UNIT-1

QUESTION BANK ON ELECTROSTATICS

LEVEL-1 (1 MARK)

1.What is the basic cause of quantization of charge?

2.The test charge used to measure electric field at a point should be vanishingly small. Why?

3.At what points dipole field intensity is parallel to the line joining the charges?

4.Is the force acting between two point charges q_1 & q_2 at some distance in air, attractive or repulsive when (i) $q_1q_2 > 0$ (ii) q_1 & $q_2 < 0$?

5.When an electric dipole does placed in a non-uniform electric field experiences a zero torque but non-zero force?

6.If the radius of the Gaussian surface enclosing a charge halved, how does the electric flux through the Gaussian surface change?

7.Define electric dipole moment. Write its SI unit.

8.What is an ideal electric dipole?

9.On what factors does capacitance of parallel plate capacitors depends.

10.What is the dimensional formula of ε_0

LEVEL-1(2 MARKS)

11.State the law of conservation of charge. Give two examples to illustrate it.

12.An electric dipole is held in a uniform electric field.

13.Using suitable diagram ,show that it does not undergo any translatory motion, and

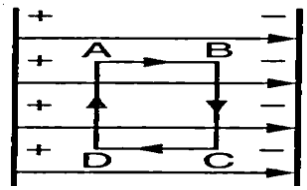
14.Derive an expression for the torque acting on it and specify its direction. When is this torque maximum?

15.Define electric flux. Write its SI unit. A charge q is enclosed by a spherical surface of radius R. If the radius is reduced to half, how would the electric flux through the surface change**?**

16.A hollow metal sphere of radius 10 cm is charged such that the potential on its surface is 5V. What is the potential at the centre of the sphere ?

17.If a point charge +q is taken first from A to C and then from C to B , points A and B lying on a circle drawn with another charge +q at its centre C, then along which path more work will be done ?

18.A uniform electric field E exists between two charged plates as shown in figure . What would be the work done in moving a charge particle ‘q’ along the closed path ABCD ?

a. 

19.No work is done in moving a test charge over an equipotential surface .Why ?

20.If electric field at a point is zero, can it have some value of electric potential and vice versa ?

21.Draw the plot showing the variation of (i)Electric field (E) and (ii) electric potential (V) with distance ‘r’ due to a point charge Q

22. Draw the equipotential surfaces due to an electric dipole .Locate the points where the potential due to dipole is zero.

23.Derive an expression for the capacitance of a parallel plate capacitor .

24. Distinguish between polar and non polar dielectrics . Give one example of each .

LEVEL-1 (3 MARKS)

25.Deduce the expression for the electrostatics energy stored in a capacitor of capacitance C , and having a

charge Q .How will the (i) energy stored (ii) electric field inside the capacitor be affected when it is completely filled with a dielectric material of dielectric constant K .

26.A capacitor is charged from a battery. Assuming that the capacitor is disconnected from the charging battery, explain how; (a) the capacitance, (b) p. d. across the plates and Energy stored in the capacitor change, when a medium of dielectric constant `k' is introduced between the plates.

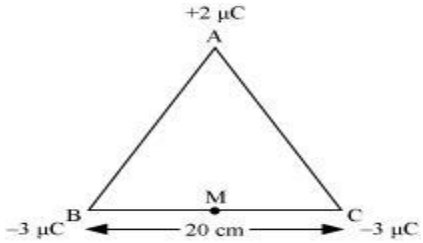
27.Using Gauss's theorem in electrostatics, deduce an expression for electric field intensity due to a charged spherical shell at a point (i) inside (ii) on its surface (iii) outside it. Graphically show the variation of electric field intensity with distance from the centre of shell.

28.An electric dipole of moment 2 x 10 - 8 C m is placed in an electric field of 5 x 10 -5 NC with its axis making an angle of 30^0 with the field. What is the torque acting on the dipole?

29.State the Gauss's theorem in electrostatics. Apply this theorem to derive an expression for electric field intensity at a point near an infinitely long straight charged wire.

30.Two point charges $4Q$, Q are separated by 1 m in air. At what point on the line joining the charges is the electric field intensity zero? Also calculate the electrostatic potential energy of the system of charges, taking the value of charge, $Q = 2 \times 10^{-7}$ C.

31.Three point charges of + 2 μC, − 3 μC and − 3μC are kept at the vertices A, B and C respectively of an equilateral triangle of side 20 cm as shown in the figure. What should be the sign and magnitude of the charge to be placed at the mid-point (M) of side BC so that the charge at A remains in equilibrium?



32.A thin conducting spherical shell of radius R has charge Q spread uniformly over its surface. Using Gauss's law, derive an expression for an electric field at a point outside the shell.Draw a graph of electric field $E(r)$ with distance r from the centre of the shell for $0 \leq r \leq \infty$.

33.When two capacitors are connected in series, the effective capacitance is 2.4μF and when connected in parallel, the effective capacitance is 10μF. Calculate the individual capacitances. (6 μF, 4 μF)

34.A parallel plate capacitor with air between the plates has a capacitance of 8 pF. The separation between the plates is now reduced by half and the space between them is filled with a medium of dielectric constant 5. Calculate the value of capacitance of parallel plate capacitor in second case. (80pF)

LEVEL-2 (1MARK)

1.What is work done in moving a charge between two points on an equipotential surface? (

2.Electric field is zero at appoint. Can electric potential be zero at this point? (not necessary)

3.Write a relation for polarization of a dielectric material in the presence of external electric field.

4.At what point is the electric dipole, field intensity (i) parallel and (ii) antiparallel to dipole moment of the dipole?

