10^{-10} A D) $8.2x10^{-11}$ A

ii) S. I .unit of electric current is

A) Cs B) Ns^{-2}

C) Cs^{-1} D)$Ç^{-1}s$

iii) A steady current flows in a metallic conductor of non uniform cross section. Which quantity remains constant

A)Electric field B) current density

C) current D) Drift velocity

7. Whenever an electric current is passed through a conductor, it becomes hot after some time. The phenomenon of the production of heat in a resistor by the flow of an electric current through it is called heating effect of current or Joule heating. Thus, the electrical energy supplied by the source of emf is converted into heat. In purely resistive circuit, the energy expended by the source entirely appears as heat. But if the circuit has an active element like a motor, then a part of energy supplied by the source goes to do useful work and the rest appears as heat. Joule's law of heating forms the basis of various electrical appliances such as electric bulb, electric furnace, electric press etc.

i) Which of the following is correct statement?
(a) Heat produced in a conductor is independent of the current flowing.
(b) Heat produced in a conductor varies inversely as the current flowing.
(c) Heat produced in a conductor varies directly as the square of the current flowing.
(d) Heat produced in a conductor varies inversely as the square of the current flowing.

ii) If the coil of a heater is cut to half, what would happen to heat produced?
(a) Doubled
(b) Halved
(c) Remains same
(d) Becomes four times.

iii) A 25 W and 100 W are joined in series and connected to the mains. Which bulb will glow brighter?
(a) 100 W
(b) 25 W

(c) Both bulbs will glow brighter
(d) None will glow brighter

iv) A rigid container with thermally insulated wall contains a coil of resistance 100 Ω, carrying 1 A. Change in its internal energy after 5 min will be
(a) 0 kJ
(b) 10 kJ
(c)20 kJ
(d) 30 kJ

v) The heat emitted by a bulb of 100 W in 1 min is
(a) 100 J
(b) 1000 J
(c) 600 J
(d) 6000 J

8. EMF of a cell is maximum potential difference between the two electrodes of the cell when no current is drawn from the cell. Internal resistance is the resistance offered by the electrolyte of the cell when current is passing through it. It depends upon the factors: distance between the electrodes ,nature of the electrolyte,temperature,nature of electrodes. For a freshly prepared cell value of internal resistance is generally low and goes on increasing as the cell is put to more and more use. The potential difference between the two electrodes of a cell in a closed circuit is called terminal potential difference and its value is always less than EMF of the cell in closed circuit. Relationship between emf,internal resistance and terminal potential difference is written as V=E - Ir

i) The terminal potential difference of the two electrodes in a cell is equal to EMF of the cell when

B) I #0. B) I =0

. C) both A and B. D) None of the above

i) A cell of emf E and internal resistance r gives a current of 0.5 A with external resistance of 12 ohm and a current of 0.25 A with an external resistance of 25 ohm. What is value of internal resistance?

A) 5 ohm. B) 1 ohm.

C) 7 ohm D) 3 ohm

iv) Choose the wrong statement.

A) Potential difference across the terminals of the cell in a closed circuit is always less than it's EMF.

B) Internal resistance of a cell decrease with decrease in the temperature of electrolyte.

C) Potential differences versus current graph for a cell is a straight line with a negative Slope.

D) Terminal potential difference of the cell when it is being charged is given by

V= E + Ir

9. A single cell provides a feeble current. In order to get a higher current in a circuit we often use a combination of cells. A combination of cells is called a battery. Cells can be joined in series parallel or in a mixed way. 2 cells are said to be connected in series when negative terminal of one cell is connected to positive terminal of the other cell and so on. 2 cells are said to be connected in parallel if was positive terminal of each cell is connected to one point and negative terminal of each cell is connected to other poi . In a mixed grouping of cells a number of identical cells are joined in series and all such rules are then connected in parallel with each other.

i) To draw the maximum current from a combination of cells how should be cells grouped.

A) Parallel

B) Series

C) Mixed grouping

D) Depends upon the relative values of internal and external resistances.

ii) The total EMF of the cells when n identical sells each of emf E connected in parallel is

A) nE B) n^2 E C) E D) E/n

iii) If two cells of internal resistance r out of n cells are wrongly connected in series then total resistance is

A) 2nr B) nr-4r C) nr D) r

10. 1942 a German physicist Kirchoff extended ohm's law to complicated circuits and gave two laws which enable us to determine current in any part of the circuit. According to Kirchoff first rule algebraic sum of currents meeting at a Junction enclosed circuit as zero . The current flowing in a conductor towards the Junction is taken as positive and the current flowing away from the Junction is taken as negative. According to kitchen's 2nd rule in a closed loop the algebraic sum of the algebraic sum of EMF's and algebraic some of the products of current and resistance in various arms of the loop is 0. While traversing a loop if negative pole of the cell is encountered first then EMF is negative otherwise positive.

i) Kirchoffs first law follows

A) Law of conservation of energy

B) Law of conservation of charge

C) Law of conservation of momentum

D) Newton's third Law of motion

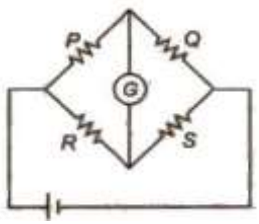
ii) Point out the right statement about Validity of Kirchoffs Junction rule.

A) The current flowing towards the Junction are taken as positive.

B) The current's flowing away from the Junction are taken as negative.
C) Bending or reorienting the wire does not change the validity of Kirchoffs Junction rule.
D) All of the above.

iii) The algebraic sum of voltages around a closed path in a closed circuit is equal to
A) Infinity
B) 1
C) Zero
D) None of the above

11. A Wheatstone bridge is an arrangement of 4 resistances P,Q,R and S connected as shown in the figure.Their values are so adjusted that the galvanometer G shows no deflection.



The bridge is then said to be balanced when this condition is achieved. The balancing condition of Wheatstone bridge is given as following.P/Q = R /S If any three resistances are known the 4th resistance can be found. The practical form of Wheatstone bridge is slide wire bridge or meter bridge. Using meter bridge the unknown resistance can be determined by the following formula S = (100-l)/l × R where l is balancing length of meter bridge.

i) In the Wheatstone bridge ,P is 5 ohm,Q is 6 ohm ,R is 10 ohm ,S is 5 ohm.
What is the value of additional resistance to be used in series with S so that bridge is balanced

A) 9 ohm
B) 7 ohm
C) 10 ohm
D) 5 ohm

ii) A Wheatstone bridge with four resistance P,Q,R,S is most sensitive when
A) All resistances are equal
B) All resistances are unequal
C) P=Q,R greater than P and S greater than Q
D) P=Q, R less than P and S less than Q

iii) When a metal conductor connected to left gap in a meter bridge is heated . The balancing point .
A) Shifts towards right .
B) Shifts towards left.
C) Remains unchanged.
D) Remains at zero.

12. Potentiometer is an apparatus used for measuring the EMF of a cell Or potential difference between two points in an electrical circuit accurately. It is also used to determine the internal resistance of a primary cell. The Potentiometer is based on the principle that potential difference across any portion of the length of wire is directly proportional to the length of the wire provided constant current is flowing through the wire and wire is of uniform area of Cross section. The resistance of potentiometer wire should be high.

i) Which of the following is true about potentiometer
A) Its sensitivity is low
B) It measures the EMF of a cell accurately
C) Is based upon the deflection method.

ii) Sensitivity of a potentiometer can be increased by
A) Decreasing potential gradient along the wire
B) Increasing potential gradient along the wire

C) Decreasing current through the wire
Increasing current through the wire.

iii) A potentiometer is an accurate and versatile device to make electrical measurements of emf
A) because the method involves Potential gradient
B) This condition of no current flow through the galvanometer.
C) A combination of cells galvanometer and resistances
D) Cells

13. According to Ohm's Law the current flowing through a conductor is directly proportional to the potential difference across the ends of the conductor. Where R is the resistance of the conductor. This electrical resistance of a conductor is the obstruction to the flow of current offered by the conductor. It depends upon length, area of crosssection, nature of the material and temperature of the conductor. We can write
$V = IR$ And $R = \rho l/A$
Where ρ is electrical resistivity of the material of the conductor.

i) Specific assistance of a wire depends
A) Length B) Area of cross section
C) Nature of material D) none of the above

ii) The shape of graph between potential difference and current through a conductor is
A) straight line B) curve
C) First curve r then straight line D) First straight line then curve.

iii) If a wire of resistance R is stretched to 3 times it's original length that new resistance will be

A) 6R
B) 9R
C) 27R
D) 3R

14. The resistance of a conductor at t° C is given by $R_t = R_0 (1+\alpha t)$. Where R_t is resistance at t° C and R_0 is the resistance at 0° C and α is the temperature coefficient of resistance. Over a limited range of temperature resistivity is given by Where $\rho_t = \rho_0 (1+\alpha t)$ where α is temperature coefficient of resistivity. Its SI unit is K^{-1}. For metals α is positive i.e. resistance increases with rise in temperature whereas for insulators and semiconductors α is negative i.e. resistance decreases with rise in temperature.

i) Fractional increase in resistivity per unit increase in temperature is defined asA) Resistivity B)Temperature coefficient of resistivityC) Conductivity D) Drift velocity

ii) The material whose resistivity is insensitive to temperature is
A) Silicon
B) Copper
C) Silver
D) Nichrome

iii) For metallic conductors the ratio V/I is
A) Independent of temperature
B) Increases as the temperature rises
C) Decreases as the temperature rises
D) Decreases or increase as temperature rises depending upon the metal.

15. Whenever an electric current is passed through a conductor it becomes hot after some time. The phenomena of production of heat in a resistance by flow of electric current through it is called heating effect of current or Joule's l heating. Thus the

electrical energy supplied by the source of emf has converted into heat. In purely resistive circuit the energy expended by the source entirely appears as heat. But if the circuit has an active element like motor then a part of energy supplied by source goes by source goes to do useful work and rest appears as heat. Joules law of heating forms the basis of various electrical appliances such as electric bulb, electric furnace and electric press etc.

i) Joules heat is produced because
 A) wire takes heat from surrounding.
 B) As electrons undergo collision with positive ions kinetic energy gets converted into heat.
 C) Heat is not depending upon current.
 D) none of the above

ii) If a coil of a heater is made up of.
 A) copper
 B) Iron
 C) Nichrome
 D) none of the above

iii) A 25 Wand a 100W are joined in parallel and connected to mains which bulb will grow brighter.
 A)100W
 B) 25W
 C)Both will glow same
 D) None will glow brighter

16. Mobility of charge carrier is defined as magnitude of drift velocity of charge per unit electric field applied. It is given by $\mu = vd / E$ As $vd = q E t /m$ It becomes $\mu = q t/m$ Where t is average relaxation time of charge while drifting towards opposite electrode and m is the mass of charge

particle. Mobility of holes which are positive charge carriers present in the semiconductors is given by.
$\mu h = e\tau h /m$
The mobility is positive for both positive current carriers and negative current careers although their drift velocities below are opposite to each other. The conventional current in conducting material due to motion of negative charge carriers will be in same direction as that due to positive charge carriers. Therefore total current in the conducting material is sum of current due to positive current careers and negative current carriers.If there are only electrons in The conducting material as current carriers and then drift velocity is given by.
S.I. unit of mobility is m2V-1s-1

i) What is the effect of doubling the length of conductor keeping voltage applied constant on mobility of charge carriers in a wire?
A) Mobility will be doubled
B) Mobility will be halved
C) Remains same
D) Quadrupled

ii) When temperature is increased mobility in a metallic conductor
A) Decreases
B) Increases
C) No effect
D) Depends upon dimensions of wire.

iii) What is drift velocity of electrons in a conductor when an electric field of strength 200V/m is applied and mobility of electrons is 4.5 x 10^{-6} $m^2V^{-1}s^{-1}$
A) 9.0 x 10^{-4} m/s
B) 8.0 x 10^{-4} m/s
C) 4.5 x 10^{-4} m/s

D) None of the above

17. Just as the resistance is the obstruction to the flow of electrical current by a conductor , Conductance is the ease with which current can flow through the conductor. Conductance is a measure of the ease with which the charges can flow through the conductor. It reciprocal of the resistance and is denoted by G.

$G = 1/R$

It's SI unit is ohm^{-1} or mho or siemen S.

Electrical conductivity is defined as reciprocal of resistivity. It is represented by

$\sigma = 1/\rho$

SI unit of electrical conductivity is Sm^{-1} .

Electrical conductivity of a conductor depends upon nature of the material of the conductor temperature. It is independent of dimensions of the conductor i.e. its length and area of cross section .Relationship between current density electric field and conductivity is given by $J = \sigma E$.

i) The conductance and conductivity of a wire of resistance 0.01 ohm , area of cross section 10^{-4} m^2 and length o.1 m are:
   A) 1000S and 10 S m^{-1}
   B) 100 S and 10^{-4} S m^{-1}
   C) 100 S and 10^5 S m^{-1}
   D) Both zero

ii) The conductance and conductivity of a non ohmic conductor
   A. Increases with rise in temperature
   B. Decreases with rise in temperature
   C. Independent of rise or fall in temperature.
   D. Depends upon the material under consideration.

iii) A wire of resistance R and conductivity σ is bent in the shape of circle.The new resistance between its diametrically opposite ends and resistivity will be
A) R / 2 . and σ /2
B) R/6 and σ /6
C) R/8 and σ/2
D) R / 4 and σ

18. Sensitivity of a potentiometer

A potentiometer is sensitive if

- It is capable of measuring very small potential differences.
- It shows a significant change in balancing length for a small change in potential difference being measured .

Sensitivity of potentiometer depends on the potential gradient along its wire; smaller the potential gradient ,greater will be the sensitivity of potentiometer.

The sensitivity of a potentiometer can be increased by reducing the potential gradient.

It can be done into ways

i) By increasing the length of potentiometer wire

ii)By reducing that current in the circuit with the help of rheostat .

i) The sensitivity of potentiometer can be increased by introducing a resistance Box in the circuit
A) Introducing some resistance from the resistance Box decreases the value of current in the circuit therefore potential gradient decreases hence sensitivity of potentiometer increases.
B) Resistance Box makes the circuit complete hands we can measured the MF of the sin

C) Resistance Box is a very low resistance which is used to control the value of current in the circuit

D) None of the above

ii) A ten wire potentiometer is sensitive than a four wire potentiometer because

A) Potential gradient of ten wire potentiometer is less than four wire potentiometer.

B) Potential gradient of ten wire potentiometer is more than four wire potentiometer

C) Sensitivity is not related to potential gradient.

D) none of the above

iii) Graph between Potential vs length is drawn for two potentiometers A and B made l up of same material, slope of A is more than slope of B

A) A is more sensitive than B
B) B is more sensitive than A
C) A is equally sensitive to B
D) None of the above

19. The resistance of metallic conductor increases with rise in temperature. The resistance is given by the expression.

$R = ml/ n e^2 t A$

Here resistance is inversely proportional to number density of electrons and inversely proportional to the relaxation time t .Since metallic conductors already have large number of free charge carriers so the factor of charge carriers does not affect much the resistance but there is significant change in the relaxation time. As temperature increases the collisions of electrons with positive irons become more and more frequent because the positive ions start by vibrating about their mean positions with greater amplitude and the electrons collide more frequently with positive irons as a result of which relaxation time decreases. And therefore resistance of the metallic conductor increases with increase in temperature. Variation of resistance with temperature is given by the following expression.

$R = R_0 (1+ \alpha t)$

Where R_0 is resistance at 0° C and t is rise in temperature.

α is temperature coefficient of resistance and it is positive for metals for non ohmic conductors ,value of α is negative because the resistance decreases with rise in temperature. This is because as we increase temperature of non ohmic conductors like semiconductors the number of free charge carriers become more and more unlike metals where most of the electrons are already in free state.

i) For metallic conductors variation of the potential difference versus current becomes nonlinear for higher values of current. It's because of

   A) Resistance increases at higher temperature for higher current.
   B) Resistance decreases at higher temperature for higher current.
   C) Graph remains linear always
   D) None of the above

ii) The temperature at which resistance of a copper wire will become double its value at 0°C.Given that

   A) 256 °C
   B) 265 ° C
   C) 322° C
   D) 240° C

iii) For making electrical instruments like potentiometer, meter bridge we prefer to choose material with
   A) High value of temperature coefficient of resistance
   B) Low value of temperature coefficient of resistance
   C) Any value of temperature coefficient but just a good conductor.
   D) None of the above

20. EMF of a cell is defined as the work done by the source in taking a unit positive charge from low potential to high potential. It is also equal the energy supplied by the source in taking a unit positive charge once round the complete circuit. EMF of a cell is equal to the maximum potential difference between the terminals of the cell when cell is in the open circuit.
    Terminal potential difference:
    The potential drop across the terminals of a cell when cell is in the closed circuit that is current is being drawn from the cell is called potential difference.
    Relationship between EMF ,terminal potential difference and internal resistance is given by:
    $V = E - Ir$
    The potential difference is equal to the EMF of the cell in open circuit i.e no current is drawn from the cell. A real cell always has some internal resistance so when current is drawn from the cell we have terminal potential difference less than EMF of the cell in a closed circuit.
    i) EMF is measured by potentiometer not by voltmeter because:

A) Potentiometer is basically based upon null method ie no current is drawn from cell.
B) Voltmeter is better as it has low resistance .
C) Both Voltmeter and Potentiometer are equally suitable.
D) None of the above.

ii) Under which condition terminal potential difference may be more than emf of cell
A) During discharging of cell
B) During charging of cell
C) Terminal potential difference is never equal to emf
D) None of the above

iii) A cell of 2V and internal resistance 0.1 ohm is connected to a 3.9 ohm external resistance. What will be potential difference across terminals of the cell?
A) 2 V
B) 1.95V
C) 2.2 V
D) 0 V

Chapter-4 Moving charges and Magnetism

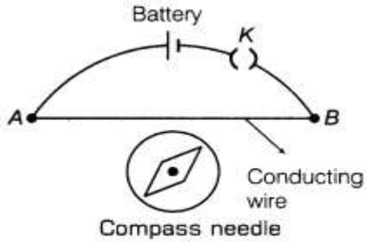
SECTION I:

GIST OF CHAPTER

1. Concept of magnetic field: The space in the surroundings of a magnet or a current-carrying conductor in which its magnetic influence can be experienced is called magnetic field.

Its SI unit is Tesla (T) = weber/m^2, CGS unit is gauss (G). 1G=10^{-4}T.

2. Oersted's experiment: In 1820, the Danish physicist Hans Christian Oersted noticed that a current in a straight wire caused a noticeable deflection in a nearby magnetic compass needle. It is noticeable when the current is large and the needle sufficiently close to the wire so that the earth's magnetic field may be ignored. Reversing the direction of the current, reverses the orientation of the needle. The deflection increases on increasing the current or bringing the needle closer to the wire. He demonstrated that the current-carrying conductor produces magnetic field around it.



When key K is closed, then deflection occurs in the compass needle and vice-versa.

3. Biot-Savart's Law: According to this law, the magnetic field due to small; current-carrying element dl at any nearby point P is given by

$$d\mathbf{B} = \frac{\mu_0}{4\pi} \cdot \frac{I d\mathbf{l}\ \hat{\mathbf{r}}}{|\mathbf{r}|^2} \quad \text{or} \quad dB = \frac{\mu_0}{4\pi} \cdot \frac{I dl \sin\theta}{r^2}$$

and direction is given by Ampere's swimming rule or right hand thumb rule.

where, $\frac{\mu_0}{4\pi} = 10^{-7}$ T-m/A

and μ_0 = permeability of free space and r = distance of point P from current-carrying element.

(i) Magnetic field at any point on a thin current carrying conductor is zero. (θ = 0 degree or 180 degrees).
(ii) If θ=90, B = max.

4. Applications of Biot-Savart's Law:

- Magnetic field at the centre of current carrying circular coil/loop:

$$B = \frac{\mu_0 I}{2r}$$

where, r is the radius of a circular loop.

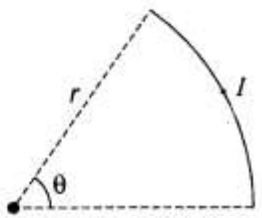
For N turns of coil, $B = \frac{\mu_0 NI}{2r}$

- Magnetic field at the centre of semi-circular current-carrying conductor.

$$B = \frac{\mu_0 I}{4r}$$

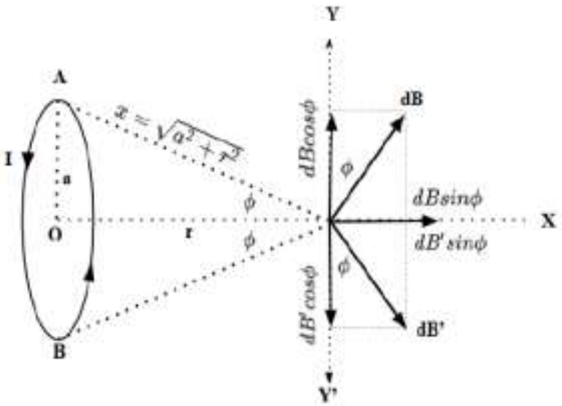
- Magnetic field at the centre of an arc of circular current-carrying conductor which subtends an angle 0 at the centre.

$$B = \frac{\mu_0}{4\pi} \cdot \frac{I\theta}{r}$$



- Magnetic field at any point lies on the axis of circular current-carrying conductor

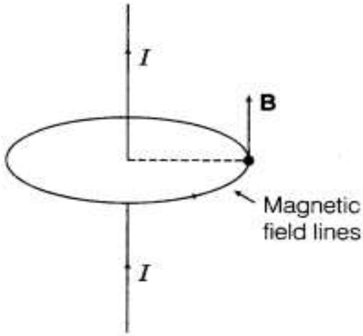
$$B = \frac{\mu_0 N I a^2}{2(r^2 + a^2)^{\frac{3}{2}}}$$



Representation: $\odot$ Outward $\otimes$ Inward

5. Ampere's circuital law: According this law, "The line integral of magnetic field around any closed path is equal to μ_0 times to the total current in the closed path."

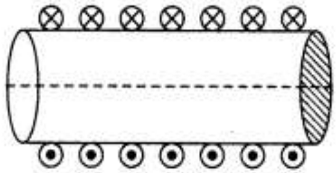
Mathematically, $\oint \vec{B}.\vec{dl} = \mu_0 I$



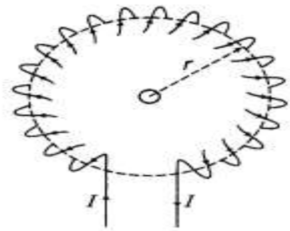
6. Applications of Ampere's circuital law:

- Magnitude of magnetic field of a straight wire using Ampere's law: $B = \frac{\mu_0 I}{2\Pi r}$

- Magnetic Field due to a Straight Solenoid:
  (i) At any point inside the solenoid, $B = \mu_o nI$ where, n = number of turns per unit length.
  (ii) At the ends of the solenoid, $B = 1/2\mu_o nI$



- Magnetic Field due to Toroidal Solenoid:
  (i) Inside the toroidal solenoid, $B = \mu_o nI$ here, n = N/2πr, N= total number of turns.
  (ii) In the open space, interior or exterior of toroidal solenoid, B= 0



7. Force on a moving charge placed in electric and magnetic field:

Lorentz force:- The Lorentz force is the force experienced by a charged particle moving in space where both electric and magnetic field exists. Simply this force is a combination of force due to electric field ($\overrightarrow{F_E}$) and force due to magnetic field ($\overrightarrow{F_B}$).

Force due to magnetic field: The force acting on a moving charge when placed in magnetic field is given by: $F_B = qvB\sin\theta$

$$\overrightarrow{F_B} = q(\vec{v} \text{ X } \vec{B}) \text{ ------------------- (1)}$$

Force due to electric field:

Force on point charge +q due to electric field, $\overrightarrow{F_E} = q\vec{E}$ ---------------- (2)

On combining equation (1) & (2), we have the Lorentz force

$$\overrightarrow{F_L} = q(\vec{v} \text{ X } \vec{B}) + q\vec{E}$$

$$\overrightarrow{F_L} = q[(\vec{v} \text{ X } \overrightarrow{B}) + \vec{E}]$$

If the electric and magnetic forces are in opposite directions the total force on the charge is zero and the charge will move in the fields undeflected. Then

$$F_E = F_B$$

$$qE = qvB$$

$$v = \frac{E}{B}$$

This condition can be used to select charged particles of a particular velocity out of a beam containing charges moving with different speeds. The crossed E and B fields, therefore, serve as a velocity selector.

8. Force acting on a current carrying conductor in a uniform magnetic field:

$\vec{F} = I(\vec{l} \times \vec{B})$

F=BIl sinθ where l = Length of conductor

Direction of force can be found out by using Fleming's left hand rule. Thumb –F, fore finger –B, central finger – I

9. Force between two infinitely long straight parallel current carrying conductors:

$$F = \frac{\mu_0 I_1 I_2}{2\Pi r} L$$

The force acting per unit length on the conductor

$$f = \frac{F}{L} = \frac{\mu_0 I_1 I_2}{2\Pi r}$$

(a) If currents are in same direction, the wires will attract each other.

(b) If currents are in opposite direction, the wires will repel each other.

10. Definition of ampere:

One ampere is the value of that steady current which, when maintained in each of the two very long, straight, parallel conductors, placed one metre apart in vacuum, would produce a force equal to 2×10^{-7} newtons per metre on each other.

11. Torque experienced by a current loop in uniform magnetic field B:

$$\tau = IAB\sin\theta$$

For N-turns of the coil, $\tau = NIAB\sin\theta$ where θ is the angle between plane of rectangular coil and magnetic field

$\tau = MB\sin\theta$ Or $\vec{\tau} = \vec{M} \times \vec{B}$

Here M=Magnetic dipole moment = NIA

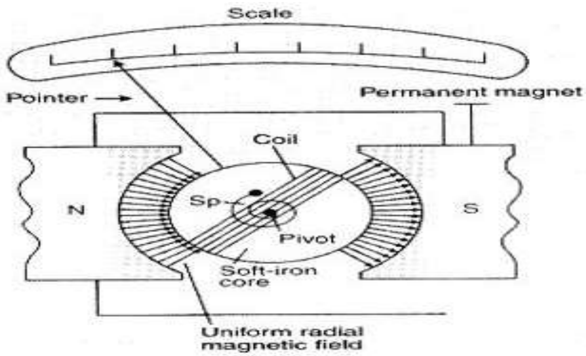
12. Moving coil galvanometer:

It is a sensitive instrument used for detecting small electric currents.

