Physics assignment #02
Chapter 23 ~~Q/A~~ Examples
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Example 23.1:-
The .... two partical.

Solution:-

$$F_e = k_e \frac{|e||-e|}{r^2}$$

$$= (8.99 \times 10^{9} N \cdot m^2/C^2) \frac{(1.60 \times 10^{-19} C)^2}{(5.3 \times 10^{-11} m)^2}$$

$$\boxed{= 8.2 \times 10^{-8} N}$$

$$F_g = \frac{G m_e m_p}{r^2} = \frac{(6.67 \times 10^{-11} N \cdot m^2/kg^2)(9.11 \times 10^{-31} kg)(1.67 \times 10^{-27} kg)}{(5.3 \times 10^{-11} m)^2}$$

$$\boxed{= 3.6 \times 10^{-47} N}$$

Example 23.2:-
Consider .... exerted on q_3.

Solution:-

$$F_{23} = k_e \frac{|q_2||q_3|}{a^2}$$

$$= (8.99 \times 10^{9} N \cdot m^2/C^2) \frac{(2.0 \times 10^{-6} C)(5 \times 10^{-6}}{(0.10 m)^2}$$

$$\boxed{= 9.0 N}$$

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$$F_{13} = k_e \frac{|q_1||q_3|}{(\sqrt{2}a)^2}$$

$$= (8.99\times10^9\, N\cdot m^2/C^2)\frac{(5.0\times10^{-6}C)(5.0\times10^{-6}C)}{2(0.10m)^2} = \boxed{11N}$$

$$F_{13x} = F_{13}\cos45^\circ = 7.9N$$
$$F_{13y} = F_{13}\sin45 = 7.9N$$

$$F_{3x} = F_{13x} + F_{23x} = 7.9N + (-9.0N) = -1.1N$$
$$F_{3y} = F_{13y} + F_{23y} = 7.9N + 0 = 7.9N$$

$$\boxed{\vec{F}_3 = (-1.1\hat{i} + 7.9\hat{j})N}$$

Example:- 23.3:-

Three ...... q_3?

Solution:-

$$\vec{F}_3 = \vec{F}_{23} + \vec{F}_{13} = -k_e\frac{|q_2||q_3|}{x^2}\hat{i} + k_e\frac{|q_1||q_3|\hat{i}}{(2-x)^2}$$

$$\cancel{k_e}\frac{|q_2|\cancel{|q_3|}}{x^2} = \cancel{k_e}\frac{|q_1|\cancel{|q_3|}}{(2-x)^2}$$

$$(2-x)^2|q_2| = x^2|q_1|$$

$$(4.00 - 4.00x + x^2)(6.00\times10^{-6}C) = x^2(15.0\times10^{-6}C)$$

$$3.00x^2 + 8.00x - 8.00 = 0$$

$$\boxed{x = 0.775m}$$

Example 24.4:-

TWO .... each sphere.

Solution:

(1) $\Sigma F_x = T\sin\theta - F_e = 0 \rightarrow T\sin\theta = F_e$

(2) $\Sigma F_y = T\cos\theta - mg = 0 \rightarrow T\cos\theta = mg$

$$\tan\theta = \frac{F_e}{mg} \rightarrow F_e = mg\tan\theta$$

$$F_e = (3.0\times10^{-2}\,kg)(9.80\,m/s^2)\tan(5.0)$$

$$= 2.6\times10^{-2}\,N$$

$$\sin\theta = \frac{a}{L} \rightarrow a = L\sin\theta$$

$$a = (0.15\,m)\sin(5.0) = 0.013\,m$$

$$F_e = k_e\frac{|q|^2}{r^2} \rightarrow |q| = \sqrt{\frac{F_e r^2}{k_e}} = \sqrt{\frac{F_e(2a)^2}{k_e}}$$

$$|q| = \sqrt{\frac{(2.6\times10^{-2}\,N)[2(0.013\,m)]^2}{8.99\times10^{9}\,N\cdot m^2/C^2}}$$

$$\boxed{= 4.4\times10^{-8}\,C}$$

example 23.5:

charges .... as shown.

Solution (A).

$$E_1 = k_e\frac{|q_1|}{r_1^2} = k_e\frac{|q_1|}{(a^2+y^2)}$$

$$E_2 = k_e\frac{|q_2|}{r_2^2} = k_e\frac{|q_2|}{b^2+y^2}$$

$$E_1 = k_e\frac{|q_1|}{(a^2+y^2)}\cos\phi\,\hat{i} + k_e\frac{|q_1|}{(a^2+y^2)}\sin\phi\,\hat{j}$$

$$E_2 = k_e\frac{|q_2|}{(b^2+y^2)}\cos\theta\,\hat{i} - k_e\frac{|q_2|}{(b^2+y^2)}\sin\theta\,\hat{j}$$

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$$\boxed{\begin{aligned} &1)\ E_x = E_{1x}+E_{2x} = k_e\frac{|q_1|}{(a^2+y^2)}\cos\phi + k_e\frac{|q_2|}{(b^2+y^2)}\cos\theta \\ &2)\ E_y = E_{1y}+E_{2y} = k_e\frac{|q_1|}{(a^2+y^2)}\sin\phi + k_e\frac{|q_2|}{(b^2+y^2)}\sin\theta \end{aligned}}$$

b) Evaluate ..... $a=b$?