5.A 10μC charge is at the centre of a square of side 10 cm . Find the work done in moving the charge of 4 C between two diagonally opposite points on the square .(zero)

6.Define electric field intensity . Write its S.I. unit . Write the magnitude and direction of electric field intensity due to an electric dipole of length 2a at the midpoint of the line joining the two charges.

7.The force of attraction between two point charges placed at distance d apart in a medium is F. What should be the distance apart in the same medium so that the force of attraction between them becomes F/4 ? (2d)

8.Name the physical quantity whose SI unit is (i) coulomb/ volt (ii) newton/coulomb.

9.In a medium, the force of attraction between two point electric charges, distance d apart, is F. What distance apart should these be kept in the same medium so that the force between them becomes 3F? 10.What is the amount of work done in moving a 100nC charge between two points 5cm apart on an equipotential surface?

LEVEL-2 (2MARKS)

11.Can two equipotential surfaces intersect? Explain.

12.What is the work done by the field of a nucleus in a complete circular orbit of electron? What if the orbit is elliptical?

13.Prove that work done in moving a unit charge along a closed path in an electric field is zero.

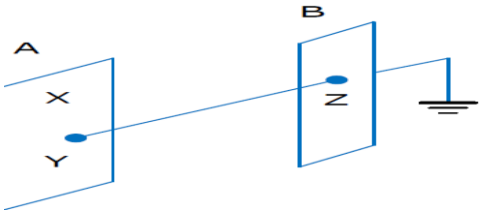
14.Obtain an expression for the electric potential at a point due to group of N point charges 15.Draw the equipotential surfaces due to an electric dipole . Locate the points where the potential due to dipole is zero.

16.Two point charges, q $=8\times10^{-8}$ C and Q= -2×10^{-8} C are separated by a distance of 10 cm in air.

a) Find at what distance from the Q, would the electric potential be zero.

b) What is the net electric field at the mid- point between the charges

17.Two identical plane metallic surfaces A and B are kept parallel to each other in air separated by a distance of 1.0 cm as shown in the figure. Surface A is given a positive potential of 10V and the outer surface of B is earthed.



What is the magnitude and direction of uniform electric field between point y and z? What is the work done in moving a change of 20 μC from point x to y?

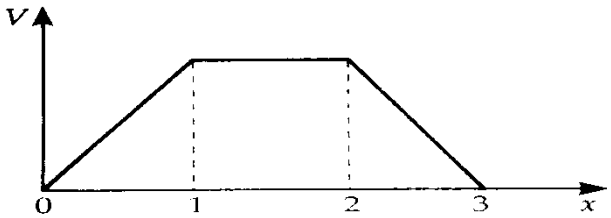
18.Can we have non-zero electric potential in the space, where electric field strength is zero?

19.An electric dipole of length 2 cm is placed with its axis making an angle 60 degrees with respect to a uniform electric field of 10^5 N/C. If it experiences a torque of 8 √3 Nm, calculate the

(i) magnitude of charge on the dipole, and

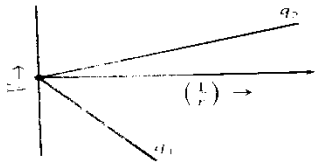
(ii) potential energy of the dipole.

20.The electric potential as a function is shown in fig. Construct a graph of electric field strength E.

b. 

(hint E= -dv/dr., E is -ve for 0<x<1, E=0 for 1<x<2and E is +ve for 2<x<3 .)

21.The two graphs given here shows the variation of electrostatic potential (V) with 1/r (r being the distance of the field from the point charges) for two charges q_1 and q_2 1. Which charge is having higher magnitude. 2.what is the sign of two charges.



LEVEL-2 (3 MARKS)

22.(a) Using Gauss' law, derive an expression for the electric field intensity at any point outside a uniformly charged thin spherical shell of radius *R* and charge density σ C/m^2. Draw the field lines when the charge density of the sphere is (i) positive, (ii) negative.

23.Show that in a uniform electric field, a dipole experiences only a torque but no net force. Derive an expression for the torque.

24.An electric dipole of length 10cm having charges ± 6 X 10^{-3} C, placed at 30^o with respect to a uniform electric field, experiences a torque of $6\sqrt{3}$ Nm. Calculate (a) magnitude of electric field (b) the potential energy of the dipole.

25.The electric field in a region can be expressed as

$$\vec{E} = \left(\frac{3}{5}\vec{i} + \frac{4}{5}\vec{j}\right)\left(2000\frac{N}{C}\right) .$$

Determine the flux of the field through a rectangular surface of area 0.2m^2, situated parallel to X-Y plane.

26.Two large thin metal plates are parallel and close to each other. On their inner faces, the plates have surface charge densities of opposite signs and of magnitude 17X 10^{-22} C-m^2. What is E

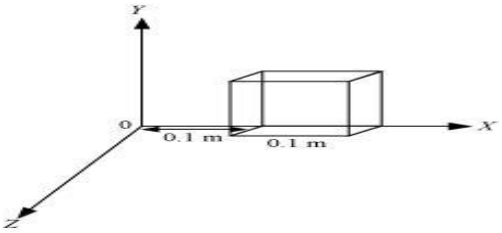
(a)To the left of the plates? (b)To the right of the plates? (c)In between the plates?

27.Two point charges q_A = 3 μC and q_B = -3 μC are located 20 cm apart in vacuum. What is the electric field at the mid-point O of the line joining the two charges?

28.If a negative test charge of magnitude 1.5 X 10^{-9} C is placed at this point, what is the force experienced by the test charge?

29.(a) Define electric flux. Write its SI unit.

