NATIONAL ACADEMY FOR LEARNING

2023-24

REVISION WORKSHEET

<u>1Mark</u>

1. For a metallic conductor, what is the relation between current density (j), conductivity s and electric field intensity E**.**
2. Name the materials which obey ohm's law.
3. What is meant by drift speed of free electrons
4. Calculate the electric current density in a uniform wire connected to a battery of emf 3.5V and negligible internal resistance. The resistance of the wire is 2 ohm and area of cross section is 0.70×10^{-6} m^2.
5. State the physical condition in which ohm's law is not valid for a conductor.
6. What is the unit of electrical conductance?
7. State ohm's law
8. Write the vector equation connecting current density j with electric field intensity E, for an ohmic conductor.
9. What are the factors on which the resistivity of a material depends.
10. Give an expression for the drift velocity of free electrons.

2Mark

11. Draw labelled graphs to show how electrical resistance varies with temperature for: i) A metallic wire ii) A piece of carbon
12. What is current density? Write the vector equation connecting current density j with electric field intensity E, for an ohmic conductor.
13. A potential difference of V volt is applied across a copper wire of length L and diameter d. How will the drift velocity be affected if i) V is double ii) *L* is doubled.
14. When a potential difference of 3V is applied between the two ends of a 60 cm long metallic wire, current density in it is found to be $1 \times 10^{-7} A/m^2$. Find conductivity of the material of the wire in SI system.
15. Name one material whose resistivity decreases with rise in temperature. Explain briefly on the basis of free electron theory why the resistivity decreases.

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REVISION WORKSHEET

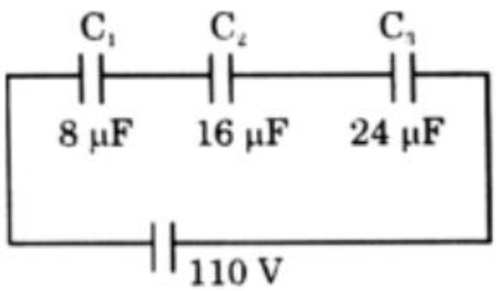
ELECTRIC POTENTIAL AND CAPACITANCE

1 Mark

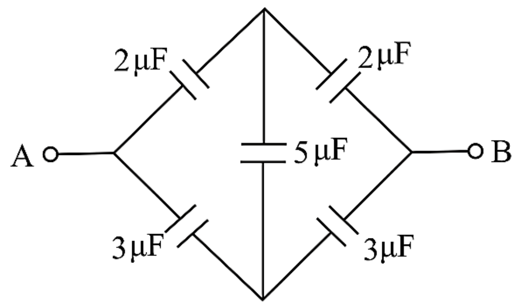
1. Define Capacitance of a conductor.
2. How much work is done in taking an electron around a nucleus in a circular path.
3. In an electric dipole, at which point is the electric potential zero?
4. Define equipotential surface.
5. How much work will be done by an external agent to turn an electric dipole of moment p through i) 90^0 ii) 180^o
6. A parallel plate air capacitor has a capacitance of 5μF. It becomes 50μF when a dielectric medium occupies the entire space between its two plates. What is the dielectric constant of the medium?
7. Assuming earth to be an insulated spherical conductor of radius 6400 km. Calculate its capacitance.

2 Mark

8. You are provided with 8 μF capacitors. Show with the help of a diagram hoe will you arrange them to get a resultant capacitance of 20 μF.
9. A capacitor is connected to a battery. If we move its plates further apart, work will be done against the electrostatic attraction between the plates. What will be the effect on the energy of the capacitor.
10. A capacitor is charged and the charging battery is removed. A slab of dielectric is then introduced between the plates of the capacitor. How will the electric field between the plates be affected? Why?
11. Find the electric charge Q_1 on plates of capacitor C_1 shown in figure below (Ans : 48×10^{-5} C)



12. Find the equivalent capacitance between A and B.



Ans: 2.5 μF

13. An electric flash lamp has 20 Capacitors each of capacitance 5 μF connected in parallel. The lamp is operated at 100 Volt. Calculate how much energy will be radiated in a flash? (0.5 J)
14. Draw a diagram to show the electric lines of force due to an electric dipole. What will be the net electric force acting on an electric dipole placed in a uniform electric field.
15. An isolated 16 μF parallel air capacitor has a potential difference of 1000V. A dielectric slab having relative permittivity 5 is introduced to fill the space between two plates completely. Calculate the new capacitance of the capacitor. (80μF)

Important Points to Remember on Capacitors and Dielectrics

1. Electrostatic potential:

(i) Electrostatic force is a conservative force. Work done by an external force in bringing a charge q from a point R to a point P is $U_P - U_R$ which is the difference in potential energy of charge q between the final and initial points.