Principle: When a current carrying coil is placed in a magnetic field, it experiences a torque.

I α Φ and I = GΦ where k= GNAB=Torsion constant of the spring , G=Galvanometer constant or figure of merit

Current sensitivity,

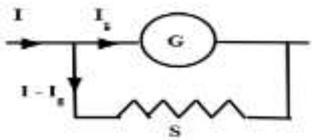


$I_s = \frac{\Phi}{I} = \frac{NBA}{k}$

Voltage sensitivity, $I_v = \frac{\Phi}{V} = \frac{NBA}{kR}$

13. Conversion of galvanometer into ammeter:

A small resistance S is connected in parallel to the galvanometer coil

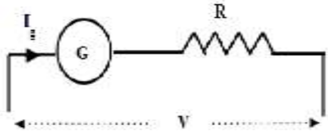


$S = \frac{I_g G}{I - I_g}$; $R_A = \frac{GS}{G+S}$

14. Conversion of galvanometer into voltmeter:

A high resistance R is connected in series to the galvanometer coil

$R = \frac{V}{I_g} - G$;



$R_v = G + R$

SECTION: II
EXPRESSIONS/FORMULAE USED

SR. NO.	FORMULAE	APPLICATIONS
1.	Biot-savart's law $dB = \frac{\mu_0}{4\Pi} X \frac{Idl\sin\theta}{r^2}$	»To find magnetic field at a point due to current element. »To find magnetic field due to a straight conductor.
2.	$B = \frac{\mu_0 NIa^2}{2\sqrt[3]{a^2 + x^2}}$	Magnetic field at the centre of current carrying circular coil/loop, x=0 $B = \frac{\mu_0 NI}{2a}$
3.	Ampere's circuital law	»Magnetic field due to infinitely long straight

	$\oint \vec{B}.\vec{dl} = \mu_0 I$	wire, $B = \frac{\mu_0 I}{2\Pi r}$ »Magnetic Field due to a Straight Solenoid, $B = \mu_0 nI$ »Magnetic Field due to toroidal Solenoid, $B = \mu_0 nI$
4.	$\vec{F} = q(\vec{v}X\vec{B})$ F=qvBsinθ	Force on a charge particle in magnetic field.
5.	$\vec{F} = q[\vec{E} + (\vec{v}X\vec{B})]$ Type equati	»Lorentz force »As velocity selector $v = \frac{E}{B}$
6.	$\vec{F} = I(\vec{l}X\vec{B})$ F=BIl sinθ	To find force on a current carrying conductor in a magnetic field.
7.	$\frac{F}{l} = \frac{\mu_0 I_1 I_2}{2\Pi r}$	Force per unit length between two parallel current carrying conductors.
8.	$\tau = NIABsin\theta$ $\vec{\tau} = \vec{M}X\vec{B}$ M=NIA	To find torque on a current loop in a magnetic field
9.	In a moving coil galvanometer,	The deflection produced in the galvanometer coil is

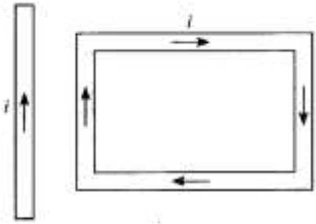
	$I = \frac{k}{NBA}\Phi$ $G = \frac{k}{NBA}$	directly proportional to the current flowing through it. Therefore, linear scale can be provided.
10.	$S = \frac{I_g G}{I - I_g}$ $R_A = \frac{GS}{G + S}$	Conversion of galvanometer into ammeter.
11.	$R = \frac{V}{I_g} - G$ $R_V = G + R$	Conversion of galvanometer into voltmeter.

SECTION: III

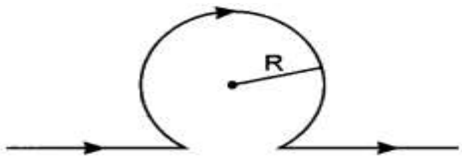
MCQS

1. Biot-Savart law indicates that the moving electrons (velocity v) produce a magnetic field B such that
   (a) B ⊥ v.
   (b) B ∥ v.
   (c) it obeys inverse cube law.
   (d) it is along the line joining the electron and point of observation.
2. 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

3. 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. A rectangular loop carrying a current i is situated near a long straight wire such that the wire is parallel to the one of the sides of the loop and is in the plane of the loop. If a steady current I is established in wire as shown in figure, the loop will



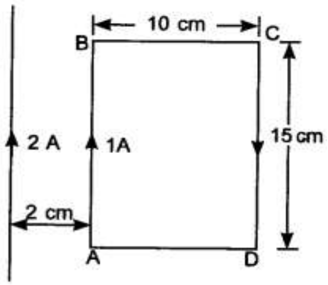
(a) rotate about an axis parallel to the wire.
(b) move away from the wire or towards right.
(c) move towards the wire.
(d) remain stationary.
5. A circular coil of radius 4 cm and of 20 turns carries a current of 3 amperes. It is placed in a magnetic field of intensity of 0.5 weber/m^2. The magnetic dipole moment of the coil is
(a) 0.15 ampere-m^2 (b) 0.3 ampere-m^2
c) 0.45 ampere-m^2 (d) 0.6 ampere-m^2
6. The strength of magnetic field at the centre of circular coil is



(a) $\frac{\mu_0 I}{R}\left(1-\frac{1}{\pi}\right)$ (b) $\frac{\mu_0 I}{\pi R}$

(c) $\frac{\mu_0 I}{2R}\left(1-\frac{1}{\pi}\right)$ (d) $\frac{\mu_0 I}{2R}\left(1+\frac{1}{\pi}\right)$

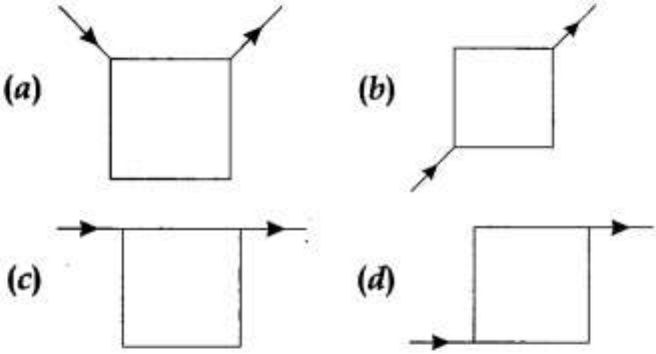
7. The maximum current that can be measured by a galvanometer of resistance 40 Ω is 10 mA. It is converted into voltmeter that can read upto 50 V. The resistance to be connected in the series with the galvanometer is
   (a) 2010 Ω (b) 4050 Ω
   (c) 5040 Ω (d) 4960 Ω
8. What is the net force on the rectangular coil?



(a) 25×10^{-7} N towards wire.
(b) 25×10^{-7} N away from wire.
(c) 35×10^{-7} N towards wire.
(d) 35×10^{-7} N away from wire.

9. If the beams of electrons and protons move parallel to each other in the same direction, then they
   (a) attract each other.
   (b) repel each other.
   (c) no relation
   (d) neither attract nor repel.

10. Current flows through uniform, square frames as shown in the figure. In which case is the magnetic field at the centre of the frame not zero?



11. Two identical current carrying coaxial loops, carry current I in opposite sense. A simple amperian loop passes through both of them once. Calling the loop as C, then which statement is correct?

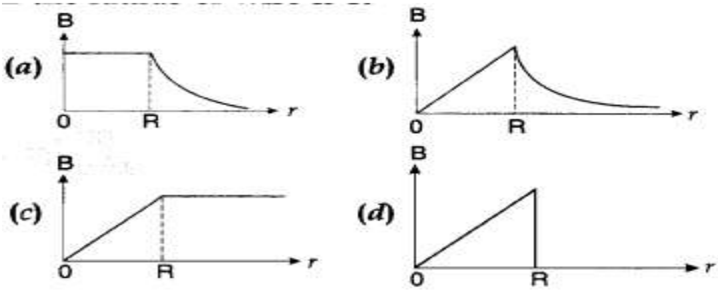
(a) $\oint_c \vec{B}.\overrightarrow{dl} = \mp 2\mu_0 I$

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

(c) there is no point on C where $\vec{B}$ and $\overrightarrow{dl}$ are perpendicular.

(d) none of these.

12. The correct plot of the magnitude of magnetic field $\vec{B}$ vs distance r from centre of the wire is, if the radius of wire is R



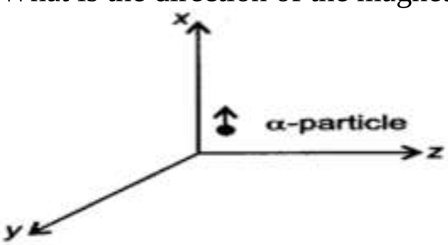
13. The magnetic moment of a current I carrying circular coil of radius r and number of turns N varies as
(a) $1/r^2$ (b) $1/r$
(c) r (d) r^2

14. In a moving coil galvanometer, the deflection (Φ) on the scale by a pointer attached to the spring is
(a) $\left(\frac{NA}{kB}\right) I$ (b) $\left(\frac{NA}{kAB}\right) I$
(c) $\left(\frac{NAB}{k}\right) I$ (d) $\left(\frac{NAB}{kI}\right)$

15. A moving coil galvanometer can be converted into an ammeter by
(a) introducing a shunt resistance of large value in series.
(b) introducing a shunt resistance of small value in parallel.
(c) introducing a resistance of small value in series
(d) introducing a resistance of large value in parallel.

16. Conversion of a moving coil galvanometer into a voltmeter is done by
(a) introducing a resistance of large value in series.
(b) introducing a resistance of small value in parallel.
(c) introducing a resistance of large value in parallel.
(d) introducing a resistance of small value in series.

17. A beam of α-particles projected along +x-axis, experiences a force due to a magnetic field along the +y-axis. What is the direction of the magnetic field?



(a) positive direction of X-axis
(b) negative direction of Y-axis

(c) negative direction of Z-axis

(d)Positive direction of Z-axis

18. When a magnetic compass needle is carried nearby to a straight wire carrying current, then(I) the straight wire cause a noticeable deflection in the compass needle.(II) the alignment of the needle is tangential to an imaginary circle with straight wire as its centre and has a plane perpendicular to the wire

(a) (I) is correct

(b) (II) is correct

(c) both (I) and (II) are correct

(d) neither (I) nor (II) is correct

19. 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) Only electron gains or looses energy.

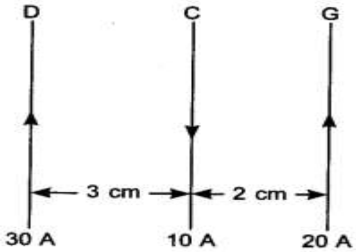
(d) the motion of the centre of mass (CM) is determined by E alone.

20. A conducting circular loop of radius r carries a constant current i. It is placed in a uniform magnetic field B, such that B is perpendicular to the plane of the loop. The magnetic force acting on the loop is

(a) irB. (b) 2πriB

(c) zero (d) πriB

21. Three long, straight parallel wires, carrying current are arranged as shown in the figure. The force experienced by a 25 cm length of wire C is



(a) 10^{-3} N (b) 2.5×10^{-3} N
(c) zero (d) 1.5×10^{-3} N

22. The current sensitivity of a moving coil galvanometer increases with decrease in:
(a) magnetic field (b) area of a coil
c) number of turns (d) None of these

23. What happens to the magnetic field at the centre of a circular current carrying coil if we double the radius of the coil keeping the current unchanged?
(a) halved (b) doubled
(c) quadrupled (d) remains unchanged

24. Circular loop of radius 0.0157 m carries a current 2 A. The magnetic field at the centre of the loop is:
(a) 1.57×10^{-3} Wb/m² (b) 8.0×10^{-5} Wb/m²
(c) 2.0×10^{-3} Wb/m² (d) 3.14×10^{-1} Wb/m²

25. The strength of the magnetic field around an infinite current carrying conductor is:
(a) same everywhere
b) inversely proportional to distance
(c) directly proportional to distance
(d) None of these

26. A current carrying power line carries current from west to east. Then the direction of the magnetic field 2 m above it is :
(a) west to east (b) south to north
(c) north to south (d) None of these

27. According to Ampere's Circuital law

(a) $\oint \vec{B}.\vec{dl} = \frac{\mu_0 I}{4\Pi}$ (b) $\oint \vec{B}.\vec{dl} = \mu_0 I$
(c) $\oint \vec{B} X \vec{dl} = \mu_0 I$ (d) $\oint \vec{B} X \vec{dl} = 0$

28. The force between two parallel current carrying conductors is F. If the current in each conductor is doubled, then the force between them becomes:
(a) 4F (b) 2F
(c) F (d) F/4

29. Which of the following is not a unit of magnetic induction?
(a) gauss (b) tesla
(c) oersted (d) weber/metre²

30. A charge + q is sent through a magnetic field. The force acting on it is maximum when the angle between the direction of motion of the charged particle and the magnetic field:
(a) 0° (b) 45°
(c) 90 (d) 180°

31. A wire of length 2 metre carries a current 1 ampere, is bent to form a circle. The magnetic moment of the coil is:
(a) 2π (b) π/2
(c) π/4 (d) 1/π

32. A charge q moves in a region, where electric field E and magnetic field B both exist, then force on it is:
(a) $\vec{F} = q(\vec{v} X \vec{B})$
(b) $\vec{F} = q\left[\vec{E} X (\vec{v} X \vec{B})\right]$
(c) $\vec{F} = q\left[\vec{E} + (\vec{B} X \vec{v})\right]$
(d) $\vec{F} = q\left[\vec{E} + (\vec{v} X \vec{B})\right]$

33. The SI unit of magnetic dipole moment is'
(a) ampere (b) ampere metre²
(c) tesla (d) None of these

34. Two thin long parallel wires separated by a distance r are carrying a current I amp. each. The magnitude of the force per unit length applied by one wire on the other is:

(a) $\mu_0 I^2/r^2$ (b) $\mu_0 I^2/2\pi r$ (c) $\mu_0 I/2\pi r$ (d) $\mu_0 I/4\pi r$

35. The force on a current carrying conductor in a magnetic field is maximum, when angle between the length of the conductor and the magnetic field is:
(a) $\pi/2$ (b) $\pi/4$
(c) π (d) zero

36. What happens between the two streams of electrons moving parallel to each other in the same direction:
(a) attract each other.
(b) cross the electric and magnetic field of each other.
(c) repel each other.
(d) none of these.

37. A proton and an electron enter a region in which a magnetic field is suddenly switched on. The forces experienced by them are:
(a) equal and opposite.
(b) different in magnitude but in same direction.
(c) in the ratio of 1840.
(d) same in magnitude and direction.

38. A 3.0 cm wire carrying a current of 10 A is placed inside a solenoid perpendicular to its axis. The magnetic field inside the solenoid is given to be 0.27 T. What is the magnetic force on the wire?
(a) 0.081 N (b) 0.81 T
(c) 8.1 T (d) 81 T

39. A closely wound solenoid 80 cm long has 5 layers of windings of 400 turns each. The diameter of the solenoid is 1.8 cm. If the current carried is 8.0 A, estimate the magnitude of B inside the solenoid near its centre.
(a) 25×10^{-2} T (b) 2.5×10^{-3} T
(c) 25×10^{-3} T (d) 2.5×10^{-2} T

40. A toroid has a core (non-ferromagnetic) of inner radius 25 cm and outer radius 26 cm, around which 3500 turns

of a wire are wound. If the current in the wire is 11 A, what is the magnetic field inside the core of the toroid?

(a) Zero (b) 3.02×10^{-2} T

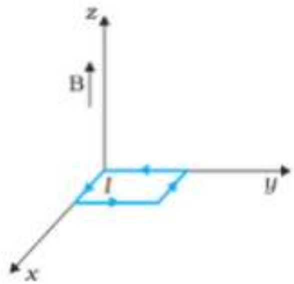
(c) 3.02×10^{-3} T (d) 30.02×10^{-2} T

41. A straight horizontal conducting rod of length 0.45 m and mass 60 g is suspended by two vertical wires at its ends. A current of 5.0 A is set up in the rod through the wires. What magnetic field should be set up normal to the conductor in order that the tension in the wires is zero?

(a) 0.26 T (b) 2.6 T

(c) 26 T (d) none of these

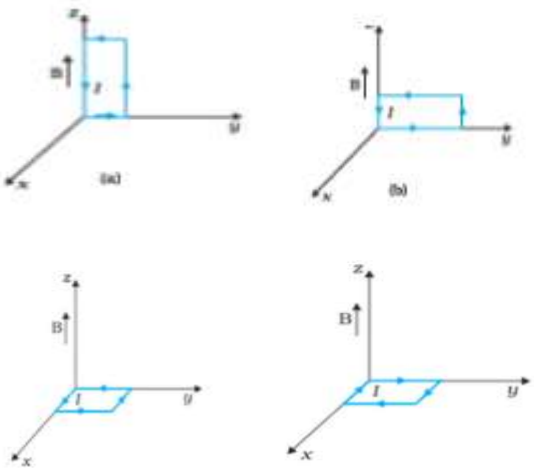
42. A uniform magnetic field of 3000 G is established along the positive z-direction. A rectangular loop of sides 10 cm and 5 cm carries a current of 12 A. What is the torque on the loop in the case shown in figure?



(a) -1.8×10^{-2} Nm (b) zero

(b) (c) 1.8×10^{-2} Nm (d) 1.8×10^{-3} Nm

43. A current carrying rectangular loop is placed in a uniform magnetic field in different orientations as shown in the figure. Which case corresponds to unstable equilibrium?



(i) (ii) (iii) (iv)

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

44. A galvanometer coil has a resistance of 15Ω and the metre shows full scale deflection for a current of 4 mA. How will you convert the metre into an ammeter of range 0 to 6 A.
(a) By connecting a resistance of 10 mΩ in series with the galvanometer.
(b) By connecting a shunt resistance of 10 mΩ across the galvanometer.
(c) By connecting a shunt resistance of 10 Ω across the galvanometer.
(d) By connecting a resistance of 10 Ω in series with the galvanometer.

45. An ammeter, a milli-ammeter, a voltmeter and a milli-voltmeter are converted from the same galvanometer.

Which one has the lowest and which one has the highest resistance?

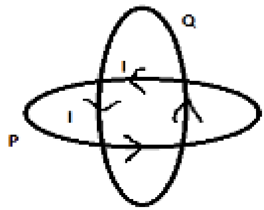
(a) a milliammeter has the lowest resistance and a milli-voltmeter has the highest resistance.

(b) an ammeter has the lowest resistance and a voltmeter has the highest resistance.

(c) an ammeter has the highest resistance and a voltmeter has the lowest resistance.

(d) a milliammeter has the highest resistance and a millivoltmeter has the lowest resistance.

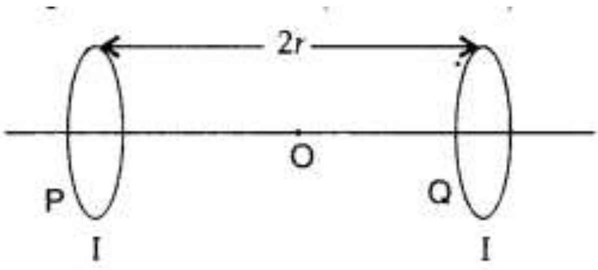
46. Two identical circular wires P and Q each of radius R and carrying current 'I' are kept in perpendicular planes such that they have a common centre as shown in the figure. Find the magnitude of the net magnetic field at the common centre of the two coils.



(a) $\frac{\mu_0 NI}{\sqrt{2}R}$ (b) $\frac{\mu_0 NI}{\sqrt{3}R}$

(b) (c) $\frac{\mu_0 NI}{2R}$ (d) $\frac{\mu_0 2NI}{\sqrt{2}R}$

47. Two identical circular loops, P and Q, each of radius r and carrying equal currents are kept in the parallel planes having a common axis passing through O. The direction of current in P is clockwise and in Q is anti-clockwise as seen from O which is equidistant from the loops P and Q. Find the magnitude of the net magnetic field at O.



(a) $\frac{\mu_0 I}{2r}$ (b) $\frac{\mu_0 I}{r}$

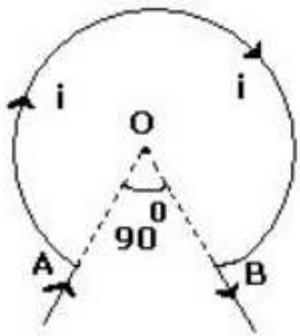
(c) $\frac{\mu_0 I}{2\sqrt{2}r}$ (d) $\frac{\mu_0 I}{\sqrt{2}r}$

48. It is desired to pass only 10% of the current through a galvanometer of resistance 90. How much shunt resistance be connected across the galvanometer?

(a) 0.1Ω (b) 1 Ω

(c) 10 Ω (d) 100 Ω

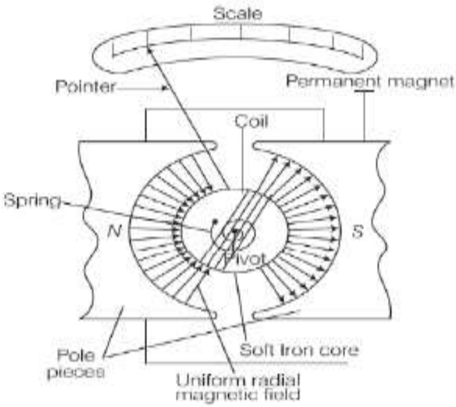
49. The magnetic field at the centre of circular coil of radius 1 cm and carrying current of 4 A is:



(a) $\frac{8\Pi}{3}$ x 10^{-4} T (b) $\frac{8\Pi}{3}$ X 10^{-5} T

(c) 2Π X 10^{-5} T (d) 2Π X 10^{-4} T

50. Figure shows the construction details of moving coil galvanometer.



Match the parts with its function:

Column I	Column II
A. Soft iron core	1. Producing deflecting torque.
B. Pole pieces	2. Produces restoring torque.
C. Spring	3. Produces radial field.
D. Coil	4. Increases field strength.

	A	B	C	D
(a)	1	2	3	4
(b)	1	2	4	3
(c)	2	1	3	4
(d)	4	3	2	1

SECTION: IV

ASSERTION-REASONING QUESTIONS

DIRECTIONS: Two statements are given-one labelled Assertion (A) and the other labelled Reason (R). Select the correct answer to these questions from the codes (a), (b), (c) and (d) as given below.

(a) Both A and R are true and R is the correct explanation of A.
(b) Both A and R are true but R is not the correct explanation of A.
(c) A is true but R is false.
(d) A is false and R is also false.

1. Assertion: The magnetic field produced by a current-carrying solenoid is independent of its length and cross-sectional area.Reason: The magnetic field inside the solenoid is uniform.
2. Assertion: A charge, whether stationary or moving produces a magnetic field around it.
   Reason: Moving charges produce only electric field in the surrounding space.
3. Assertion: If we increase the current sensitivity of a galvanometer by increasing the number of turns, its voltage sensitivity also increases.
   Reason: Resistance of a wire is inversely proportional of its length.
4. Assertion: The resistance of ideal voltmeter is infinite.
   Reason: The lower resistance of voltmeter gives a reading lower than the actual potential difference across the terminals.
5. Assertion: Magnetic field lines can be entirely confined within the core of a toroid, but not within a straight solenoid.
   Reason: The magnetic field inside the solenoid is uniform.
6. Assertion: An ammeter is connected in series in the circuit.
   Reason: An ammeter is a high resistance galvanometer.
7. Assertion: There is a spark in the switch when the switch is closed.

Reason: Current flowing in the conductor produces magnetic field.

8. Assertion: The magnetic field intensity at the centre of a circular coil carrying current changes if the current through the coil is doubled.

   Reason: The magnetic field intensity is independent of the current in the conductor.

9. Assertion: In electric circuits wires carrying currents in opposite directions are often twisted together.

   Reason: If the wires are not twisted together, the combination of the wires forms a current loop. The magnetic field generated by the loop might affect adjacent circuits or components.

10. Assertion: If two long parallel wires, hanging freely are connected to a battery in series, they come closer to each other.

    Reason: Force of attraction acts between the two parallel wires in series carrying current.

11. Assertion: When the observation point lies along the length of the current element, magnetic field is zero.

    Reason: Magnetic field close to current element is zero.

12. Assertion: We can increase the range of ammeter but cannot decrease it.

13. Reason: Minimum range of an ammeter is fixed.

13. Assertion: In a conductor, free electrons keep on moving but no magnetic force acts on a conductor in a magnetic field.

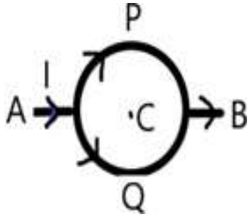
Reason: Force on free electron due to magnetic field always acts perpendicular to its direction of motion.

14. Assertion: Two parallel wires carrying current in same direction, attract each other while if two similar charge moving parallel to each other repel each other.

    Reason: Electric force is stronger than magnetic force.

15. Assertion: An electron and proton enters a magnetic field with equal velocities then the force experienced by proton will be more than electron.
    Reason: The mass of proton is 1999 times more than the mass of electron.
16. Assertion: When a magnetic dipole is placed in a non-uniform magnetic field, only a torque acts on the dipole.
    Reason: Force would also act on the dipole if magnetic field were uniform.
17. Assertion: Magnetic moment is measured in J/T or A m^2.
    Reason: J/T is equivalent to Am^2.
18. Assertion: The magnetic Lorentz force, $\vec{F} = q(\vec{v} x \vec{B})$ is a non–conservative force.
    Reason: The work done by the Lorentz force is always zero.
19. Assertion: A phosphor bronze strip is used in a moving coil galvanometer
    Reason: Phosphor bronze strip has the maximum value of torsional constant k.
20. Assertion: In a moving coil galvanometer, the magnetic field is radial.
    Reason: Due to radial magnetic field, the plane of the coil always remains perpendicular to the magnetic field.
21. Assertion: The torque acting on square and circular current carrying coils having equal areas, placed in uniform magnetic field, will be same.
    Reason: Torque acting on a current carrying coil placed in uniform magnetic field does not depend on the shape of the coil, if the areas of the coils are same.
22. Assertion: An electron projected parallel to the direction of magnetic force will experience maximum force.
    Reason: Magnetic force on a charge particle is given by $F = BIL\sin\theta$.

23. Assertion: The voltage sensitivity may not necessarily increase on increasing the current sensitivity.
    Reason: Current sensitivity increases on increasing the number of turns of the coil.
24. 24. Assertion: The magnetic field at the centre of the current carrying circular coil shown in the fig. is zero.