(b) The electric field components due to a charge inside the cube of side 0.1 m are as shown:



$E_x = \alpha x$, Where α = 500 N/C − m

$E_y = 0$, $E_z = 0$

Calculate (i) the flux through the cube and (ii) the charge inside the cube

30.Define electric flux .write its SI unit.A Charge q is enclosed by a spherical surface of radius R .If the radius is reduced to half ,how would the electric flux through the surface charges ?

31.What is an electric polarization of a dielectric? What is the effect on capacitance of a capacitor when a dielectric of width 't' is placed between the two plates of parallel plate capacitor?

32.Three point charges of 1C, 2C & 3C are placed at the corners of an equilateral triangle of side 1m. Calculate the work done to move these charges to the corners of a smaller equilateral triangle of sides 0.5m.

LEVEL 3 (1 MARK)

1.In a parallel plate capacitor the capacitance increases from 4 μF to 80 μF on introducing a dielectric slab of thickness equal to plate separation. Calculate the dielectric constant of the medium. (Hint: C=εA/d)

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

3.In a medium, the force of attraction between two point electric charges, distance d apart, is F. What distance apart should these be kept in the same medium so that the force between them becomes 3F?

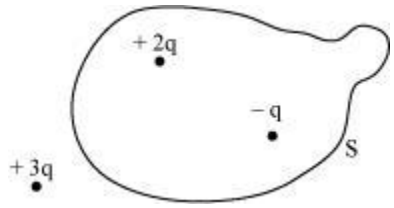
4.What is the amount of work done in moving a 100nC charge between two points 5cm apart on an equipotential surface?

5.Is it possible for a metallic sphere of radius 1cm to hold a charge of 1c?

6.It is advised to be inside a car or a bus than to stand under a tree during the thunder storm. Why?

7.Show that no work is done to move a charge on equipotential surface.

8.Figure shows three point charges +2q, −q and + 3q. Two charges + 2q and −q are enclosed within a surface 'S'. What is the electric flux due to this configuration through the surface 'S'?



9.The force of attraction between two point charges placed at distance d apart in a medium is F. What should be the distance apart in the same medium so that the force of attraction between them becomes F/4 ?

(2 MARKS)

10(i) Can two equipotential surfaces intersect each other? Give reasons.

(ii) Two charges −q and +q are located at points A (0, 0, −a) and B (0, 0, +a) respectively. How much work is done in moving a test charge from point P (7, 0, 0) to Q (−3, 0, 0)?

11.The electric field and electric potential at any point due to a point charge kept in air is 20 NC^{-1} and 10 JC^{-1} respectively. Calculate the magnitude of this charge.

12.The electric field E due to a point charge at any point near it is defined as, where q is the test charge and F is the force acting on it. What is the physical significance of $\lim_{q \to 0}$ in this expression? Draw the electric field lines of a point charge Q when (i) Q > 0 and (ii) Q < 0.

13.A spherical rubber balloon carries a charge that is uniformly distributed over its surface. As the balloon is blown up and increases in size, how does the total electric flux coming out of the surface change? Give reason.

14.A parallel plate capacitor with air between the plates has a capacitance of 8 pF . The separation between the plates is now reduced by half and the space between them is filled with a medium of dielectric constant5. Calculate the value of capacitance of parallel plate capacitor in second case. (80pF)

15.Two parallel plate capacitors of 20 μF and 30 μ F are charged to 30 V and 20 V respectively. If the plates of these capacitors with same type of charge are connected together. Find

(a) The common potential of the capacitor (b) Charges on the capacitor at common potential

(c)Loss of energy in the process (V=24volt, 480μC,720 μC, $6*10^{-4}$J)

16.Draw a graph showing the variation of potential with distance from the positive charge to negative charge of a dipole, by choosing the mid-point of the dipole as the origin.

17.Three electric charges -1μc,+2μc and +1μc are placed at the three vertices of an equilateral triangle of side 10cm .Find (a) the energy of the system (b) find the work done in separating the charges.

18.Apply Gauss theorem to calculate the electric field of a thin infinitely long straight line of charge, with a uniform charge density of ƛ C/m.

An infinite line charge produces a field of $9x10^4$ N/C at a distance of 2cm .calculate the linear charge density.

19.1A polythene piece rubbed with wool is found to have a negative charge of 3.2×10^{-7}C. (i) Estimate the number of electrons transferred.(ii) Is there a transfer of mass from wool to polythene?

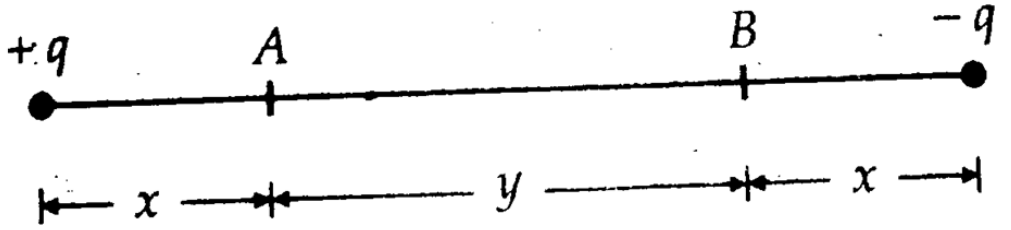
20.ABC is an equilateral triangle of side 10 cm. D is the mid-point of BC, charge 100 μC, – 100μC and 75 μC are placed at B, C and D respectively. What is the force experienced by a 1 μC positive charge placed at A? (3 MARKS)

21.Draw 3 equipotential surfaces corresponding to field that uniformly increases in magnitude but remains constant along Z-direction. How are these surfaces different from that of a constant electric field along Z-distances?

22.An infinite number of charges each equal to q are placed along the x axis at x=1,x=2,x=4…..and so on.(i) Find the potential at a point x=0 due to this set of charges (ii) What will be the potential if in the above set up the consecutive charges have opposite signs?

