Blue Print (As per PU Board)

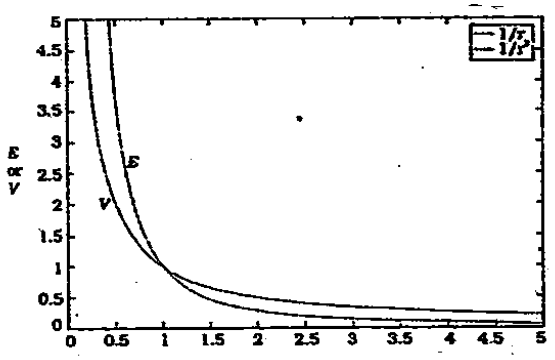
Topic	1 mark questions	2 marks questions	3 marks questions	5 marks questions	Total Marks
Electrostatic Potential & Capacitance	–	1	2	2	18

One mark questions

1. **What is an equipotential surface?**
   Answer: It 8is a surface with a constant value of potential at all points on the surface.
2. **Define potential energy of a point charge** $'q'$ **in an external electric field** $'E'$
   Answer: It is defined as the product of the charge and the potential at a given point.
   $U_q = V_r \times q$
3. **In the derivation for the potential energy of a dipole in an external field, why** $\theta_v = \pi/2$ **is assumed?**
   Answer: The work done against the external field E in bringing $+q$ and $-q$ are equal and opposite and they cancel out. That is $q\left[V(r_1) - V(r_2)\right] = 0$
4. **Define electron volt.**
   Answer: Electron volt is defined as the work done in accelerating an electron through a potential difference of $1V$.

Two marks questions

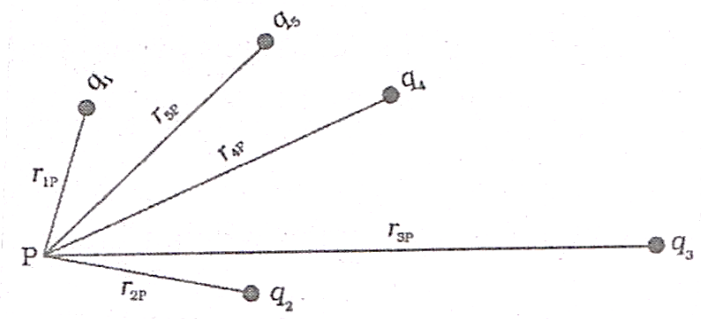
5. **What is electrostatic shielding? Mention one application of electrostatic shielding**.
   Answer: There is no electric field inside a hollow spherical conductor. This process in which a region free from electric field is produced is called electrostatic shielding. (1 mark)
   Electrostatic shielding is used to protect highly sensitive electric instruments. They can be placed inside a hollow metallic box. Since there is no electric field inside the box and the box prevents any external field from entering inside it, the sensitive electric instruments are protected. (1 mark)
6. **What are the factors on which the capacitance of a capacitor depends?**
   Answer: It depends on
   (i) The geometrical configuration of capacitor (1 mark)
   (ii) The dielectric medium between the plates (1 mark)
7. **On what factors the capacitance depends?**
   Answer: It depends on (a) geometrical configuration of capacitor and
   (b) the dielectric medium between the plates
8. **Draw the curves representing the variation of electrostatic potential and field with distance of the point.**
   Sol:



Three marks questions

9. Arrive the expression for the potential due to a system of charges.

Answer:



Consider a system of charges $q_1, q_2, q_3, ...q_n$ with position vectors $r_1, r_2, r_3, ...r_n$

The potential due to q_1 is $V_1 = \frac{1}{4\pi\varepsilon_0}\frac{q_1}{r_{1p}}$ where r_{1p} = distance between q_1 and p

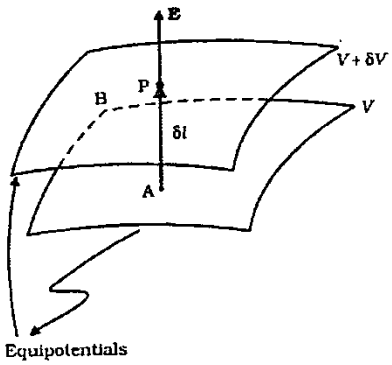
Similarly $V_2 = \frac{1}{4\pi\varepsilon_0}\frac{q_2}{r_{2p}}$ $V_3 = \frac{1}{4\pi\varepsilon_0}\frac{q_3}{r_{3p}}$ $V_n = \frac{1}{4\pi\varepsilon_0}\frac{q_n}{r_{np}}$

By the principle of super position, the potential at P due to the total charge configuration is the algebraic sum of the potentials due to the individual charges,

$V = V_1 + V_2 + V_3 + ... + V_n$

$$V = \frac{1}{4\pi\varepsilon_0}\left[\frac{q_1}{r_{1p}} + \frac{q_2}{r_{2p}} + \frac{q_3}{r_{3p}} + ... + \frac{q_n}{r_{np}}\right]$$

10. Arrive the relation between electric field and potential.



Answer: Consider two closely spaced equipotential surfaces A and B with potentials V and $V+\delta V$, where δV is the change in V in the direction $\vec{E}$ Let a point P be on the surface B, δl be the perpendicular distance from the surface A. If a unit positive charge moves from surface B to A along this perpendicular against the direction of $V_A - V_B$ = Potential difference

$|E|\delta l = V - (V + \delta V) = -\delta V$

Since δV is $-ve$ $|E| = -\frac{dV}{\delta 1}$

11. Explain how a dielectric develops a net dipole moment in an external electric field?

Answer: A dielectric is a non-conductor of electricity. The molecules may be polar or non-polar.

In a non-polar molecule the centers of $+ve$ and $-ve$ charges coincide, hence no net dipole moment. In an external electric field the $+ve$ and $-ve$ charges are displaced in opposite direction till the external

force on the constituent charges of the molecules is balanced by the restoring force. Thus a non-polar molecule develops a dipole moment called polarization.
In polar molecules the dielectric develops an external field due to the orientation of the individual molecules.

12. Derive the expression for potential energy of a system of two charges in an external field.
Answer: Let us consider two charges at q_1 and q_2 at r_1 and r_2 in an external field.

Work done in bringing the charge q_1 from $\propto$ to $r_1 = q_1 V(r_1)$

Work done in bringing q_2 to $r_2 =$

Work done on q_2 against the external field + work done on q_2 against the field due to q_1

Work done in bringing q_2 to $r_2 = q_2 V(r_2) + \frac{1}{4\pi\varepsilon_0}\left[\frac{q_1 q_2}{r_{12}}\right]$

Where r_{12} = distance between q_1 and q_2

The potential energy of the system = total work done in assembling the configuration

Potential Energy $U = q_1 V(r_1) + q_2 V(r_2) + \frac{1}{4\pi\varepsilon_0}\left(\frac{q_1 q_2}{r_{12}}\right)$