    Reason: The magnitudes of magnetic fields are equal and the directions of magnetic fields due to both the semicircles are opposite.
25. Assertion: The range of a voltmeter can be both increased or decreased.
    Reason: The required resistance (to be connected in series) can be calculated by using the relation, $R = \frac{V}{I_g} - G$
26. Assertion: The coils of a spring come close to each other, when current is passed through it.
    Reason: It is because, the coils of a spring carry current in the same direction and hence attract each other.
27. Assertion: The magnetic field at the ends of a very long current carrying solenoid is half of that at the centre.
    Reason: If the solenoid is sufficiently long, the field within it is uniform.
28. Assertion: When radius of a circular loop carrying current is halved, its magnetic moment becomes one-fourth of the initial value.
    Reason: Magnetic moment depends on the area of the loop.

29. Assertion: The magnitude of magnetic field in a region is equal to the number of magnetic field lines per unit area where area should be normal to the field.
    Reason: Magnetic field is tangential to a magnetic field line.
30. Assertion: Magnetic field due to an infinite straight conductor varies inversely as the distance from it.
    Reason: The magnetic field due to a straight conductor is in the form of concentric circles.

SECTION: V

20 CASE-STUDY BASED QUESTIONS

CASE 1: Ampere's Circuital Law

Ampere found that the magnetic field lines of a straight current carrying conductor are concentric circles in a plane perpendicular to the conductor. Ampere's law is stated with reference to the loops of magnetic field lines .We consider a loop to be made up of a number of small line elements. Consider one such element of length dl. Let B_t be the tangential component of the field $\vec{B}$ at this element .We multiply it by the element length dl. We add all such products when the length of these elements become small and their number gets larger ,this summation tends to an integral .Ampere's law states that the line integral of the magnetic field $\vec{B}$ around any closed loop is equal to μ_0 times the net current I passing through the closed-loop.

$$\oint \overrightarrow{B}.\overrightarrow{dl} = \mu_0 I$$

The closed loop is called Amperian loop .Ampere's law is valid for any arbitrary closed loop and holds only for steady currents. However, Ampere's law is useful only for calculating the magnetic field only in highly symmetrical situations where $\vec{B}$ is tangential to loop and has a non zero constant B, or $\vec{B}$ is normal to the loop, or B vanishes.

1.1 Only the current inside the Amperian lope contributes in

(a) finding magnetic field at any point on the Amperian loop.

(b) line integral of magnetic field .

(c) in both of the above.

(d) in neither(a) nor (b).

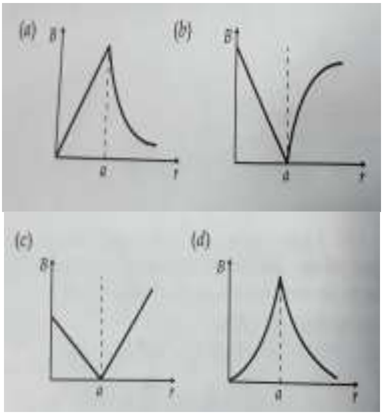
1.2 An electric current passes through a long wire. At a distance 5 cm from the wire, the magnetic field is B. The field at 20 cm from the wire would be

(a) B/2 (b) B/3 (c) B/4 (d) B/5

1.3. 1A current flows through an infinitely long straight wire. The magnetic field produced at a point 1m away from it is

(a) 2×10^{-3}T (b) $2\Pi \times 10^{-3}$T (c) 2×10^{-7}T (d) $2\Pi \times 10^{-7}$T

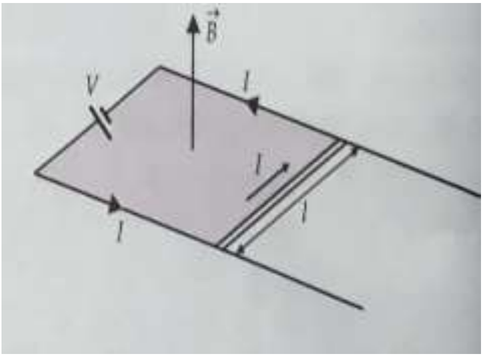
1.4 A long straight wire of circular cross-section (radius a), carries a steady current I and the current I is uniformly distributed across this cross-section. Which of the following plot represents the variation of magnitude of magnetic field B with distance r from the centre of the wire?



1.5 A steady electric current is flowing through a cylindrical conductor.
(a) The magnetic field in the vicinity of the conductor is zero.
(b) The electric field in the vicinity of the conductor is zero.
(c) The magnetic field at the axis of the conductor is zero.
(d) The electric field at the axis of the conductor is zero.

CASE 2 Force on a current carrying conductor in a magnetic field

When a current carrying conductor is placed in an external magnetic field, it experiences are mechanical force. A current is an assembly of moving charges and a magnetic field exerts a force on a moving charge. That is



why, a current carrying conductor when placed in the magnetic field experiences a sideways force as the force experienced by the moving electrons is transmitted to the conductor as a whole. A conductor of length l carrying a current I held in a magnetic field $\vec{B}$ at an angle θ with it experiences of force given by $F = BIlsin\theta$ .In vector form, $\vec{F} = I(\overrightarrow{\imath} \times \overrightarrow{B})$ The direction of $\vec{F}$ is perpendicular to both $\vec{\imath}$ *and* $\vec{B}$ and is given by Fleming's left hand rule. A contributing bar with mass m and length l slides over horizontal rails that are connected to voltage source V. The source maintains a constant current I in the rails and bar, and a uniform magnetic field $\vec{B}$, acting vertically upwards, acts in the region between rails.

2.1 Ignoring friction, air resistance and electrical resistances, the magnitude and direction of the net force on the conducting bar is

(a) IlB, to the right (b) IlB, to the left

(c) Ilb, to the righ (d) 2IlB, to the left

2.3 If the bar has mass m, find the distance d that the bar must move along the rails from rest to attain speed v.

(a) $\frac{3v^2m}{2IlB}$ (b) $\frac{5v^2m}{2IlB}$

(c) $\frac{v^2m}{IlB}$ (d) $\frac{v^2m}{2IlB}$

2.3 A force acting on a conductor of length 5m carrying a current of 8A kept perpendicular to the magnetic field of 1.5 T is:

(a) 100 N (b) 60 N

(c) 50 N (d) 75 N

2.4 A straight wire of mass 200 g and length 1.5 m carries a current of 2 A. It is suspended in mid-air by a uniform horizontal magnetic field B. The magnitude of B (in T) is (assume that g = $9.8 m/s^2$)

(a) 2 (b) 1.5

(c) 0.55 (d) 0.65

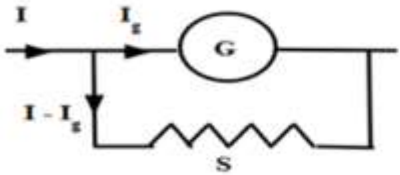
2.5 A wire of length l carries a current I along x-axis. A magnetic field exists given by .The magnitude of magnetic force acting on the wire is

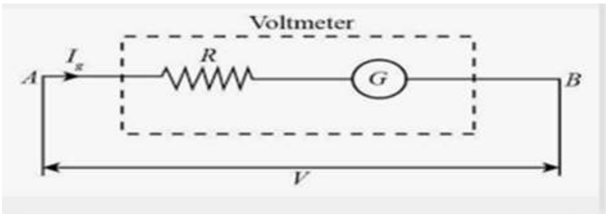
(a) ilB_0 (b) $\sqrt{3}ilB_0$

(c) $2ilB_0$ (d) $\sqrt{2}ilB_0$

CASE 3 Using galvanometer as an ammeter and a voltmeter

A galvanometer is a device used to detect current in an electric circuit. It cannot as such be used as an ammeter to measure current in a given circuit. This is because a galvanometer is a very sensitive device, it gives a full scale deflection for a current of the order of μA. Moreover, for measuring currents, the galvanometer has to be connected in series, and it has a large resistance this will change the value of current in the circuit. To overcome these difficulties, we connect a small resistance R called shunt resistance in parallel with the Galvanometer coil, so that most of the current passes through the shunt. Now to use galvanometer as a voltmeter, it has to be connected in parallel with the circuit element across which we need to measure potential difference. Moreover, it may draw a very small current, otherwise it will appreciable change the voltage being measured. To ensure this, a large resistance R is connected in series with the galvanometer.





3.1 A sensitive galvanometer like a moving coil galvanometer can be converted into an ammeter or a voltmeter by connecting a suitable resistance to it. Which of the following statements is true?
(a) a voltmeter is connected in parallel and current through it is negligible.
(b) an ammeter is connected in parallel and potential difference across it is small.

(c) a voltmeter is connected in series and potential difference across it is small.
(d) an ammeter is connected in series in a circuit and the current through it is negligible.

3.2 By mistake a voltmeter is connected in series and an ammeter is connected in parallel with a resistance in an electrical circuit. What will happen to the instruments?

(a) Voltmeter is damaged (b) Ammeter is damaged
(c) Both are damaged (d) None is damaged.

3.3 A galvanometer coil has a resistance of 15 ohm and gives full scale deflection for a current of 4 mA. To convert it to an ammeter of range 0 to 6 A

(a) 10 milliohm resistance is to be connected in parallel to the galvanometer.
(b) 10 milliohm resistance is to be connected in series with the galvanometer.
(c) 0.1 ohm resistance is to be connected in parallel to the galvanometer.
(d) 0.1 ohm resistance is to be connected in series with the galvanometer.

3.4 Two identical galvanometers are converted into an ammeter and a milli-ammeter. Resistance of the shunt of milli-ammeter is ________ than the resistance of the shunt of ammeter.

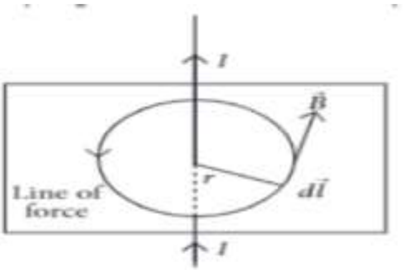
(a) more (b) equal
(c) less (d) zero

3.5 A voltmeter has resistance of G ohm and range of V volt. The value of resistance used in series to convert it into a voltmeter of range nV volt is:

(a) nG (b) (n-1)G
(c) G/n (d) G/n-1

CASE <u>Ampere's Circuital Law</u>

Ampere's law gives a method to calculate the magnetic field due to given current distribution. According to it, the circulation of the resultant magnetic field along a closed plane curve is equal to μ_0 times the total current crossing the area bounded by the closed curve, provided the electric field inside the loop remains constant. Ampere's law is more useful under certain symmetrical conditions. Consider one such case of a long straight wire with circular cross-section (radius R) carrying current I uniformly distributed across this cross-section.



4.1 The magnetic field at a radial distance r from the centre of the wire in the region r › R, is

(a) $\frac{\mu_0 I}{2\Pi r}$ (b) $\frac{\mu_0 I}{2\Pi R}$

(c) $\frac{\mu_0 I R^2}{2\Pi r}$ (d) $\frac{\mu_0 I r^2}{2\Pi r}$

4.2 The magnetic field at a distance r in the region r < R is

(a) $\frac{\mu_0 I}{2r}$ (b) $\frac{\mu_0 I r^2}{2\Pi R^2}$

(c) $\frac{\mu_0 I}{2\Pi r}$ (d) $\frac{\mu_0 I r}{2\Pi R^2}$

4.3 The magnetic field at a point R/2 above the surface of the wire is

(a) $\frac{\mu_0 I}{2\Pi r}$ (b) $\frac{\mu_0 I r^2}{2\Pi R^2}$

(c) $\frac{\mu_0 I}{3\Pi R}$ (d) $\frac{\mu_0 I}{3\Pi r}$

4.4 A long straight wire of radius R carries a steady current I. The current is uniformly distributed across its cross-section. The ratio of magnetic field at r= R/2 and r=2R is

(a) ½ (b) 2

(c) ¼ (d) 1

4.5 A direct current I flows along the length of an infinite long straight thin walled pipe, then the magnetic field is

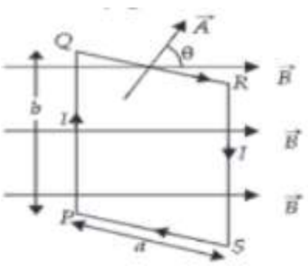
(a) uniform throughout the pipe but not zero

(b) zero only along the axis of the pipe.

(c) zero at any point inside the pipe.

(d)maximum at the centre and minimum at the edges.

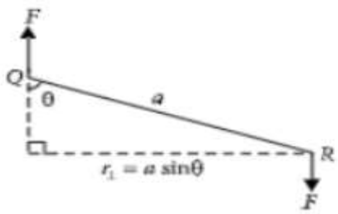
CASE 5 Torque on a rectangular loop placed in uniform magnetic field



When a rectangular loop PQRS side 'a' and 'b' carrying current I is placed in uniform magnetic field $\vec{B}$, such that area $\vec{A}$ a makes an angle θ with the direction of magnetic field then force on the arm QR and SP of loop are equal, opposite and collinear, thereby perfectly cancel each other, whereas forces on the arms PQ and RS of loop are equal and opposite but not collinear, so they give rise to torque on the loop. Force on side PQ for RS of loop is F = IbBsin90^0 = IbB and perpendicular distance between the two non-collinear forces is asinθ.

So, torque on the loop,τ = IABsinθ

In vector form, $\vec{\tau} = \vec{M} \times \vec{B}$ where $\vec{M} = NI\vec{A}$ is called magnetic dipole moment of current loop and is directed in direction of area vector $\vec{A}$ i.e normal to the plane of loop.



5.1 A circular loop of area 1 cm^2 carrying a current of 10 A is placed in a magnetic field of 0.1T which is perpendicular to plane of the loop. The torque on the loop due to the magnetic field is

(a) zero (b) 10^{-4} Nm

(c) 10^{-2} Nm (d) 1 Nm

5.2 Relation between magnetic moment M of a revolving electron and angular velocity ω is

(a) M α ω (b) M α ω^2

(c) M α $\sqrt{\omega}$ (d) none of these

5.3 A current loop in a magnetic field

(a) can be in equilibrium in two orientations, both the equilibrium states are unstable.

(b) can be in equilibrium in two orientations, one stable while the other is unstable.

(c) experiences a torque whether the field is uniform or non-uniform in all orientations.

(d) can be in equilibrium in one orientation.

5.4 The magnetic moment of a current I carrying circular coil of radius r and number of turns N varies as

(a) $1/r^2$ (b) 1/r

(c) r (d) r^2

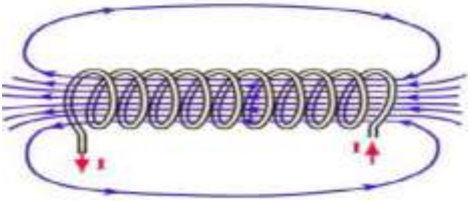
5.5 Rectangular coil carrying current is placed in a non-uniform magnetic field. On that coil, the total

(a) Force is non-zero (b) Force is zero

(c) Torque is zero. (d) None of these.

CASE 6 Magnetic field inside a solenoid

As shown in figure a solenoid where the wire is coiled around a cylinder, each wire loop in this coil acts as if it was a separate circular wire carrying the same current I, the current in the coiled wire and the dense enough array of such loops may be approximated by a cylindrical current sheet with the current density K = I × (N/L) = I × L(loops) /solenoid length. For simplicity, let's assume a long solenoid (length ≫ diameter) which we approximate as infinitely long. For a long solenoid (compared to its diameter), the magnetic field inside the solenoid is approximately uniform and approximately parallel to the axis, except near the ends of the solenoid. Outside the solenoid, the magnetic field looks like the field of a physical dipole, with the North pole at one end of the solenoid and the South pole at the other end and is approximately negligible.



6.1 Which of the following material can be used to make loops around the cylinder?

(a) Plastic (b) Glass

(c) Quartz (d) copper

6.2 The magnetic field inside the solenoid is and

(a) Non-Uniform and parallel to the axis.

(b) Uniform and parallel to the axis.

(c) Non-uniform perpendicular to the axis.

(d) Uniform and perpendicular to the axis.

6.3 A proton is moving from left to right direction and outside the solenoid, then what is the direction of force on the proton?

(a) upwards (b) downwards

(c) proton will not deflect (d) inwards

6.4 The magnetic field inside the solenoid depends upon the number of turns?

(a) inversely proportional

(b) directly proportional

(c) proportional to the number of turns

(d) none of these.

6.5 Direction of magnetic field due to a solenoid can be determined by

(a) Ohm's Law (b) Fleming's left-hand rule
(c) Ampere's Right-hand rule (d) Biot-savart's Law

CASE 7 Magnetic Effect of current

In 1820, a Danish physicist, Hans Christian Oersted, discovered that there was a relationship between electricity and magnetism. By setting up a compass through a wire carrying an electric current, Oersted showed that moving electrons can create a magnetic field. Oersted found that, for a straight wire carrying a steady (DC) current: The magnetic field lines encircle the current-carrying wire. The magnetic field lines lie in a plane perpendicular to the wire. If the direction of the current is reversed, the direction of the magnetic force reverses. The strength of the field is directly proportional to the magnitude of the current. The strength of the field at any point is inversely proportional to the distance of the point from the wire.

7.1 First who discovered the relation between electric and magnetic field is-
(a) Hans Christian Oersted (b) Charles William Oersted
(c) Charles Maxwell (d) Andre Marie Ampere

7.2 If magnitude of the current in the wire increases, strength of magnetic field-
(a) Increases (b) Decreases
(c) remains unchanged (d) none of these

7.3 Which of the following statements is true?
(a) There is no relationship between electricity and magnetism.
(b) An electrical current produces a magnetic field.
(c) A compass is not affected by electricity.
(d) A compass is not affected by a magnet.

7.4 A compass needle is placed below a straight conducting wire. If current is passing through the conducting wire from

North to South. Then the deflection in the north pole of the needle is ____.

(a) Towards West. (b) Towards East.

(c) keeps oscillating in East-West direction (d) No deflection

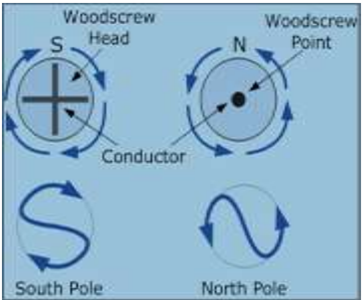
7.5 Charges at rest can produces-

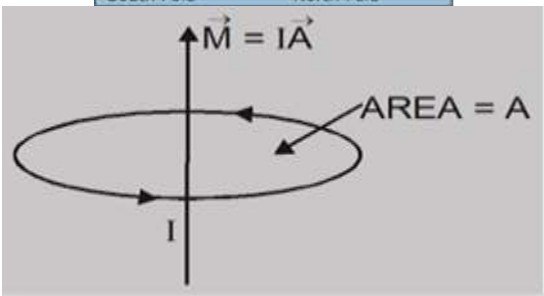
(a) Static electric field (b) Magnetic field

(c) Induced current (d) Conventional current

CASE 8 CURRENT LOOP AS A MAGNETIC DIPOLE

Current loop behaves likes a magnetic dipole and has a magnetic field. They behave just like a magnet. Interesting part is, it depends upon the direction of current in loop which decides whether magnetic field line is in outward or inward direction. With the help of this outward and inward direction of magnetic field, North and South poles get decided.





Anticlockwise direction of current creates north pole (outward direction magnetic field) and clockwise direction of current creates a south pole (inward direction magnetic field). Magnetic dipole moment M with the circular current loop carrying a current I and of area A. The magnitude of m is given by: |M|=I x A

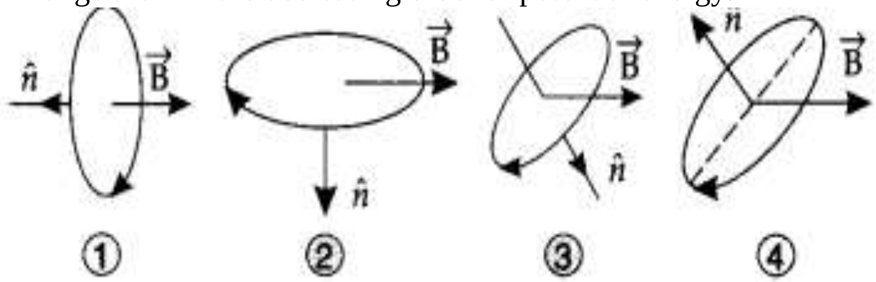
Current in the circular coil produces magnetic field and amperes found out that magnetic field created due to circular coil is similar to the magnetic field due to a bar magnet. Wood screw head sign shows that direction of screw is inward because we are not able to see pointed part of screw and so direction is inward. This inward direction of screw denotes the direction of the magnetic field.

8.1 A thin circular wire carrying a current I, has a magnetic moment M. The shape of a wire is changed to a square and it carries the same current. It will have a magnetic moment-

(a) $4M/\pi^2$ (b) M

(c) 4π x M (d) $4M/\pi$

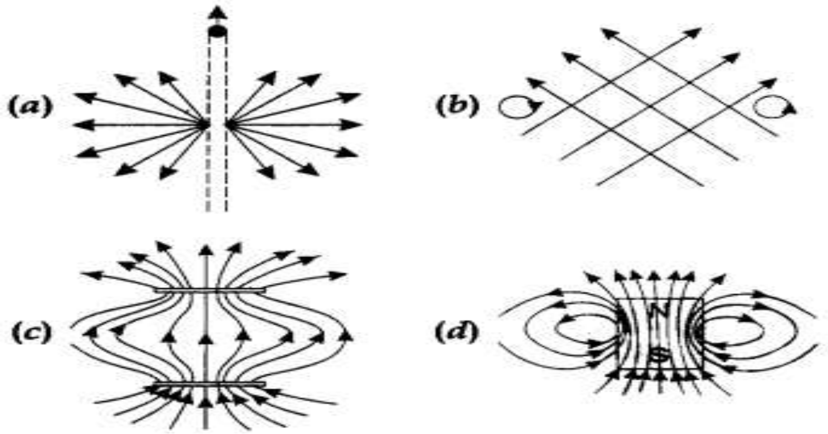
8.2 A current carrying loop is placed in a uniform magnetic field in four different orientations as shown in figure. Arrange them in the decreasing order of potential energy.



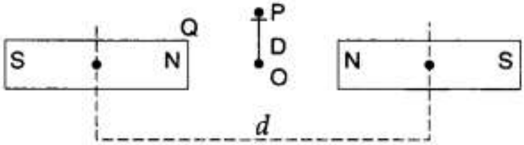
(a) 4, 2, 3, 1 (b) 1, 4, 2, 3

(c) 4, 3, 2,1 (d) 1, 2, 3, 4

8.3 Point out the correct direction of magnetic field in the given figures.



8.4 Two identical bar magnets are fixed with their centres at a distance d apart. A stationary charge Q is placed at P in between the gap of the two magnets at a distance D from the centre O as shown in the figure. The force on the charge Q is



(a)Zero (b) directed along OP (c) directed along PO (d) directed perpendicular to plane of paper.

8.5 In a bar magnet, magnetic field lines-

(a) are produced only at north pole like rays of light from a bulb.

(b) starts from north pole and ends at the south pole.

(c) emerge in circular paths from the middle of the bar.

(d) form closed continuous loops.

CASE 9 <u>Force on a current carrying conductor in a uniform magnetic field</u>

When a current-carrying conductor is placed in an external magnetic field, it experiences a force. Current constitutes a number of charges in motion. These moving charges experience a magnetic force when they are moving in a magnetic field. This force is numerically equal to F = qvBsinθ As a result, a current-carrying conductor when placed in a magnetic field experiences a sideways force as the force experienced by the moving electrons is transmitted to the conductor as a whole. A conductor of length L carrying a current I I held in a magnetic field at an angle θ with it, experiences a force given by F = BILsinθ. The direction of this force is given by Fleming's left hand rule and is always perpendicular to the plane containing the conductor and the magnetic field.

9.1 A force acting on a conductor of length 5m carrying a current of 8A kept perpendicular to the magnetic field of 1.5 T is

(a) 100 N (b) 60 N
(c) 50 N (d) 75 N

9.2 A straight conductor of mass 200 g and length 1.5 m carries a current of 2 A. It is suspended in mid-air by a uniform horizontal magnetic field B. The magnitude of B (in Tesla) is (assume that g= $9.8ms^{-2}$).

(a) 2 (b) 1.5
(c) .55 (d) .65

9.3A charge of 10 C is moved in a circular path of radius 10cm by a magnetic force. The work done on the charged particle by the magnetic force is

(a) 10 J (b) 100 J
(c) zero (d) insufficient data

9.4 The force experienced by a charge in a magnetic field is given by $\vec{F} = q(\vec{v} \times \vec{B})$. Identify the incorrect statement.

(a) $\vec{v}$ and $\vec{B}$ are always perpendicular.
(b) $\vec{v}$ and $\vec{F}$ are always perpendicular.
(c) $\vec{F}$ and $\vec{B}$ are always perpendicular.
(d) None of these.

9.5 The direction of force experienced by a conductor placed in a magnetic field is determined by

(a) Fleming's right hand rule.
(b) Right Hand Thumb rule.
(c) cork screw rule.
(d) Fleming's left hand rule.

CASE 10 BIOT-SAVART LAW

A magnetic field can be produced by moving, charges or electric currents. The basic equation governing the magnetic field due to a current distribution is the Biot -Savart law. Finding the magnetic field resulting from a current distribution involves the vector product, and is inherently a calculus problem when the distance from the current to the field point is continuously changing. According to this law, the magnetic field at a point due to a current element of length dl carrying current I, at a distance r from the element is: $\overrightarrow{dB} = \frac{\mu_0}{4\Pi} \frac{I(\overrightarrow{dl} X \vec{r})}{r^3}$

Biot-Savart law has certain similarities as well as differences with Coulomb's law for electrostatic field e.g., there is an angle dependence in Biot-Savart law which is not present in electrostatic case.

10.1 The direction of magnetic field $\overrightarrow{dB}$ due to a current element $I\overrightarrow{dl}$ at a point of distance $\vec{r}$ from it, when a current I passes through a long conductor, is in the direction
(a) of position vector $\vec{r}$ of the point
(b) of current element $\overrightarrow{dl}$
(c) perpendicular to both $\overrightarrow{dl}$ and $\vec{r}$.
(d) perpendicular to $\overrightarrow{dl}$ only.

