DPP
DAILY PRACTICE PROBLEMS

Class : XIIth
Date :

Solutions

Subject : PHYSICS
DPP No. :9

Topic :- Electric charges and fields

1 **(c)**

$\tau_{\max} = pE = q(2l)E = 2 \times 10^{-6} \times 0.01 \times 5 \times 10^{5}$

$= 10 \times 10^{-3} N - m$

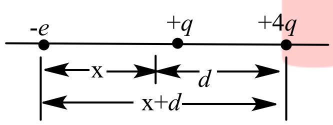
2 **(a)**

Following figures show the situations of charges fixed on the axis. An electron is placed to the left of these charges. The cases are as follows

Case I Let distance between $+q$ and $-4q = d$

$\therefore$ distance between $-e$ and $+q = x$

$\therefore$ distance between $-e$ and $-4q = (x + d)$



Now, force between $-e$ and $+q$

$F_1 = -\frac{1}{4\pi\varepsilon_0}\frac{qe}{x^2}$ (attractive)

Force between $-e$ and $-4q$

$F_2 = \frac{1}{4\pi\varepsilon_0}\frac{4qe}{(x+d)^2}$ (repulsive)

Solving, we get

$x = d$

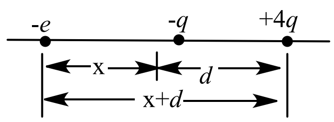
$\therefore F_1 = -F_2$

$F_{\text{net}} = 0$

Hence no net force acts on the electron and so it will be in equilibrium.

Case II In this case force acting between e and $-q$

$$F_1 = \frac{1}{4\pi\varepsilon_0}\frac{qe}{x^2} \qquad \text{(repulsive)}$$



and force between $-e$ and $+4q$

$$F_2 = -\frac{1}{4\pi\varepsilon_0}\frac{4qe}{(x+d)^2} \qquad \text{(attractive)}$$

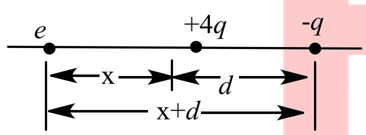
Solving we get

$$x = d$$

$$\therefore \qquad F_1 = -F_2 \qquad \text{(numerically)}$$

$\therefore$ Net force on $-e$ is zero

Case III Again force between $-e$ and $4q$



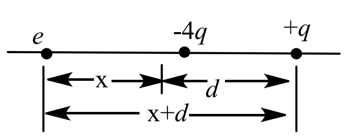
Similarly, $F_1 = -\frac{1}{4\pi\varepsilon_0}\frac{4qe}{x^2}$ (attractive)

$$F_2 = -\frac{1}{4\pi\varepsilon_0}\frac{qe}{(x+d)^2} \qquad \text{(repulsive)}$$

Since, electron is closer to $+4q$ than $-q$, so $F_1 > F_2$

In this case electron will not remain at rest and starts moving towards the system.

Case IV In this case force between $-e$ and $-4q$



$$F_1 = +\frac{1}{4\pi\varepsilon_0}\frac{4qe}{x^2} \qquad \text{(repulsive)}$$

Force between $-e$ and $+q$

$F_2 = -\frac{1}{4\pi\varepsilon_0}\frac{qe}{(x+d)^2}$ (attractive)

Since, electron is closer to $-4q$ than +q, then $F_1 > F_2$.

Thus, electron will move away from the system. It means equilibrium stage cannot be obtained.

3 **(a)**

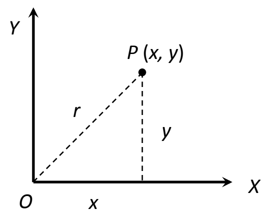
Electric flux is equal to the product of an area element and the perpendicular component of **E**. As the surface is lying in Y-Z plane

$\therefore \boldsymbol{E}.d\boldsymbol{A} = \phi = (5)(20)$

$= 100$ unit.