23.A charge Q is distributed over two hallow concentric spheres of radii r and R, where R>r ,such that the surface charge densities are equal. Find the potential at a common center?

24.In the given figure the potential at points A and B are V_A and V_B respectively. Calculate V_A and V_B for the given

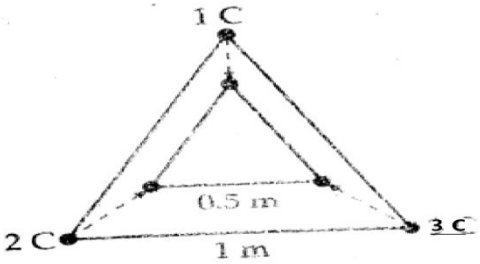


arrangement.

(hint $V_A = V_{B=}$ Kqy/x(x+y)

25. A 600pF capacitor is charged by a 200V supply. It is then disconnected from the supply and is connected to another uncharged 600pF capacitor how much electrostatic energy is lost in the process?

26.Three point charges of 1C,2C and 3C are placed at the corners of an equilateral triangle of side 1m.Calculate the work required to be done to move the charges to the corners of a smaller equilateral triangle of side 0.5m.



Ans $w = 99 \times 10^9$ J.

26.N spherical droplets each of radius r, have been charged to have a potential of V each. If all these drops have to coalesce to form a single large droplet , what would be the potential of this large drop? (given- capacitance of sphere of radius x $=4\pi\varepsilon_0 kx$).

a.(Hint :$R=N^{1/3}r$, $V' = N^{2/3}V$)

27.Keeping the voltage of a charging source constant , what would be the %change in the energy stored in the parallel plate capacitor if the separation between its plate were to be decreased by 10%? (Ans11.11%)

28.A uniform electric field $E=E_X$ i N/C for x>0 and$E = -E_x i$ for x<0.A right circular cylinder of length, L cm and radius r cm has its center at origin and its axis along the x-axis. Find out the net outward flux .Using the Gauss,law write the expression for the net charge within the cylinder.

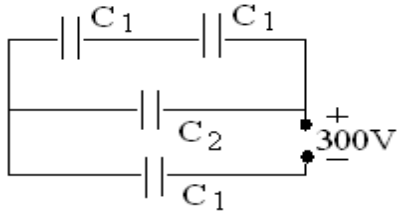
29.A uniformly charged conducting sphere of diameter 2.5 m has a surface charge density of 100μC/m^2 .Calculate the (i)charge on the sphere and (ii)total electric flux through the sphere

30. Find the expression for the capacitance of a parallel plate capacitor of area A and plate separation d if i) a dielectric slab of thickness t, and ii) a metallic slab of thickness t, where (t<d) are introduced one by one between the plates of the capacitor. In which case would the capacitance be more and why?

5 marks question

1.Derive the expression for the potential due to a dipole. Find the potential along the equatorial and axial line of a dipole.

2.In the given network C1 =200pF and C2 = 100pF. Calculate (i) equivalent capacitance of the network and (ii) energy stored in the network of capacitors



(ans: C= 100pF, E= $4.5*10^{-2}$J)

3.A dielectric slab of thickness t introduced between the plates of a parallel plate capacitor separated by a distance d. (t < d). Derive an expression for the capacitance of the capacitor.

4.Explain the effect of introducing a dielectric slab between the plates of a parallel plate capacitor on its capacitance. Derive an expression for its capacitance with a dielectric as the medium between the plates.

5.A parallel plate capacitor of plate area A and separation d is charged to a potential V. The battery is then disconnected and a dielectric slab of thickness d and dielectric constant K is inserted in the capacitor .What change if any, will take place in

i. Charge on the plates.
ii. Voltage across the capacitor.
iii. Electric field between the plates.
iv. Capacitance of the capacitor.
v. Energy stored. Justify your answer in each case.

6.Using Gauss theorem derive the expression for electric field intensity due to a charged spherical shell at point
(a) on the surface of spherical shell (b) inside the shell. (c) out side the shell.

7.Derive an expression for dipole field intensity at any point on (a)axial line of dipole. (b)equatorial line

8.Derive an expression for the work done in rotating an electric dipole from angle α_1 to α_2 in a uniform electric field E. Hence find the work done when the dipole is
(i) initially parallel to the field and
(ii) initially perpendicular to the field.

9.(i) Define electric flux. Write its SI unit.Using Gauss's law, prove that the electric field at a point due to a uniformly charged infinite plane sheet is independent of the distance from it. How is the field directed, if
(a) the sheet is positively charged (b) negatively charged?

10.An oil drop of 12 excess electrons is held stationary under a constant electric field of 2.55 $X10^4$N/C in Millikan's oil drop experiment. The density of the oil is 1.26 g/cc. Estimate the radius of the drop.

11.A free pith ball of 8g carries a positive charge of 5 X 10^{-8} C. What must be the nature and magnitude of charge that should be given to a second pith-ball fixed 5 cm vertically below the former pith-ball so that the upper pith-ball is stationary?

UNIT II CURRENT ELECTRICITY

ONE MARK QUESTIONS **LEVEL 1 :**

1.How does the drift velocity of electrons in a metallic conductor vary with increase in temperature?

2.A wire of resistively ρ is stretched to three its initial length, what will be its new resistively.

3.Constantan is used for making the standard resistance. Why?

