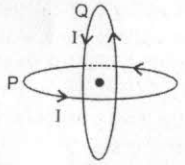
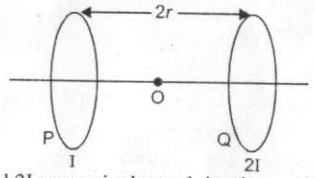
1 Magnetic effects of current (2 mark)

1. 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 and direction of the net magnetic field at the common centre of the two coils. [Delhi 2012]

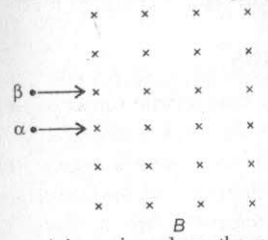


2. Two identical circular loops, P and Q, each of radius r and carrying currents I

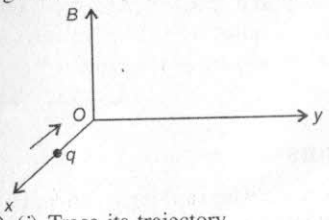


and 2I respectively are lying in parallel planes such that they have a common axis.
The direction of current in both the loops is clockwise as seen from O which is equidistant from both loops. Find the magnitude of the net magnetic field at point O. [Delhi 2012]

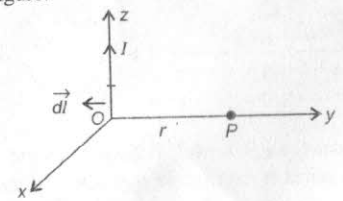
3. A circular coil of N turns and radius R carries a current I. It is unwound and rewound to make another coil of radius R/2, current I remaining the same. Calculate the ratio of the magnetic moments of the new coil and the original coil. [AI 2012]
4. A circular coil of 'N' turns and diameter 'd' carries a current 'I'. It is unwound and rewound to make another coil of diameter '2d', current 'I' remaining the same. Calculate the ratio of the magnetic moments of the new coil and the original coil. [AI 2012]
5. A circular coil of closely wound N turns and radius r carries a current I. Write the expression for the following : [AI 2012]
   (*i*) the magnetic field at its centre
   (*ii*) the magnetic moment of this coil
6. A particle of charge 'q' and mass 'm' is moving with velocity $\vec{V}$. It is subjected to a uniform magnetic field $\vec{B}$ directed perpendicular to its velocity. Show that it describe a circular path. Write the expression for its radius. [Foreign 2012]
7. A straight wire of length L is bent into a semi-circular loop. Use Biot-Savart law to deduce an expression for the magnetic field at its centre due to the current I passing through it. [Delhi 2011C]
8. How is a moving coil galvanometer converted into a voltmeter? Explain, giving the necessary circuit diagram and the required mathematical relation used. [Delhi 2011C]
9. Define the current sensitivity of a moving coil galvanometer. "Increasing the current sensitivity may not necessarily increase the voltage sensitivity." Justify this statement. [Delhi 2011C]
10. A long solenoid of length 'l' having N turns carries a current I. Deduce the expression for the magnetic field in the interior of the solenoid. [AI 2011C]
11. Obtain, with the help of necessary diagram, the expression for the magnetic field in the interior of a toroid carrying current. [AI 2011C]
12. A toroid of N turns of mean radius r carries a current 'I'. Show that the magnetic field in its interior is given by $B = \frac{\mu_0 NI}{2\pi r}$. Draw the necessary diagram. [AI 2011C]
13. Write the expression for Lorentz magnetic force on a particle of charge 'q' moving with velocity $\vec{v}$ in a magnetic field $\vec{B}$. Show that no work is done by this force on the charged particle. [AI 2011]
14. An α-particle and a proton moving with the same speed enter the same magnetic field region at right angles to the direction of the field. Show the trajectories followed by the two particles in the region of the magnetic field. Find the ratio of the radii of the circular paths which the two particles may describe. [Foreign 2010]



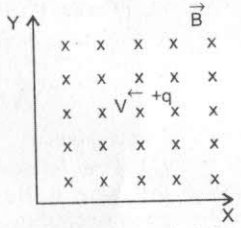
15. A charge 'q' moving along the x-axis with a velocity $\vec{v}$ is subjected to a uniform magnetic field B acting along the z-axis as it crosses the origin O. [Delhi 2009]