10.2 The magnetic field due to a current in a straight wire segment of length l, at a point on its perpendicular bisector at a distance r (r >>L)
(a) decreases as l/r. (b) decreases as I/ r^2.
(c) decreases as I/ r^3. (d) approaches a finite limit as r $\rightarrow\infty$

10.3 Two long straight wires are set parallel to each other. Each carries a current i in the same direction and the separation between them is 2r. The intensity of the magnetic field midway between them

(a) $\frac{\mu_0 i}{r}$ (b) $\frac{4\mu_0 i}{r}$

(c) Zero (d) $\frac{\mu_0 i}{4r}$

10.5 A long straight wire carries a current along the z- axis for any two points in the x-y plane. Which of the following is always false?

(a) The magnetic fields are equal.

(b) The directions of magnetic fields are the same.

(c) The magnitude of the magnetic fields are equal.

(d) The field at one point is opposite to that at the other point.

10.5 Biot-Savart law can be expressed alternatively as

(a) Coloumb's Law (b) Ampere's Circuital law

(c) Ohm's Law (d) Gauss's law

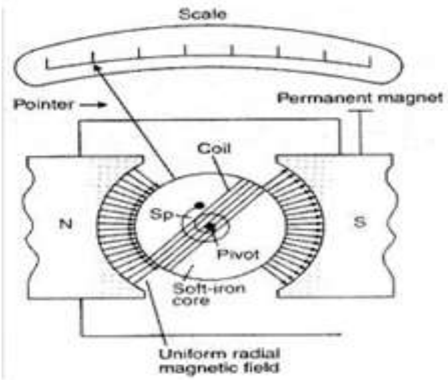
CASE 11 Moving Coil Galvanometer

Moving coil galvanometer operates on Permanent Magnet Moving Coil (PMMC) mechanism and was designed by the scientist D'arsonval. Moving coil galvanometers are of two types:

(i) Suspended coil type

(ii) Pivoted coil type or tangent galvanometer

Its working is based on the fact that when a current carrying coil is placed in a magnetic field, it experiences a torque. This torque tends to rotate the coil about its axis of suspension in such a



way that the magnetic flux passing through the coil is maximum.

11.1 A moving coil galvanometer is an instrument which
(a) is used to measure emf.
(b) is used to measure potential difference.
(c) is used to measure resistance.
(d) is a deflection instrument which gives a deflection when a current flows through its coil.
11.2 To make the field radial in a moving coil galvanometer,
(a) Number of turns of coil is kept small.
(b) Magnet is taken in the form of horse- shoe.
(c) Poles are of very strong magnets.
(d) Poles are cylindrically cut.
11.3 The deflection in a moving coil galvanometer is
(a) directly proportional to torsional constant of spring.
(b) directly proportional to the number of turns in the coil.
(c) inversely proportional to the area of coil.
(d) inversely proportional to the current in the coil.
11.4 In a moving coil galvanometer, having a coil of N-turns of area A and carrying current I is placed in a radial field of strength B
The torque acting on the coil is
(a) NA^2B^2l (b) $NABl^2$
(c) N^2ABl (d) $NABl$
11.5 To Increase the current sensitivity of a moving coil galvanometer, we should decrease
(a) Strength of magnet. (b) Torsional constant of spring.
(c) Number of turns in coil. (d) Area of coil.

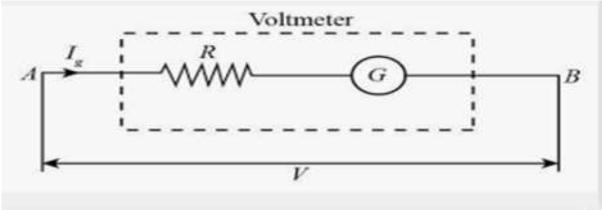
CASE 12. <u>Conversion of Galvanometer to Voltmeter</u>

A galvanometer can be converted into voltmeter of given range by connecting a suitable resistance R_s in series with the galvanometer, whose value is given by:

$$R_s = \frac{V}{I_g} - G$$

where V is the voltage to be measured, I_g is the current for full scale deflection of galvanometer and G is the resistance of galvanometer.

Series resistors (R_s) increases range of voltmeter and the effective resistance of galvanometer. It also protects the galvanometer from damage due to large current.



Voltmeter is a high resistance instrument and it is always connected in parallel with circuit element across which potential difference is to be measured. An ideal voltmeter has infinite resistance. In order to increase the range of voltmeter n times, the value of resistance to be connected in series with galvanometer is $R_s = (n-1)\,G$.

12.1.10 mA current can pass through a galvanometer of resistance 25Ω. What resistance in series should be connected through it, so that it is converted into a voltmeter of 100 V?

(a) 0.975Ω (b) 99.75 Ω
(c) 975 Ω (d) 9975 Ω

12.2 There are 3 voltmeters A, B, C, having the same range but their resistance are 15,000Ω, 10,000 Ω and 5,000 Ω, respectively. The best voltmeter amongst them is the one whose resistance is

(a) 5000 Ω (b) 10,000 Ω
(c) 15,000 Ω (d) all are equally good.

12.3 A millimeter of range 0 to 25 mA and resistance of 10 Ω is to be converted into a voltmeter with a range of 0 to 25 V. The resistance that should be connected in series will be

(a) 930 Ω (b) 960 Ω

(c) 990 Ω (d) 1010 Ω

12.4 To convert a Moving Coil Galvanometer (MCG) into a voltmeter

(a) a high resistance R is connected in parallel with MCG.

(b) a low resistance R is connected in parallel with MCG.

(c) a low resistance R is connected in series with MCG.

(d) a high resistance R is connected in series with MCG.

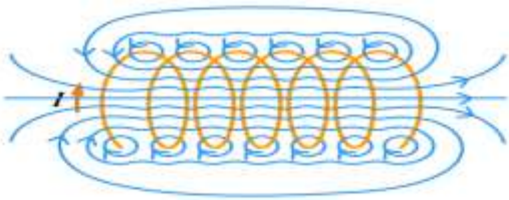
12.5 The resistance of an ideal voltmeter is

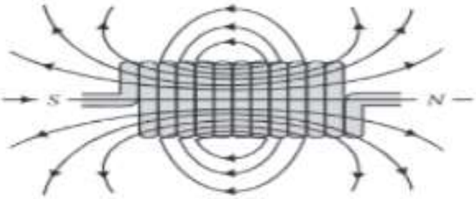
(a) Zero (b) low

(c) high (d) infinity

CASE 13MAGNETIC FIELD DUE TO SOLENOID

A solenoid is a long coil of wire tightly wound in the helical form. Solenoid consists of closely stacked rings electrically insulated from each other wrapped around a non-conducting cylinder.. Figure below shows the magnetic field lines of a solenoid carrying a steady current I. We see that if the turns are closely spaced, the resulting magnetic field inside the solenoid becomes fairly uniform, provided that the length of the solenoid is much greater than its diameter. For an "ideal" solenoid, which is infinitely long with turns tightly packed, the magnetic field inside the solenoid is uniform and parallel to the axis, and vanishes outside the solenoid.





13.1 A long solenoid has 800 turns per meter length of solenoid. A current of 1.6A flows through it. The magnetic induction at the end of the solenoid on its axis is

(a) 16×10^{-4} T (b) 8×10^{-4} T

(c) 32×10^{-4} T (d) 4×10^{-4} T

13.2 Choose the correct statement in the followings.

(a) The magnetic field inside the solenoid is less than that of outside.

(b) The magnetic field inside an ideal solenoid is not at all uniform.

(c) The magnetic field at the center, inside an ideal solenoid is atmost twice that at the ends.

(d) The magnetic field at the center, inside an ideal solenoid is almost half of that at the ends.

13.3 The magnetic field (B) inside a long solenoid having n turns per unit length & carrying current I when iron core is kept in it is (μ_0 = permeability of vaccum, χ = magnetic susceptibility)

(a) $\mu_0 nI(1-\chi)$ (b) $\mu_0 nI\chi$

(c) $\mu_0 nI^2(1+\chi)$ (d) $\mu_0 nI(1+\chi)$

13.4 A solenoid of length *l* and having n turns carries a current l is in anticlockwise direction. The magnetic field is

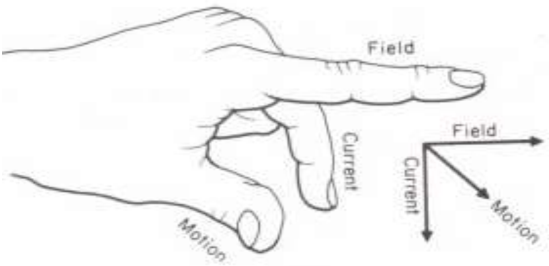
(a) $\mu_0 nI$ (b) $\mu_0 \frac{nI}{l^2}$ (c) along the axis of solenoid
(d) perpendicular to the axis of coil

13.5 The magnitude of the magnetic field inside a long solenoid is increased by
(a) decreasing its radius.
(b) decreasing the current through it.
(c) increasing its area of cross-section.
(d) introducing a medium of higher permeability.

CASE14 Motion of Charged Particle Inside Magnetic Field

A charged particle moving in a magnetic field experiences a force that is proportional to the strength of the magnetic field, the component of the velocity that is perpendicular to the magnetic field and the charge of the particle.

The force is given by $\vec{F} = q(\vec{v} X \overrightarrow{B})$ where q is the electric charge of the particle, v is the instantaneous velocity of the particle and B is the magnetic field (in tesla).The direction of force is determined by the rules of cross product of two vectors. Force is perpendicular to both velocity and magnetic field. Its direction is same as $\vec{v}\ X\ \vec{B}$ if q is positive and opposite of $\vec{v}\ X\ \vec{B}$ if q is negative. The force is always perpendicular to both- the velocity of the particle and the magnetic field that created it. Because the magnetic force is always perpendicular to the motion, the magnetic field can do no work on an isolated charge. It can only do work indirectly, via the electric field generated by a changing magnetic field.



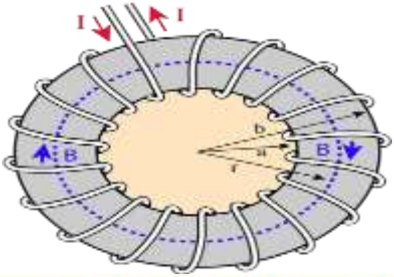
14.1 When a magnetic field is applied on a stationary electron, it
(a) remains stationary.
(b) spins about its own axis.
(c) moves in the direction of the field.
(d) moves perpendicular to the direction of the field.
14.2 A proton is projected with a uniform velocity v along the axis of a current carrying solenoid, then
(a) The proton will be accelerated with along the axis
(b) The proton path will be circular about the axis
(c) The proton moves along helical path
(d) The proton will continue to move with velocity v along the axis.
14.3 A charged particle experiences magnetic force in the presence of magnetic field. Which of the following statement is correct?
(a) The particle is stationary & magnetic field is perpendicular.
(b) The particle is moving & magnetic field is perpendicular to the velocity.
(c) The particle is stationary & magnetic field is parallel.
(d) The particle is moving & magnetic field is parallel to velocity.

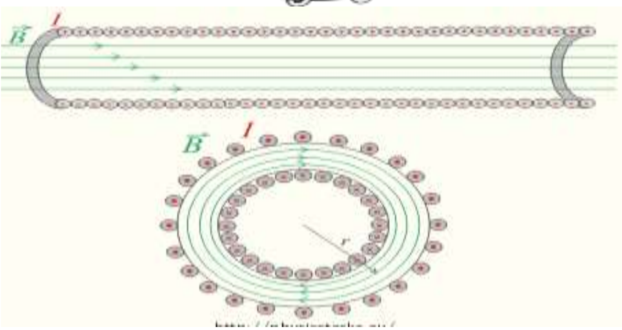
14.4 A charge q moves with a velocity 2 ms^{-1} along x-axis in a uniform magnetic field $\vec{B} = \hat{\imath} + 2\hat{\jmath} + 3\hat{k}$ T, then charge will experience a force
(a) In z-y plane (b) Along -y axis
(c) Along + z axis (d) Along - z axis

14.5 Moving charge will produce
(a) Electric field only (b) Magnetic field only
(c) Both electric & magnetic field (d) None of these

CASE 15 Toroid

The toroid is a hollow circular ring on which a large number of turns of wire are closely wound. It can be viewed as a solenoid which has been bent into a circular shape to close on itself. The magnetic field vanishes in the open space inside and outside the toroid. The magnetic field inside the toroid is constant in magnitude and is given by B = μ_0 n I, where n is the number of turns per unit length and I is the current flowing in the toriod, μ_0 is the absolute permeability of the free space.





15.1 The magnetic field inside a toroid of radius R is B. If the current through it is doubled and its radius is also doubled keeping the number of turns per unit length the same, magnetic field produced by it will be

(a) B/2 (b) B/4 (c)B (d) 2B

15.2 What is the magnetic field in the empty space enclosed by the toroid of radius R?

(a) $\frac{\mu_0}{4\Pi}\frac{2I}{R}$ (b) Infinity

(c) Zero (d) $\frac{\mu_0}{4\Pi}\frac{\Pi I}{R}$

15.3 A toroid of 300 turns/m and radius 2 cm is carrying a current of 5 A. What is the magnitude of magnetic field intensity in the interior of the toriod?

(a) 1.9 T (b) 1.9 x 10^{-6} T

(c) 1.9 x 10^{-3} T (d) 1.9 x 10^{-7} T

15.4 Magnetic field due to a current carrying toroid is independent of

(a) Its number of turns (b) Current

(c) Radius (d) None of these

15.5 How can you increase the magnetic field inside a toroid?

(a) by increasing the radius

(b) by decreasing the current.

(c) by introducing a soft iron core inside a toroid.

(d) by decreasing the total number of turns.

CASE 16 Force on a charge in Electric and Magnetic field

A point charge q (moving with a velocity v and located at r at a given time t) in the presence of both the electric field E and magnetic field B. The force on an electric charge q due to both of them can be written as: $\overrightarrow{F_L} = q[(\vec{v} \times \overrightarrow{B}) + \vec{E}] = F_e + F_m$. It is called the 'Lorentz force'.

16.1 If the charge q is moving under a field, the force acting on the charge depends upon the magnitude of the field as well as the velocity of the charge particle, what is the nature of the field?

(a) Electric field.

(b) Magnetic field.

(c) Both electric and magnetic field perpendicular to each other.

(d) None of these.

16.2 The magnetic force acting on the charge 'q' placed in a magnetic field will vanish if
(a) if v is small. (b) if v is perpendicular to B.
(c) if v is parallel to B. (d) none of these.
16.3 If an electron of charge -e is moving along + X direction and magnetic field is along + Z direction, then the magnetic force acting on the electron will be along
(a) + X axis. (b) - X axis.
(c) - Y axis. (d) + Y axis.
16.4 A particle enters a region of constant magnetic field with velocity perpendicular to the direction of magnetic field. It goes undeflected. Identify the particle?
(a) Proton (b) Electron
(c) Neutron (d) Alpha particle
16.5 In a field, the force experienced by a charge depends only upon the magnitude of the field and does not depend upon the velocity. What is the nature of the field?
(a) Electric field.
(b) Magnetic field.
(c) Both electric and magnetic field perpendicular to each other.
(d) None of these

CASE 17 Velocity Selector

A charge q moving with a velocity v in presence of both electric and magnetic fields experience a force $\overrightarrow{F_L} = q\left[(\vec{v} \, X \, \overrightarrow{B}) + \vec{E}\right]$. If electric and magnetic fields are perpendicular to each other and also perpendicular to the velocity of the particle, the electric and magnetic forces are in opposite directions. If we adjust the value of electric and magnetic field such that magnitude of the two forces are equal. The total force on the charge is zero and the charge will move in the fields undeflected.
17.1 What will be the value of velocity of the charge particle, when it moves undeflected in a region where the

electric field is perpendicular to the magnetic field and the charge particle enters at right angles to the fields.

(a) v = EB (b) v = B/E

(c) v = EB/q (d) v = E/B

17.2 Proton, neutron, alpha particle and electron enter a region of uniform magnetic field with same velocities. The magnetic field is perpendicular to the velocity. Which particle will experience maximum force?

(a) proton (b) electron

(c) alpha particle (d) neutron

17.3 A charge particle moving with a constant velocity passing through a space without any change in the velocity. Which can be true about the region?

(a) $E = 0, B = 0$ (b) $E \neq 0, B \neq 0$

(c) $E = 0, B \neq 0$ (d) All of these

17.4 A beam of alpha particle passes undeflected with a horizontal velocity v, through a region of electric and magnetic fields, mutually perpendicular to each other and normal to the direction of the beam. If the magnitude of electric and magnetic fields are 120kV m^{-1} and 60mT respectively, what is the velocity of the beam?

(a) $0.5 \text{ X } 10^{-6}$ m/s (b) 72 m/s

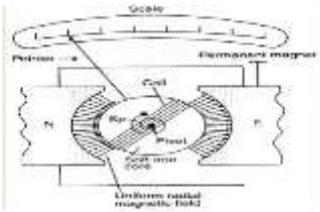
(c) $2 \text{ X } 10^{-6}$ m/s (d) $2 \text{ X } 10^{6}$ m/s

17.5 What is the force on the electron moving with a velocity of $5.0 \text{ X } 10^{7}$ m/s in a magnetic field of 1.0 Wb m^{-2} at an angle of 30^{0}?

(a) $4 \text{ X } 10^{-12}$ N (b) $1.6 \text{ X } 10^{-11}$ N

(c) $8 \text{ X } 10^{-12}$ N (d) $\frac{8}{\sqrt{2}} X\ 10^{-12}$ N

CASE 18 <u>Moving Coil Galvanometer</u>



Moving coil galvanometer is an electromagnetic device that can measure small values of current. It is also known as

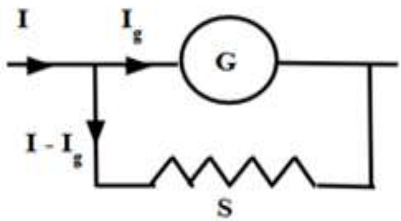
Weston galvanometer. It works on the principle that when a current loop is placed in an external magnetic field, it experiences torque, and the value of torque can be changed by changing the current in the loop. Moving coil galvanometer consists of permanent horse-shoe magnets, coil with many turns, soft iron core, pivoted spring, non-metallic frame, scale and pointer. The coil is free to rotate about a fixed axis, in a uniform radial magnetic field formed by using concave pole pieces of a magnet. When a current flows through the coil, a torque acts on it.

18.1 What is the principle of moving coil galvanometer?
(a) Torque acting on a current carrying coil placed in a uniform magnetic field.
(b) Torque acting on a current carrying coil placed in a non-uniform magnetic field.
(c) Potential difference developed in the current carrying coil.
(d) None of these.
18.2 If the field is radial, then the angle between magnetic moment of galvanometer coil and the magnetic field will be
(a) 0° (b) 30°
(c) 60° (d) 90°
18.3 Why pole pieces are made concave in the moving coil galvanometer?
(a) to make the magnetic field radial.
(b) to make the magnetic field uniform.
(c) to make the magnetic field non-uniform.
(d) none of these.
18.4 What is the function of radial field in the moving coil galvanometer?
(a) to make the torque acting on the coil maximum.
(b) to make the magnetic field strong.
(c) to make the current scale linear.
(d) all the above.

18.5 If the rectangular coil used in the moving coil galvanometer is made circular, then what will be the effect on the maximum torque acting on the coil in magnetic field for the same area of the coil?
(a) remains the same.
(b) becomes less in circular coil.
(c) becomes greater in circular coil.
(d) depends on the orientation of the coil.

CASE 19 Conversion of Moving Coil Galvanometer into an Ammeter

The galvanometer cannot be used as an ammeter to measure the value of the current directly as it is a very sensitive device and gives a full-scale deflection for current of the order of μA. For measuring large currents with it, a small resistance is connected in parallel with the galvanometer coil. The resistance connected in this way is called shunt. The value of the shunt resistance depends on the range of the current required to be measured.



19.1 How is a moving coil galvanometer converted into an ammeter of desired range?
(a) Connecting a shunt resistance in series.
(b) Connecting a shunt resistance in parallel.
(c) Connecting a large resistance in series.
(d) Connecting a large resistance in parallel.

19.2 A moving coil galvanometer of resistance G gives a full-scale deflection for a current I_g. It is converted into an ammeter of range (0- I) ampere. What should be the value of shunt resistance to convert it into an ammeter of desired range?

(a) $S = \frac{I_g G}{I - I_g}$ (b) $S = \frac{IG}{I - I_g}$

(c) $S = \frac{I_g G}{(I - I_g) S}$ (d) $S = \frac{I_g G}{I_g - I}$

19.3 Which one will have the greatest resistance – a micro-ammeter, a milli-ammeter, an ammeter?

(a) micro-ammeter (b) milli-ammeter

(c)Ammeter (d)All will have the same resistance

19.4 The resistance of the ammeter will be

(a) $\frac{G+S}{GS}$ (b) G+S

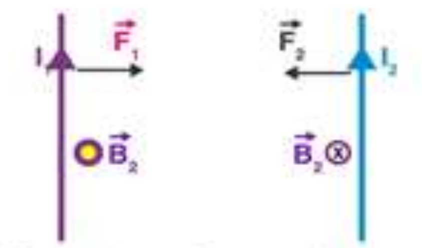
(c) $\frac{1}{G} + \frac{1}{S}$ (d) $\frac{GS}{G+S}$

19.5 An ammeter of resistance 0.8 Ω can measure currents upto 1.0A.What must be the shunt resistance to enable the ammeter to measure current upto 5.0A?

(a) 0.1Ω (b) 0.2Ω

(c) 0.3Ω (d)0.4Ω

CASE 20 Force between two infinitely long parallel current- carrying wires



Current carrying conductors

Two current-carrying conductors placed near each other will exert magnetic forces on each other. Ampere studied the nature of this magnetic force and its dependence on the product of magnitude of currents in both the conductors, on the shape and size of conductors as well as the distances between the conductors. Using Fleming's left hand rule, it is observed that currents flowing in the same direction attract each other and currents flowing in the opposite directions repel each other. Thus, force per unit length acting on a conductor of infinite length is given by:

$$\frac{F}{l} = \frac{\mu_0 I_1 I_2}{2\Pi r}$$

20.1 A vertical wire carries a current in upward direction. An electron beam sent horizontally towards the wire will be deflected

(a) towards right (b) towards left

(c) upwards (d) downwards

20.2 A current carrying, straight wire is kept along axis of a circular loop carrying a current. The straight wire

(a) will exert an inward force on the circular loop.

(b) will exert an outward force on the circular loop.

(c) will not exert any force on the circular loop.

(d) will exert a force on the circular loop parallel to itself.

20.3 A proton beam is going from north to south and electron beam is going from south to north. Neglecting the earth's magnetic field, the electron beam will be deflected

(a) towards the proton beam

(b) away from the proton beam

(c) upwards

(d) downwards

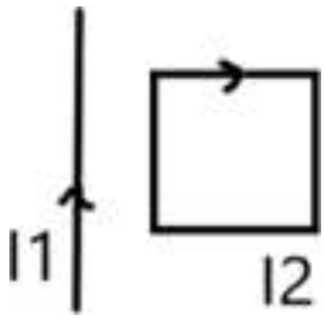
20.4 Consider the situation shown in fig. The straight wire is fixed but the loop can move under magnetic force. The loop will

(a) remain stationary.

(b) move towards the wire.

(c) move away from the wire.

(d) rotate about the wire.



20.5 Two long and parallel straight wires A and B carrying currents of 8.0A and 5.0A in the same direction are separated by a distance of 4.0cm.The force on the 10cm section of wire A is

(a) 2×10^{-4} N (b) 2×10^{-5} N

(c) 4×10^{-5} N (d) 4×10^{-4}N

Chapter 5: Magnetism and Matter

GIST:

- Current loop as a magnetic dipole and its magnetic dipole moment,
- magnetic dipole moment of a revolving electron,
- magnetic field intensity due to a magnetic dipole (bar magnet) along its axis and perpendicular to its axis,
- torque on a magnetic dipole (bar magnet) in a uniform magnetic field;
- bar magnet as an equivalent solenoid, magnetic field lines;
- earth's magnetic field and magnetic elements.
- Para-, dia- and ferro - magnetic substances, with examples.
- Electromagnets and factors affecting their strengths,
- permanent magnets.

MCQ's

1. 1. The earth behaves as a magnet with magnetic field pointing approximately from the geographic
   (a) North to South
   (b) South to North
   (c) East to West
   (d) West to East
2. The strength of the earth's magnetic field is
   (a) constant everywhere.
   (b) zero everywhere.
   (c) having very high value.
   (d) vary from place to place on the earth's surface.
3. Which of the following is responsible for the earth's magnetic field?
   (a) Convective currents in earth's core
   (б) Diversive current in earth's core.

(c) Rotational motion of earth.
(d) Translational motion of earth.

4. Which of the following independent quantities is not used to specify the earth's magnetic field?
(a) Magnetic declination (θ).
(b) Magnetic dip (δ).
(c) Horizontal component of earth's field (B_H).
(d) Vertical component of earth's field (B_V).

5. 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 is
(a) always zero
(b) positive, negative or zero
(c) unbounded
(d) always negative

6. The angle of dip at a certain place where the horizontal and vertical components of the earth's magnetic field are equal is
(a) 30°
(b) 75°
(c) 60°
(d) 45°

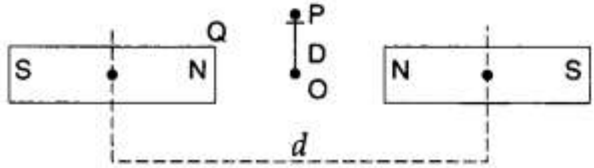
7. The vertical component of earth's magnetic field . at a place is √3 times the horizontal component the value of angle of dip at this place is
(a) 30°
(b) 45°
(c) 60°
(d) 90°

8. At a given place on earth's surface the horizontal component of earth's magnetic field is $2 \times 10^{3-5}$ T and resultant magnetic field is $4 \times 10^{3-5}$ T. The angle of dip at this place is
(a) 30°
(b) 60°

(c) 90°
(d) 45°

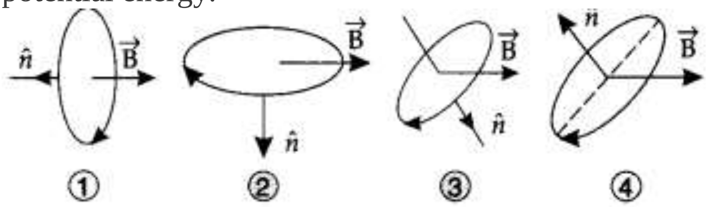
9. Which of the following property shows the property of ferromagnetic substances?
(a) The ferromagnetic property depends on temperature. ‘
(b) The ferromagnetic property does not depend on temperature.
(c) At high enough temperature ferromagnet becomes a diamagnet.
(d) At low temperature ferromagnet becomes a paramagnet.
10. The primary origin of magnetism lies in
(a) atomic current and intrinsic spin of electrons.
(b) polar and non polar nature of molecules.
(c) pauli exclusion principle.
(d) electronegative nature of materials.
11. Magnetic moment for solenoid and corresponding bar magnet is
(a) equal for both
(b) more for solenoid
(c) more for bar magnet
(d) none of these
12. Which of the following is correct about magnetic monopole?
(a) Magnetic monopole exist.
(b) Magnetic monopole does not exist.
(c) Magnetic monopole have constant value of monopole momentum.
(d) The monopole momentum increase due to increase at its distance from the field.
13. Two identical bar magnets are fixed with their centres at a distance d apart. A stationary charge Q is placed at P in between the gap of the two magnets at a distance D from the centre O as shown in the

figure. The force on the charge Q is



(a) zero
(b) directed along OP
(c) directed along PO
(d) directed perpendicular to the plane of paper

14. A current carrying loop is placed in a uniform magnetic field in four different orientations as shown in figure. Arrange them in the decreasing order of potential energy.