4 **(b)**

$E_x = -\frac{dV}{dx} = +ky$;$E_y = -\frac{dV}{dy} = +kx$



$\Rightarrow E = \sqrt{E_x^2 + E_y^2} = k\sqrt{x^2 + y^2} = kr \Rightarrow E \propto r$

5 **(c)**

The time required to fall through distance d is

$d = \frac{1}{2}\left(\frac{qE}{m}\right)t^2$ or $t = \sqrt{\frac{2dm}{qE}}$

Since $t^2 \propto m$, a proton takes more time

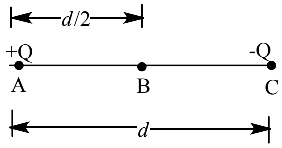
6 **(b)**

For electron $s = \frac{eE}{m_e} \times t_1^2$, For proton $s = \frac{eE}{m_p} \times t_2^2$

$\therefore \frac{t_2^2}{t_1^2} = \frac{m_p}{m_e} \Rightarrow \frac{t_2}{t_1} = \sqrt{\frac{m_p}{m_e}} = \left(\frac{m_p}{m_e}\right)^{1/2}$

7 **(b)**

Two equal and opposite charges are placed at a distance d. Electric field at centre(B) due to $+Q$charge



$$(E_1) = \frac{1}{4\pi\varepsilon_0}\frac{Q}{\left(\frac{d}{2}\right)^2}$$

Similarly, electric field due to $-Q$charge

$$(E_2) = \frac{1}{4\pi\varepsilon_0}\frac{(Q)}{\left(\frac{d}{2}\right)^2}$$

Therefore, net electric field at point

$E = E_1 + E_2$

$$= \frac{1}{4\pi\varepsilon_0}\frac{4Q}{d^2} + \frac{1}{4\pi\varepsilon_0}\frac{4Q}{d^2} = \frac{1}{4\pi\varepsilon_0}\frac{8Q}{d^2}$$

8 **(d)**

Capacitance of the given assembly

$$C = 4\pi\varepsilon_0\left(\frac{R_1R_2}{R_2 - R_1}\right) \Rightarrow C \propto \frac{R_1R_2}{(R_2 - R_1)}$$

9 **(d)**

$$V = \frac{C_1V_1 + C_2V_2}{C_1 + C_2} \Rightarrow 20 = \frac{10 \times 50 + C_2 \times 0}{10 + C_2}$$

$\Rightarrow 200 + 20C_2 = 500 \Rightarrow C_2 = 15\mu F$

10 **(c)**

According to graph we can say that potential difference across the capacitor C_1 is more than that across C_2. Since charge Q is same *i.e.*, $Q = C_1V_1 = C_2V_2$

$$\Rightarrow \frac{C_1}{C_2} = \frac{V_2}{V_1} \Rightarrow C_1 < C_2 \quad [V_1 > V_2]$$

11 **(c)**

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

Now if V is constant, then U is greatest when $'C_{eq}'$ is maximum. This is when all the three are in parallel

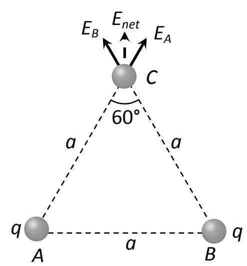
12 **(a)**

$$\frac{1}{C_{eq}}=\frac{1}{2}+\frac{1}{3}+\frac{1}{6}\Rightarrow C_{eq}=1\,\mu F$$

Total charge $Q=C_{\text{eq}}.V=1\times 24=24\,\mu C$

So p.d. across $6\,\mu F$ capacitor $=\frac{24}{6}=4\,volt$

13 **(c)**



$$|E_A|=|E_B|=k.\frac{q}{a^2}$$

So, $E_{net}=\sqrt{E_A^2+E_B^2+2E_AE_B\cos 60^{o}}$

$$=\frac{\sqrt{3}k.q}{a^2}$$

$$\Rightarrow E_{net}=\frac{\sqrt{3}\,q}{4\pi\varepsilon_0 a^2}$$

14 **(c)**

Electric lines of force never intersect the conductor. They are perpendicular and slightly curved near the surface of conductor

