NCERT EXERCISE SOLUTIONS

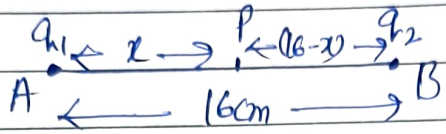
Electrostatic potential and capacitance Ch. 2

Qu1 Two charges . . . . . to be zero.

Sol^n:- Given,

$q_1 = 5\times10^{-8}\,C$, $q_2 = -3\times10^{-8}\,C$

$r = 16\,cm = 16\times10^{-2}\,m$



As the charges are +ve and -ve, potential can be zero at two points.
Let potential is zero at point P (inside)
i.e.

$$V_A + V_B = 0 \Rightarrow V_A = -V_B$$

here $V_A = \dfrac{K q_1}{x}$ and $V_B = \dfrac{K q_2}{(16-x)} = \dfrac{-K\times3\times10^{-8}}{(16-x)}$

$= \dfrac{K\times5\times10^{-8}}{x}$

[By using $V = \dfrac{Kq}{r}$]

Now.

$$\frac{\cancel{K}\times5\times\cancel{10^{-8}}}{x} = \frac{\cancel{K}\times3\times\cancel{10^{-8}}}{(16-x)}$$

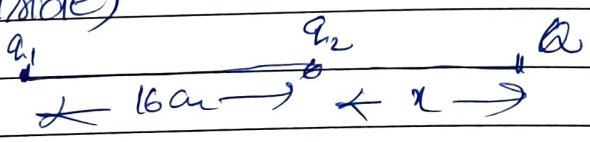
or $\dfrac{5}{x} = \dfrac{3}{16-x}$

or $80 - 5x = 3x$

or $80 = 8x$

or $= 10\,cm.$

Again Let the potential is zero at point Q (outside)



$V_A = -V_B$

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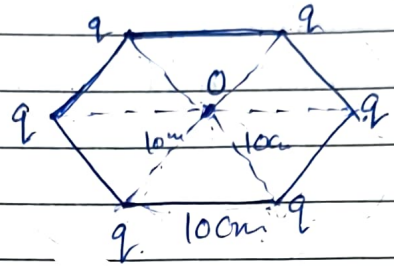
Qu2. A regular hexagon - - - - - of the hexagon.

Sol^n - Given,

side of hexagon = 10 cm. = 10×10^{-2} m

charge on each vertices $q = 5\,\mu C = 5 \times 10^{-6}$ C



$$V = 6 \times k \frac{q}{r}$$

$$= 6 \times 9 \times 10^{9} \times \frac{5 \times 10^{-6}}{10 \times 10^{-2}}$$

$$= 5 \times 54 \times 10^{9-6+1}$$

$$V = 270 \times 10^{4}$$

or $V = 2.7 \times 10^{6}$ V.

i.e. Potential at the centre of hexagon is 2.7×10^{6} V.

Ans

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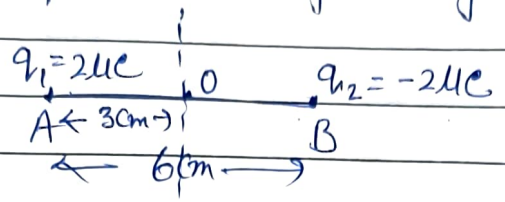
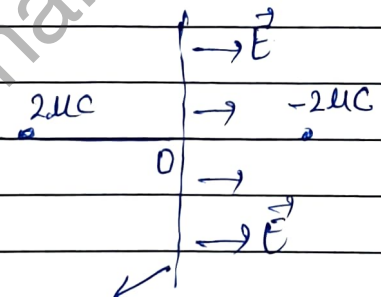
Qu3. Two charges - - - - - - this surface.

Sol^n - (a) Equipotential surface of the system.



the equipotential surface for two equal and opposite charges (electric dipole) is the plane perpendicular to AB and passing through mid point 'O'. At O potential is zero.

(b) the direction of electric field is perpendicular to equipotential surface and from +ve to -ve charge



equipotential surface

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Qu 4. A spherical conductor - - - of the sphere.

