NORTH SOUTH UNIVERSITY

Department of Mathematics & Physics

Assignment – 4

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Course Title	: General Physics-II
Section	: 4
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Ans. to the ques. no. 07

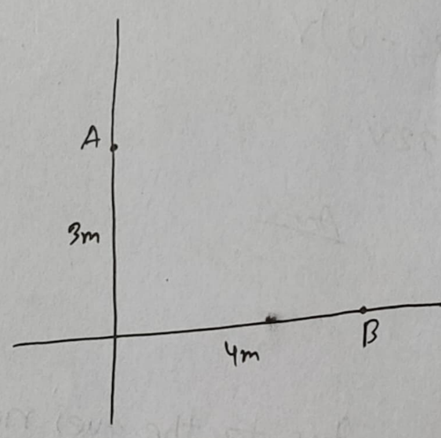
Given that,

$$E_y = E_z = 0$$

$$E_x = (4\ N/C)x$$

Point A on the y-axis at $y = 3\ m$

Point B on the x-axis at $x = 4m$



$$\therefore V_A = -\int_0^3 E_y\, dy$$

$$= 0$$

$$\therefore V_B = -\int_0^4 E_x\, dx = -\int_0^4 4x \cdot dx$$

$$\cancel{= -E_x \int_0^4 dx} \quad = -4 \cdot \left.\frac{x^2}{2}\right]_0^4$$

$= -E_x \cdot x \Big]_0^4$

$= -4E_x$

$=$

$= -2 \cdot x^2 \Big]_0^4$

$= -2(16-0)$

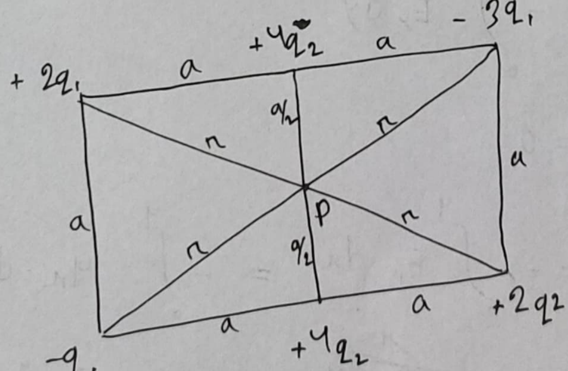
$= -32\text{ V}$

$\therefore V_B - V_A = (-32-0)\text{ V}$

$= -32\text{ V}$

Ans

Ans. to the ques. no. 16



Here,

$q_1 = 3 \cdot 40 \times 10^{-12}$ c

$q_2 = 6 \cdot 00 \times 10^{-12}$ c

$a = 39$ cm $= 0 \cdot 39$ m

Here

all corner particles are equidistance from P.

So, there total charge, $q = 2q_1 * 3q_1 - q_1 + 2q_1$

$= 0$

∴ The potential for these four point charge,

$$V = \frac{1}{4\pi\epsilon_0 \cdot r} (\Sigma q_i) = \frac{1}{4\pi\epsilon_0 \cdot r} \cdot 0$$

$$= 0$$

Now,

Potential of middle two charge,

$$V = \frac{1}{4\pi\epsilon_0 \cdot \frac{a}{2}} \cdot (4q_2 + 4q_2)$$

$$= \frac{1}{4\pi\epsilon_0} \cdot \frac{8q_2 \cdot 2}{a}$$

$$= \frac{9\times10^9 \times 8 \times 6\cdot00\times10^{-12} \times 2}{0\cdot39} = 2\cdot22 \text{ V}$$

Ans

Ans. to the ques. no. 24

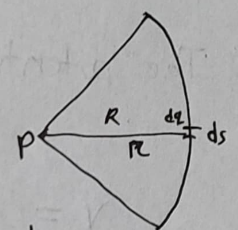
Given that,

Radious $= R = 3.71$ cm $= 0.0371$ m

Change $= Q = -25.6$ pC $= -25.6 \times 10^{-12}$ C

Length $= L = R\theta = R \cdot \frac{2\pi}{3} = \frac{2\pi R}{3}$

Change density $= \lambda = \frac{Q}{L} = \frac{3Q}{2\pi R}$



ds = differential line element

dq = differential change element

$= \lambda\, ds$

r = distance of point P from dq

$= R$

dV = differential potential at point p due to dq

$$\therefore dV = \frac{1}{4\pi\epsilon_0} \cdot \frac{dq}{r} = \frac{1}{4\pi\epsilon_0} \cdot \frac{\lambda\, ds}{R}$$

$$= \frac{1}{4\pi\epsilon_0} \cdot \frac{3Q\, ds}{2\pi R^2}$$

$$\therefore V = \int dV = \int_{s=0}^{s=\frac{2\pi R}{3}} \frac{1}{4\pi\epsilon_0} \cdot \frac{3Q}{2\pi R^2} \cdot ds$$

$$= \frac{1}{4\pi\epsilon_0} \cdot \frac{3Q}{2\pi R^2} \cdot s\Big]_0^{\frac{2\pi R}{3}}$$

$$= \frac{1}{4\pi\epsilon_0} \cdot \frac{3Q}{2\pi R^2} \cdot \frac{2\pi R}{3}$$

$$= \frac{1}{4\pi\epsilon_0} \cdot \frac{Q}{R}$$

$$= \frac{9\times10^9 \times (-25.6\times10^{-12})}{0.0371}$$

$$= -6.21\ V$$

Ans

Ans. to the ques. no. 25

Given,

Radious, $R = 8.20\ cm = 0.082\ m$

Change, $Q_1 = 4.20 \times 10^{-12}\ C$

Change $Q_2 = -6Q_1 = -6 \times 4.20 \times 10^{-12}\ C$

a)