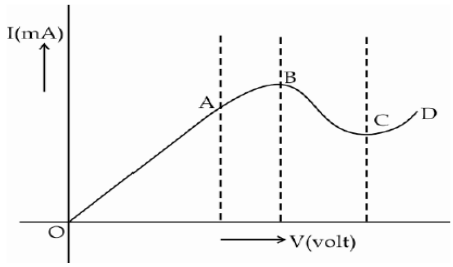
4.Define mobility . Give its SI unit.
5.On which conservation principle Kirchoff's laws are based.
6.Can Kirchoff's rules can be applied to both d.c. and a.c.
7.The colours of four bands are yellow, violet, brown and gold. What is the resistance.
8.Define electrical conductivity of a material . Give its SI units.
9.How drift velocity is related to current flowing through the conductor.
10.Why are the connecting resistors in a metre Bridge made of thick copper strips ?

LEVEL 2 :

11. How will you join three resistances, each of 2 ohm so that the effective resistance is 3 ohm?
12. How does the random motion of free electrons in a conductor get affected when a potential difference is applied across its ends?
13. Why the terminal Potential is always less than EMF of a cell, while in use?
14. You are asked to measure e.m.f of a cell. Which instrument will you use? A high resistance Voltmeter or Potentiometer and why?
15. State the Condition under which the terminal potential difference across a battery and its emf are equal.
16. Why is copper not used for making potentiometer wires ?
17. How does the relaxation time of electron in the conductor change when temperature of the conductor decreases

18. In the given graph of voltage vs current for a semiconductor,

Identify the negative resistance region.



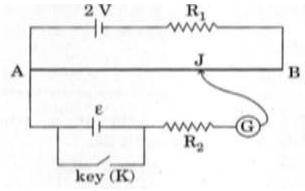
19.Of which material normally the potentiometer & meter bridge wire made and why?
20. Plot a graph showing variation of current vs voltage for the a diode.

LEVEL 3

21. Can the terminal potential difference of a cell exceed its emf? Give reason for your answer.
22. Name the physical quantity measured by potential gradient.
23. Two wire of equal length one copper and manganin have same resistance , which wire is thicker?
24. The emf of the driving cell used in the main circuit of the potentiometer should be more than the P.D. to be measured. Why ?
25. Why a ten wire potentiometer more sensitive than a four wire one? Why should jockey be not rubbed against the potentiometer wire ?
26. Figure shows the circuit diagram of a potentiometer for

determining the emf ε of a cell of negligible interna

resistance. What is the purpose of using high resistance R_2



27. What happens if the galvanometer and cell are interchanged at the balance point of the bridge? Would the galvanometer show any current?
28. In an experiment on metre bridge, if the balancing length is X, what would be its value ,when the radius of the meter bridge wire is doubled ? Justify your answer.

29.A cell of emf 2 V and internal resistance 0.1**Ω** is connected to a 3.9 **Ω** external resistance. What will be the potential difference across the terminals of the cell?

TWO MARK QUESTIONS

LEVEL 1 :

1.Name the material used for making standard resistors? Give two reasons.

2.Given any two limitations of Ohm's law.

3.State Kirchhoff s rules. Explain briefly how these rules are justified.

4.A P.D of 30V is applied across a colour coded carbon resistor with rings of blue, black and yellow colours. What is the current to the resistor?

5.Mention two factors on which the internal resistance of a cell depends .

6.Show graphically the variation of resistivity with temperature for

(a) Metals (Cu) (b) alloys (nichrome)

7.Establish a relation between current and drift velocity.

8.State the principle of potentiometer. Draw a circuit diagram used to compare the e.m.f. of two primary cells.

9.Distinguish between emf and terminal P.D. of a cell. What are their units.

10. Derive net emf of two cells connected in series.

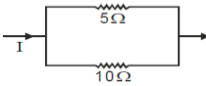
LEVEL 2:

11. What happens to the drift velocity (v_d) of electrons and to the resistance R if length of a conductor is doubled (keeping potential difference unchanged)?

12.A conductor of length L is connected to a DC source of emf .If this conductor is replaced by another conductor of same material and same area of cross section , but length is 3L.How will the drift velocity change?

13. Draw a plot showing the variation of terminal voltage (V) vs the current (I) drawn from the cell. Using this plot, how does one determine the internal resistance of the cell ?

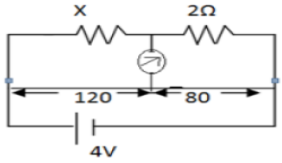
14. In the arrangement of resistors shown, what fraction of current I will pass through 5Ω resistor?



15.In a meter bridge, two unknown resistances R and S when connected in the two gaps, give a null point at 40 cm away from one end. What is the ratio of R and S?

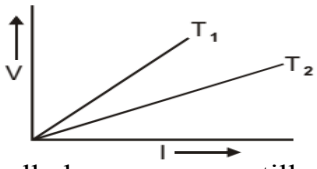
16.In a potentiometer arrangement, a cell of emf 1.25 V gives a balance point at 35.0 cm length of the wire. If the cell is replaced by another cell and the balance point shifts to 63.0 cm, what is the emf of the second cell?

17.Find the value of the unknown resistance X and the current drawn by the circuit from the battery if no current flows through the galvanometer. Assume the resistance per unit length of the wire is $0.01\Omega cm^{-1}$.



(Ans X = 3Ω)

18.V – I graph for a metallic wire at two different temperatures T_1 and T_2 is as shown in the figure. Which of the two temperatures is higher and why?



19.If the electron drift speed is so small ($\sim 10^{-3}$m/s) and the electron's charge is very small, how can we still obtain a large amount of current in a conductor.

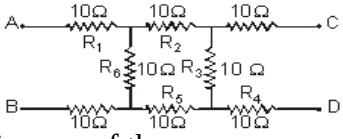
20.A large no. of free electrons are present in metals. Why is there no current in the absence of E.F across it ,but there is a current in the presence of E.F.?