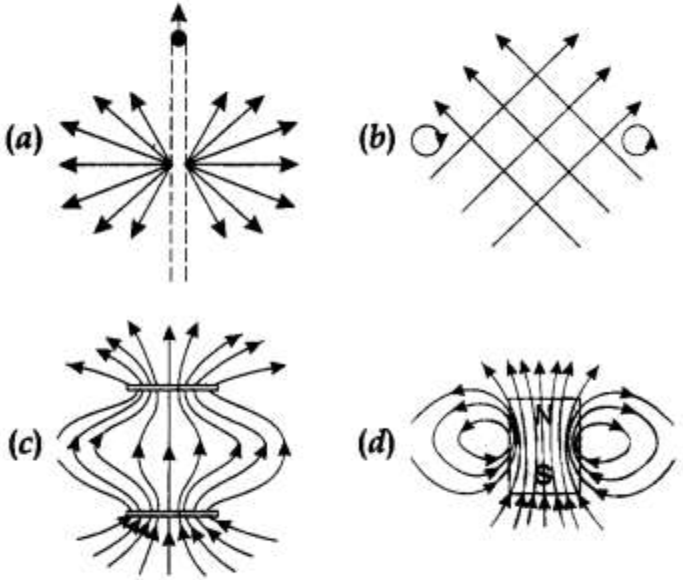


(a) 4, 2, 3,1
(b) 1, 4, 2, 3
(c) 4, 3, 2,1
(d) 1, 2, 3, 4

15. Which of the following is not showing the essential difference between electrostatic shielding by a conducting shell and magnetostatic shielding?
(a) Electrostatic field lines can end on charges and conductors have free charges.
(b) Magnetic field lines can end but conductors cannot end them.
(c) Lines of magentic field cannot end on any material and perfect shielding is not possible.
(d) Shells of high permeability materials can be used

to divert lines of magnetic field from the interior region.

16. The net magnetic flux through any closed surface, kept in a magnetic field is
    (a) zero
    (b) $\mu 04\pi$
    (c) $4\pi\mu_0$
    (d) $4\mu 0\pi$
17. Point out the correct direction of magnetic field in the given figures.



18. S.I. unit of flux is :
    (a) Ohm
    (b) Weber
    (c) Tesla
    (d) None
19. What is the angle of dip at a place where the horizontal component of earth's magnetic field is equal to the vertical component?
    (a) 0°

(b) 30°
(c) 45°
(d) 90°

20. Which of the following has a low value in ferrites?
(a) Conductivity
(b) Permeability
(c) Magnetic susceptibility
(d) All the above

21. The dimensional representation of magnetic flux density is :
(a) $[MLT^{-2}]$
(b) $[MLT^{-2}A^{-1}]$
(c) $[MLT^{-2}A^{-2}]$
(d) $[MT^{-2}A^{-1}]$

22. Tangent law is applicable only when:
(a) two uniform and mutually perpendicular magnetic fields exist
(b) two magnetic fields exist
(c) horizontal component of earth's magnetic field is present
(d) uniform magnetic field are used

23. Ferrites may be:
(a) ant. ferromagnetic
(b) ferromagnetic
(c) ferrimagnetic
(d) None of the above

24. A magnetic bar of M magnetic moment is placed m the field of magnetic strength B, the torque acting on it is :
(a) $\vec{M} . \vec{B}$
(b) $-\vec{M} . \vec{B}$
(c) $\vec{M} \times \vec{B}$.
(d) $\vec{B} \times \vec{M}$

25. The magnetic lines of force inside a bar magnet:
    (a) do not exist
    (b) depends on area of cross-section of bar magnet
    (c) are from N-pole to S-pole of the magnet
    (d) are from S-pole to N-pole of the magnet.
26. A magnetic dipole moment is a vector quantity directed from:
    (a) S to N
    (b) N to S
    (c) E to W
    (d) W to E
27. What is the magnetic field in the empty space enclosed by the toroidal solenoid of radius ‘R’? ,
    (a) Infinity
    (b) μ04π.2πlR
    (c) μ04π.(πlR)
    (d) zero
28. A current carrying power line carries current from west to east. What will be direction of magnetic field 1 meter above it?
    (a) N to S
    (b) S to N
    (c) E to W
    (d) W to E
29. The dimensional representation of l/MB−−−−−√ is similar to that of:
    (a) frequency
    (b) time
    (c) distance
    (d) speed
30. On quadrupling the moment of inertia of a magnet, its frequency of oscillation will become:
    (a) half
    (b) double

(c) four times
(d) one-fourth

31. The magnetic field strength due to a short bar magnet directed along its axial line at a distance r is B. What is its value at the same distance along the equatorial line?
(a) B
(b) 2B
(c) B2
(d) B4

32. The neutral point in the magnetic field of a horizontally placed bar magnet is a point where the magnetic field due to that bar magnet is:
(a) zero
(b) more than that of earth
(c) less than that of earth
(d) equal to that of earth

33. In a moving coil galvanometer, we use a radial magnetic field so that the galvanometer scale is :
(a) exponential
(b) linear
(c) algebraic
(d) logarithmic

34. The force between two parallel wire 2×10^{-7} Nm^{-1}, placed 1 m apart to each other in vacuum. The electric current flowing through the wires is:
(a) 1 A
(b) zero
(c) 5×10^{6} A
(d) 2×10^{-7} A

35. The force acting per unit length of a semi circular wire of radius R carrying a current I is:
(a) µ0l24R
(b) µ0l22R

(c) µ0l2R
(d) 2µ0l2R

36. Which of the following has higher magnetic susceptibility?
(a) diamagnetic
(b) paramagnetic
(c) ferromagnetic
(d) None of these

37. The magnetic field of earth is due to:
(a) induction effect of the sun
(b) the presence of a large magnet at the centre of the earth
(c) interaction of cosmic rays with the current of earth
(d) motion and distribution of some material in an outside the earth

38. In a bar magnet, magnetic lines of force z :
(a) are produced only at north pole like rays of light from a bulb
(b) starts from north pole and ends at the south pole
(c) emerge in circular paths from the middle of the bar
(d) run continuously through the bar and outside

39. The Mariner’s compass is provided with Gimbals arrangement so as to :
(a) keep the needle always horizontal
(b) give a direct reading of declination
(c) give the direct value of dip
(d) all of the above

40. A wire of length I has a magnetic moment M. It is then bent into a semi-circular arc. The neyv magnetic moment is :
(a) M
(b) M.l.

(c) $2M\pi$
(d) $M\pi$

41. The relation between geometric length (L) and magnetic length (L_m) is:
(a) $L_m = 56\ L_g$
(b) $L_m = 65\ L_g$
(c) (a) $L_m = L_g$
(d) L_m = 2RY;UL L_g

42. The radius of curvature of the path of charged particle in a uniform magnetic file is directly proportional to the
(a) charge on fie particle
(b) Momentum of particle
(c) energy of particle
(d) Strength of field

43. The magnetic field at the centre of a current carrying circular loop is B. If the radius of the loop is doubled keeping the current unchanged, the magnetic field at the centre of loop will become:
(a) B2
(b) B4
(c) 2B
(d) 4B

44. 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) cannot be positive or negative.
(d) is not bounded.

45. A magnetic needle is kept in a non-uniform magnetic field. It experiences
(a) a torque but not a force.
(b) neither a force nor a torque.

(c) a force and a torque.
(d) a force but not a torque.

46. A 25 cm long solenoid has radius 2 cm and 500 total number of turns. It carries a current of 15 A. If it is equivalent to a magnet of the same size and magnetisation $\overline{M}$, then $|\overline{M}|$ is
(a) 3 π Am^{-1}
(b) 30000 π Am^{-1}
(c) 300 Am^{-1}
(d) 30000 Am^{-1}

47. Three needles N_1 N_2 and N_3 are made of a ferromagnetic, a paramagnetic and a diamagnetic substance respectively. A magnet, when brought close to them, will
(a) attract N_1 strongly, but repel N_2 and N_3 weakly.
(b) attract all three of them.
(c) attract N_1 and N_2 strongly but repel N_3.
(d) attract N_1 strongly, N_2 weakly and repel N_3 weakly.

48. Curie temperature is the temperature above which
(a) a ferromagnetic material becomes paramagnetic.
(b) a ferromagnetic material becomes diamagnetic.
(c) a paramagnetic material becomes diamagnetic.
(d) a paramagnetic material becomes ferromagnetic.

49. The material suitable for making electromagnets should have
(a) high retentivity and high coercivity.
(b) low retentivity and low coercivity.
(c) high retentivity and low coercivity.
(d) low retentivity and high coercivity.

50. Curie law xT = constant, relating magnetic susceptibility (x) and absolute temperature (T) of magnetic substance is obeyed by
(a) all magnetic substances.
(b) paramagnetic substances.

(c) diamagnetic substances.
(d) ferromagnetic substances.

Assertion and Reason Questions

Directions: These questions consist of two statements, each printed as Assertion and Reason. While answering these questions, you are required to choose any one of the following four responses.
(a) If both Assertion and Reason are correct and the Reason is a correct explanation of the Assertion.
(b) If both Assertion and Reason are correct but Reason is not a correct explanation of the Assertion.
(c) If the Assertion is correct but Reason is incorrect.
(d) If both the Assertion and Reason are incorrect.
(e) If assertion is false but reason is true.
Q.1. Assertion : We cannot think of a magnetic field configuration with three poles
Reason : A bar magnet does exert a torque on itself due to its own field.
Q.2. Assertion : In high latitudes one sees colourful curtains of light hanging down from high altitudes
Reason : The high energy charged particles from the sun are deflected to polar regions by the magnetic field of the earth.
Q.3. Assertion : The true geographic north direction is found by using a compass needle.
Reason : The magnetic meridian of the earth is along the axis of rotation of the earth.
Q.4. Assertion : A disc-shaped magnet is deviated above a superconducting material that has been
cooled by liquid nitrogen.
Reason : Superconductors repel a magnet.
Q.5. Assertion : Magnetic Resonance Imaging (MRI) is a useful diagnostic tool for producing
images of various parts of human body.

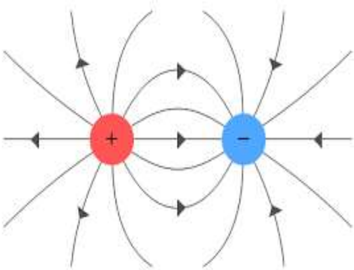
Reason : Protons of various tissues of the human body play a role in MRI.
Q.6. Assertion : Diamagnetic materials can exhibit magnetism.
Reason : Diamagnetic materials have permanent magnetic dipole moment.
Q.7. Assertion : Ferro-magnetic substances become paramagnetic above Curie temp.
Reason : Domains are destroyed at high temperature.
Q.8. Assertion : If a compass needle be kept at magnetic north pole of the earth the compass needle may stay in any direction.
Reason : Dip needle will stay vertical at the north pole of earth
Q.9. Assertion : The ferromagnetic substance do not obey Curie's law.
Reason : At Curie point a ferromagnetic substance start behaving as a paramagnetic substance.
Q.10. Assertion : The ferromagnetic substance do not obey Curie's law.
Reason : At Curie point a ferromagnetic substance start behaving as a paramagnetic substance.
Q.11. Assertion : A paramagnetic sample display greater magnetisation (for the same magnetic field) when cooled.
Reason : The magnetisation does not depend on temperature.
Q.12. Assertion : Electromagnetic are made of soft iron.
Reason : Coercivity of soft iron is small.
Q.13. Assertion : The sensitivity of a moving coil galvanometer is increased by placing a suitable magnetic material as a core inside the coil.
Reason : Soft iron has high magnetic permeability and cannot be easily magnetized or demagnetized.

Q.14. Assertion : The poles of magnet can not be separated by breaking into two pieces.
Reason : The magnetic moment will be reduced to half when a magnet is broken into two equal pieces.
Q.15. Assertion : We cannot think of magnetic field configuration with three poles.
Reason : A bar magnet does exert a torque on itself due to its own field.
Q.16 .Assertion : The poles of magnet cannot be separated by breaking into two pieces.
Reason : The magnetic moment will be reduced to half when a magnet is broken into two equal pieces.
Q.17. Assertion : Basic difference between an electric line and magnetic line of force is that former is discontinuous and the latter is continuous or endless.
Reason : No electric lines of forces exist inside a charged body but magnetic lines do exist inside a magnet.
Q.18. Assertion :Magnetic moment of an atom is due to both, the orbital motion and spin motion of every electron.
Reason :A charged particle produces a magnetic field.
Q.19. Assertion :When radius of circular loop carrying current is doubled, its magnetic moment becomes four times.
Reason : Magnetic moment depends on area of the loop.
Q.20. Assertion : The earth?s magnetic field is due to iron present in its core.
Reason : At a high temperature magnet losses its magnetic property or magnetism.

Case Study Questions

Q1. Read the following source and answer any four out of the following questions:

Electric charge is the physical property of matter that causes it to experience a force when placed in an electromagnetic field. There are two types of charges positive and negative charges. Also, like charges repel each other whereas unlike charges attract each other.



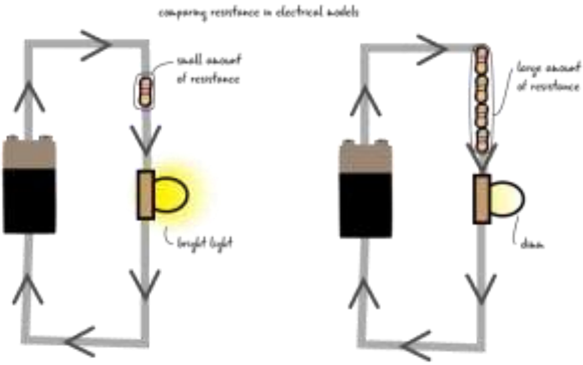
1. Charge on a body which carries 200 excess electrons is:
   1. $-3.2 \times\times 10^{-18}$ C
   2. $3.2 \times\times 10^{18}$ C
   3. $-3.2 \times\times 10^{-17}$ C
   4. $3.2 \times\times 10^{-17}$ C
2. Charge on a body which carries 10 excess electrons is:
   1. $-1.6 \times\times 10^{-18}$ C
   2. $1.6 \times\times 10^{-18}$ C
   3. $2.6 \times\times 10^{-18}$ C
   4. $1.6 \times\times 10^{-21}$ C
3. Mass of electron is:
   1. $9.1 \times\times 10^{-31}$ kg
   2. $9.1 \times\times 10^{-31}$ g
   3. $1.6 \times\times 10^{-19}$ kg
   4. $1.6 \times\times 10^{-19}$ g
4. A body is positively charged, it implies that:
   1. there is only a positive charge in the body
   2. there is positive as well as negative charge in the body but the positive charge is more than negative charge

3. there is equally positive and negative charge in the body but the positive charge lies in the outer regions
4. the negative charge is displaced from its position

5. On rubbing, when one body gets positively charged and other negatively charged, the electrons transferred from positively charged body to negatively charged body are:
   1. valence electrons only
   2. electrons of inner shells
   3. both valence electrons and electrons of the inner shell.
   4. none of the above

Q2. Read the following source and answer any four out of the following questions:

Resistance is a measure of the opposition to current flow in an electrical circuit. Resistance is measured in ohms.
Also Resistivity, the electrical resistance of a conductor of unit cross-sectional area, and unit length. … A characteristic property of each material, resistivity is useful in comparing various materials on the basis of their ability to conduct electric currents.



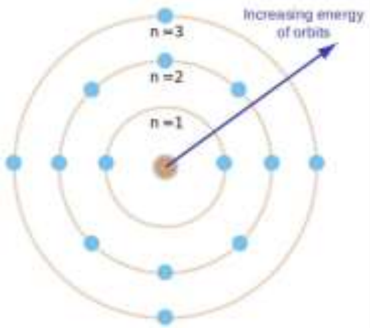
1. Resistivity is independent of:

1. nature of material
2. temperature
3. dimensions of material
4. none of the above

2. As compare to short wires, long wires have ________ resistance.
   1. more
   2. less
   3. same
   4. zero
3. As compare to thin wires, thick wires have ________ resistance.
   1. more
   2. less
   3. same
   4. zero
4. The resistance of a wire depends upon:
   1. cross-sectional area
   2. length of wire
   3. wire's nature
   4. all of the above
5. A copper wire having the same size as steel wire have:
   1. more resistance
   2. less resistance
   3. same resistance
   4. none of the above

Q3. Read the source given below and answer any four out of the following questions:

The Bohr model of the atom was proposed by Neil Bohr in 1915. It came into existence with the modification of Rutherford's model of an atom. Rutherford's model introduced the nuclear model of an atom, in which he explained that a nucleus (positively charged) is surrounded by negatively charged electrons.



1. Which of the following statements does not form a part of Bohr's model of a hydrogen atom?
    1. The energy of the electrons in the orbit is quantized
    2. The electron in the orbit nearest the nucleus has the lowest energy
    3. Electrons revolve in different orbits around the nucleus
    4. The position and velocity of the electrons in the orbit cannot be determined simultaneously
2. What is in the center of the Rutherford model?
    1. Single proton
    2. Multiple electrons
    3. A nucleus
    4. Neutrons
3. When an electron jumps from its orbit to another orbit, energy is:
    1. emitted only
    2. absorbed only
    3. both (a) and (b)
    4. none of these
4. How were the limitations of the Rutherford model which could not explain the observed features of atomic spectra explained in Bohr's model of a hydrogen atom?

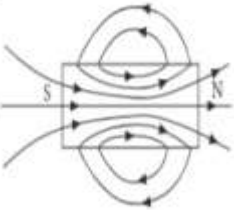
1. It must emit a continuous spectrum
2. It loses its energy
3. Gaining its energy
4. A discrete spectrum

5. When electron remains between orbits its momentum is:
    1. quantized
    2. emitted
    3. dequantized
    4. none of the above

Q4.

Gauss's Law for Magnetism

By analogy to Gauss's law of electrostatics, we can write Gauss's law of magnetism as $\oint \vec{B}\cdot d\vec{s} = \mu_0 m_{inside}$ where $\oint \vec{B}\cdot d\vec{s}$ is the magnetic flux and m_{inside} is the net pole strength inside the closed surface.
We do not have an isolated magnetic pole in nature. At least none has been found to exist till date. The smallest unit of the source of magnetic field is a magnetic dipole where the net magnetic pole is zero. Hence, the net magnetic pole enclosed by any closed surface is always zero. Correspondingly, the flux of the magnetic field through any closed surface is zero.



(i) Consider the two idealised 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) $\vec{E}$ 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
   (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 $\oint \vec{E}\cdot \vec{dl} = 0$.
   (d) case (ii) contradicts $\oint \vec{H}\cdot \vec{dl} = I_{en}$.

(ii) The net magnetic flux through any closed surface, kept in a magnetic field is
   (a) zero   (b) $\frac{\mu_0}{4\pi}$ (c) $4\pi\mu_0$ (d) $\frac{4\mu_0}{\pi}$

(iii) A closed surface S encloses a magnetic dipole of magnetic moment $2ml$. The magnetic flux emerging from the surface is
   (a) $\mu_0 m$ (b) zero   (c) $2\mu_0 m$ (d) $\frac{2m}{\mu_0}$

(iv) Which of the following is not a consequence of Gauss's law?
   (a) The magnetic poles always exist as unlike pairs of equal strength.
   (b) If several magnetic lines of force enter in a closed surface, then an equal number of lines of force must leave that surface.
   (c) There are abundant sources or sinks of the magnetic field inside a closed surface.
   (d) Isolated magnetic poles do not exist.

Q5.

Magnetisation and Magnetic Intensity

When the atomic dipoles are aligned partially or fully, there is a net magnetic moment in the direction of the field in any small volume of the material. The actual magnetic field inside material placed in magnetic field is the sum of the applied magnetic field and the magnetic field due to magnetisation. This field is called magnetic intensity (H).

$$H = \frac{B}{\mu_0} - M$$

where M is the magnetisation of the material, μ_0 is the permittivity of vacuum and B is the total magnetic field. The measure that tells us how a magnetic material responds to an external field is given by a dimensionless quantity is appropriately called the magnetic susceptibility : for a certain class of magnetic materials, intensity of magnetisation is directly proportional to the magnetic intensity.

(i) Magnetization of a sample is

(a) volume of sample per unit magnetic moment
(b) net magnetic moment per unit volume
(c) ratio of magnetic moment and pole strength
(d) ratio of pole strength to magnetic moment.

(ii) Identify the wrongly matched quantity and unit pair.

(a) Pole strength - A m
(b) Magnetic susceptibility - dimensionless number
(c) Intensity of magnetisation - A m^{-1}
(d) Magnetic permeability - Henry m

(iii) A bar magnet has length 3 cm, cross-sectional area 2 cm^2 and magnetic moment 3 A m^2. The intensity of magnetisation of bar magnet is

(a) 2×10^5 A/m
(b) 3×10^5 A/m
(c) 4×10^5 A/m
(d) 5×10^5 A/m

(iv) A solenoid has core of a material with relative permeability 500 and its windings carry a current of 1 A. The number of turns of the solenoid is 500 per metre. The magnetization of the material is nearly

(a) 2.5×10^3 A m^{-1}
(b) 2.5×10^5 A m^{-1}
(c) 2.0×10^3 A m^{-1}
(d) 2.0×10^5 A m^{-1}

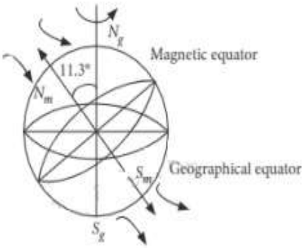
(v) The relative permeability of iron is 6000. Its magnetic susceptibility is

(a) 5999
(b) 6001
(c) 6000×10^{-7}
(d) 6000×10^7

Q6.

Earth's Magnetic Field

The magnetic field lines of the earth resemble that of a hypothetical magnetic dipole located at the centre of the earth. The axis of the dipole is presently tilted by approximately 11.3° with respect to the axis of rotation of the earth.



The pole near the geographic North pole of the earth is called the North magnetic pole and the pole near the geographic South pole is called South magnetic pole.

(i) The strength of the earth's magnetic field varies from place to place on the earth's surface, its value being of the order of

(a) 10^5 T (b) 10^{-6} T (c) 10^{-5} T (d) 10^8 T

(ii) A bar magnet is placed North-South with its North-pole due North. The points of zero magnetic field will be in which direction from centre of magnet?

(a) North-South (b) East-West

(c) North-East and South-West (d) None of these.

(iii) The value of angle of dip is zero at the magnetic equator because on it

(a) V and H are equal (b) the values of V and H zero

(c) the value of V is zero (d) the value of H is zero.

(iv) The angle of dip at a certain place, where the horizontal and vertical components of the earth's magnetic field are equal, is

(a) 30° (b) 90° (c) 60° (d) 45°

v) At a place, angle of dip is 30°. If horizontal component of earth's magnetic field is H, then the total intensity of magnetic field will be

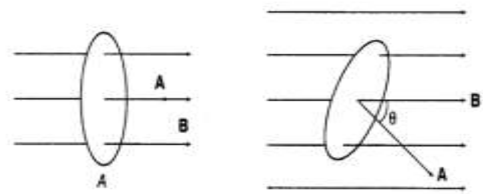
(a) $\frac{H}{2}$ (b) $\frac{2H}{\sqrt{3}}$ (c) $H\sqrt{\frac{3}{2}}$ (d) $2H$

Chapter 6: Electromagnetic Induction

GIST OF CHAPTER EXPRESSION AND FORMULAS

1. **Magnetic Flux** The magnetic flux linked with any surface is equal to total number of magnetic lines of force passing normally through it. It is a scalar quantity.

Suppose, we consider small area dA in field B, then $\phi = \int \mathbf{B} \cdot d\mathbf{A}$



Magnetic flux, $\phi = BA$ = Maximum value   Magnetic flux, $\phi = BA$ $\theta = \mathbf{B} \cdot \mathbf{A}$

SI unit of magnetic flux is Weber (Wb).

CGS unit of magnetic flux is Maxwell (Mx).

$$1\ \text{Wb} = 10^8\ \text{Mx} = 1\ \text{Tm}^2$$

Magnetic flux is a scalar quantity and its dimensional formula is $[ML^2T^{-2}A^{-1}]$.

2. Electromagnetic induction:- The phenomenon of generation of current or emf by changing the magnetic flux is known as Electromagnetic Induction EMI).

3. Faraday's Law of Electromagnetic Induction

First Law Whenever magnetic flux linked with the closed loop or circuit changes, an emf induces in the loop or circuit which lasts so long as change in flux continuous.

Second Law The induced emf in a closed loop or circuit is directly proportional to the rate of change of magnetic flux linked with the closed loop or circuit

i.e. $$e \propto \frac{(-)\,\Delta\phi}{\Delta t} \Rightarrow e = -N\frac{\Delta\phi}{\Delta t}$$

where, N = number of turns in loop.

Negative sign indicates the Lenz's law.

4. Lenz's Law The direction of induced emf or induced current is such that it always opposes the cause that produce it.

NOTE: Lenz's law is a consequence of the law of conservation of energy.