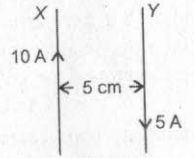
   (*i*) Trace its trajectory.
   (*ii*) Does the charge gain kinetic energy as it enters the magnetic field ? Justify your answer.
16. State Biot-Savart law.
   A current I flows in a conductor placed perpendicular to the plane of the paper. Indicate the direction of the magnetic field due to a small element $\vec{dl}$ at point P situated at a distance $\vec{r}$ from the element as shown in the figure. [Delhi 2009]



17. A point charge is moving with a constant velocity perpendicular to a uniform magnetic field as shown in the figure. What should be the magnitude and direction of the electric field so that the particle moves undeviated along the same path ? [Foreign 2009]



18. Using Ampere's circuital law, obtain an expression for the magnetic field along the axis of a current carrying solenoid of length l and having N number of turns. [AI 2008]
19. How do you convert a galvanometer into an ammeter ? Why is an ammeter always connected in series ? [AI 2005]
20. Two long parallel straight wires X and Y separated by a distance of 5 cm in air carry currents of 10 A and 5 A respectively in opposite direction. Calculate the magnitude and direction of the force on a 20 cm length of the wire Y. [HOTS]



21. A circular coil of 100 turns, radius 10 cm carries a current of 5A. It is suspended vertically in a uniform horizontal magnetic field of 0.5 T, the field lines making an angle of 60° with the plane of the coil. Calculate the magnitude of the torque that must be applied on it to prevent it from turning. [HOTS]
22. A straight wire, of length L, carrying a current I, stays suspended horizontally in mid air in a region where there is a uniform magnetic field $\vec{B}$. The linear mass density of the wire is λ. Obtain the magnitude and direction of this magnetic field. [HOTS]

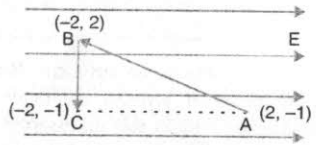
Electrostatics

(2 mark)

1. Draw a plot showing the variation of (*i*) electric field (E) and (*ii*) electric potential (V) with distance *r* due to a point charge Q.
[Delhi 2012]

2. An electric dipole is held in a uniform electric field.
   (*i*) Show that the net force acting on it is zero.
   (*ii*) The dipole is aligned parallel to the field. Find the work done in rotating it through the angle of 180°. [AI 2012]

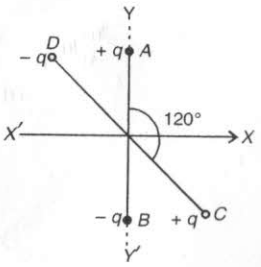
3. A test charge 'q' is moved without acceleration from A to C along the path from A to B and them from B to C in electric field E as shown in the figure. (i) Calculate the potential difference between A and C. (ii) At which point (of the two) is the electric potential more and why ?



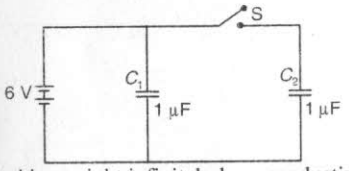
[AI 2012]

4. Two uniformly large parallel thin plates having charge densities $+\sigma$ and $-\sigma$ are kept in the *X-Z* plane at a distance '*d*' apart. Sketch an equipotential surface due to electric field between the plates. If a particle of mass *m* and charge '$-q$' remains stationary between the plates, what is the magnitude and direction of this field ? [Delhi 2011]

5. Two small identical electrical dipoles *AB* and *CD*, each of dipole moment '*p*' are kept at an angle of 120° as shown in the figure. What is the resultant dipole moment of this combination ? If this system is subjected to electric field $(\vec{E})$ directed along $+X$ direction, what will be the magnitude and direction of the torque acting on this ? [Delhi 2011]



6. Figure shows two identical capacitors, C_1 and C_2, each of 1 μF capacitance connected to a battery of 6 V. Initially switch '*S*' is closed. After sometimes '*S*' is left open and dielectric slabs of dielectric constant $K = 3$ are inserted to fill completely the space between the plates of the two capacitors. How will the (*i*) charge and (*ii*) potential difference between the plates of the capacitors be affected after the slabs are inserted ? [Delhi 2011]



7. A thin straight infinitely long conducting wire having charge density λ is enclosed by a cylindrical surface of radius *r* and length *l*, its axis coinciding with the length of the wire. Find the expression for the electric flux through the surface of the cylinder. [AI 2011]