LEVEL 3 :

21. Estimate the average drift speed of conduction electrons in a copper wire of cross section area 2.5 X $10^{-7}m^2$ carrying a current of 2.7A. Assume the density of conduction electrons to be 9 x 10^{28} m^3.

(Ans : 7.5 x10^{-4} m/s)

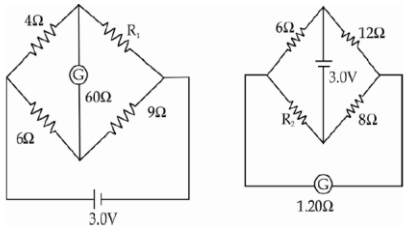
22,What will be the equivalent resistance between the two points A and D of figure?



(Ans 30 ohm)

23. You are required to find the resistivity of a given wire in the laboratory. Draw a circuit diagram of the apparatus you will use to determine it . Give the formula used.

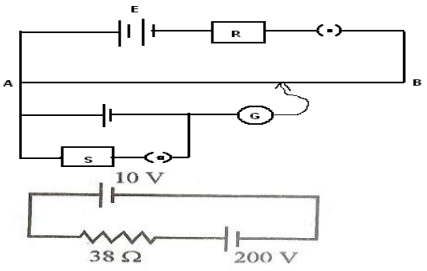
24. Figure shows two circuits each having a galvanometer and a battery of 3V.



When the galvanometer in each arrangement do not show any deflection ,obtain the

ratio $\frac{R1}{R2}$. **(Ans $\frac{R1}{R2}$.=3/2)**

25. Two students X and Y perform an experiment on potentiometer separately using the circuit diagram shown here. Keeping other things unchanged (i) X increases the value of resistance R.
(ii) Y decreases the value of resistance S in the set up.
How would these changes affect the position of the null point in each case and why?

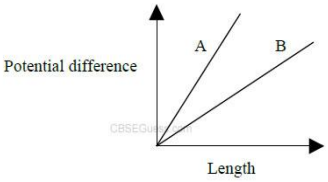


26.A 10V battery of negligible internal resistance is connected across a 200 V battery and a resistance of 38 Ω as shown in fig. find the value of current ?

27.Find the value of unknown resistance X in the given circuit, if no current flows through the section AD. Also calculate the current drawn by the circuit from the battery of emf 6.0 V and negligible internal resistance.

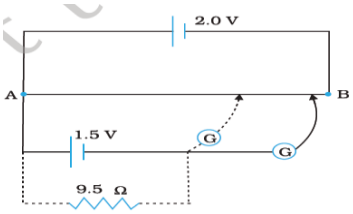
(Ans : X = 6 Ω , I = 1A)

28.The variation of potential difference V with length l in case of two potentiometers A and B is as shown. Which one of these will yo prefer for comparing emfs of two cells and why?



(Ans : Slope = V/L = k , $k_A > k_B$

29. Figure shows a 2.0 V potentiometer used for the determination of internal resistance of a 1.5 V cell. The balance point of the cell in open circuit is 76.3 cm. When a resistor of 9.5 Ω is used in the external circuit of the cell, the balance point shifts to 64.8 cm length of the potentiometer wire. Determine the internal resistance of the cell.



(Ans r = ($\frac{l1}{l2}$ -1) R , r = 1.7 Ω)

30.A cell of e.m.f. 'E' and internal resistance 'r' is connected across a variable resistor 'R'. Plot a graph showing the variation of terminal potential 'V' with resistance 'R'. Predict from the graph the condition under which 'V' becomes equal to 'E'.

3 Marks Questions

LEVEL 1

1.State Kirchhoff's Rules for an electrical circuit. Hence obtain the balanced condition of Wheatstone bridge.
2.How Meter Bridge can be used to find unknown resistance. Hence how will you calculate resistivity of the material?
3.Give the principle of potentiometer .With the help of a circuit diagram explain how it can be used to compare emf of two cells
4.What do you mean by the potential gradient? Give its SI units. How sensitivity of potentiometer depends on potential gradient.

5.(i)How sensitivity of a potentiometer can be increased
(ii) Draw a graph between pot. Difference and length of potentiometer wire.
(iii) Why 10 wire potentiometer is preferred over 4-wire potentiometer.
6.What is meant by 'drift velocity of free electrons'? Derive Ohm's law on the basis of the theory of the electrons.
7.You are given 'a' resistors, each of resistance 'r'. These are first connected to get minimum possible resistance. In the second case, these are again connected differently to get maximum possible resistance. Compute the ratio between the minimum and maximum values of resistance so obtained?
8.Draw a circuit diagram using a meter bridge and write the necessary mathematical relation used to determine the value of an unknown resistance. Why cannot such an arrangement be used for measuring very low resistances?

9.Define specific resistance. Write its SI unit. Derive an expression for resistivity of a wire in terms of its material's parameters, number density of free electrons and relaxation time.

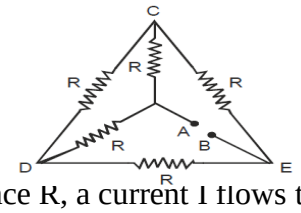
10.Derive the mathematical relation between mobility and drift velocity of charge carrier in a conductor. Name the charge carrier responsible for the conduction of e,ectric current in (i) an electrolyte (ii) an ionized gas.

LEVEL 2

11. In the following circuit , a metre bridge is shown in its balanced state.The metre bridge wire has a resistance of 1Ω/cm. Calculate the valueof the unknown resistance X and the current drawn from the battery of negligible internal resistance.

(Ans X= 4 Ω, I = 0.66 A)

12.(i) Calculate Equivalent Resistance of the given electrical network between points A and B.
(ii) Also calculate the current through CD & ACB if a 10V d.c source is connected between point A and B and the value of R = 2Ω.



