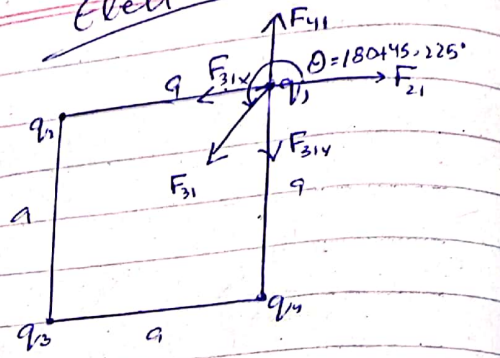
Question 02
Electric Forces



$q_1 = -5\,\mu C$

$q_2 = -8\,\mu C$

$q_3 = 15\,\mu C$

$q_4 = -16\,\mu C$

$a = 0.05\,m$

$a' = a\sqrt{2} = 0.0707\,m$

$F_1 = F_{21} - F_{31x}$

$F_1 = F_{41} - F_{31y}$

For F_{21}:-

$$F_{21} = \frac{Kq_1q_2}{a^2} = \frac{9\times10^9 \times -5\times10^{-6} \times -8\times10^{-6}}{(0.05)^2}$$

$$F_{21} = 144\,N$$

For F_{31}

$$F_{31} = \frac{Kq_1q_3}{a'^2} = \frac{9\times10^9 \times -5\times10^{-6} \times 15\times10^{-6}}{(0.0707)^2}$$

$$F_{31} = -135.04\,N$$

For F_{41}:-

$$F_{41} = \frac{Kq_1q_4}{r^2} = \frac{9\times10^9 \times -5\times10^{-6} \times -16\times10^{-6}}{0.05^2}$$

$$F_{41} = 288\,N$$

For F_{1x}:-

$$F_{1x} = 144 - (-135.04)\cos(225°)$$

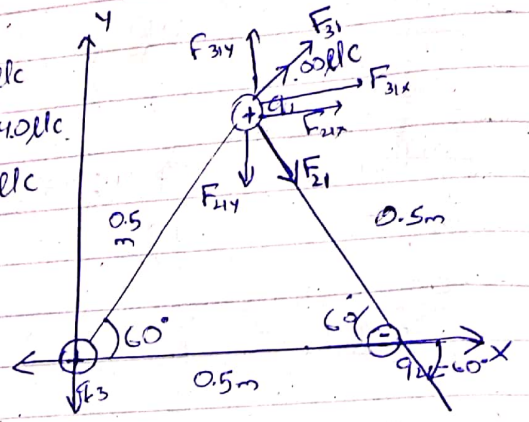
$$F_{1x} = 48.51\,N$$

For F_{1y}:-

$$F_{1y} = 288 - (-135.04)\sin(225°)$$

$$F_{1y} = 192.51\,N$$

QUESTION 02



$F_{1x} = F_{31x} + F_{21x}$

$F_{1y} = F_{31y} - F_{21y}$

For F_{31}

$$F_{31} = \frac{Kq_1q_3}{r^2} = \frac{9\times10^9 \times 7\times10^{-6} \times 2\times10^{-6}}{(0.5)^2}$$

$F_{31} = 0.504N$

For F_{21} :-

$$F_{21} = \frac{Kq_1q_2}{r^2} = \frac{(9\times10^9)(7\times10^{-6})(-4\times10^{-6})}{0.5^2}$$

$F_{21} = -1.008N$

FOR F_{1x} :-

$F_{1x} = F_{31x} - F_{21x}$

$= 0.504\cos(60°) - (-1.008)\cos(-60)$

$F_{1x} = 0.756N$

For F_{1y} :-

$F_{1y} = F_{31y} - F_{21y}$

$= 0.504\sin(60) + 1.008\sin(-60)$

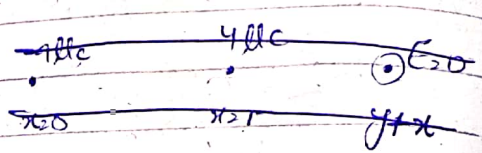
$F_{1y} = -0.436N$

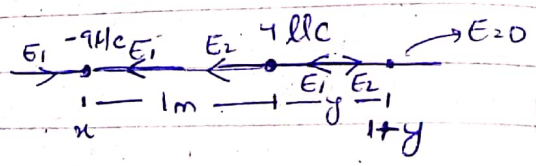
$F_{1x} = 0.756N$

Question 03:

$q_1 = -9\,\mu C$, $x = 0$

$q_2 = 4\,\mu C$, $x = 1$





When E will be zero
F will also be zero
→ E will only be zero
when $E_1 = E_2$

$$E_1 = E_2$$

$$\frac{K q_1}{(1+y)^2} = \frac{K q_2}{y^2}$$

$$\frac{(1+y)^2}{y^2} = \frac{q_1}{q_2}$$

$$\sqrt{\left(\frac{1+y}{y}\right)^2} = \sqrt{\frac{q_1}{q_2}}$$

$$\frac{1+y}{y} = \sqrt{\frac{+9\times10^{-6}}{4\times10^{-6}}}$$

$$\frac{1+y}{y} = 1.5$$

$$1+y = 1.5y$$

$$1 = 0.5y$$

$$\boxed{y = 2m}$$

Question 04

$r = 0.5 \times 10^{-10}\ m$

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

$m_e = 9.109 \times 10^{-31}\ kg$

$m_p = 1.67 \times 10^{-27}\ kg$

$F_e/F_g = \frac{Kq_1q_2}{r^2} \div \frac{Gm_1m_2}{r^2}$

$= \frac{9 \times 10^9 \times 1.602 \times 10^{-19} \times 1.602 \times 10^{-19}}{6.67 \times 10^{-11} \times 9.109 \times 10^{-31} \times 1.67 \times 10^{-27}}$

$F_e/F_g = 2.27 \times 10^{39}$

$F_g/F_e = \frac{1}{2.27 \times 10^{39}}$

$F_g/F_e = 4.4 \times 10^{-40}$

Question 05

$r = ?$

$01, \frac{9 \times 10^9 \times (1.602 \times 10^{-19})^2}{r^2}$

$r = \sqrt{9 \times 10^9 \times (1.602 \times 10^{-19})^2}$

$r = 1.52 \times 10^{-14}\ m$

Question 06 :-

$V = 2941 km/s = 2.94 \times 10^6\ m/s$

$r = 1.13cm = 0.0113m$

$e = 1.9 \times 10^{19} C$

$m = 1.67 \times 10^{-27} kg$

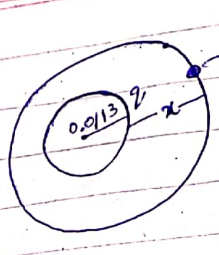
charge on sphere = ?

Since the proton is revolving centripetal force must be equal to electrostatic force

$F_c = F_e$

$\frac{mv^2}{r} = \frac{Keq}{r^2}$; $\frac{mv^2r}{Ke} = q$

Question 06



$V = 294\ km/s = 2.94 \times 10^5\ m/s$

$r = 1.13\ cm = 0.0113\ m$

$e = 1.9 \times 10^{-19}$

$m = 1.67 \times 10^{-27}\ kg$

q on sphere $= ?$

Since the proton in revolving the electrostatic force must be equal to the centripetal force

$$F_e = F_c$$

$$Eq = \frac{mV^2}{r}$$

$$\frac{KQ}{r^2} \cdot q = \frac{mV^2}{r}$$

$$Q = \frac{mV^2 r}{Kq} \quad ; \quad Q = \frac{mV^2 r}{Kq}$$

$$\therefore Q = \frac{1.67 \times 10^{-27} \times (2.94 \times 10^5)^2 \times (0.013)}{9 \times 10^9 \times 1.6 \times 10^{-19}}$$

$$Q = 1.13 \times 10^{-9}\ C$$