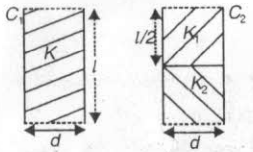
8. Plot a graph showing the variation of coulomb force (*F*) versus $\left(\frac{1}{r^2}\right)$, where *r* is the distance between the two charges of each pair of charges: (1μC, 2μC) and (2μC, –3μC). Interpret the graphs obtained. [AI 2011]

9. A parallel plate capacitor is being charged by a time varying current. Explain briefly how Ampere's circuital law is generalized to incorporate the effect due to the displacement current. [AI 2011]

10. Net capacitance of three identical capacitors in series is 1 μF. What will be their net capacitance if connected in parallel ?
Find the ratio of energy stored in the two configurations if they are both connected to the same source. [AI 2011]

11. Calculate the amount of work done in rotating a dipole, of dipole moment 3×10^{-8} cm, from its position of stable equilibrium to the position of unstable equilibrium, in a uniform electric field of intensity 10^4N/C. [Foreign 2011]

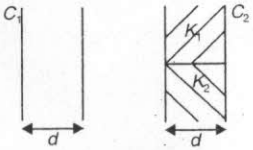
12. Two identical parallel plate (air) capacitors C_1 and C_2 have capacitances *C* each. The space between their plates is now filled with dielectrics as shown. If the two capacitors still have equal capacitance, obtain the relation between dielectric constants *K*, K_1 and K_2.
[Foreign 2011]



13. State the principle of the device that can build up high voltages of the order of a few million volts. Draw its labelled diagram. A stage reaches in this device when the potential at the outer sphere cannot be increased further by piling up more charge on it. Explain why.
[Foreign 2011]

14. You are given an air filled parallel plate capacitor C_1. The space between its plates is now filled with slabs of dielectric constants K_1 and K_2 as shown in C_2. Find the capacitance of the capacitor C_2 if area of the plates is *A* and distance between the plates is *d*.
[Foreign 2011]

15. You are given an air filled parallel plate capacitor C_1. The space between its plates is now filled with slabs of dielectric constants K_1 and K_2 as shown in C_2. Find the capacitance of the capacitor C_2 if area of the plates is *A* and distance between the plates is *d*.
[Foreign 2011]



16. (*a*) Draw equipotential surfaces due to a point Q > 0.
   (*b*) Are these surfaces equidistant from each other ? If not, explain why.
[Delhi 2011C]

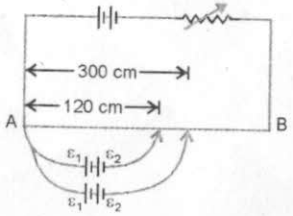
17. Calculate the amount of work done in turning an electric dipole of dipole moment 2×10^{-8} C m from its position of unstable equilibrium to the position of stable equilibrium, in a uniform electric field of intensity 10^3 NC^{-1}.
[Delhi 2011C]

18. Deduce the expression for the energy stored in a parallel plate capacitor C having charges +Q and –Q on its plates. [Delhi 2011C]

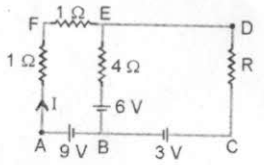
19. Two point charges 2μC and –2μC are placed at points A and B 6 cm apart.
   (*i*) Draw the equipotential surfaces of the system.

Current Electricity (3 mark)

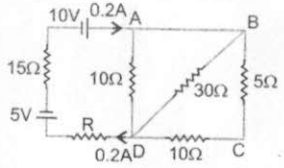
1. In the figure a long uniform potentiometer wire AB is having a constant potential gradient along its length. The null points for the two primary cells of emfs ε_1 and ε_2 connected in the manner shown are obtained at a distance of 120 cm and 300 cm from the end A. Find (*i*) $\varepsilon_1/\varepsilon_2$ and (*ii*) position of null point for the cell ε_1.
   How is the sensitivity of a potentiometer increased ? [Delhi 2012]



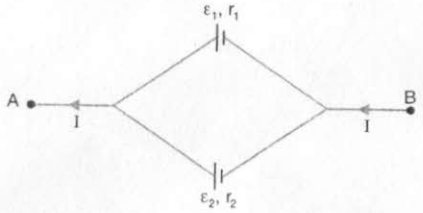
2. Using Kirchoff's rules determine the value of unkown resistance R in the circuit so that no current flows through 4 Ω resistance. Also find the potential difference between A and D.
   [Delhi 2012]