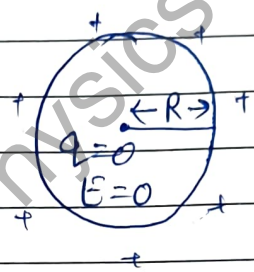
Sol^n Given,

Radius of spherical conductor $R = 12\,cm$.
$= 12 \times 10^{-2}\,m$

Charge on the surface of conductor $q = 1.6 \times 10^{-7}\,C$

(a) Electric field inside the sphere

As we know, inside a conductor $q = 0$
therefore $E = 0$



Ans

(b) E just outside the surface

$$E = \frac{1}{4\pi\epsilon_0}\frac{q}{R^2} \qquad [\because r = R]$$

$$= \frac{9 \times 10^9 \times 1.6 \times 10^{-7}}{(12 \times 10^{-2})^2}$$

$$= \frac{9 \times 1.6}{12 \times 12} \times 10^{9-7+4}$$

$$E = 10^5\,N/C$$ Ans

(c) E at a distance 18 cm.

here $r = 18\,cm = 18 \times 10^{-2}\,m$

$$E = \frac{1}{4\pi\epsilon_0}\frac{1.6 \times 10^{-7}}{(18 \times 10^{-2})^2}$$

$$= \frac{9 \times 10^9 \times 1.6}{18 \times 18} \times 10^{-7+4} = \frac{8 \times 10^{8-3}}{18}$$

$$= 4.44 \times 10^4\,N/C$$ Ans

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OR $E = 4.44 \times 10^4 \, N/C$ Ans

Qus. A parallel plate :- ——— dielectric constant is 6.

Solⁿ- Given,

$$C_0 = 8 \, pF = \frac{A\epsilon_0}{d}$$

Now

$$C = \frac{A\epsilon}{d'} = \frac{A K\epsilon_0}{d'}$$ [$\epsilon \rightarrow$ for medium and $\epsilon = K\epsilon_0$]

given $d' = \frac{d}{2}$ and $K = 6$

then,

$$C = \frac{K A\epsilon_0}{d/2}$$

$$= 2K\left(\frac{A\epsilon_0}{d}\right)$$

$$= 2KC_0$$

$$= 2 \times 6 \times 8 \times 10^{-12}$$

$$= 96 \times 10^{-12} \, F$$

$$= 96 \, pF$$

Ans

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Qu6. Three capacitors . - - - - 120 V supply.

Solⁿ. Here capacitors are connected in series and c is same for each capacitor

$$C_1 = C_2 = C_3 = 9pF$$

so.

$$\frac{1}{C_{eq}} = \frac{1}{C_1} + \frac{1}{C_2} + \frac{1}{C_3}$$

$$\frac{1}{C_{eq}} = \frac{3}{C}$$

or $C_{eq} = \frac{C}{3} = \frac{9}{3}$

$$C_{eq} = 3pF \quad \text{Ans}$$

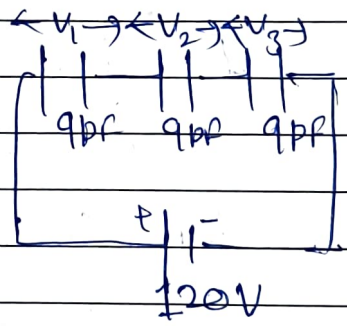
(b) $q_{net} = C_{eq} \times V$

$$= 3 \times 10^{-12} \times 120V \quad [\because V = 120V]$$

For series

$$V = V_1 + V_2 + V_3$$

$$120 = \frac{q}{C} + \frac{q}{C} + \frac{q}{C}$$



$$120 = \frac{3q}{C}$$

or $q = 40 \times 9 \times 10^{-12}$

$$= 360 \times 10^{-12} C$$

As q is const and $C_1 = C_2 = C_3$,

$$V_1 = V_2 = V_3 = \frac{q}{C} = \frac{360 \times 10^{-12}}{9 \times 10^{-12}}$$

$$= 40 V$$

There is a potential drop of 40 Volt through each capacitor.

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Qu7. Three capacitors - - - - - - 100 V supply.

Sol^n: $C_1 = 2pF$, $C_2 = 3pF$ and $C_3 = 4pF$

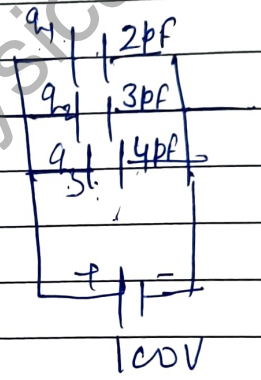
(a) Total capacitance in parallel connection.

$$C_{eq} = C_1 + C_2 + C_3$$
$$= 2 + 3 + 4$$
$$C_{eq} = 9pF$$

Ans

(b) $V = 100\ V$

In parallel V is same through each capacitor.



so,

$$q_1 = C_1 V$$
$$= 2 \times 10^{-12} \times 100$$
$$= 200 \times 10^{-12}\ C$$

or $q_1 = 200\ pC$ Ans

$$q_2 = C_2 V$$
$$= 3 \times 10^{-12} \times 100$$
$$= 300 \times 10^{-12}\ C$$

or $q_2 = 300\ pC$ Ans

and $q_3 = C_3 V$
$$= 4 \times 10^{-12} \times 100$$
$$= 400 \times 10^{-12}\ C$$

or $q_3 = 400\ pC$ Ans

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Qu 8. In a parallel . . . . . of the capacitor?