5. If N is the number of turns and R is the resistance of a coil. The magnetic flux linked with its each turn changes by dΦ in short time interval dt, then induced current flowing through the coil is

$$I = \frac{|e|}{R} = -\frac{1}{R}\left(N\frac{\Delta\phi}{\Delta t}\right)$$

6. If induced current is produced in a coil rotated in a uniform magnetic field, then

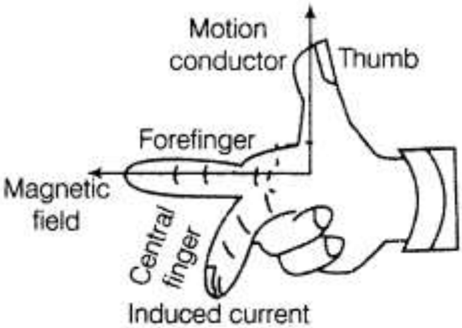
$$I = \frac{NBA\omega \sin \omega t}{R} = I_0 \sin\omega t$$

where, $I_0 = \dfrac{NBA\omega}{R}$ = Peak value of induced current

7. Motional Emf The potential difference induced in a conductor of length l moving with velocity v, in a direction perpendicular to magnetic field B is given by

$$\varepsilon = \int (\mathbf{v} \times \mathbf{B}).d\mathbf{l} = vBl$$

8. Fleming's Right Hand Rule If the thumb, forefinger and middle finger of right hand are stretched mutually perpendicular to each other such that the forefinger points the direction of magnetic field, thumb points towards the motion of conductor, then middle finger points towards the direction of induced current in the conductor.



9. The induced emf developed between two ends of conductor of length l rotating about one end with angular velocity ω in a direction perpendicular to magnetic field is given by,

$$\varepsilon = \frac{\bar{B}\omega l^2}{2}$$

10. The induced emf can be produced in a coil by
(i) putting the coil/loop/circuit in varying magnetic field.
(ii) changing the area A of the coil inside the magnetic field,
(iii) changing the angle between B and A.

11. EDDY CURRENTS

1. Eddy currents are induced in solid metallic sheets/cylinders, when magnetic flux linked with them changes. Direction of eddy currents can be given by Lenz's law
or by Fleming right hand rule.

2. Eddy current causes undesirable heating and wastage of power in transformer, rotating
armature and dynamo.

2. Eddy current can be minimised by taking laminated core which consists of thin metallic

3. sheets insulated from each other by varnish and placed normal to the direction of magnetic field.
4. Applications of Eddy Currents Inspite of the undesirable effects, eddy currents are used in many ways, Some of them are given below:
   (i) Speedometer (ii) Induction meter
   (iii)Induction furnace (iv) Electromagnetic shielding
   (v) Electromagnetic damping (vi) Energy meter

. **Self-Induction** The phenomenon of production of induced emf in a coil, when a current passes through it, undergoes a change.

∵ Total flux linked with coil, $N\phi \propto I$

$$N\phi = LI$$

where, ϕ = flux linked with each turn

and L = coefficient of self induction or self-inductance.

Also, induced emf, $e = -L\frac{dI}{dt}$

SI unit of self-induction is Henry (H).

1 Henry (H) = 1 V-s/A or 1 Tm^2/A

Self-inductance of a long solenoid, is one whose length is very large as compared to its area of cross-section. The magnetic field B at any point inside such a solenoid is practically constant and given by

$$L = \frac{\mu N^2 A}{l}$$

where, N = number of turns,

A = area of solenoid

and l = length of solenoid.

Mutual Induction The phenomenon of generation of induced emf in secondary coil when current linked with primary coil changes.

$$N_2\phi_2 = MI_1$$

where, $N_2\phi_2$ = flux linked with secondary coil

I_1 = current in primary coil

Also, $$e_2 = \frac{-MdI_1}{dt}$$

SI unit of mutual inductance is Henry (H)

1 Henry (H) = 1 V-s/A or 1 Tm^2/A

Mutual inductance (M) of closely wound solenoids,

$$M = \frac{\mu_0 N_1 N_2 A}{l}$$

where, N_1 and N_2 = number of turns in primary and secondary solenoids,

A = area of solenoid

and l = length of solenoid

Two inductors are in parallel combination, then equivalent inductance is given by

$$\frac{1}{L} = \frac{1}{L_1} + \frac{1}{L_2}$$

Two inductors are in series combination

$$L = L_1 + L_2$$

Magnetic energy stored in an inductor

$$U = \frac{1}{2} LI^2$$

where, I is the current in the inductor.

MULTIPLE CHOICE QUESTIONS

1. Whenever the magnetic flux linked with an electric circuit changes, an emf is induced in the circuit. This is called
   (a) electromagnetic induction
   (b) lenz's law
   (c) hysteresis loss
   (d) kirchhoff's laws
2. In electromagnetic induction, the induced charge is independent of
   (a) change of flux
   (b) time.
   (c) resistance of the coil
   (d) None of these
3. An induced e.m.f. is produced when a magnet is plunged into a coil. The strength of the induced e.m.f. is independent of
   (a) the strength of the magnet
   (b) number of turns of coil
   (c) the resistivity of the wire of the coil
   (d) speed with which the magnet is moved
4. According to Faraday's law of electromagnetic induction

(a) electric field is produced by time varying magnetic flux.
(b) magnetic field is produced by time varying electric flux.
(c) magnetic field is associated with a moving charge.
(d) None of these.

5. A moving conductor coil produces an induced e.m.f. This isin accordance with
(a) Lenz’s law
(b) Faraday’s law
(c) Coulomb’s law

6. A coil of insulated wire is connected to a battery. If it is taken to galvanometer, its pointer is deflected, because
(a) the induced current is produced
(b) the coil acts like a magnet
(c) the number of turns in the coil of the galvanometer are changed
(d) None of these

7. The polarity of induced emf is given by
(a) Ampere’s circuital law
(b) Biot-Savart law
(c) Lenz’s law
(d) Fleming’s right hand rule

8. The self inductance of a coil is a measure of
(a) electrical inertia
(b) electrical friction
(c) induced e.m.f.
(d) induced current

9. The coils in resistance boxes are made from doubled insulated wire to nullify the effect of
(a) heating
(b) magnetism
(c) pressure

(d) self induced e.m.f.

10. Two pure inductors each of self inductance L are connected in series, the net inductance is
(a) L
(b) 2 L
(c) L/2
(d) L/4
11. Lenz's law is a consequence of the law of conservation of
(a) charge
(b) mass
(c) energy
(d) momentum
12. A magnet is moved towards a coil (i) quickly (ii) slowly, then the induced e.m.f. is
(a) larger in case (i)
(b) smaller in case (i)
(c) equal to both the cases
(d) larger or smaller depending upon the radius of the coil
13. The laws of electromagnetic induction have been used in the construction of a
(a) galvanometer
(b) voltmeter
(c) electric motor
(d) generator
14. Two coils are placed closed to each other. The mutual inductance of the pair of coils depends upon
(a) the rate at which currents are changing in the two coils.
(b) relative position and orientation of two coils.
(c) the material of the wires of the coils.
(d) the currents in the two coils.
15. Two identical coaxial circular loops carry a current i each circulating in the same direction. If the loops

approach each other, you will observe that the current in
(a) each increases
(b) each decreases
(c) each remains the same
(d) one increases whereas that in the other decreases

16. When current in a coil changes from 5 A to 2 A in 0.1 s, average voltage of 50 V is produced. The self-inductance of the coil is
(a) 1.67 H
(b) 6 H
(c) 3 H
(d) 0.67 H

17. The self inductance associated with a coil is independent of
(a) current
(b) induced voltage
(c) time
(d) resistance of a coil

18. A coil having 500 sq. loops of side 10 cm is placed normal to magnetic flux which increases at a rate of 1 T/s. The induced emf is
(a) 0.1 V
(b) 0.5 V
(c) 1 V
(d) 5 V

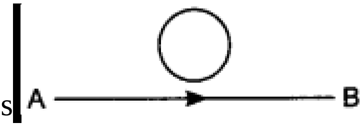
19. A coil of 100 turns carries a current of 5 mA and creates a magnetic flux of 10-5 weber. The inductance is
(a) 0.2 mH
(b) 2.0 mH
(c) 0.02 mH
(d) 0.002 H

20. The north pole of a long bar magnet was pushed slowly into a short solenoid connected to a short

galvanometer. The magnet was held stationary for a few seconds with the north pole in the middle of the solenoid and then withdrawn rapidly. The maximum deflection of the galvanometer was observed when the magnet was

(a) moving towards the solenoid
(b) moving into the solenoid
(c) at rest inside the solenoid
(d) moving out of the solenoid

21. The current flows from A to B is increasing as shown in the figure. The direction of the induced current in the loop is



(a) clockwise.
(b) anticlockwise.
(c) straight line.
(d) no induced e.m.f. produced.

22. In a coil of self-induction 5 H, the rate of change of current is 2 As-1. Then emf induced in the coil is

(a) 10 V
(b) -10 V
(c) 5 V
(d) -5 V

23. Why is the core of a transformer laminated?

a) To prevent eddy currents
b) To prevent mutual induction
c) To prevent self induction
d) None of these.

24. Two identical coaxial coils P and Q carrying equal amount of current in the same direction are brought nearer. The current in

(a) P increases while in Q decreases
(b) Q increases while in P decreases

(c) both P and Q increases
(d) both P and Q decreases

25. Faraday's laws are consequence of the conservation of
(a) charge
(b) energy
(c) magnetic field
(d) both (b) and (c)

26. Direction of current induced in a wire moving in a magnetic field is found using
(a) Fleming's left hand rule
(b) Fleming's right hand rule
(c) Ampere's rule
(d) Right hand clasp rule

27. Which of the following statements is not correct?
(a) Whenever the amount of magnetic flux linked with a circuit changes, an emf is induced in circuit.
(b) The induced emf lasts so long as the change in magnetic flux continues.
(c) The direction of induced emf is given by Lenz's law.
(d) Lenz's law is a consequence of the law of conservation of momentum.

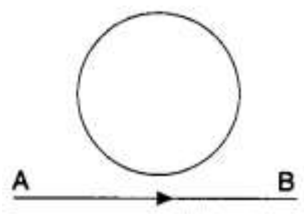
28. Lenz's law is a consequence of the law of conservation of
(a) charge
(b) energy
(c) induced emf
(d) induced current

29. A solenoid is connected to a battery so that a steady current flows through it. If an iron core is inserted into the solenoid, the current will
(a) increase
(b) decrease

(c) remain same
(d) first increase then decrease

30. There is a uniform magnetic field directed perpendicular and into the plane of the paper. An irregular shaped conducting loop is slowly changing into a circular loop in the plane of the paper. Then
(a) current is induced in the loop in the anti-clockwise direction.
(b) current is induced in the loop in the clockwise direction.
(c) ac is induced in the loop.
(d) no current is induced in the loop.

31. In the given figure current from A to B in the straight wire is decreasing. The direction of induced current in the loop is A



(a) clockwise
(b) anticlockwise
(c) changing
(d) nothing can be said

32. Which of the following does not use the application of eddy current?
(a) Electric power meters
(b) Induction furnace
(c) LED lights
(d) Magnetic brakes in trains

33. The north pole of a bar magnet is rapidly introduced into a solenoid at one end (say A). Which of the

following statements correctly depicts the phenomenon taking place?
(a) No induced emf is developed.
(b) The end A of the solenoid behaves like a south pole.
(c) The end A of the solenoid behaves like north pole.
(d) The end A of the solenoid acquires positive potential.

34. A metal plate can be heated by
(a) passing either a direct or alternating current through the plate.
(b) placing in a time varying magnetic field.
(c) placing in a space varying magnetic field, but does not vary with time.
(d) both (a) and (b) are correct.

35. Identify the wrong statement.
(a) Eddy currents are produced in a steady magnetic field.
(b) Eddy currents can be minimized by using laminated core.
(c) Induction furnace uses eddy current to produce heat.
(d) Eddy current can be used to produce braking force in moving trains.

36. If number of turns in primary and secondary coils is increased to two times each, the mutual inductance
(a) becomes 4 times
(b) becomes 2 times
(c) becomes A times
(d) remains unchanged 4

37. When the rate of change of current is unity, the induced emf is equal to
(a) thickness of coil
(b) number of turns in coil

(c) coefficient of self inductance
(d) total flux linked with coil

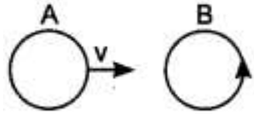
38. Two inductors of inductance .L each are connected in series with opposite? magnetic fluxes. The resultant inductance is (Ignore mutual inductance)
(a) zero
(b) L
(c) 2L
(d) 3L

39. A square of side L metres lies in the x-y plane in a region, where the magnetic field is given by $B = B_o$ {li + 3j + 4k) T, where B_o is constant. The magnitude of flux passing through the square is
(a) $2B_o L^2$ Wb.
(b) $3B_o L^2$ Wb.
(c) $4B_o L^2$ Wb.
(d) $\sqrt{26} B_o L^2$ Wb.

40. A loop, made of straight edges has six corners at A(0, 0, 0), B(L, 0, 0) C(L, L, 0), D(0, L, 0), E(0, L, L) and F(0,0, L). A magnetic field $B = B_o$ (i+k)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.

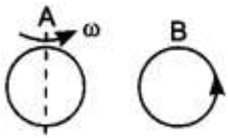
41. An e.m.f is produced in a coil, which is not connected to an external voltage source. This is not due to
(a) the coil being in a time varying magnetic field.
(b) the coil moving in a time varying magnetic field.
(c) the coil moving in a constant magnetic field.
(d) the coil is stationary in external spatially varying magnetic field, which does not change with time.

42. There are two coils A and B as shown in Figure. 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 counter-clockwise. 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 counter-clockwise direction in A.

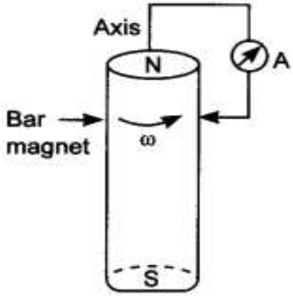
43. Same as question 42 except the coil A is made to rotate about a vertical axis (Figure). No current flows in B if A is at rest. The current in coil A, when the current in B (at t = 0) is counterclockwise and the coil A is as shown at this instant, t = 0, is



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

44. A cylindrical bar magnet is rotated about its axis (Figure). A wire is connected from the axis and is

made to touch the cylindrical surface through a

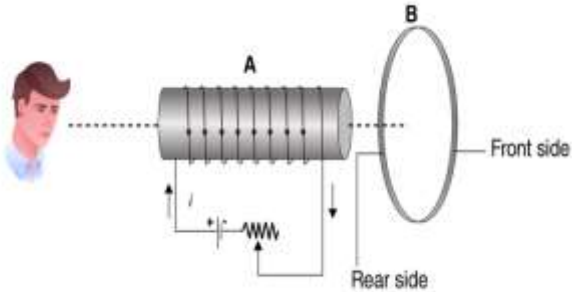


contact. Then

(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.

45. Eddy currents do not cause
(a) damping
(b) heating
(c) sparking
(d) loss of energy

46. An observer is seeing the setup of an aluminium ring B facing an electromagnet A. The current I through A can be altered if Electromagnetic Induction



(a) B is independent of an increase or decrease of I
(b) If I increases, A will attract B
(c) If I increase, A will repel B
(d) If I decrease, A will repel B

47. A wire loop is rotated in a magnetic field such that the frequency of change of direction of the induced emf is
(a) Six times per revolution
(b) Four times per revolution
(c) Twice per revolution
(d) Once per revolution

48. Which of the following is the equivalent quantity of mass in electricity?
(a) Current
(b) Charge
(c) Potential
(d) Inductance

49. What is the unit of inductance?
(a) Volt/ampere
(b) Joule/ampere
(c) Volt-ampere/sec
(d) Volt-sec/ampere

50. What is the angle made by the plane of eddy currents with the plane of magnetic lines of force?
(a) 0°
(b) 40°
(c) 90°
(d) 180°

Assertion and Reason questions

Directions: These questions consist of two statements, each printed as Assertion and Reason.

While answering these questions, you are required to choose any one of the following four responses.
Assertion (a) If both Assertion and Reason are correct and the Reason is a correct explanation of the Assertion.
(b) If both Assertion and Reason are correct but Reason is not a correct explanation of the Assertion.
(c) If the Assertion is correct but Reason is incorrect.
(d) If both the Assertion and Reason are incorrect.

1. Assertion : Induced emf will always occur whenever there is change in magnetic flux.
   Reason : Current always induces whenever there is change in magnetic flux.
2. Assertion : Faraday's laws are consequence of conservation of energy.
   Reason : In a purely resistive ac circuit, the current legs behind the emf in phase.
3. Assertion : Only a change in magnetic flux will maintain an induced current in the coil.
   Reason : The presence of large magnetic flux through a coil maintain a current in the coil of the circuit is continuous.
4. Assertion : Lenz's law violates the principle of conservation of energy.
   Reason : Induced emf always opposes the change in magnetic flux responsible for its production.
5. Assertion : An induced current has a direction such that the magnetic field due to the current opposes the change in the magnetic flux that induces the current.
   Reason : Above statement is in accordance with conservation of energy.
6. Assertion : Acceleration of a magnet falling through a long solenoid decreases.

Reason : The induced current produced in a circuit always flow in such direction that it opposes the change to the cause that produced it.

7. Assertion : Figure shows a horizontal solenoid connected to a battery and a switch. A copper ring is placed on a smooth surface, the axis of the ring being horizontal. As the switch is closed, the ring will move away from the solenoid.
   Reason : Induced emf in the ring, $e = -d\Phi/dt$
8. Assertion : An emf can be induced by moving a conductor in a magnetic field.
   Reason : An emf can be induced by changing the magnetic field.
9. Assertion : Figure shows a metallic conductor moving in magnetic field. The induced emf across its ends is zero.
   Reason : The induced emf across the ends of a conductor is given by $e = Bv\ell\sin\theta$.
10. Assertion : Eddy currents are produced in any metallic conductor when magnetic flux is changed around it.
    Reason : Electric potential determines the flow of charge.
11. Assertion : An induced emf appears in any coil in which the current is changing.
    Reason : Self induction phenomenon obeys Faraday's law of induction.
12. Assertion : When number of turns in a coil is doubled, coefficient of self-inductance of the coil becomes 4 times.
    Reason : This is because L α N2.
13. Assertion : The induced emf and current will be same in two identical loops of copper and aluminium, when rotated with same speed in the same magnetic field.

Reason : Mutual induction does not depend on the orientation of the coils.

14. Assertion: The emf will be same but current will different as resistance will be different of Cu and Al.
    Reason: Mutual inductance depends on orientation of coil, size, shape, no. of turns and relative position.
15. Assertion: The bar magnet falling vertically along the axis of horizontal coil will be acceleration less than g.
    Reason: Clockwise current induced in the coil
16. Assertion: An electric motor will have maximum efficiency when back EMF becomes equal to half of applied EMF
    Reason: Efficiency of an electric motor depends only on magnitude of back EMF
17. Assertion: Only a change in magnetic flux will maintain an induced current in the coil
    Reason: The presence of large magnetic flux through a coil maintain a current in the coil if the circuit is continuous
18. .Assertion: A thin aluminium disc, spinning freely about a central pivot, it is quickly brought to rest when placed between the poles of a strong u- shaped magnet.
    Reason: A current induced in a disc rotating in a magnetic field produces a torque which tends to oppose the motion of the disc.
19. Assertion: The magnetic flux through a closed surface containing a bar magnet is zero.
    Reason: Gauss's law applies in the case of electric flux only.
20. Assertion: If you varying current is flowing through a machine of iron, eddy Currents are produced.
    Reason: Change in magnetic flux through an area cause eddy Currents.

21. Assertion: A low voltage bulb in a coil glows when alternating current is passed through a neighbouring coil.
    Reason: Bulb glows because of EMF induced in the coil due to self induction.
22. Assertion: A glowing bulb becomes dim when an iron bar is put in the inductor in AC circuit.
    Reason: Resistance of the circuit increases.
23. Assertion: Use is made of Eddy Currents in induction brakes.
    Reason: As eddy currents always oppose the relative motion.

24. Assertion: Faraday's law are consequences of conservation of energy.
    Reason: It is purely resistive the current lags behind EMF.
25. Assertion: If current passing through a circular loop is doubled then magnetic flux linked with the circular loop will also becomes two times
    Reason:- No flux will link to the coil by its own current
26. Assertion: Only a change in magnetic flux will maintain an induced current in the coil.
    Reason The presence of large magnetic flux through a coil maintain a current in the coil if circuit is continuous
27. Assertion: When two coils are bonded on each other, thus mutual inductance between the two coil is maximum.
    Reason: Mutual inductance does not depend upon the orientation of coil
28. Assertion: Metallic surface is moved in and out the magnetic field then induced EMF is produced in it.

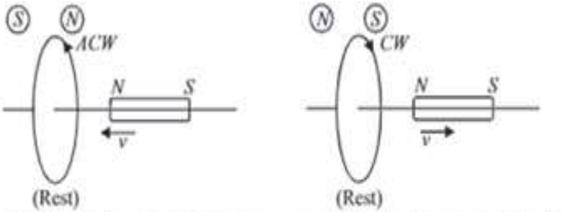
Reason: Eddy Currents will be produced in metallic surface moving in and out of magnetic field.

29. Assertion: An aircraft flies along the meridian, the potential develops at the ends of its wings.
Reason: Whenever there is change in the magnetic flux emf induceds
30. Assertion: Sensitive electrical instrument should not be placed in the vicinity of an electromagnet.
Reason: Magnetic flux is essential to maintain an induced current in the coil.

CASE STUDY BASED QUESTIONS

CASE STUDY 1

Lenz's law states that direction of induced current in a circuit in such a way that it opposes the change which produces it. Thus if the magnetic flux linked with the closed circuit increases the induced current flows in such a direction that magnetic flux is created in opposite direction of the original magnetic flux. If the magnetic flux linked with the closed circuit decreases the induced current flow in such a direction so as to create a magnetic flux in the direction of regional flux .



(Coil face behaves as North pole to oppose the motion of magnet.)
(Coil face behaves as South pole to oppose the motion of magnet.)

Q1. Direction of induced current in coil will be

a) Clock wise
b) Anticlock wise
c) Variable
d) Zero

Q2. Which of the following statement is correct

a) The induced EMF is not the direction opposing the change in magnetic flux so as to oppose the cause which produces it
b) Relative motion between coil and magnet produces change in magnetic flux
c) EMF is induced only if the magnet is moved toward the coil
d) EMF is induced only if the coil is moved toward the coil

Q3 The polarity of induced EMF is given by

a) Ampere circuital law
b) Biot Savart law
c) Lenz's law
d) Fleming right hand rule

Q4. Lenz's law is consequence of law of of conservation of

a) Charge
b) Mass
c) Momentum
d) Energy

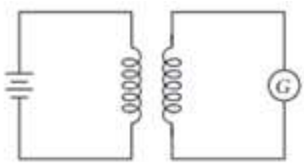
Q5 Two coils A and B are kept in a horizontal tube side by side without touching it other. if the current in coil A increases with time, in response the coil B

a) It is attracted by A
b) Remain stationary

c) Is repelled
d) Rotate

CASE STUDY 2

Mutual inductance is the phenomena of inducing EMF in a coil, due to change in current in the neighbouring coil. The amount of mutual inductance that link one coil to another depends very much on relative positioning of the two coils, their geometry and relative separation between them. Mutual inductance between the two coil increases μ_r times if the coils are bounded over an iron core of relative permeability μ_r.



Q1. A short solenoid of radius a number of turns per unit length n_1 and length L is kept coaxially inside a very long solenoid of radius b, number of turns per unit length n_2 . what is the mutual inductance of this system

a) $\mu_o \pi b^2 n_1 n_2 L$
b) $\mu_o \pi a^2 n_1 n_2 L^2$
c) $\mu_o \pi a^2 n_1 n_2 L$
d) $\mu_o \pi b^2 n_1 n_2 L^2$

Q2. If a change in current of 0.01 A in one coil produces a change in magnetic flux of 2×10^{-2} weber in another coil, then mutual inductance between coilis

a) Zero
b) 0.5 H
c) 2H
d) 3H

Q3. Mutual inductance of two coil can be increased by

a) Decreasing the number of turns in the coils.

b) Increasing the number of turns in the coil.
c) Winding the coil on wooden Core .
d) None of these.

Q4. When a sheet of iron is placed in between two coaxial coil, then mutual inductance between the coil will

a) Increase
b) Decrease
c) Remain same
d) Cannot be predicted

Q5. The SI unit of of mutual inductance is

a) Ohm
b) mho
c) Henry
d) None of these

CASE STUDY 3

EDDY CURRENT AND ITS USES

Current can be induced not only in conducting coils, but also in conducting sheets or blocks. Current is induced in a solid metallic masses when magnetic flux threading through them changes. Such currents flow in the form of irregularly shaped loop throughout the body of the metal. These currents look like seeies or whirlpools in water so they are known as Eddy Currents. Eddy Currents have both undesirable effects and practically useful applications for example it causes unnecessary heating and wastage of power in electric motors, dynamos and in the cores of Transformers

1) The working of speedometer of train is based on
   a) wattless current
   b) Eddy Currents
   c) alternating currents
   d) pulsating currents

2). Identify the wrong statement

a) Eddy Currents are produced in a steady magnetic field

b) Induction furnace use Eddy Currents to produce the heat

c) Eddy current can be used to produce braking force in moving trains

d) power metre working principle of Eddy Currents

3). Which of the following is best method to reduce Eddy Currents

a) Laminating code

b) Using thick wire

c) By reducing hysteresis loss

d) None of these

4) the direction of induced Eddy current is given by

a) Fleming left hand rule

b) Biot savert's law

c) Lenz's law

d) Ampere circuital law

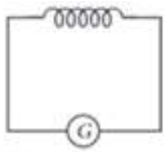
5) Eddy Currents can be used to heat localised tissues of human body this branch of medical therapy is called

a) Hyperthermia
b) Diathermy
c) Inductothermy
d) None of these

CASE STUY 4

Self induction

when a current I flows through a coil, flux linked with it is $\phi = L I$ Where L is constant known as self inductance of the coil. Any change in current set up an induced EMF in the coil. Thus self induction of a coil is the the induced EMF set up in it when the current passing through it changes at the unit rate. It is measure of opposition to the growth and decay of current flowing through the coil. Also value of self induction depends on number of turns in the solenoid, its area of cross section and relative permeability of its core material



Q1. The induction in the coil play the same role as

a) inertia in mathematics

b).energy in mechanics

c). momentum in mechanics

d).force in mechanics

2). A current of 2.5 ampere flows through a coil of inductance 5 Henry. The magnetic flux linked with the coil is

a) 0.5 Weber

b) 12.5 weber

c) Zero

d) 2 Weber

3) The inductance L of the solenoid depends upon its radius R as

a) Lα R

b) Lα1/R

c) $L\alpha R^2$

d) $L\alpha R^3$

4) Unit of self inductance is

a) Weber ampere

b) Weber^{-1} ampere

c) Ohm second

d) Farad

5) The induced EMF in a coil of 10 Henry inductance in which current varies from 9 A to 4 A in 0.2 s is

a). 200 volt

b). 250 volt

c)300 volt
d) 350 volt

CASE STUDY 5

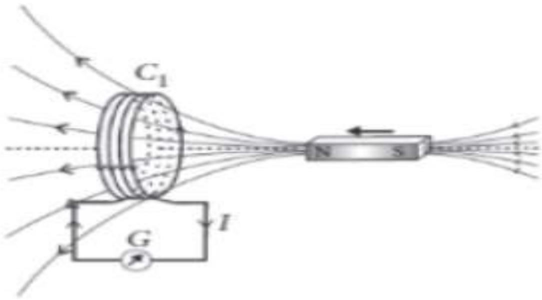
The induced electromotive force with different polarities induced current whose magnetic field oppose the change in magnetic flux through the loop in order to ensure that original flux is maintained through the loop when current flows in it. To better understand lenses law let us consider two cases.