(ii) Potential at a point is the work done per unit charge (by an external agency) in bringing a charge from infinity to that point. If potential at infinity is chosen to be zero, potential at a point with position vector r due to a point charge Q placed at the origin is given is given by, $V(r) = \frac{1}{4\pi\varepsilon_o} \frac{Q}{r}$

(iii) The electrostatic potential at a point with position vector r due to a point dipole of dipole moment $\boldsymbol{P}$ placed at the origin is, $V(r) = \frac{1}{4\pi\varepsilon_o} \frac{\boldsymbol{P} \cdot \hat{r}}{r^2}$

(iv) For a charge configuration $q_1, q_2, \ldots, q_n$ with position vectors $r_1, \;\; r_2, \ldots r_n$ the potential at a point P is given by the superposition principle, $V = \frac{1}{4\pi\varepsilon_0}\left(\frac{q_1}{r_{1p}} + \frac{q_2}{r_{2P}} + \ldots + \frac{q_n}{r_{nP}}\right)$ where $r_{1\mathrm{P}}$ is the distance between q_1 and P, as and so on.

(v) An equipotential surface is a surface over which potential has a constant value. The electric field E at a point is perpendicular to the equipotential surface through the point.

2. Electrostatic potential energy:

(i) Potential energy stored in a system of charges is the work done (by an external agency) in assembling the charges at their locations. Potential energy of two charges q_1, q_2 at $r_1, \; r_2$ given by, $U = \frac{1}{4\pi\varepsilon_0} \frac{q_1 q_2}{r_{12}}$ where r_{12} is distance between q_1 and q_2.

(ii) The potential energy of a charge q in an external potential $V(r)$ is $qV(r)$. The potential energy of a dipole moment $\boldsymbol{p}$ in a uniform electric field $\boldsymbol{E}$ is $-\boldsymbol{p} \cdot \boldsymbol{E}$

3. Conductor in electrostatic field:

Electrostatics field $\boldsymbol{E}$ is zero in the interior of a conductor, just outside the surface of a charged conductor, $\boldsymbol{E}$ is normal to the surface given by $\boldsymbol{E} = \frac{\sigma}{\varepsilon_0}\hat{\mathbf{n}}$ where $\hat{\boldsymbol{n}}$ is the unit vector along the outward normal to the surface and σ is the surface charge density.

4. Capacitor:

(i) A capacitor is a system of two conductors separated by an insulator. Its capacitance is defined by $C = Q/V$ where Q and $-Q$ are the charges on the two conductors and V is the potential difference between them.

(ii) For a parallel plate capacitor (with vacuum between the plates), $C = \varepsilon_0 \frac{A}{d}$ where A is the area of each plate and d the separation between them.

(iii) If the medium between the plates of a capacitor is filled with an insulating substance (dielectric), the net electric field inside the dielectric and hence the potential difference between the plates is reduced. Consequently, the capacitance C increases from its value C_0. When there is no medium (vacuum), $C = KC_0$ where K is the dielectric constant of the insulating substance.

5. Combination of capacitors:

(i) For capacitors in the series combination, the total capacitance C is given by: $\frac{1}{C} = \frac{1}{C_1} + \frac{1}{C_2} + \frac{1}{C_3} + \ldots$
where $C_1, C_2, C_3 \cdots$ are individual capacitances.

(ii) In the parallel combination, the total capacitance C is: $C = C_1 + C_2 + C_3 + \ldots$
where $C_1, C_2, C_3 \cdots$ are individual capacitances.

6. Energy stored in capacitor:

(i) The energy U stored in a capacitor of capacitance C, with charge Q and voltage V is $U = \frac{1}{2}QV = \frac{1}{2}CV^2 = \frac{1}{2}\frac{Q^2}{C}$

(ii) The electric energy density (energy per unit volume) in a region with electric field is $(1/2)\varepsilon_0 E^2$.