Solⁿ: Given,

Area $A = 6\times10^{-3}\,m^2$

$d = 3\,mm = 3\times10^{-3}\,m$

$V = 100\,V$

capacitance

$$C = \frac{A\epsilon_0}{d}$$

$$= \frac{\cancel{6}^{2}\times10^{-3}\times8.86\times10^{-12}}{\cancel{3}\times10^{-3}}$$

$$= 2\times8.86\times10^{-3-12+3}$$

$$= 17.72\times10^{-12}$$

$$\simeq 18\times10^{-12} = 18\,pF$$

Ans

Now $q = CV$.

$$= 18\times10^{-12}\times100$$

$$= 18\times10^{-10} = 1.8\times10^{-9}$$

$$= 1.8\,nC$$ Ans

Qu. 9. Explain what - - - - - was disconnected.

Solⁿ Given

$t = d = 3\,mm = 3\times10^{-3}\,m$

dielectric constant $K = 6$

When battery remains connected

(1) $V = V_0$ const

$= 100\,V$ Ans

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(ii) $C = KC_0$
$= 6 \times 18$
$= 108\ pF$ Ans

(iii) $q = Kq_0$
$= 6 \times 1.8 = 10.8\ nC$
$= 1.08 \times 10^{-8}\ C$ Ans

When battery disconnected -

(i) $V = \frac{V_0}{K} = \frac{100}{6} = 16.67$ Volt Ans

(ii) $C = KC_0 = 6 \times 18$
$= 108\ pF$ Ans

(iii) $q = q_0$ Const
$= 1.8\ nC$
$= 1.8 \times 10^{-8}\ C$ Ans

Que10. Given,
$C = 12\ pF = 12 \times 10^{-12}\ F$
$V = 50\ V$
Energy stored in the capacitor

$U = \frac{1}{2} CV^2$
$= \frac{1}{2} \times 12 \times 10^{-12} \times (50)^2$
$= 6 \times 2500 \times 10^{-12}$
$= 150 \times 10^{-10}$
$= 1.5 \times 10^{-8}\ J$ Ans

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Qu 1. A 600 pF capacitor . . . in the process?

Sol^n $C_1 = 600\,pF$, $C_2 = 600\,pF$
$= 6\times10^{-10}\,F$ $= 6\times10^{-10}\,F$

$V_1 = 200\,V$ $V_2 = 0\,V$

$$\text{Energy loss} = \frac{C_1C_2(V_1-V_2)^2}{2(C_1+C_2)}$$

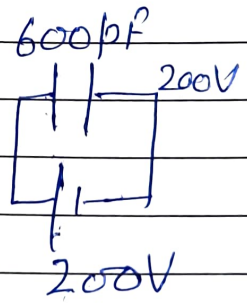
$$= \frac{6\times10^{-10}\times6\times10^{-10}(200-0)^2}{2\times(6+6)\times10^{-10}}$$

$$= \frac{\cancel{6}^{3}\times\cancel{6}\times(200)^2\times10^{-20}}{2\times\cancel{12}_{2}\times10^{-10}}$$

$$= \frac{3}{2}\times4\times10^{4}\times10^{-20}\times10^{+10}$$

Energy loss $= 6\times10^{-6}\,J$ Ans

Method 2



$C = 600\,pF = 6\times10^{-10}\,F$
$V = 200\,V$

Energy stored

$$U = \frac{1}{2}CV^2$$

$$= \frac{1}{2}\times6\times10^{-10}\times(200)^2$$

$$= 12\times10^{-6}\,J$$

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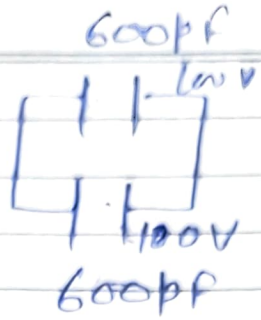
Common potential



$$V' = \frac{C_1V_1 + C_2V_2}{C_1 + C_2}$$

$$V' = \frac{6\times10^{-10}\times 200 + 6\times10^{-10}\times 0}{(6+6)\times10^{-10}}$$

$$V' = 100\,V$$

Now energy of the system

$$U' = 2\times\frac{1}{2}CV'^2$$

$$= \cancel{2}\times\frac{1}{\cancel{2}}\times 6\times10^{-10}\times(100)^2$$

$$= 6\times10^{-10+4}$$

$$= 6\times10^{-6}\,J$$

loss of energy

$$U - U' = 12\times10^{-6} - 6\times10^{-6}$$

$$= 6\times10^{-6}\,J$$

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