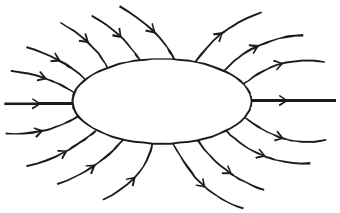
16 Electrostatic Potential and Capacitance

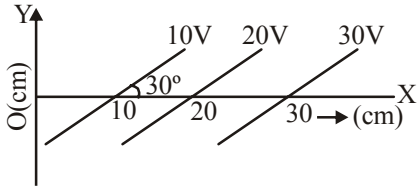
Diagram Based Questions :

1. Figure below shows a hollow conducting body placed in an electric field. Which of the quantities are zero inside the body?



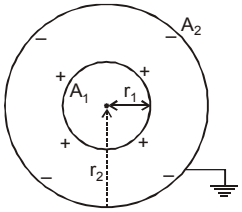
(a) Electric field and potential
(b) Electric field and charge density
(c) Electric potential and charge density.
(d) Electric field, potential and charge density.

2. Equipotential surfaces are shown in figure. Then the electric field strength will be



(a) 100 Vm^{-1} along X-axis
(b) 100 Vm^{-1} along Y-axis
(c) 200 Vm^{-1} at an angle 120° with X-axis
(d) 50 Vm^{-1} at an angle 120° with X-axis

3. Two spherical conductors A_1 and A_2 of radii r_1 and r_2 ($r_2 > r_1$) are placed concentrically in air. A_1 is given a charge +Q while A_2 is earthed. Then the equivalent capacitance of the system is



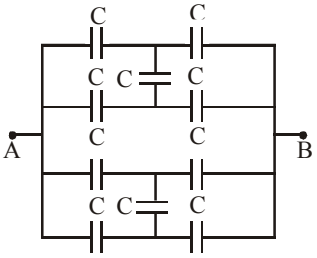
(a) $\frac{4\pi \in_0 r_1 r_2}{r_2 - r_1}$

(b) $4\pi \in_0 (r_1 + r_2)$

(c) $4\pi \in_0 r_2$

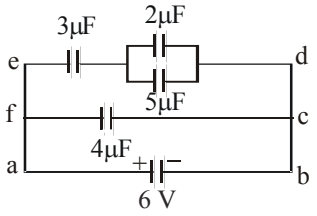
(d) $4\pi \in_0 r_1$

4. The effective capacitance of combination of equal capacitors between points A and B shown in figure is



(a) C (b) 2C
(c) 3C (d) $\frac{C}{2}$

5. In the circuit given below, the charge in μC, on the capacitor having capacitance 5 μF is



(a) 4.5 (b) 9
(c) 7 (d) 15

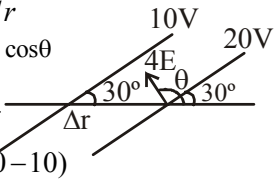
Solution

1. **(b)** Electric field is always zero inside a conductor. If there is any excess of charge on a hollow conductor it always resides on the outer surface of conductor. Therefore inside a hollow conductor there is no charge and hence charge density is zero.

2. **(c)** Using $dV = -\vec{E}.d\vec{r}$

$\Rightarrow \quad \Delta V = -E\,\Delta r\cos\theta$

$\Rightarrow \quad E = \dfrac{-\Delta V}{\Delta r\cos\theta}$



$\Rightarrow \quad E = \dfrac{-(20-10)}{10\times10^{-2}\cos120°}$

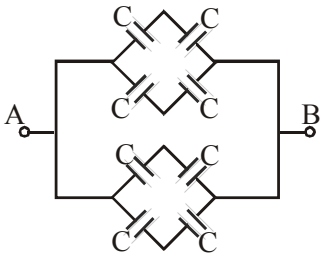
$= \dfrac{-10}{10\times10^{-2}(-\sin30°)}$

$= \dfrac{-10^2}{-1/2} = 200\ V/m$

Direction of E be perpendicular to the equipotential surface *i.e.* at 120° with X-axis.

3. **(a)**

4. **(b)**



The figure shows two independent balanced wheatstone Brides connected in parallel each having a capacitance C. So,

$C_{net} = C_{AB} = 2C$

5. **(b)** Potential difference across the branch de is 6 V.
Net capacitance of de branch is 2.1 μF

So, q = CV

$\Rightarrow$ q = 2.1 × 6 μC

$\Rightarrow$ q = 12.6 μ C

Potential across 3 μF capacitance is

$V = \dfrac{12.6}{3} = 4.2$ volt

Potential across 2 and 5 combination in parallel is 6 – 4.2 = 1.8 V

So, q' = (1.8) (5) = 9 μC