DPP
DAILY PRACTICE PROBLEMS

Class : XIIth
Date :

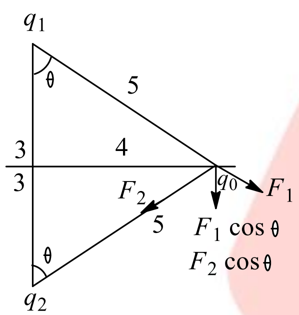
Solutio

Subject : PHYSICS
DPP No. :1

Topic :- Electric charges and fields

1 **(a)**

Here, $q = \pm 6.0\text{nC} = \pm 6.0 \times 10^{-9}\text{C}$
$2\,a = 6\text{ cm} = 6 \times 10^{-2}\text{m}$
$r = 4\text{ cm}$(on equatorial line)
$= 4 \times 10^{-2}\text{m}$
$q_0 = 2\text{ nC}$
$= 2 \times 10^{-9}\,C, F = ?$
$F = F_1 \cos\theta + F_2 \cos\theta$
$= 2 \times \frac{1}{4\pi\varepsilon_0}\frac{qq_0}{r^2}\cos\theta$



$= 2 \times 9 \times 10^9 \times \frac{6\times10^{-9}\times2\times10^{-9}}{(5\times10^{-2})^2} \times \frac{3}{5}$
$= 5.18 \times 10^{-5}\text{N}$
$\vec{F} = -51.8\hat{j}\mu\text{N}$

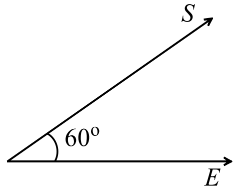
2 **(a)**

The electric intensity outside a charged sphere.

$E = \frac{\sigma R^2}{\varepsilon_0 r^2}$

3 **(d)**

Force acting on the charged particle $= q\vec{E}$
Work done in moving a distance S,



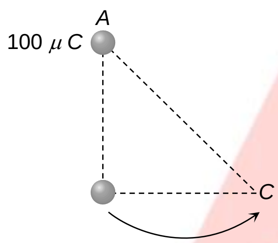
$W = q\vec{E}.\vec{S} = (qE) \times S \times \cos\theta$
$10J = (0.5\,C) \times E \times 2\cos 60^o$
$\Rightarrow E = 10 \times 2 = 20\,NC^{-1} = 20\,Vm^{-1}$

4 **(d)**

$$\frac{\sigma_{small}}{\sigma_{Big}} = \frac{q}{Q} \times \frac{R^2}{r^2} = \frac{q}{(nq)} \times \frac{(n^{1/3}r)^2}{r^2} = n^{-1/3} = (64)^{-1/3} = \frac{1}{4}$$

5 **(d)**

Work done in displacing charge of $5\mu C$ from B to C is $W = 5 \times 10^{-6}(V_C - V_B)$ where



$V_B = 9 \times 10^9 \times \frac{100 \times 10^{-6}}{0.4} = \frac{9}{4} \times 10^6 V$

and $V_C = 9 \times 10^9 \times \frac{100\times10^{-6}}{0.5} = \frac{9}{5} \times 10^6 V$

so $W = 5 \times 10^{-6} \times \left(\frac{9}{5} \times 10^6 - \frac{9}{4} \times 10^6\right) = -\frac{9}{4} J$

6 **(c)**

Here, $\theta = 60^0, E = 10^5 NC^{-1}$

$\tau = 8\sqrt{3}$ Nm, $q = ?, 2a = 2cm = 2 \times 10^{-2}m$

From $\tau = pE\sin\theta = q(2a)E\sin\theta$

$q = \frac{\tau}{2aE\sin\theta} = \frac{8\sqrt{3}}{2\times10^{-2}\times10^5\times\sin 60°}$

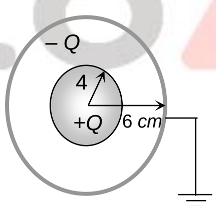
$= \frac{8\sqrt{3}}{2\times10^3\times\sqrt{3}/2}$

$q = 8 \times 10^{-3}$ C

7 **(d)**

Suppose charge on inner sphere is $+Q$ as shown. Potential on inner sphere

$V = \frac{Q}{4} - \frac{Q}{6}$



$\Rightarrow 3 = Q\left(\frac{1}{4} - \frac{1}{6}\right) \Rightarrow Q = 36\ e.s.u$

8 **(c)**

Solid angle, $\Omega = \frac{A}{r^2}$

$= \frac{\pi R^2}{r^2} \Rightarrow \frac{\pi \times (1)^2}{10^6} \Rightarrow 0.00018°$

9 **(b)**

$F = \frac{q_1 q_2}{4\pi\varepsilon_0 r^2} = \frac{q_1(q_1 - q_2)}{4\pi\varepsilon_0 r^2}$