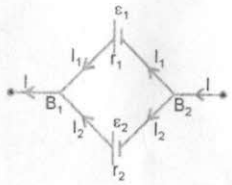
3. Define relaxation time of the free electrons drifting in a conductor. How is it related to the drift velocity of free electrons ? Use this relation to deduce the expression for the electrical resistivity of the material. [AI 2012]
4. Calculate the value of the resistance R in the circuit shown in the figure so that the current in the circuit is 0.2 A. What would be the potential difference between points A and D ?
   [AI 2012]



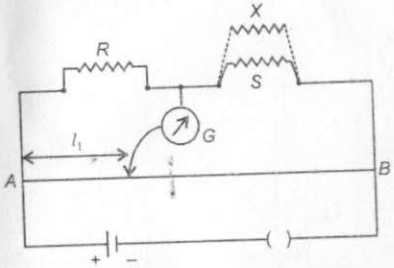
5. Two cells of emfs ε_1, ε_2 and internal resistance r_1 and r_2 respectively are connected in parallel as shown in the figure.
   [Foreign 2012]



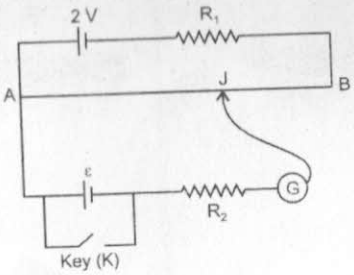
   Deduce the expression for
   (*i*) the equivalent e.m.f. of the combination,
   (*ii*) the equivalent resistance of the combination, and
   (*iii*) the potential difference between the points A and B.
6. Two cells of emf ε_1 and ε_2 having internal resistances r_1 and r_2 respectively are connected in parallel as shown. Deduce the expressions for the equivalent emf and equivalent internal resistance of a cell which can replace the combination between the points B_1 and B_2.
   [AI 2011 C]



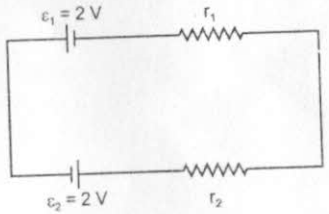
7. Define the terms (*i*) drift velocity, (*ii*) relaxation time.
   A conductor of length L is connected to a dc source of emf ε. If this conductor is replaced by another conductor of same material and same area of cross-section but of length $3L$, how will the drift velocity change ?
   [Delhi 2011]
8. State the underlying principle of a potentiometer.
   Describe briefly, giving the necessary circuit diagram, how a potentiometer is used to measure the internal resistance of a given cell.
   [Foreign 2011]
9. Two heating elements of resistances R_1 and R_2 when operated at a constant supply of voltage, V, consume powers P_1 and P_2 respectively. Deduce the expressions for the power of their combination when they are, in turn, connected in (*i*) series and (*ii*) parallel across the same voltage supply. [AI 2011]
10. (*i*) State the principle of working of a meter bridge.
    (*ii*) In a meter bridge balance point is found at a distance l_1 with resistances R and S as shown in the figure.
    When an unknown resistance X is connected in parallel with the resistance S, the balance point shifts to a distance l_2. Find the expression for X in terms of l_1, l_2 and S. [AI 2009]



11. (*a*) State the principle of working of a potentiometer.
    (*b*) Figure shows the circuit diagram of a potentiometer for determining the emf 'ε' of a cell of negligible internal resistance.



    (*i*) What is the purpose of using high resistance R_2 ?
    (*ii*) How does the position of balance point (J) change when the resistance R_1 is decreased ?
    (*iii*) Why cannot the balance point be obtained
    (1) When the emf ε is greater than 2V, and
    (2) When the key (K) is closed ?
    [Foreign 2009]
12. State Kirchhoff's rules. Use Kirchhoff's rules to show that no current flows in the given circuit. [Foreign 2009]



13. Prove that the current density of a metallic conductor is directly proportional to the drift speed of electrons. [Delhi 2008]
14. A number of identical cells, n, each of emf E, internal resistance r connected in series are charged by a d.c. source of emf E′, using a resistor R.
    (*i*) Draw the circuit arrangement.
    (*ii*) Deduce the expressions for (a) the charging current and (b) the potential difference across the combination of the cells.
    [Delhi 2008]