(Ans : R_{AB} = 2Ω I_{CD} = 0, I_{ACB}= 2. 5A)

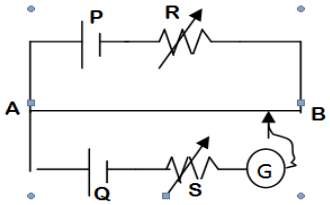
13.When a battery of emf E and internal resistance r is connected to a resistance R, a current I flows through it. Derive a relation between E, I, r and R.

14.Define electrical resistivity and write down the factors on which it depends

15.What is the difference between the emf and terminal potential difference of a cell. Can value of potential difference be greater than emf of the cell.

16.Discuss the grouping of 2 unidentical cells in series and parallel and find their equivalent emf and internal resistances .

17.In the potentiometer circuit shown, the balance point is at X.
State with reason where the balance point will be shifted when
(a)Resistance R is increased, keeping all parameters unchanged.
(b)Resistance S is increased keeping R constant.
(c)Cell P is replaced by another cell whose emf is lower than thatof that cell Q.

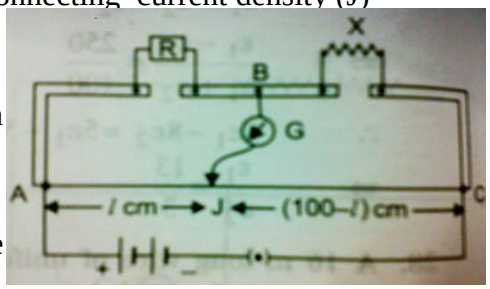


18.Define the terms resistivity and conductivity and state their S.I. units. Draw a graph showing the variation of resistivity with temperature for a typical semiconductor.

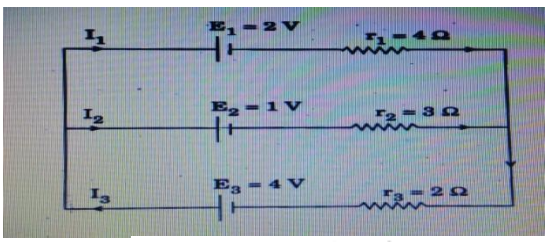
19.Explain how does the conductivity of a :
(i) Metallic conductor (ii) Semi conductor and (iii)Insulator varies with the rise of temperature

20.Define the term current density of a metallic conductor. Deduce the relation connecting current density (J) and conductivity (σ) of the conductor, when an electric field E is applied to it

LEVEL 3



21.A resistance R = 4Ω is connected to one of the gaps in a meter bridge, which uses a wire of length 1 m. An unknown resistance X > 4Ω is connected in the other gap as shown in the figure. The balance point is noticed at 'l' cm from the positive end of the battery. On interchanging R and X, it is found that the balance point further shifts to 20 cm (away from the end A). Neglecting the end corrections, calculate the value of unknown resistance 'X' used.**(Ans: 6 Ω)**

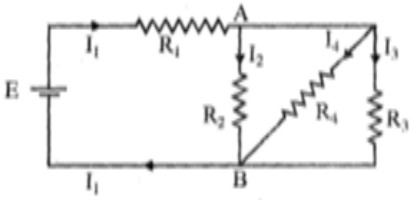


22. State Kirchhoff's rules. Use these rules to write the expressions for the current I_1, I_2 and I_3 in the circuit diagram shown.

(Ans: I_1=2/13 A I_2 = 7/13 A I_3 = 9/13 A)

23.In the circuit shown, R_1 = 4 Ω, R_2 = R_3 =15 Ω, R_4 = 30 Ω and E = 10 V. Calculate the equivalent resistance of the circuit and the current in each resistor.

Ans: R=10 Ω, I_1=1 A, I_2 = 0.4 A I_3 = 0.4 A I_4=0.2 A

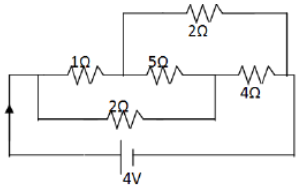


24.A battery of 10 V and negligible internal resistance is connected across the diagonally opposite corners of a cubical network consisting of 12 resistors each of resistance 1 Ω . Determine the equivalent resistance of the network and the current along each edge of the cube. (**Ans: R=5/6 Ω, I=2 A, I/2 = 1A**)

25.Calculate the electrical energy in SI units consumed by a 100 W bulb and a 60 W fan connected in parallel in 5 minutes.

26.A wire of resistance 4R is bend in the form of circle .What is the effective resistance between the ends of diameter?.**(Ans: R)**

27.Calculate the current drawn from the battery in the given network.



(Ans I= 1 A)

28.The resistance of a platinum wire at 0^0C is 4 Ω. What will be the resistance at 100^0C, if the temperature coefficient of resistance is 0.0038 /^{0}C

(Ans:R_t = 5.52 Ω Result : The resistance increases with the temperature.)

29.A cell of emf E and internal resistance r is connected to two external resistances R_1 and R_2 and a perfect ammeter. The current in the circuit is measured in four different situations :

(i) Without any external resistance in the circuit. **(ii)** With resistance R_1 , only (iii) With R_1 and R_2 in series combination **(iv)**With R_1 and R_2 in parallel combination

The currents measured in the four cases are 0.42 A, 1.05 A, 1.4 A and 4.2 A, but not necessarily in that order. Identify the currents corresponding to the four cases mentioned above.

30.A potential difference V is applied to a conductor of length l, diameter d. How are the electric field e, the drift velocity v_d and resistence R affected when (i) V is doubled (ii) l is doubled (iii) d is doubled.