$\therefore F$ will be maximum, if

$\frac{dF}{dq_1} = 0$

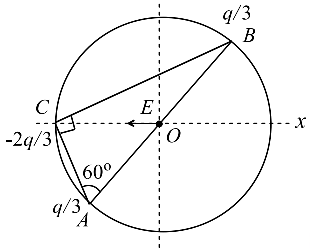
$\therefore q - 2q_1 = 0$ or $q_1 = q/2$ or $q_1/q = 0.5$

10 **(a)**

$$E = \frac{V}{d} = \frac{30 - (-10)}{(2 \times 10^{-2})} = 2000\ V/m$$

11 **(c)**

Net electric field due to both charges $q/3$, will get cancelled. Electric field due to $\left(\frac{-2q}{3}\right)$ will be directed in $-$ve axis



$$E = \frac{k\left(\frac{2q}{3}\right)}{R^2} \Rightarrow E = \frac{q}{6\pi\varepsilon_0 R^2}$$

P.E. of system $= \frac{K\left(\frac{q}{3}\right)^2}{2R} + \frac{K\frac{q}{3}\left(-\frac{2q}{3}\right)}{2R\sin 60^o} + \frac{K\frac{q}{3}\left(-\frac{2q}{3}\right)}{2R\cos 60^o}$

P.E. of system $\neq 0$

Force between B and C

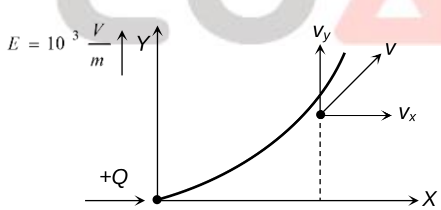
$$F = \frac{K\left(\frac{2q}{3}\right)\left(\frac{q}{3}\right)}{(2R\sin 60^o)^2} = \frac{4 \times 2Kq^2}{9 \times 4 \times 3R^2} = \frac{2q^2}{9 \times 3 \times 4\pi\varepsilon_0 R^2}$$

(attractive) $= \frac{1}{54\pi \in_0} \frac{q^2}{R^2}$

Potential at O, $V = \frac{K\left(\frac{q}{3} + \frac{q}{3} - \frac{2q}{3}\right)}{R} = 0$

12 **(c)**

Body moves along the parabolic path



For vertical motion : By using $v = u + at$

$$\Rightarrow v_y = 0 + \frac{QE}{m}.t = \frac{10^{-6} \times 10^3}{10^{-3}} \times 10 = 10m/sec$$

For horizontal motion – It's horizontal velocity remains the same $i.e.$ after 10 sec, horizontal velocity of body $v_x = 10m/sec$

Velocity after 10 sec $v = \sqrt{v_x^2 + v_y^2} = 10\sqrt{2}\ m/sec$

13 **(b)**

Capacitance of a cylindrical capacitor $= \frac{2\pi\varepsilon_0 L}{\ln(b/a)}$

Energy stored in the capacitor

$$\frac{1}{2}\frac{Q^2}{C} = \frac{1}{2}\frac{Q^2 \ln(b-a)}{2\pi\varepsilon_0 L} = [\text{const}]\frac{Q^2}{L}$$

If the charge is doubled and length is doubled,

$[const]\frac{Q'^2}{L'} = \frac{4}{2}\left(\frac{Q^2}{L}\right) = 2$ times the energy

14 **(c)**

Electric field

$$E = -\frac{d\phi}{dt} = -2ar$$

By Gauss's theorem

$$E(4\pi r^2) = \frac{q}{\varepsilon_0}$$

$$q = -8\pi\varepsilon_0 ar^2$$

$$\rho = \frac{dq}{dV} = \frac{dq}{dr} \times \frac{dr}{dV}$$

$$= (-24\pi\varepsilon_0 ar^2) \times \frac{1}{4\pi r^2}$$

$$\rho = -6\varepsilon_0 a$$

15 **(b)**

Because metals are good conductor

16 **(a)**

$$E = -\frac{dV}{dx} = -\frac{d}{dx}(5x^2 + 10x - 9) = -10x - 10$$

$$\therefore (E)_{x=1} = -10 \times 1 - 10 = -20V/m$$

17 **(a)**

Work done $W = Q(V_B - V_A) \Rightarrow (V_B - V_A) = \frac{W}{Q}$

$$= \frac{10 \times 10^{-3}}{5 \times 10^{-6}} J/C = 2\ kV$$

18 **(b)**

The given arrangement is equivalent to the parallel combination of three identical capacitors.

Hence equivalent capacitance $= 3C = 3\frac{\varepsilon_0 A}{d}$

19 **(c)**

Inside a conducting body, potential is same everywhere and equals to the potential of it's surface

20 **(c)**

$c \propto r \Rightarrow C = 4\pi\varepsilon_0 R$

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