3) $E_x = k_e\frac{q}{(a^2+y^2)}\cos\theta + k_e\frac{q}{(a^2+y^2)}\cos\theta = 2k_e\frac{q}{a^2+y^2}\cos\theta$

$E_y = k_e\frac{q}{(a^2+y^2)}\sin\theta - k_e\frac{q}{(a^2+y^2)}\sin\theta = 0$

4) $\cos\theta = \frac{a}{r} = \frac{a}{(a^2+y^2)^{1/2}}$

$E_x = 2k_e\frac{q}{(a^2+y^2)}\cdot\frac{a}{(a^2+y^2)^{1/2}} = \boxed{k_e\frac{2qa}{(a^2+y^2)^{3/2}}}$

c) Find .... the origin

5) $\boxed{E \approx k_e\frac{2qa}{y^3}}$

example 23.6:.
A rod .... from one end.

Solution:.

$de = k_e\frac{dq}{x^2} = \frac{k_e\lambda dx}{x^2}$

$E = \int_a^{l+a} k_e\lambda\, dx/x^2$

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$$E = k_e\lambda \int_a^{L+a} \frac{dx}{x^2} = k_e\lambda\left[-1/x\right]_a^{L+a}$$

(1) $$E = k_e \frac{Q}{L}\left(\frac{1}{a} - \frac{1}{L+a}\right) = \boxed{\frac{k_e Q}{a(L+a)}}$$

Example 23.7:-

A ring........place of the ring.

Solution:-

1) $$dE_x = k_e \frac{dq}{r^2}\cos\theta = k_e \frac{dq}{(a^2+x^2)}\cos\theta$$

2) $$\cos\theta = \frac{x}{r} = \frac{x}{(a^2+x^2)^{1/2}}$$

$$dE_x = k_e \frac{dq}{(a^2+x^2)} \frac{x}{(a^2+x^2)^{1/2}} = \frac{k_e x}{(a^2+x^2)^{3/2}} dq$$

$$E_x = \int \frac{k_e x}{(a^2+x^2)^{3/2}} dq = \frac{k_e x}{(a^2+x^2)^{3/2}} \int dq$$

3) $$E = \frac{k_e x}{(a^2+x^2)^{3/2}} Q$$

Example 23.8:-

A disk...... of the disk.

Solution:-

$$dE_x = \frac{k_e x}{(r^2+x^2)^{3/2}}(2\pi\sigma r\,dr)$$

$$E_x = k_e x\pi\sigma \int_0^R \frac{2r\,dr}{(r^2+x^2)^{3/2}}$$

$$= k_e x\pi\sigma \int_0^R (r^2+x^2)^{-3/2} d(r^2)$$

$$= k_e x\pi\sigma \left[\frac{(r^2+x^2)^{-1/2}}{-1/2}\right]_0^R = 2\pi k_e\sigma \left[1 - \frac{x}{(R^2+x^2)^{1/2}}\right]$$

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Example 23.9

A uniform .... negative plate.

Solution (A):-

$$V_f^2 = V_i^2 + 2a(x_f - x_i) = 0 + 2a(d - 0) = 2ad$$

$$V_f = \sqrt{2ad} = \sqrt{2\left(\frac{qE}{m}\right)d} = \sqrt{\frac{2qEd}{m}}$$

(B):- $W = \Delta K$

$$F_e \Delta x = K_{(B)} - K_{(A)} = \frac{1}{2} m v_f^2 - 0 \rightarrow V_f = \sqrt{\frac{2F_e \Delta x}{m}}$$

$$V_f = \sqrt{\frac{2(qE)(d)}{m}} = \boxed{\sqrt{\frac{2qEd}{m}}}$$

Example 23.10:-

An electron .... $L = 0.100 m$.

Solution (A):-

$$\Sigma F_y = ma_y \rightarrow a_y = \frac{\Sigma F_y}{m} = \frac{-eE}{m_e}$$

$$a_y = -\frac{(1.60 \times 10^{-19} C)(200 N/C)}{9.11 \times 10^{-31} kg} \boxed{= -3.51 \times 10^{13} m/s^2}$$

(B)

$$x_f = x_i + V_x t \rightarrow t = \frac{x_f - x_i}{V_x}$$

$$t = \frac{l - 0}{V_x} = \frac{0.100 m}{3.00 \times 10^6 m/s} \boxed{= 3.33 \times 10^{-8} s}$$

$$y_f = y_i + V_{yi} t + \frac{1}{2} a_y t^2$$

$$y_f = 0 + 0 + \frac{1}{2}(-3.51 \times 10^{13} m/s^2)(3.33 \times 10^{-8} s)^2$$

$$= 0.0195 m = -1.95 m$$