Case 1:- When a magnet is moving towards the coil

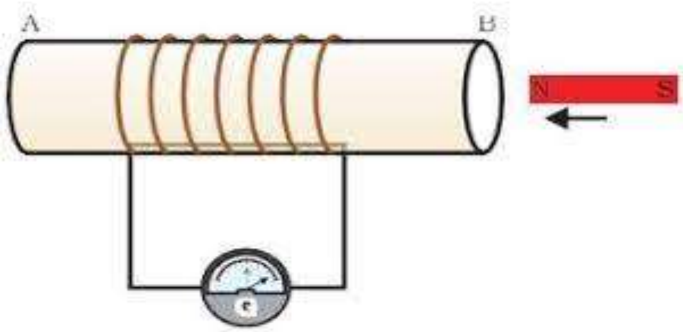
when the north pole of a magnet is approaching towards the coil, the magnetic flux linking the coil increases. According to Faraday's law of electromagnetic induction when there is changing flux, an EMF and hence the current is induced in the coil and the this current will create its own magnetic field. Now according to Lenz's law, this magnetic field created will oppose its own or we can say a oppose the increase in flux through the coil and this is possible only if approaching coil side attain North polarity, as we know similar pole repel each other. Once we know the magnetic polarity of the coil side, we can easily find the direction of induced current by applying right hand rule. In this case current flows in anticlockwise direction.

Case number 2:- when magnet is moving away from the coil

when north pole of a magnet is moving away from the coil, the magnetic flux linking the coil decreases. According to Faraday's law of electromagnetic induction, an EMF and hence current is induced in the coil and this current will create its own magnetic field. Now according to Lenz's law, this magnetic field created will oppose its own or we can say opposes the decrease in flux through the coil and this is possible only if approaching coil side attend South polarity. As we know unlike poles attract each othe. Once we know the magnetic polarity of the coil side we can easily find the direction of induced current by applying right hand rule. In this case, current flow in clockwise direction.



Q1 What is direction of induced magnetic field?



a) Left
b) Right
c) Up
d) Down

Q 2 The north pole of a long bar magnet was pushed slowly into a short solenoid connected to a galvanometer. The magnet was held stationary for a few seconds with the north pole in the middle of solenoid and then withdrawn rapidly. The maximum deflection of the galvanometer was observed when

a) The magnet was moving towards the solenoid.
b) Moving into the solenoid
c) At rest inside the solenoid
d) Moving out of the solenoid

Q 3 A closed iron ring is held horizontally and a bar magnet is dropped through the ring with its length along the axis of the ring. The acceleration of falling magnetic is

a) Equal to g
b) Less than
c) More than g
d) Depends on the diameter of the ring and length of magnet

Q 4 Whenever there is a relative motion between a coil and magnet the magnitude of induced EMF setup in the coil

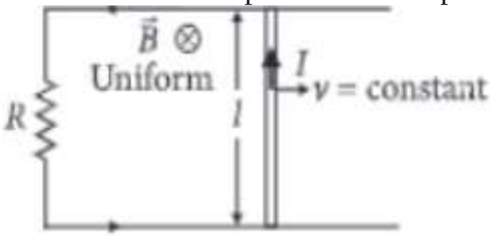
a) Does not depend on relative speed between the coil and magnet
b) Magnetic moment of coil
c) Resistance of coil
d) Number of turns in the coil

Q5 A coil of metal wire is kept stationary in a non uniform magnetic field

a) An EMF and current both are induced in the coil.
b) Current but not EMF is induced in the coil.
c) An emf but not current is induced in the coil.
d) Neither an EMF nor current is induced in the coil

CASE STUDY 6

The EMF induced across the ends of a conductor due to its motion in a magnetic field is called motional EMF. It is produced due to the magnetic Lorentz Force acting on free electrons of the conductor. For a circuit shown in figure, if a conductor of length L moves with a velocity v in magnetic field B perpendicular to both its length and direction of magnetic field then all the induced parameters are possible



in the circuit.

Q1 Direction of current induced in a wire moving in a magnetic field is found by using

a) Fleming's left hand rule
b) Fleming's right hand rule
c) Ampere's rule
d) Right hand clasp rule

Q 2 To a conducting rod of length L is moving in a transverse magnetic field of strength B
with velocity v. The resistance of the rod is R. The current in rod is

a) BLv/R
b) BL v
c) Zero
d) $(BLv)^2/R$

Q 3 0.1m long conductor carrying a current of 50 ampere is held perpendicular to
magnetic field of 1.25 m T. The mechanical power required to move the conductor with
a speed of 1 m/s is

a) 62.5 m W
b) 625 m W
c) 6.25 m W

d) 12.5 m W

Q4 A bicycle generator creates 1.5 V at 15 km per hour. The EMF generated at 10 km per hour is

a) 1.5 V
b) 2 V
c) 0.5 V
d) 1 V

Q 5 Dimensional formula for EMF is

a) $[M L^{2} T^{-3} A^{-1}]$
b) $[M L^{2} T^{-1} A^{1}]$
c) $[M L^{2} A]$
d) $[M L T^{-2} A^{-2}]$

CASE STUDY 7

An Eddy Currents is a current setup in the conductor in response to changing magnetic field. They flow in closed loop in a plane perpendicular to magnetic field. By Lenz's law the currents swirls in such a way as to create magnetic field opposing the change for this to occur in a conductor, electron swirl in a plane perpendicular to magnetic field.

Because of tendency of Eddy Currents to oppose, Eddy Currents cause a loss of energy Eddy Currents Transformer more useful form of energy. Eddy Currents can also be removed by cracks or slits in the conductor, which break the circuit and prevent the current loops from circulating. This means Eddy current can be used to detect defect in materials. This is called non destructive testing and is often used in in airplanes. The magnetic field produced by Eddy Currents is measured, where change in field reveals the presence of irregularity; a defect will reduce the size of Eddy Currents, which is in turn reduce the magnetic field strength.

Another application of Eddy current is magnetic levitation. Conductors are exposed to varying magnetic field which induce Eddy Currents within the conductor and produce a repulsive magnetic field, pushing the magnet and conductor apart. This alternating magnetic field can be caused by relative motion between the magnet and conductor or with an electromagnet applied with varying current to vary the magnetic field strength

Q1 What is the heat generated in Eddy current operations?

a) V I
b) VIR
c) I^2 R T
d) I^2 R

Q 2 With an increase in density of the material, the power loss in eddy current

a) Increases
b) Decreases
c) Does not change
d) Not related

Q 3 Generation of Eddy Currents depends on the principle of

a) waveguide theory
b) electromagnetic induction
c) Magneto resistive force
d) all of the above

Q 4 Eddy Currents generated in a test object flow

a) in the same plane as magnetic flux
b) in the same plane as coil is wound
c) 90 degree to the coil winding plane
d) Eddy Currents have no predictable

Q 5 The Discovery of electromagnetic induction is credited to

a) ARAGO
b) OERSTED
c) MAXWELL
d) FARADAY

CASE STUDY 8

Mutual inductance between the two coils is defined as the property of the coil due to which it opposes the change in current in other coil all you can say in the neighbouring coil. When the current in the neighbouring coil changes the flux set up in the coil and because of this, changing flux, EMF is induced in the coil called mutually induced EMF and phenomena is known as mutual induction. The value of mutual induction M depends on the following factors

1. Number of turns in secondary or neighbouring coil
2. Cross sectional area
3. Closeness of two coils.

When on a magnetic Core, two or more than two coils are are wound, the coil are are said to be mutually coupled. The current, when passed in any one of the coil wound around the magnetic Core, produce magnetic flux which links all the coils together and also the one in which current is passed. Hence there will be both self and mutual EMF in each of the coils.

The best example of mutual inductance is transformer, which works on the principle of Faraday's law of electromagnetic induction. Faraday's law of electromagnetic induction states that the magnitude of voltage is directly proportional to rate of change of flux.

Q 1 The phenomena due to which there is an induced current in the coil due to current in the neighbouring coil is

a) Electromagnetism
b) Susceptance
c) Mutual inductance
d) Steady current

Q2 Mutual inductance between two magnetically coupled coils depends on

a) Permeability of the core material
b) Number of turns of the coils

c) Cross sectional area of their common Core
d) all of the above.

Q 3 Which of the following is unit of inductance

a) Ohm
b) Henry
c) Ampere
d) Weber per metre

Q 4 Which of the following circuit elements will oppose the change in circuit current

a) capacitance
b) inductance
c) resistance
d) all of the above

Q 5 If in an iron cored coil the iron core is removed so as to make the air cored coil the inductance of the coil will be

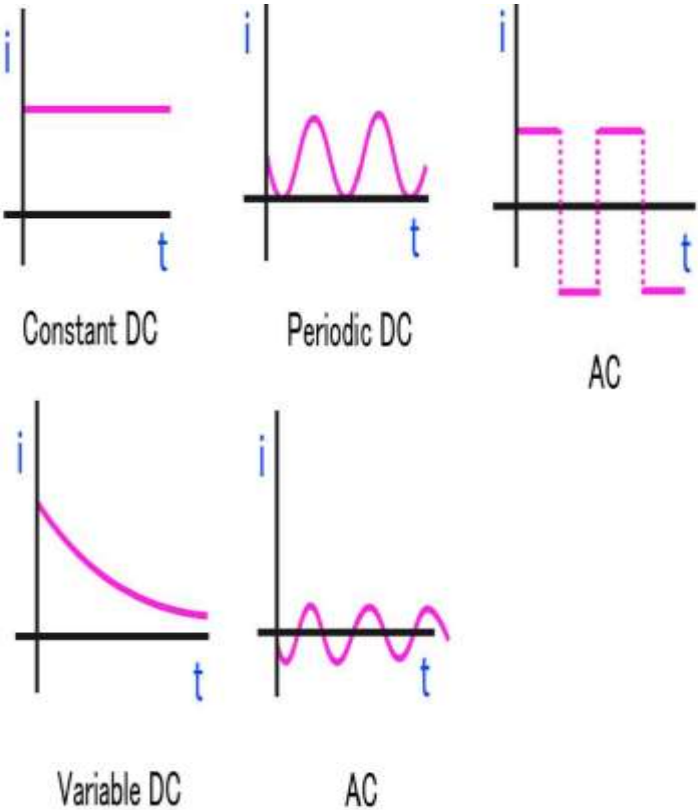
a) More
b) Less
c) Same
d) None of the above.

Chapter 7: Alternating Current

Gist:

Alternating current , peak and r m s value of alternating current /voltage ,
reactance and impedance, LC oscillation (qualitative treatment only) , LCR series circuit,
resonance ,power in AC circuits ,AC generator and transformer

Alternating current is a current that changes its magnitude and polarity at regular interval of time. If the current maintains its direction constant it is called direct current.



EXPRESSION AND FORMULA USED

AC voltage, $v = V_0 \sin\omega t$
AC current, $i = I_0 \sin\omega t$
Capacitive Reactance $V_0/I_0 = 1/\omega C = X_c$
RMS voltage, $V_{rms} = V_0/\sqrt{2}$
RMS current, $I_{rms} = I_0/\sqrt{2}$
Inductive Reactance $V_0/I_0 = \omega L = X_L$
Phase angle of an RLC series circuit $\Phi = \tan^{-1} (X_L - X_C)/R$
AC version of Ohm's law, $I_0 = V_0/Z$
RLC series circuit Impedance , Z=√R2+(XL−XC)2
Average power associated with circuit element, $P_{av} = (1/2)$

Power Consumed or Supplied in AC circuit

The average power consumed in a cycle

$$\frac{\int_0^{\frac{2\pi}{\omega}} P\,dt}{\frac{2\pi}{\omega}} = \frac{1}{2} \times V_m I_m \cos\Phi$$

$$\text{i.e. } \frac{V_m}{\sqrt{2}} \cdot \frac{I_m}{\sqrt{2}} \cdot \cos\Phi = V_{rms}\ I_{rms} \cos\Phi$$

$$\text{Here, } \cos\Phi = \text{Power Factor}$$

Purely Resistive Circuit: In a purely resistive circuit, the power is dissipated by the resistance and phase of both voltage and current remains the same

$P = V_{rms} I_{rms} \cos\Phi = V_{rms}^2/R$

Pure Inductive Circuit: In a purely inductive circuit current lags the voltage by 90^0

$i = i_m \sin(\omega t - \pi/2)$

Purely Conductive Circuit: In a purely inductive circuit, the current flowing through the capacitor leads the voltage by 90^0.

$I = I_m \sin(\omega t + \pi/2)$

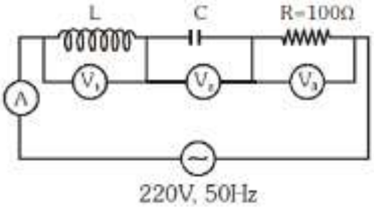
Resonant angular frequency of the circuit, $\omega_0 = \sqrt{1/LC}$

Resonance condition in LCR SERIES CIRCUIT

L w = 1/w C

MCQ

1. In the given circuit the reading of voltmeter V_1 and V_2 are 300 volts each. The reading of the voltmeter V3 and ammeter A are respectively:



(1) 100 V, 2.0 A (2) 150 V, 2.2 A
(3) 220 V, 2.2 A (4) 220 V, 2.0 A

2. The impedance of a circuit, when a resistance R and an inductor of inductance L are connected in series in an AC circuit of frequency f is :-

(1) $\sqrt{R + 2\pi^2 f^2 L^2}$ (2) $\sqrt{R + 4\pi^2 f^2 L^2}$

(3) $\sqrt{R^2 + 4\pi^2 f^2 L^2}$ (4) $\sqrt{R^2 + 2\pi^2 f^2 L^2}$

3. In a transformer, number of turns in the primary are 140 and that in the secondary are 280. If current in primary is 4A, then that in the secondary is
(1) 4 A (2) 2 A
(3) 6 A (4) 10 A

4. In a series LCR circuit, resistance R = 10Ω and the impedance Z = 20Ω. The phase difference between the current and the voltage is
(1) 30° (2) 45°
(3) 60° (4) 90°

5. In the case of an inductor :

(1) voltage lags the current by $\frac{\pi}{2}$

(2) voltage leads the current by $\frac{\pi}{2}$

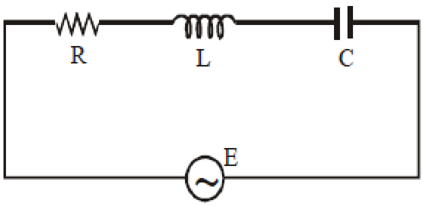
(3) voltage leads the current by $\frac{\pi}{3}$

(4) voltage leads the current by $\frac{\pi}{4}$

6. In a series resonant LCR circuit, if L is increased by 25% and C is decreased by 20%, then the resonant frequency will :-
   (1) Increase by 10%
   (2) Decrease by 10%
   (3) Remain unchanged
   (4) Increase by 2.5%
7. An L–C–R series circuit is at resonance with 10V each across L, C and R. If the resistance is halved the respective voltages across L, C and R are :-
   (1) 10V, 10V and 10V
   (2) 20V, 20V and 5V
   (3) 20V, 20V and 10V
   (4) 5V, 5V and 5V
8. The value of L, C and R for a circuit are 1H, 9F and 3Ω. What is the quality factor for the circuit at resonance :-
   (1) 1 (2) 9
   (3) $\frac{1}{9}$ (4) $\frac{1}{3}$
9. In an a.c. LCR circuit a capacitor and an inductor in series are connected with an a.c. voltage source of 90 volts. An ammeter and a voltmeter are connected in the circuit to measure the curent in

the circuit and the voltage across the capacitor plus the inductor combination. If $X_L = X_C = 4\Omega$ andR= 45Ω, the reading of ammeter (I) and the voltmeter (V) are -
(1) I = 2 amp. and V = 0 volt.
(2) I = 2 amp. and V = 8 volt.
(3) I = 2 amp. and V = 2 volt.
(4) I = 3 amp. and V = 1 volt.

10. If E = 200Volt, R = 25 Ω, L=2H and C=2μF and the frequency is variable then the current at f = 0 and f = ∞ will be respectively –



(1) 0A, 8A (2) 8A, 0A
(3) 8A, 8A (4) 0A, 0A

11. An alternating e.m.f. of angular frequency ω is applied across an inductance. The instantaneous power developed in the circuit has an angular frequency :-

(1) $\frac{\omega}{4}$ (2) $\frac{\omega}{2}$

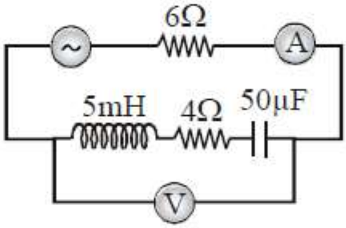
(3) ω (4) 2ω

12. An L–C–R series circuit with 100 ohm resistance is connected to an ac source of 100 V and angular frequency 300 rad/s. When the capacitance is removed, the current lags behind the voltage by 45°, when the inductance is removed, the current leads the voltage by 45°. The current flowing in the circuit will be –

(1) 1A (2) 1·5 A
(3) 2A (4) 3 A

13. When an ac generator of 120 V is connected in series with a capacitor and a resistor of 30 Ω, the circuit carries a current 1·5A. The potential difference across the capacitor will be –
(1) 1·11 V (2) 111 V
(3) Zero (4) 220 V

14. In circuit shown in figure the ac source gives a voltage V = 20 cos (2000 t). Neglecting source resistance, the voltmeter and ammeter reading will be



(1) 0V, 0.47A (2) 1.68V, 0.47A
(3) 0V, 1.4A (4) 5.6V, 1.4A

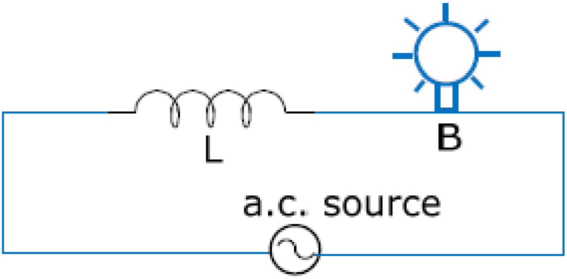
15. An electrical element X when connected to an alternating voltage source has current through it leading the voltage by $\frac{\pi}{2}$radian. Identify X
(a) Capacitor (b) Resistor
(c) Inductor (d) Series LR ckt.

16. A transformer steps up 220 V to2200 V. What is the transformation ratio?
(a) 20 (b) 0.1
(c) 0.2 (d) 10

17. Average power dissipated in an ideal inductor in a.c. circuit is:
(a) Infinite (b) 100

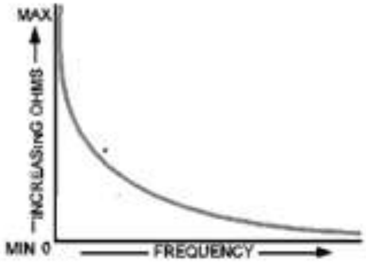
(c) Zero (d) one

18. A Capacitor blocks
    (a) Only a.c. (b) Only d.c.
    (c) Both ac and dc (d) None of these.
19. An inductor L of reactance XL is connected in series with a bulb B to an a.c. source as shown in the figure.



How does the brightness of the bulb change when Number of turns of the inductor is increased.
(a) Increases (b) Decreases
(c) Remains same (d) none of these
20. The instantaneous current in an ac circuit is i=2.0 sin314t, what is its frequency?
    (a) 100 Hz (b) 60 Hz
    (c) 50 Hz (d) 2π
21. The instantaneous current in an ac circuit is i=2.0 sin314t, what is rms value of the current.
    (a) 1.414 A (b) $2\sqrt{2}$A
    (c) 1 A (d) 2 A
22. What is phase difference between voltage and current in LCR series circuit if power factor is 0.707?
    (a) 45^o (b) 30^o
    (c) 90^o (d) 180^o
23. What is phase difference between voltage and current in LCR series circuit at resonance?
    (a) 45^o (b) 30^o
    (c) 90^o (d) 0^o

24. The graph given below corresponds to variation of quantity **'P'** versus frequency ;



The quantity **'P' is:**

(a) X_c **(b) X_L**

(c) R **(d) Z of series LCR ckt with**

L$\neq C \neq R \neq 0$

25. In a transformer, number of turns in the primary are 140 and that in the secondary are 280. If current in primary is 4A, then that in the secondary is

(1) 4 A (2) 2 A (3) 6 A (4) 10 A

26. In a series LCR circuit, resistance R = 10□ and the impedance Z = 20□. The phase difference between the current and the voltage is

(1) 30° (2) 45°

(3) 60° (4) 90°

27. The impedance of a circuit, when a resistance R and an inductor of inductance L are connected in series in an AC circuit of frequency f is :-

(1) $\sqrt{R + 2\pi^2 f^2 L^2}$ (2) $\sqrt{R + 4\pi^2 f^2 L^2}$

(3) $\sqrt{R^2 + 4\pi^2 f^2 L^2}$ (4) $\sqrt{R^2 + 2\pi^2 f^2 L^2}$

28. In the case of an inductor :

(1) voltage lags the current by $\frac{\pi}{2}$

(2) voltage leads the current by $\frac{\pi}{2}$

(3) voltage leads the current by $\frac{\pi}{3}$

(4) voltage leads the current by $\frac{\pi}{4}$

29. In an AC circuit, V and I are given by V=150 sin (150t) volts and I = 150 sin $\left(150t+\frac{\pi}{3}\right)$ amperes. The power dissipated in the circuit is:

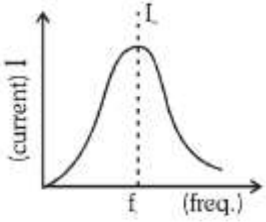
(1) 100 W (2) 150 W
(3) 5625 W (4) zero

30. A sinusoidal ac current passes through a resistor of resistance R in LCR series circuit which is in resonance. If phase difference between supplied voltage and supplied current is θ and peak value of supplied current is I_0, then power dissipated in the ckt is :-

(1) $I_0^2 R\cos\theta$ (2) $\frac{I_0^2 R}{2}$

(3) $I_0^2 R$ (4) $\frac{I_0^2 R}{2}\cos\theta$

31. the graph shows variation of I with f for a series R-L-C network. Keeping L and C constant. If R decreases :



(a) Maximum current (I m) increases
(b) Sharpness of the graph increases

(c) Quality factor increases
(d) Band width increases
(1) a, b, c (2) b, c, d
(3) c, d, a (4) All

32. If the current through an inductor of inductance L is given by I = I0 sin ω t, then the voltage across inductor will be :-
(1) $I_0 \omega L \sin(\omega t - \pi/2)$
(2) $I_0 \omega L \sin(\omega t + \pi/2)$
(3) $I_0 \omega L \sin(\omega t - \pi)$
(4) None of these

33. An A.C source is connected to a resistive circuit. Which of the following is true ?
(1) Current leads the voltage and both are in same phase
(2) Current lags behind the voltage and both are in same phase
(3) Current and voltage are in same phase
(4) Any of the above may be true depending upon the value of resistance

34. In a given series LCR circuit R=4Ω, X_L=5Ω and X_C = 8Ω, the current :-
(1) Leads the voltage by $\tan^{-1}(3/4)$
(2) Leads the voltage by $\tan^{-1}(5/8)$
(3) Lags the voltage by $\tan^{-1}(3/4)$
(4) Lags the voltage by $\tan^{-1}(5/8)$

35. In a step-up transformer, turn ratio is 8 : 1. A 60Hz, 120 volt input is connected with its primary coil. Load resistance in secondary coil is $10^4\Omega$. Find current in secondary coil.
(1) 96 A (2) 0.96 A
(3) 9.6 A (4) 96 mA

36. The output voltage of an ideal transformer, connected to a 240V a.c. mains is 24V. When this transformer is used to light a bulb with rating (24V, 24W), calculate the

current in the primary coil of the circuit.

(1) 0.3A (2) 0.1A

(3) 0.8A (4) 1.02A

37. The frequency for which a 5.0μF capacitor has a reactance of 1000 Ω is given by

(A) 1000/π cycle /sec (B) 100/π cycle /sec

(C) 200 cycle /s (D) 5000 cycles /sec

38. In an a.c. circuit V and I are given by V = 50 sin50t volt and I = 100 sin(50t + π/3) mA. The power dissipated in the circuit

(A) 2.5 kW (B) 1.25 kW

(C) 5.0 kW (D) 500 watt

39. The average power dissipation in pure inductance in ac circuit, is

(A) $1/2LI^2$ (B) $2LI^2$

(C) $LI^2/4$ (D) zero.

40. Circuit as shown in figure below, choose the correct statement.

(A) current in resistance R and current in inductor L will be in 90° phase difference.

(B) potential drop across R and potential drop across L will be in same phase.

(C) current through C and current through L will be in 90° phase difference.

(D) current in R and current in L will be in same phase.