Total potential at the center of the circle,

$$V = \frac{1}{4\pi\epsilon_0 \cdot R}(Q_1 + Q_2)$$

$$= \frac{Q_1 - 6Q_1}{4\pi\epsilon_0 \cdot R}$$

$$= \frac{-5Q_1}{4\pi\epsilon_0 \cdot R}$$

$$= \frac{1}{4\pi\epsilon_0} \cdot \frac{-5Q_1}{R}$$

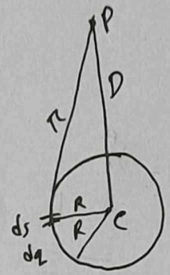
$$= \frac{9\times10^9 \times (-5\times4.20\times10^{-12})}{0.082}$$

$$= -2.30\,V$$

Ans

b)

distance from center point P = D = 6.71 cm = 0.0671 m



distance from dq to point P,

$$r = \sqrt{R^2 + D^2}$$

ds = differential line element

dq = differential charge element

$= \lambda ds$

$r = \sqrt{R^2 + D^2}$

Length, $L = 2\pi R$

charge density, $\lambda = \frac{Q}{L}$

$\therefore$ For Q_1,

$$L = \frac{2\pi R}{4} = \frac{\pi R}{2}$$

$$\therefore \lambda = \frac{2Q_1}{\pi R}$$

$\therefore$ dv = differential ~~tine~~ potential at point P due to dq

$$= \frac{1}{4\pi\epsilon_0} \cdot \frac{dq}{r} = \frac{1}{4\pi\epsilon_0} \cdot \frac{\lambda ds}{\sqrt{R^2+D^2}}$$

$$= \frac{1}{4\pi\epsilon_0} \cdot \frac{2Q_1 \cdot ds}{\pi R\sqrt{R^2+D^2}}$$

$$\therefore V_{Q_1} = \int dv = \int_{s=0}^{s=\pi R/2} \frac{1}{4\pi\epsilon_0} \cdot \frac{2Q_1}{\pi R\sqrt{R^2+D^2}} \cdot ds$$

$$= \frac{1}{4\pi\epsilon_0} \cdot \frac{2Q_1}{\pi R\sqrt{R^2+D^2}} \cdot s\Big]_0^{\frac{\pi R}{2}}$$

$$= \frac{1}{4\pi\epsilon_0} \cdot \frac{2Q_1}{\pi R} \cdot \frac{\pi R}{2} \cdot \frac{1}{\sqrt{R^2+D^2}}$$

$$= \frac{1}{4\pi\epsilon_0} \cdot \frac{Q_1}{\sqrt{R^2+D^2}}$$

As well as,

$$V_{Q_2} = \frac{1}{4\pi\epsilon_0} \cdot \frac{Q_2}{\sqrt{R^2+D^2}}$$

$\therefore$ total potential, $$V = \frac{1}{4\pi\epsilon_0 \cdot \sqrt{R^2+D^2}} \cdot (Q_1 + Q_2)$$

$$= \frac{1}{4\pi\epsilon_0} \cdot \frac{-5Q_1}{\sqrt{R^2+D^2}}$$

$$= \frac{9\times10^{9}\times(-5\times4.20\times10^{-12})}{\sqrt{(0.082)^2+(0.0671)^2}}$$

$$= -1.78\,V$$

Ans

Ans. to the ques. no. 35

Given that,

$$V = (2.0\ V/m^2)x^2 - (3.0\ V/m^2)y^2$$

We know,

$$\vec{E} = -\frac{dV}{ds}$$

$\therefore$ x-component of $\vec{E}$,

$$E_x = -\frac{dV}{dx} = -\frac{d}{dx}\left((2.0\ V/m^2)x^2 - (3.0\ V/m^2)y^2\right)$$

$$= -(2.0\ V/m^2)(2x)$$

$$E_y = -\frac{dV}{dy} = -\frac{d}{dx}\left((2.0\ V/m^2)x^2 - (3.0\ V/m^2)y^2\right)$$

$$= +(3.0\ V/m^2)(2y)$$

$$E_z = -\frac{dV}{dz} = 0$$

$\therefore \vec{E} = E_x\hat{i} + E_y\hat{j}$

$= (-2.0\ V/m^2)(2x)\ \hat{i} + (3.0\ V/m^2)(2y)\ \hat{j}$

$= (-2.0\ V/m^2)(2 \cdot 3.0m)\ \hat{i} + (3.0\ V/m^2)(2 \cdot 2.0m)\ \hat{j}$

$= (-12.0\ V/m)\ \hat{i} + (12.0\ V/m)\ \hat{j}$

Ans

Ans. to the ques. no. 36

Given that,

$V = 1500\ x^2$

$\therefore \vec{E} = -\frac{dV}{ds}$

Component wise,

$E_x = -\frac{dV}{dx} = -3000x$

$E_y = -\frac{dV}{dy} = 0$

$E_z = -\frac{dV}{dz} = 0$

$\therefore \vec{E} = (-3000x)\ \hat{i}$

at, $x = 1.3\ cm = 0.013\ m$

$$\vec{E} = (-3000 \times 0.013)\ \hat{i}$$

$$= (-39\ N/C)\ \hat{i}$$

$\therefore$ magnitude of $\vec{E}$,

$$E = 39\ N/C$$

Ans

b)

Given

$V = 1500\ x^2$

which is an increasing function.

That means potential increases with the distance of x.

We know, ~~pot~~ electric field direction is from higher potential to low potential. And x is the distance from plate 1 to plate 2. That means E.F. coming from plate 2 to towards the plate 1.