PHY112

SPECIAL GRADED ASSIGNMENTS

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SECTION-04

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Special Graded Assignments

Ans. To The Q. No. (1.1)

a) Here,

$k = 8.987 \times 10^{9}$, $e = -1.602 \times 10^{-19}$

$q = 37e = 37 \times -1.602 \times 10^{-19}$

$= -5.9274 \times 10^{-18}$

$R = 8 \times 10^{-9}$ m

$d = 42 \times 10^{-9}$ m

$r = \sqrt{R^2 + d^2} = \sqrt{(8 \times 10^{-9})^2 + (42 \times 10^{-9})^2}$

$= 4.2755 \times 10^{-8}$ m

x component of the field,

$$\frac{7Kq}{r^2} = \frac{7 \times 8.987 \times 10^{9} \times (-5.9274 \times 10^{-18})}{(4.2755 \times 10^{-8})^2}$$

$= -2039873 31.2$ N/C

(Ans)

y component of the field,

As it is radially outword

so, y component of the field

will be 0 N/C

(Ans)

z component of the field,

$$\frac{kqR}{r^3} = \frac{8.987\times10^{9}\times(-5.9274\times10^{-19})8\times10^{-9}}{(4.2755\times10^{-8})^3}$$

$= -5452657.865$ N/C

(Ans)

b) x component of the force

= x component of the field × e

$= -20398733 1.2 \times 1.602\times10^{-19}$

$= -3.267877 \times 10^{-11}$ N (Ans)

y component of the force

= y component of the field × e

$= 0 \times 1.602\times10^{-19}$

= 0 N

(Ans)

z component of the force

$= z$ component of the field $\times e$

$= -5452657.665 \times 1.602 \times 10^{-19}$

$= -8.7352 \times 10^{-13}$ N

(Ans)

c)

$F = -3.267877 \times 10^{-11} + (-8.7352 \times 10^{-13})$

$= -3.3552 \times 10^{-11}$

$|F| = 3.3552 \times 10^{-11}$

Magnitude of the acceleration,

$F = m_p a$

$\Rightarrow a = \frac{F}{m_p} = \frac{-3.3552 \times 10^{-11}}{1.6726 \times 10^{-27}}$

$= -2.0059 \times 10^{16}$

$|a| = 2.0059 \times 10^{16}$ m/s²

(Ans)

Ans. To The Q. No. (1.2)

Part -1:

Given,

$\sigma_A = -28 nC/m^2 = -28\times10^{-9} C/m^2$

$\sigma_B = -23 nC/m^2 = -23\times10^{-9} C/m^2$

We know,

Electric field due to plane sheet of change, $E = \frac{\sigma}{2\epsilon_0}$

a) (i)

$$E_{I} = \frac{28\times10^{-9}}{2\epsilon_0} + \frac{23\times10^{-9}}{2\epsilon_0}$$

$$= \frac{1}{2\times8.854\times10^{-12}}(28\times10^{-9}+23\times10^{-9})$$

$$= 2880.054 \quad N/C$$

So, of the electric field

x - component " = 2880.054 N/C

y - component " = 0 N/C

(Ans)

(ii)

$$E_{II} = \frac{-\sigma_A}{2\epsilon_0} + \frac{\sigma_B}{2\epsilon_0}$$

$$= \frac{-28\times10^{-9} + 23\times10^{-9}}{2\times8.854\times10^{-12}}$$

$$= -282.358 \text{ N/C}$$

so,

x - component $= -282.358$ N/C

y - component $= 0$ N/C

(Ans)

(iii)

$$E_{III} = \frac{-\sigma_A}{2\epsilon_0} + \frac{-\sigma_B}{2\epsilon_0}$$

$$= \frac{-28\times10^{-9} - 23\times10^{-9}}{2\times8.854\times10^{-12}}$$

$$= -2880.054 \text{ N/C}$$

so,

x - component $= -2880.054$ N/C

y - component $= 0$ N/C

(Ans)