41. In a series L, R, C, circuit which is connected to a.c. source. When resonance is obtained then net impedance Z will be

(A) Z = R

(B) Z = ωL -1/ωC

(C) Z = ωL

(D) Z = 1/Ωc

42. An L,C, R series circuit is connected to a.c. source. At resonance, the applied voltage and the current flowing through the circuit will have a phase difference of

(A) $\pi/4$ (B) zero. (C) π (D) $\pi/2$

43. What is the effective value of current?
    a) RMS current b) Average current
    c) Instantaneous current d) Total current
44. The root-mean-square value of an alternating current of 50Hz frequency is 10 ampere. The time taken by the alternating current in reaching from zero to maximum value and the peak value of current will be
    (A) 2×10^{-2} sec and 14.14 amp.
    (B) 1×10^{-2} sec and 7.07 amp.
    (C) 5×10^{-3} sec and 7.07 amp.
    (D) 5×10^{-3} sec and 14.14 amp.
45. In a series resonant circuit, the a.c. voltage across resistance R, inductance L and capacitance C are 5V, 10V and 10V, respectively. The a.c. voltage applied to the circuit will be
    (A) 20V (B) 10V
    (C) 5V (D) 25V
46. In a sinusoidal wave, average current is always _______ rms current.
    a) Greater than b) Less than
    c) Equal to d) Not related
47. A resistance R Ω is connected in series with capacitance C Farad value of impedance of the circuit is 10 Ω and R = 6Ω so, find the power factor of circuit.
    (A) 0.4 (B) 0.6
    (C) 0.67 (D) 0.9
48. In a R, L, C circuit, three elements is connected in series by an a.c. source. If frequency is less than resonating frequency then net impedance of the circuit will be
    (A) capacitive (B) inductive (C) capacitive or inductive. (D) pure resistive.

49. Using an A.C. voltmeter, the potential difference in the electrical line in a house is read to be 234 volts. If the

line frequency is known to be 50 cycles per second, the equation for the line voltage is

(A) $V = 165 \sin(100\pi t)$ (B) $V = 331 \sin(100\pi t)$
(C) $V = 234 \sin(100\pi t)$ (D) $V = 440 \sin(100\pi t)$

50. In an a.c. circuit, containing an inductance and a capacitor in series, the current is found to be maximum when the value of inductance is 0.5henry and of capacitance is 8μF. The angular frequency of the input A.C. Voltage must be equal to

(A) 500 (B) 5×10^4
(C) 4000 (D)None

ASSERTION AND REASONING :

Of the following statements, mark the correct Answers as-

A) A If both Assertion and Reason are true and the reason is the correct explanation of the assertion.
B) If both Assertion and Reason are true but reason is not the correct explanation of the assertion.
C) If Assertion is true but Reason is false.
D) If the Assertion and Reason both are false.
E) Assertion is false but Reason is true

1. Assertion: An electric bulb is first connected to a dc source and then to an ac source having the same brightness in both cases.
   Reason: The peak value of voltage for an A.C. source is √2 times the root mean square voltage
2. Assertion: In practical application, the power rating of resistance is not important.
   Reason: Property of resistance remain the same even at high temperature, .
3. ASSERTION—A transformer can't work on

DC supply
REASON—DC changes neither in magnitude nor in direction

4. ASSERTION---Soft iron is used as a core of transformer.
   REASON—Area of hysteresis loop for soft iron core is small
5. ASSERTION---An AC generator is based on the phenomenon of self induction .
   REASON ----In single coil we consider self induction only .
6. ASSERTION—An AC does not show any magnetic effect
   REASON—AC does not vary with time
7. ASSERTION—When capacitive reactance is smaller than the inductive reactance in LCR circuit ,emf leads the current
   REASON—The phase angle is angle between alternating emf and alternating current of the circuit.
8. ASSERTION---The DC and AC both can be measured by a hot wire instrument.
   REASON---The hot wire instrument is based on the principle of magnetic effect of
9. ASSERTION--In LCR circuit resonance can take place.
   REASON—Resonance can take place if inductive reactance and capacitive reactance are equal and
10. ASSERTION—Average value of AC over a complete cycle is always zero.
    REASON—Average value of AC is always defined over half cycle
11. ASSERTION—An AC does not show any magnetic effect

REASON—AC varies with time..

12. ASSERTION—A capacitor of suitable capacitance can be used in AC circuit in place of choke coil
REASON--- A capacitor blocks DC and allows only AC
13. ASSERTION---A variable capacitor is connected in series with a bulb through AC source If the capacitance of variable capacitor is decreased the brightness of the bulb is reduced
.REASON---The reactance of the capacitor increases if capacitance is reduced
14. ASSERTION—The power output of a practical transformer is always smaller than the power input
REASON---A transformer works on the principle of mutual induction
15. ASSERTION---An inductor is called the inertia of an electric circuit
REASON—An inductor tends to keep the flux constant
16. ASSERTION—Direct current is more dangerous than Alternating current of same value .
REASON—An electrocuted person sticks to direct current line. While alternating current repels the person from the line .
17. ASSERTION—AC can be transmitted over .long distances at high voltage without much power loss
REASON---The average value of AC is defined over any half cycle.
18. ASSERTION---An inductor and a capacitor are called low pass filter and high pass filter respectively
REASON---Reactance of an inductor is low for low frequency signals and that of a capacitor is high for

high frequency signals

19. ASSERTION--- The chief characteristics of a series resonant circuit is voltage magnification.
REASON---At resonance the voltage drop across L (or C)is Qtimes the applied voltage
20. ASSERTION--Wires of transmission lines carrying A.C. are made of multiple strands
REASON--- A.C. flows on surface of the conductor.
21. ASSERTION---A series resonant circuit is also known as an acceptor circuit.
REASON--- For large value of ohmic resistance ,the quality factor of a series resonant circuit is high.
22. ASSERTION—A glowing bulb becomes dim when an iron bar is put in the inductor in AC circuit
REASON- Resistance of the circuit increases
23. ASSERTION- In series LCR resonance circuit ,the impedance is equal to the ohmic resistance .
REASON-: At resonance , inductive reactance exceeds the capacitive reactance .
24. ASSERTION --- An inductor can't have zero resistance .
REASON--- This is because inductor has to be made up of some material , which must have some resistance .
25. ASSERTION --- A parallel resonance circuit is called rejector circuit .
Reason --- At resonance frequency ,current is completely cut off
26. ASSERTION ---In 220 V , 50Hz ac wall plug , peak value of alternating emf is 220 V
REASON ---Only r m s value is specified .
27. ASSERTION ---A step up transformer can also be used as step down transformer .
REASON ---$E_S / E_P = N_S/N_P$
28. ASSERTION --- The no. of turns in secondary coil of a transformer is 10 times the no. of turns in primary . \An

output voltage of 154 can be obtained using a cell of 1.5V .
REASON ----This is because in the transformer E_S / E_P = N_S/N_P

29. ASSERTION --- The alternating current lags behind the emf by a phase angle of π/2,when ac flows through an inductor .
REASON---The inductive reactance increases as the frequency of ac source decreases.
30. ASSERTION ---When the capacitive reactance smaller than the inductive reactance in LCR circuit ,emf leads the current .
REASON ---The phase angle is the angle b/w the alternating emf and alternating current of the circuit .

CASE STUDY QUESTIONS : ALTERNATING CURRENT (5 questions of 4 marks each)

1. **A transformer is an electrical device which is used for changing a.c. voltages. It is based on the phenomenon of mutual induction. It can be shown that $\frac{Es}{Ep} = \frac{Ip}{Is} = \frac{ns}{np}$ = K, where symbols have their standard meaning. For a step up transformer, K>1 and for a step down transformer, K<1. The numbers of turns in the primary and secondary coils of a transformer are 2000 and 50 respectively. The primary coil is connected to main of 120 V and secondary to a night bulb of 0.6 ohm. The efficiency of transformer is 80 %.**

i) A transformer is used :

(a) to transform electric energy into mechanical energy.

(b) to obtain suitable DC voltage.

(c) to transform AC into DC.

(d) to obtain suitable AC voltage.

ii) Which quantity is increased in step-down transformer ?

a)resistance

b)power

c)current

d)charge

iii) In step-up transformer, relation between number of turns in primary(N_p) and number of turns in secondary(N_s) is

(a) $N_s > N_p$ (b) $N_p > N_s$

(c) $N_s = N_p$ (d) $N_p = 2 N_s$

iv) Voltage across the secondary of transformer is

(a) 120 V (b) 360 V

(b) (c) 40 V (d) 3 V

v) Current in primary coil is

(a) 15 A (b) 5 / 3 A

(c) $\frac{5}{32}$ A (d) 0.6

2. A resistance of 40 ohm is connected with an inductor of self –inductance 5H and a capacitor of capacitance 80 micro F .This combination is then connected to an AC source of rms voltage 220 V .Frequency of AC source can be changed continuously

i) What should be the frequency of source which drives circuit to resonance

(a) $\frac{100}{\pi}$ (b) $\frac{75}{\pi}$ (c) $\frac{50}{\pi}$

ii) In LCR series a. c. circuit , the current

(a) is in phase with the voltage

(b) lags behind the generator voltage

(c) leads the generator voltage

(d) None of these

iii) When LCR series circuit is at resonance, then the phase angle between current and voltage is

(a) 0 (b) 2π

(c) $\pi /2$ (d) π

iv) What is the impedance of circuit in a state of resonance?

(a) 40Ω (b) 80 Ω

(c) 400 Ω d) 800 Ω

v) What is the average power consumed by circuit ?

(a) 605 W (b) 1210 $\sqrt{2}$ W

(c) 1210 W (d) 1210 W

3. Current flowing through an inductor as a function of time is given as I = 4 + 16 t. Here I is in amperes and t is in seconds. Emf induced in the inductor is 20 mV. The inductive reactance is given by $X_L = \omega L = 2\pi fL$. Thus on increasing frequency , inductive reactance increases. Howerver, when f = 0 then $X_L = 0$, from this it can be said that in DC there is no inductive reactance. In case of DC, a pure inductor behaves as a wire with zero resistance.

i) What is self-inductance of the inductor?

(a) 1.25×10^{-3} H (b) 2.5×10^{-4} H

(c) 1.25×10^{-4} H (d) 5×10^{-3} H

ii) Rate of energy supplied to inductor at t = 2 s is

(a) 0.36 W (b) 0.72 W

(c) 1.44 W (d) 2.88 W

iii) An inductor

(a) offers easy path to a.c., but blocks d.c.

(b) offers easy path to d.c., but blocks a.c.
(c) offers easy path to both a.c. and d.c.
(d) None of these .

iv) Choose the correct statement

(a) the capacitor can conduct in a d.c. circuit but not an inductor.
(b) in d.c. circuit the inductor can conduct but not a capacitor.
(c) in d.c. circuit both the inductor and capacitor cannot conduct.
(d) the inductor has infinite resistance in a d.c. circuit.

v) In oscillating LC circuit, the total stored energy is U and maximum charge upon capacitor is Q. When the charge upon the capacitor is Q / 2, the energy stored in the inductor is

(a) U / 2 (b) U / 4
(c) 4U / 3 (d) 3U / 4

4. Series LCR circuits at resonance admit maximum current at particular frequencies. Therefore it is called acceptor circuit because at resonance, impedance of LCR circuit is minimum and it easily accepts that current out of the many currents whose frequency is equal to the resonant frequency. This circuit is used in radio and TV receivers to tune the desired frequency or filtered unwanted frequencies. The antenna of a radio or TV receives signals of tuning circuit of the receiver is changed by changing the the capacitance of the tuning circuit till the resonant frequency of the circuit becomes equal to the frequency of the desired broadcasting station. At this stage, the electrical resonance takes place. The amplitude of the current with the frequency of the signal from the

desired station becomes maximum and hence it is received by the radio or TV receiver. The maximum current flows through for that a.c. voltage which has frequency equal to $f_r = \frac{1}{2\pi\sqrt{LC}}$ .If Q-value of circuit is large the signals of the other stations will be very weak. Quality factor determines the clarity of reception.Low quality factor means that bandwidth around the bandwidth around the resonance frequency is large and hence, tuning is not very accurate.

i) The current admitted by series LCR circuit corresponding to resonant frequency is

(a) maximum (b) minimum

(c) zero (d) cannot be determined

ii) In a series LCR circuit L=8H, C=0.5μF and R=100Ω. The resonant frequency of the crcuit is

(a) 1000 / π Hz (b) 500 / π Hz

(c) 250 / π Hz (d) 125 / π Hz

iii) At resonance, in a series LCR circuit, which relation does not hold

(a) $\omega = \frac{1}{LC}$ (b) $\omega = \frac{1}{\sqrt{LC}}$

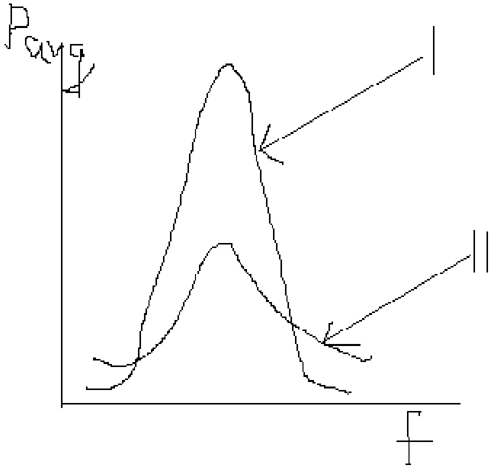
(c) $L\omega = \frac{1}{C\omega}$ (d) $C\omega = \frac{1}{L\omega}$

iv) Nita switched on the radio set to listen to her favourite music but found the reception was not clear. Also there was there was overlapping of signals. So she adjusted the tuner. Name the phenomenon involved here :

(a) reception (b) bandwith

(c) resonance (d) filtration

v) From the figure below, the curve with highest value of Q-factor is



(a) Curve I
(b) Curve II
(c) Both the curves
(d) None of them

5. A thermal power plant produces electric power of 600 kW at 4000 V, which is to be transported to a place 20 km away from the power plant for consumers usage. It can be transported either directly with a cable of large current carrying capacity or by using a combination of step-up or step-down transformers at the two ends. The drawback of the direct transmission is the large energy dissipation. In the method using transformers, the dissipation is much smaller. In this method, a step-up transformer is used at the plant side so that the current is reduced to a smaller value. At the consumers end, a step-up transformer is used

to supply power to the consumer at the specified lower voltage.

i) 11 kw of electric power can be transmitted to a distant station at (i) 220 V or (ii) 22000 V. Which of the two modes of transmission should be preferred ?

(a) 220 V (b) 22000 V

(c) Both (d) none of the two

ii) Power is transmitted from a power house on high voltage because

(a) the rate of transmission is faster at high voltage

(b) it is more economical due to less power wastage

(c) the life of current carrying wire is prolonged

(d) a precaution against the theft of transmission line

iii) The core of a transformer is laminated so that

(a) the ratio of voltage in primary and secondary coils may be increased.

(b) the weight of the transformer may be reduced

(c) residual magnetism in the core may be reduced

(d) energy loss due to eddy currents may be reduced

iv) If the direct transmission method with a cable of resistance of 0.4 Ωkm^{-1} is used, the power dissipation in % during transmission is

(a) 20 (b) 30

(c) 40 (d) 50

v) What is increased in a step down transformer ?

(a) current (b) voltage

(c) wattage (d) none

ANSWER KEY

Chapter 1 Electric charges and fields

MCQs

1	a	18	b	35	c
2	a	19	a	36	b
3	c	20	d	37	c
4	b	21	b	38	a
5	a	22	c	39	a
6	b	23	d	40	a
7	a	24	a	41	a
8	d	25	d	42	a
9	d	26	d	43	a
10	a	27	b	44	a
11	c	28	a	45	a
12	b	29	a	46	a
13	b	30	b	47	a
14	b	31	c	48	a
15	b	32	a	49	a
16	b	33	d	50	a
17	b	34	a		

Assetion Reasoning

1	b	16	a
2	a	17	b
3	a	18	a
4	b	19	c
5	d	20	a
6	b	21	a
7	a	22	c

8	c	23	a
9	c	24	d
10	b	25	d
11	c	26	d
12	a	27	a
13	b	28	c
14	d	29	a
15	c	30	b

Case Study based

1		8		15	
i	b	i	d	i	B
ii	c	ii	d	ii	B
iii	b	iii	c	iii	C
iv	d	iv	b	iv	C
v	b	9		16	
2		i	b	i	B
i	d	ii	a	ii	A
Ii	b	iii	a	iii	A
Iii	d	iv	b	iv	A
Iv	c	10		17	
3		i	a	i	A
I	d	ii	a	ii	A
Ii	a	iii	c	iii	A
Iii	c			iv	
Iv	d	11		18	
4		i	a	i	A
I	d	ii	b	ii	A
Ii	c	iii	a	iii	B
Iii	d	iv	b	iv	C

iv	d	12		19	
5		i	A	i	B
i	a	ii	B	ii	A
ii	c	iii	C	iii	B
iii	c	iv	A	iv	A
iv	d	13		20	
6		i	a	i	A
i	a	ii	a	ii	C
ii	c	iii	b	iii	A
iii	d	iv	d	iv	A
iv	c	14			
7		i	d		
i	A	ii	c		
ii	B	iii	c		
iii	A	iv	c		
iv	B				

Chapter 2. Electrostatic Potential and capacitance MCQs

1	c	11	a	21	a	31	b	41	c
2	c	12	b	22	c	32	c	42	b
3	a	13	b	23	b	33	c	43	c
4	d	14	d	24	d	34	a	44	d
5	a	15	b	25	d	35	c	45	d
6	d	16	c	26	d	36	c	46	c
7	b	17	d	27	c	37	c	47	c
8	c	18	d	28	b	38	d	48	a
9	b	19	d	29	c	39	d	49	c
10	D	20	c	30	d	40	d	50	c

Assertion Reason

1	b	12	b	23	b
2	a	13	c	24	c
3	a	14	c	25	d
4	a	15	c	26	a
5	c	16	d	27	c
6	a	17	a	28	c
7	a	18	c	29	a
8	b	19	a	30	c
9	c	20	b	31	a
10	a	21	b	32	C
11	a	22	c		

1		2		3		4	
i	d	i	b	i	b	i	b
ii	c	ii	d	ii	a	ii	c
iii	b	iii	b	iii	b	iii	a
iv	b	iv	a	iv	b	iv	b
v	b	v	c	v	c	v	c

Chapter 3: Current Electricity

MCQ

1	B	11	C	21	B	31	A	41	D
2	B	12	D	22	B	32	D	42	B
3	D	13	B	23	A	33	B	43	C
4	B	14	B	24	B	34	A	44	A
5	D	15	B	25	A	35	C	45	C
6	A	16	B	26	D	36	B	46	A
7	C	17	B	27	A	37	B	47	A
8	C	18	C	28	A	38	C	48	B

9	D	19	B	29	B	39	B	49	B
10	A	20	C	30	A	40	B	50	C

Assertion Reason

1	2	11	1	21	2
2	4	12	2	22	3
3	1	13	2	23	2
4	1	14	2	24	1
5	2	15	1	25	3
6	2	16	3	26	1
7	2	17	2	27	3
8	1	18	4	28	3
9	3	19	4	29	3
10	2	20	2	30	1

Case study based

Serial no.	MCQ NO.	Answer	Serial no.	MCQ NO.	Answer
1	i) ii) iii)	B B D	11	i) ii) iii)	A A A
2	i) ii) iii)	C A A	12	i) ii) iii)	B A B
3	i) ii) iii)	A B D	13	i) ii) iii)	C A B
4	i) ii) iii)	B B A	14	i) ii) iii)	B D B

5	i) ii) iii)	B C A	15	i) ii) iii)	B C A
6	i) ii) iii)	A B C	16	i) ii) iii)	B A A
7	i) ii) iii) iv) v)	C A B D D	17	i) ii) iii)	C A D
8	i) ii) iii)	B B B	18	i) ii) iii)	A A B
9	i) ii) iii)	D C B	19	i) ii) iii)	A A B
10	i) ii) iii)	B D C	20	i) ii) iii)	A B B

Chapter 4: Moving charges and Magnetism MCQs

1	(a)	11	(b)	21	(c)	31	(d)	41	(a)
2	(a)	12	(b)	22	(d)	32	(d)	42	(b)
3	(d)	13	(d)	23	(a)	33	(b)	43	(d)
4	(c)	14	(c)	24	(b)	34	(b)	44	(b)
5	(b)	15	(b)	25	(b)	35	(a)	45	(b)
6	(c)	16	(a)	26	(c)	36	(c)	46	(a)
7	(d)	17	(c)	27	(b)	37	(a)	47	(c)
8	(a)	18	(c)	28	(a)	38	(a)	48	(c)
9	(b)	19	(b)	29	(c)	39	(d)	49	(c)
10	(c)	20	(c)	30	(c)	40	(b)	50	(d)

30 ASSERTION-REASONING QUESTIONS

1	(b)	11	(c)	21	(a)
2	(d)	12	(b)	22	(d)
3	(d)	13	(c)	23	(b)
4	(a)	14	(a)	24	(a)
5	(b)	15	(d)	25	(a)
6	(c)	16	(d)	26	(a)
7	(b)	17	(a)	27	(b)
8	(c)	18	(b)	28	(a)
9	(a)	19	(c)	29	(b)
10	(d)	20	(c)	30	(b)

ANSWERS OF 20 CASE-STUDY BASED QUESTIONS

CASE 1	1.1(b)	1.2(c)	1.3(c)	1.4(a)	1.5(c)
CASE 2	2.1(a)	2.2(d)	2.3(b)	2.4(d)	2.5(d)
CASE 3	3.1(a)	3.2(d)	3.3(a)	3.4(a)	3.5(b)
CASE 4	4.1(a)	4.2(d)	4.3(c)	4.4(d)	4.5(c)
CASE 5	5.1(a)	5.2(a)	5.3(b)	5.4(d)	5.5(a)
CASE 6	6.1(d)	6.2(b)	6.3(c)	6.4(b)	6.5(c)
CASE 7	7.1(a)	7.2(a)	7.3(b)	7.4(b)	7.5(a)
CASE 8	8.1(c)	8.2(b)	8.3(d)	8.4(a)	8.5(d)
CASE 9	9.1(b)	9.2(d)	9.3(c)	9.4(a)	9.5(d)
CASE 10	10.1(c)	10.2(b)	10.3(c)	10.4(a)	10.5(b)
CASE 11	11.1(d)	11.2(d)	11.3(b)	11.4(d)	11.5(b)
CASE 12	12.1(d)	12.2(c)	12.3(c)	12.4(d)	12.5(d)
CASE 13	13.1(b)	13.2(c|)	13.3(d)	13.4(c)	13.5(d)
CASE 14	14.1(a)	14.2(d)	14.3(b)	14.4(a)	14.5(c)
CASE 15	15.1(d)	15.2(c)	15.3(c)	15.4(c)	15.5(c)
CASE 16	16.1(b)	16.2(c)	16.3(d)	16.4(c)	16.5(a)

CASE 17	17.1(d)	17.2(c)	17.3(d)	17.4(d)	17.5(a)
CASE 18	18.1(a)	18.2(d)	18.3(a)	18.4(d)	18.5(a)
CASE 19	19.1(b)	19.2(a)	19.3(a)	19.4(d)	19.5(b)
CASE 20	20.1(c)	20.2(c)	20.3(a)	20.4(b)	20.5(b)

Chapter 5: Magnetism and Matter
MCQs

1	B	11	A	21	D	31	C	41	A
2	D	12	B	22	A	32	B	42	B
3	A	13	A	23	B	33	B	43	B
4	D	14	B	24	C	34	A	44	B
5	B	15	B	25	D	35	A	45	C
6	D	16	A	26	A	36	C	46	D
7	C	17	D	27	D	37	D	47	D
8	B	18	B	28	A	38	B	48	A
9	A	19	C	29	B	39	C	49	C
10	A	20	A	30	A	40	C	50	B

Assertion Reasoning

1	D	11	D
2	A	12	B
3	D	13	C
4	A	14	B
5	A	15	D
6	C	16	B
7	A	17	A
8	B	18	C
9	B	19	D
10	C	20	E

Case Study based

Case 1	Answer	Case 4	Answer
1	3	1	B
2	1	2	A
3	1	3	B
4	2	4	C
5	1		
Case 2		Case 5	
1	3	1	B
2	1	2	D
3	2	3	D
4	4	4	A
5	2	5	A
Case 3		Case 6	
1	4	1	C
2	3	2	B
3	3	3	C
4	1	4	D
5	1	5	B

Chapter 6: Electromagnetic Induction

MCQs

1	A	11	C	21	A	31	B	41	D
2	B	12	B	22	B	32	C	42	D
3	C	13	D	23	A	33	C	43	A
4	A	14	B	24	D	34	D	44	A
5	D	15	B	25	B	35	A	45	C
6	A	16	A	26	B	36	A	46	C
7	C	17	D	27	D	37	C	47	C
8	A	18	D	28	B	38	C	48	D

9	D	19	C	29	B	39	C	49	D
10	B	20	D	30	A	40	B	50	C

Assertion Reasoning

QUESTION NUMBER	ANSWER	QUESTION NUMBER	ANSWER
1	C	16	C
2	C	17	C
3	C	18	A
4	A	19	C
5	B	20	A
6	A	21	C
7	A	22	A
8	B	23	A
9	A	24	C
10	B	25	C
11	B	26	C
12	B	27	C
13	D	28	A
14	B	29	A
15	C	30	A

Case Study Based

QUESTION NUMBER	ANSWER	QUESTION NUMBER	ANSWER
CASE 1		CASE 5	
1	c	1	A
2	b	2	D
3	c	3	B
4	d	4	B
5	c	5	D
CASE 2		CASE 6	
1	C	1	B

2	C (ϕ =MI)	2	A
3	B	3	C
4	A	4	D
5	C	5	a
CASE 3		CASE 7	
1	B	1	d
2	A	2	b
3	A	3	b
4	C	4	b
5	C	5	d
CASE 4		CASE 8	
1	A	1	c
2	B ϕ =L I	2	d
3	C	3	b
4	C	4	b
5	b	5	b

Chapter 7: Alternating Current

MCQs

1	3	11	4	21	A	31	1	41	A
2	3	12	1	22	A	32	2	42	B
3	2	13	2	23	D	33	3	43	A
4	3	14	4	24	A	34	1	44	D
5	2	15	1	25	2	35	4	45	C
6	3	16	D	26	3	36	2	46	B
7	3	17	C	27	3	37	B	47	B
8	1	18	B	28	2	38	B	48	A
9	1	19	B	29	3	39	D	49	B
10	4	20	C	30	2	40	A	50	A

Assertion and Reasoning

1	E	16	D
2	D	17	C
3	A	18	C
4	A	19	A
5	E	20	A
6	D	21	C
7	B	22	A
8	C	23	C
9	A	24	A
10	B	25	A
11	B	26	D
12	B	27	A
13	A	28	D
14	B	29	C
15	A	30	B

Case Study Based

CASE STUDY QUE	i	ii	Iii	iv	v
1	d	C	A	d	a
2	d	D	A	a	c
3	a	B	B	b	d
4	a	C	A	c	a
5	b	B	D	b	a