5Marks Questions

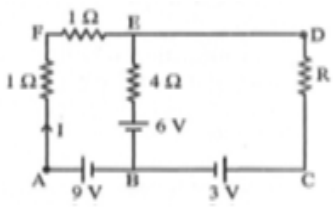
1.State the principle of potentiometer. Explain and draw a circuit diagram used to compare the e.m.f. of two primary cells.Why potentiometer is known as ideal voltmeter? How can the sensitivity of a potentiometer be increased?

2.(i) Establish a relation between drift velocity of an electron in a conductor of cross section A carrying current I and concentration 'n' of free electrons per unit volume of conductor.

(ii) Define the term resistivity and write its S.I unit. Derive the expressions for the resistivity of a conductor in terms of number density of free electrons and relaxation time.

3.(a) State and explain the kirchoff's rules for an electrical network.

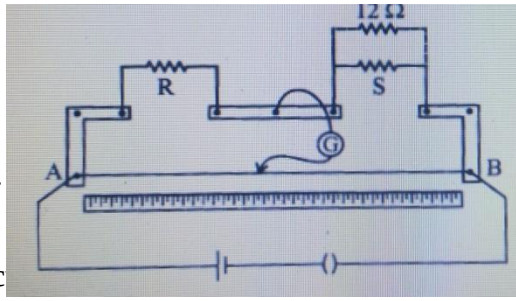
(b) Using Kirchoff's rules determine the value of unknown resistance R in the circuit so that no current flows through 4Ω resistance. Also find the potential difference between A and D



(Ans: R= 2 Ω, V_{AD} = 3 V)

4.(i) State with the help of circuit diagram the working principle of Meter Bridge. Obtain the expression for determing the unknown resistance.

(ii) In a meter bridge (Fig), the null point is found at a distance of 40 cm from A. If now a resistance of 12Ω is connected in parallel with S, the null point occurs at 50 cm. Determine the values of R and S.



(Ans: (b) R=4 Ω , S=6 Ω)

5.State the working principle of a potentiometer. Explain, with the help of a circ two primary cells are compared by using a potentiometer. Why is the use potentiometer preferred over that of a voltmeter for the measurement of emf of a cell?

6.State the principle of meter bridge Draw a circuit diagram for a meter bridge two determine the unknown resistance of a resistor why are the connections between the resistors of a meter bridge made of thick copper strips? Find the shift in the balance point of a meter bridge, when the two resistors in the two gaps are interchanged.

VALUE BASED QUESTIONS (4marks questions)

1.While performing an experiment on determination of unknown resistance using a metre bridge, Rahul obtained deflection in the galvanometer in the same direction even after repeated adjustments in the circuit and thus could not get any results. In order to avoid getting noticed and scolded by the teacher, he pretended having performed the experiment and copied the readings by another student.

Answer the following questions based on the above information :

(a)Write the possible reasons for getting the deflection in the galvanometer in the same direction.

(b) Which two values is Rahul violating in copying the readings from another student ?

(c)What is your opinion should have Rahul done in the given circumstances

2.Prof Kumar conducts an interview to select a physics teacher and asks the following two questions from every candidate :

(a) Why should a potentiometer be preferred over a voltmeter for measurement of emf of a cell?

(b) Why should a ten wire potentiometer be preferred over a four wire potentiometer?

There was a strong recommendation for candidate X who could not answer many questions including the above two. However, another candidate Y did not have any recommendations but replied most of the questions correctly. Prof Kumar recommended the selection of candidate Y ignoring completely the recommendation for the other candidate. Answer the following questions on the basis of given information:

(a)Write in your own words , the answer to the above two questions asked by Prof Kumar.

(b)Which values are displayed by Prof Kumar in the selection of teacher?

(c)Suggest one activity to promote any one of the values displayed by Prof Kumar.

3.During an experiment on determination of internal resistance of a primary cell using a potentiometer, Sohan obtained null point beyond the length of potentiometer wire, even after repeated adjustments in the circuit and thus could not get any results. He then went to his teacher and carefully understood the reason and then completed the experiment. Answer the following questions based on the above information :

(a)Write the possible reasons for getting balance point beyond the length of potentiometer wire

(b)Write two values displayed by Sohan

(c)What may be the possible corrections by the teacher.

4.Two Brothers Schin and Arjun , purchased an electric iron. Sachin insisted on using the new iron with a two pin plug which was available in the house. Arjun advised him to use it with a 3-pin plug only. Sachin got angry. But Arjun calmed down Sachin and patiently explained him the importance of using 3-pin plug. Answer the following questions on the basis of given information :

(a)Write one values each , being displayed by the Arjun and Sachin .

(b)Why we should use 3-pin plug instead of 2-pin plug ?

(c)Why a high tension source (HT) supply of 6kV must have a very large resistance.

5.Mrs. Sharma parked her car and forgot to switch off the car headlights. When she returned, she could not start the car Rohit a passerby, came to her for help. After knowing about the problem, he went to nearby garage and call mechanic Ramu. Ramu noticed that the car battery has been dis charged as headlight were left on for a long time. He brought another battery from his garage and connected its terminals to the terminals of the car battery. He succeeded in starting the engine and then disconnected his battery. This is called ‘jump starting’, Mrs. Sharma felt happy and thanked both rohit and ramu. answer the following questions based on the above information:

(a)What values were displayed by rohit?

(b)A storage battery of emf 12V and internal resistance 0.5ohm Is to be charged by a battery charger which supplies 110V dc. How much resistance must be connected in series with the battery to limit the charging current to 5A. what will be the p.d. across the terminals of the battery during charging? What is the purpose of having a series resistor in the charging circuit?