ELECTROSTATIC POTENTIAL AND CAPACITANCE

EQUIPOTENTIAL SURFACES

EQUIPOTENTIAL SURFACE:

Definition:

If potential of a surface (imaginary or physically existing) is same throughout then such surface is known as a equipotential surface.

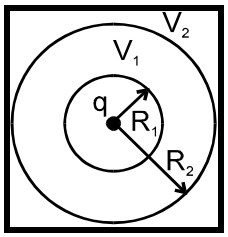
Properties of equipotential surfaces:

1. When a charge is shifted from one point to another point on an equipotential surface then work done against electrostatic forces is zero.
2. Electric field is always perpendicular to equipotential surfaces.
3. Two equipotential surfaces do not cross each other.

Examples of equipotential surfaces:

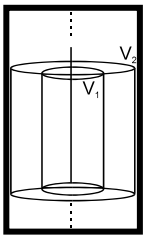
(i) Point charge:

Equipotential surfaces are concentric and spherical as shown in figure. In figure we can see that sphere of radius R_1 has potential V_1 throughout its surface and similarly for other concentric sphere potential is same.



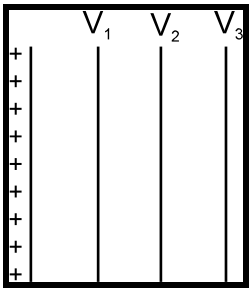
(ii) Line charge:

Equipotential surfaces have curved surfaces as that of coaxial cylinders of different radii.



(iii) Uniformly charged large conducting / non conducting sheets

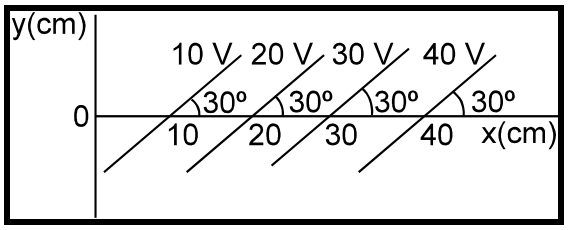
Equipotential surfaces are parallel planes.



Note:

In uniform electric field equipotential surfaces are always parallel planes.

Example. Some equipotential surfaces are shown in figure. What can you say about the magnitude and the direction of the electric field?



Solution. Here we can say that the electric will be perpendicular to equipotential surfaces.

Also $|\vec{E}| = \frac{\Delta V}{\Delta d}$

where ΔV = potential difference between two equipotential surfaces.

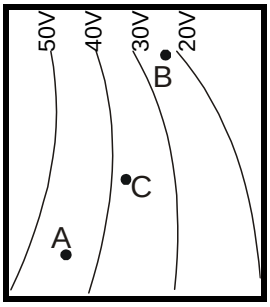
Δd = perpendicular distance between two equipotential surfaces.

So $$|\vec{E}| = \frac{10}{(10\sin 30^\circ)\times 10^{-2}} = 200 \text{ V/m}$$

Now there are two perpendicular directions either direction 1 or direction 2 as shown in figure, but since we know that in the direction of electric field electric potential decreases so the correct direction is direction 2.

Hence $E = 200$ V/m, making an angle 120° with the x-axis

Example Figure shows some equipotential surface produce by some charges. At which point the value of electric field is greatest?



Solution. E is larger where equipotential surfaces are closer. ELOF are ⊥ to equipotential surfaces. In the figure we can see that for point B they are closer so Eat point B is maximum