Part-2: (b)

Given,

$d = 14\ m$ [From part-1]

$\text{Center} = (7, 7, 0)$

$P1 = (11.2, 7, 0)$

$P2 = (7, 3.5, 0)$

$R = 1.4\ m$

$\sigma = -28\ \mu C/m^2 = -28 \times 10^{-6}\ C/m^2$

i)

We know,

$$E_i = \frac{\sigma R^2}{\epsilon_0 r^2}$$

Here,

$$r = \sqrt{(11.2-7)^2 + (7-7)^2 + (0-0)^2}$$

$$= 4.2\ m$$

$$\hat{r}_{P_1} = \frac{(11.2-7)}{4.2}\hat{i} + \frac{(7-7)}{4.2}\hat{j} + \frac{(0-0)}{4.2}\hat{k}$$

$$= 1$$

Now,

$$E_i = \frac{\sigma R^2}{\epsilon_0 r^2}\hat{r}_{P_1}$$

$$E_i = \frac{(-28\times10^{-6})(1.4)^2}{8.854\times10^{-12}(4.2)^2}\hat{i}$$

$$= -351379.1632\,\hat{i}$$

$$E_{i,net} = -351379.1632 - E_{II}$$

$$= -351379.1632 - 282.358$$

$$= -351661.5212\,\hat{i}$$

So,

x-component $= -351661.5212$ N/C

y-component $= 0$ N/C (Ans)

ii) Here,

$$r = \sqrt{(7-7)^2 + (3.5-7)^2 + (0-0)^2}$$

$$= 3.5 \text{ m}$$

$$\hat{r}_{P_2} = -1\hat{j}$$

Now,

$$E_{ii} = \frac{\sigma R}{\epsilon_0 r^2} \hat{r}_{p2}$$

$$= \frac{(-28\times10^{-6})(1.4)^2}{(8.854\times10^{-12})(3.5)^2} -\hat{j}$$

$$\simeq 505985.995 \hat{j}$$

x-component $= E_{II}$

$= -282.358$ N/C

(Ans)

y-component $= E_{ii}$

$= 505985.995$ N/C

(Ans)

Ans. To The Q. No. (1.3)

a) Given,

$R = 16\ m$, $\sigma = 15 \times 10^{-9}\ c/m^2$

$\phi = \sigma \pi R^2$

$= 15 \times 10^{-9} \times \pi \times (16)^2$

$= 1.2064 \times 10^{-5}\ c$

(Ans)

b) Electric field point $(x, y, z) \equiv (0, 9, 0)$

Now,

$$E = \frac{\sigma}{2\epsilon_0}\left(1 - \frac{y}{\sqrt{y^2 + R^2}}\right)$$

$$= \frac{15 \times 10^{-9}}{2 \times 8.854 \times 10^{-12}}\left(1 - \frac{9}{\sqrt{9^2 + (16)^2}}\right)$$

$= 431.787\ N/c$

(Ans)

c) moved point $s'(x', y', z') \equiv (0, 11, 0)$

$$E = \frac{\sigma}{2\epsilon_0}\left(1 - \frac{y'}{\sqrt{(y')^2 + (R)^2}}\right)$$

$$= \frac{15 \times 10^{-9}}{2 \times 8.854 \times 10^{-12}}\left(1 - \frac{11}{\sqrt{(11)^2 + (16)^2}}\right)$$

$= 367.182497$ N/C (Ans)

d) $\vec{P} = (6\hat{x} + 3\hat{y})$ cm

We know that,

$\tau = E \times x$ component

From (c),

$E = 367.1825$ N/C

$= 367.182497 \times 6$

$= 2203.094982$ N.m (Ans)

Potential energy,

$U = -E \times y$ component

$= (-367.182497 \times 3)$

~~$= -1101.547$~~

$= -1101.547491$ J

(Ans)