Date:

=> Assignment #3 (Applied-physics)

Name:- Yash-Raj
Roll-number:- 24K-0737.

Q#1:-

Given-Data:-

$q_1 = 3nC$ at $x_1 = 2cm$.
$q_2 = -7nC$ at $x_2 = 4cm$.
$q_3 = 5nC$ is at Origin

Required:-

Magnitude of charge resultant-force on q_3 = ?
Direction of resultant force = ?

Sol:-

force on q_3 due to q_1 and q_2:-

$$F_{13} = \frac{kq_1q_3}{r_1^2}$$

$$= \frac{(9\times10^9)(3\times10^{-9})(5\times10^{-9})}{(0.02)^2}$$

$$\boxed{F_{13} = 3.375\times10^{-13}N}$$

Name: Yash Raj Roll no:- 24K-0737 Date:

$$F_{23} = \frac{kq_1q_2}{r^2}$$

$$= \frac{(9\times10^{9})(7\times10^{-9})(5\times10^{-9})}{(0.04)^2}$$

$$\boxed{F_{23} = 1.968\times10^{-13}\,N}$$

$$F_{net} = F_{23} - F_{13}$$

$$(1.968\times10^{-13}) - (3.375\times10^{-13})$$

$$\boxed{F_{net} = -1.40625\times10^{-13}\,N}$$

$$|F_{net}| = 1.40625\times10^{-13}\,N$$

Direction:- Negative x-axis (toward q_2).

Name: Yash Raj Roll no:- 24K0737

Q#2:-

Given Data:-

$q_1 = 2\mu C$ $y = 0.3m$

$q_2 = 2\mu C$ at $x = 0$.

$q_3 = 4\mu C$ at $x = 0.4m$.

Required:-

→ magnitude of resultant force on q_3:-

→ Direction of this force:-

Sol:-

$$F = K\frac{q_1 q_2}{r^2}$$

$$r_{13} = \sqrt{x^2 + y^2}$$

$$= \sqrt{(0.4)^2 + (0.3)^2}$$

$$= \sqrt{0.16 + 0.9}$$

$$= \sqrt{0.25}$$

$$= 0.5m$$

$$F_{13} = \frac{(9\times10^9)(2\times10^{-6})(4\times10^{-6})}{(0.5)^2}$$

$$\boxed{F_{13} = 2.88\times10^{-10}N}$$

Name: Yash Raj Roll no: L-04K-0737 Date:

$\theta = \tan^{-1}\left(\frac{y_1}{x}\right)$

$\tan^{-1}\left(\frac{0.3}{0.4}\right)$

$\tan^{-1}(0.75)$

$\boxed{\theta = 36.87^\circ}$

$r_{23} = 0.4m$

$f_{23} = \frac{(9\times10^{9})(2\times10^{-6})(4\times10^{-6})}{(0.9)^2}$

$\boxed{f_{23} = 4.5\times10^{-10}N}$

$f_{13x} = f_{13}\cos\theta$, $f_{13y} = f_{13}\sin\theta$

$f_{13x} = (2.8\times10^{-10})\cos(36.87) = 2.304\times10^{-10}N$

$f_{13y} = (2.8\times10^{-10})\sin(36.87) = 1.728\times10^{-10}N$

$F_x = f_{13x} - f_{23}$

$(2.304\times10^{-10}) - (4.5\times10^{-10})$

$\boxed{F_x = -2.196\times10^{-10}N}$

Name: Yash Raj Roll-no:- 24K-0737

$F_y - F_{12y} = -1.728 \times 10^{-10} N$

$F_{net} = \sqrt{F_x^2 + F_y^2}$

$F_{net} = \sqrt{(-2.196 \times 10^{-10})^2 + (1.728 \times 10^{-10})^2}$

$\boxed{F_{net} = -2.79 \times 10^{-10} N}$

$\theta = \tan^{-1}\left(\frac{F_y}{F_x}\right)$

$\theta = \tan^{-1}\left(\frac{1.728 \times 10^{-10}}{-2.196 \times 10^{-10}}\right)$

$\theta = \tan^{-1}(-0.787)$

$\theta = 180 - 38.15^\circ$

$\boxed{\theta = 141.85^\circ}$

Name: Yash Raj Roll-no:- 24K-0737 Date:

Q#3:-

Given-Data:-

Three charges are given:

(i) $-2Q$

(ii) $+Q$

(iii) $-Q$

Required:-

$$\phi_E = \frac{Q_{enclosed}}{\epsilon_0}$$

$\oint_S dA$

=) Surface #1:-

Only $+Q$ is inside this surface.

$$\phi_{E1} = \frac{Q_{enc}}{\epsilon_0} = \frac{+Q}{\epsilon_0}$$

=) Surface #2:-

$+Q$ and $-Q$ are inside the surface.

$$Q_{enc} = +Q-(+Q)$$
$$= 0.$$

$$\phi_E = \frac{Q_{enc}}{\epsilon_0} = 0.$$

Name: Yash Raj Roll-no: 24K-0737 Date:

Surface #3:-

$-2Q$ and $+Q$ are inside this surface.

$$Q_{enc} = -2Q + Q$$
$$= -Q$$

$$\Phi_E = \frac{Q_{enc}}{\epsilon_0} = \frac{-Q}{\epsilon_0}$$

Surface #4:-

All three charges are inside this surface.

$$Q_{enc} = -2Q + Q + (-Q)$$
$$= -2Q$$

$$\Phi_E = \frac{Q_{enc}}{\epsilon_0} = \frac{-2Q}{\epsilon_0}$$ Ans.

Name: Yash Raj Roll-no: 24K-0737 Date:

Q#4:-

Given Data:-

Particle 1 initial acceleration: $7 m/s^2$
Particle 2 initial acceleration: $9 m/s^2$
$r = 3.2 \times 10^{-3} m$
$m_1 = 6.3 \times 10^{-7} kg$

Required:-

$m_2 = ?$
magnitude of charge: ?

Sol:

$F = ma$.

$F_1 = m_1 a_1$

$(6.3 \times 10^{-7})(7)$

$F_1 = 4.4 \times 10^{-6} N$

$F_2 = m_2 a_2$

$F_1 = F_2$

$4.41 \times 10^{-6} = m_2 a_2$

$m_2 = \frac{F_2}{a_2} = \frac{4.41 \times 10^{-6}}{9} = 4.9 \times 10^{-7} kg$

$\boxed{m_2 = 4.9 \times 10^{-7} kg}$

Name: Yash Raj Roll no:- 24K-0737 Date:

=) Charge on each particle:-

$$F = \frac{kq^2}{r^2}$$

$$q^2 = \frac{Fr^2}{k}$$

$$q^2 = \frac{(4.41\times10^{-6})(3.2\times10^{-3})^2}{9\times10^9} = 5.02\times10^{-21}$$

$$q = \sqrt{5.02\times10^{-21}}$$

$$\boxed{q = 7.8\times10^{-11}\,C}$$

Name: Yash Raj Roll no: 24k-0737 Date

Q#5:-

Given Data:-

$F = 1N$

$r = 1m$

$q_1 + q_2 = 5 \times 10^{-5} C$

$$F = \frac{k q_1 q_2}{r^2}$$

$$q_1 q_2 = \frac{F r^2}{k}$$

$$q_1 q_2 = \frac{(1)(2)^2}{9 \times 10^9}$$

$$\boxed{q_1 q_2 = 4.44 \times 10^{-10} C^2}$$

$$q_2 = (5 \times 10^{-5}) - q_1$$

$$q_1^2 = -(5 \times 10^{-5}) q_1 + 4.44 \times 10^{-10} = 0$$

$$q_1 = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$$

Name: Yash Raj Roll-no:- 24K-0737 Date:

$a = 1$

$b = -(5 \times 10^{-5})$

$c = 4.44 \times 10^{-10}$

$$\frac{b \pm \sqrt{b^2 - 4ac}}{2a}$$

$$q_1 = \frac{-(-5 \times 10^{-5}) \pm \sqrt{(-5 \times 10^{-5})^2 - 4(1)(4.44 \times 10^{-10})}}{2(1)}$$

$$q_1 = \frac{5 \times 10^{-5} \pm \sqrt{7.24 \times 10^{-10}}}{2}$$

$$\sqrt{7.24 \times 10^{-10}} = 8.51 \times 10^{-6}$$

$$q_1 = \frac{5 \times 10^{-5} \pm 8.51 \times 10^{-6}}{2}$$

$$q_1 = 2.93 \times 10^{-5} C$$

$$q_2 = 2.07 \times 10^{-5} C$$

Smaller charge is $\boxed{q_2 = 2.07 \times 10^{-5} C}$ Ans.