15 **(b)**

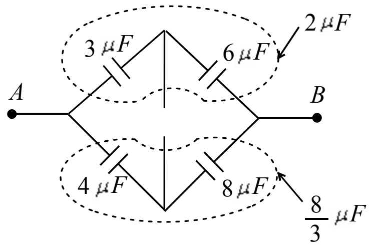
When a dielectric K is introduced in a parallel plate condenser its capacity becomes K times. Hence $C'=5C_0$. Energy stored $W_0=\frac{q^2}{2C_0}$

$$\therefore W'=\frac{q^2}{2C'}=\frac{q^2}{2\times 5C_0}\Rightarrow W'=\frac{W_0}{5}$$

16 **(d)**

Given circuit is balanced Wheatstone bridge.

So capacitor of $2\mu F$ can be dropped from the circuit



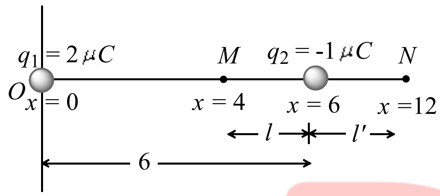
$\Rightarrow C_{AB} = 2 + \frac{8}{3} = \frac{14}{3}\,\mu F$

17 **(b)**

Because current flows from higher potential to lower potential

18 **(c)**

Potential will be zero at two points



At internal point (M): $\frac{1}{4\pi\varepsilon_0} \times \left[\frac{2 \times 10^{-6}}{(6-l)} + \frac{(-1 \times 10^{-6})}{l}\right] = 0$

$\Rightarrow l = 2$

So distance of M from origin; $x = 6 - 2 = 4$

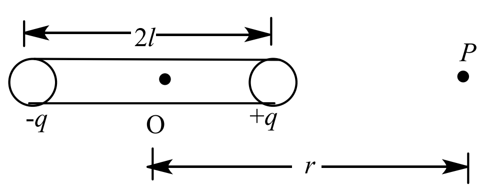
At exterior point (N)

$\frac{1}{4\pi\varepsilon_0} \times \left[\frac{2 \times 10^{-6}}{(6 + l'')} + \frac{(-1 \times 10^{-6})}{l''}\right] = 0 \Rightarrow l'' = 6$

So distance of N from origin, $x = 6 + 6 = 12$

19 **(c)**

When a dipole AB of very small length is taken, then for a point p located at a distance r from the axis the electric field is given by

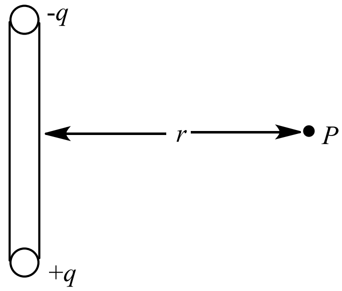


$E = \frac{1}{4\pi\varepsilon_0} \cdot \frac{2p}{r^3}$ ...(i)

Where p is dipole moment. When dipole is rotated by 90°, then electric field is given by

$E' = \frac{1}{4\pi\varepsilon_0} \cdot \frac{p}{r^3}$ ...(ii)

From Eqs. (i) and (ii), we get



$$E' = \frac{E}{2}$$

20 **(d)**

$Q_1 + Q_2 = Q$ ...(i) and $F = k\frac{Q_1 Q_2}{r^2}$ ...(ii)

From (i) and (ii) $F = \frac{kQ_1(Q - Q_1)}{r^2}$

For F to be maximum $\frac{dF}{dQ_1} = 0 \Rightarrow Q_1 = Q_2 = \frac{Q}{2}$

ANSWER-KEY										
Q.	1	2	3	4	5	6	7	8	9	10
A.	C	A	A	B	C	B	B	D	D	C
Q.	11	12	13	14	15	16	17	18	19	20
A.	C	A	C	C	B	D	B	C	C	D