Sol^n

Solution 01

1. In solution 01 we will have to use this

F= $\frac{1}{r^2} Cq_1q_2$

r = $\sqrt{(\frac{cq_1q_2}{F})}$

2. $F = \frac{Cq_1q_2}{r^2} = \frac{9\times10^9 \times 3.2\times10^{-6} \times 1.6\times10^{-6}}{(0.12)^2} = 3.2N$

3. Force on first particle, $F_1 = m_1a_1 = 5.9\times10^{-7} \times 7$
$= 4.13\times10^{-6}$

This force is equal to the force on 2nd particle, $F_2 = F_1$
$= m_2a_2$

$\therefore F_1 = m_2a_2$

$\Rightarrow m_2 = \frac{F_1}{a_2} = \frac{4.13\times10^{-6}}{9} = 4.59\times10^{-7}$ kg

$\therefore$ (a) mass of the second particle, $m_2 = 4.9\times10^{-7}$ kg

(b) let the charge on each particles is $= q$

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

$\Rightarrow F = \frac{Cq^2}{r^2}$

$\Rightarrow q = \sqrt{\frac{Fr^2}{C}}$

$\because F = F_1 = F_2$

$= \sqrt{\frac{4.13\times10^{-6} \times (5.2\times10^{-3})^2}{9\times10^9}}$

$= 1.11\times10^{-10}$ C

4. Electrostatic force between two protons.

$F_c = 9.216\times10^{-12}$ $\quad q = 1.6\times10^{-1}C$

$r = 5\times10^{-9}m.$

Gravitational force between two protons.

$$F_G = G\frac{m_1m_2}{r^2} = \frac{6.6743\times10^{-11}\times(1.67262192\times10^{-27})^2}{(5\times10^{-9})^2}$$

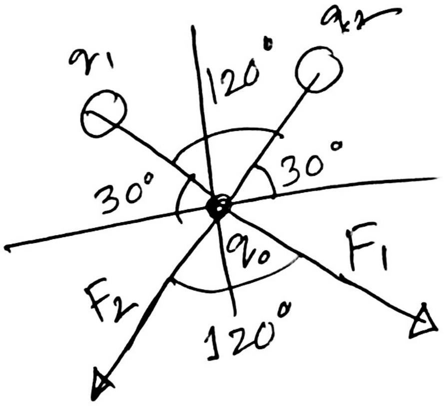
$$= 7.47\times10^{-48}$$

$$\therefore \frac{F_c}{F_G} = 1.234\times10^{36}$$

$$\therefore F_c = 1.234\times10^{36}F_G.$$

5. $$F_1 = \frac{c\,q_1q_0}{r_1^2} = \frac{9\times10^9\times3.2\times10^{-19}\times1.6\times10^{-19}}{(0.005)^2} = 1.84\times10^{-2}N$$

$$F_2 = \frac{c\,q_2q_0}{r_2^2} = \frac{9\times10^9\times5.6\times10^{-19}\times1.6\times10^{-19}}{(0.005)^2} = 3.23\times10^{-2}$$



(a) magnitude on test charge, q_0,

$$F_{net} = \sqrt{F_1^2+F_2^2+2F_1F_2\cos120^\circ}$$

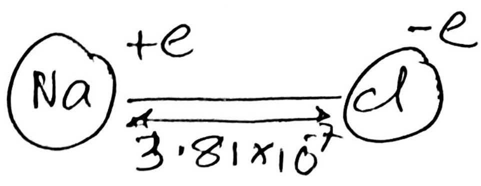
(b) Direction,

Let the resultant F_{net}

Produces angle θ with F_1

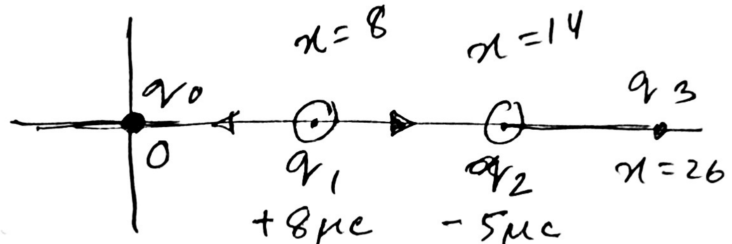
$$\tan\theta = \frac{F_2\sin120^\circ}{F_1+F_2\cos120^\circ}$$

6. $$F_c = \frac{9\times10^9 \times (1.6\times10^{-19})(1.6\times10^{-19})}{(3.81\times10^{-7})^2}$$



$$= 1.59\times10^{-15}\,N.$$

7. If the test charge



q_0 experience no electrostatic force that means the net electric field ~~of q~~ for charge q_1, q_2 and q_3 is 0.

$$\bar{E}_{net} = \bar{E}_1 + \bar{E}_2 + \bar{E}_3$$

If we consider,

Electric field on o for q_1, $E_1 = \frac{1}{4\pi\epsilon_0} \cdot \frac{q_1}{r^2}$

$$= 9\times10^9 \times \frac{8\times10^{-6}}{(8)^2}$$

$$= 1125$$

" " on o for q_2, $E_2 = -229.59$

" " " o for $q_3 \Rightarrow E_3 = \frac{9\times10^9 q}{(26)^2}$

As all the electric field lie along the same axis so we can simply add or subtract

So,

$E_{net} = E_1 + E_2 + E_3$

$0 = 1125 + -229.59 + \frac{9\times10^9 q}{(26)^2}$

$\therefore q = -6.72\times10^{-5}$ C.

8. Gravitational force on a proton on earth's surface, $F_G = mg = 1.67\times10^{-27}\times9.8$

$= 1.63\cancel{7}\times10^{-26}$ N.

$\because F_G = F_C$

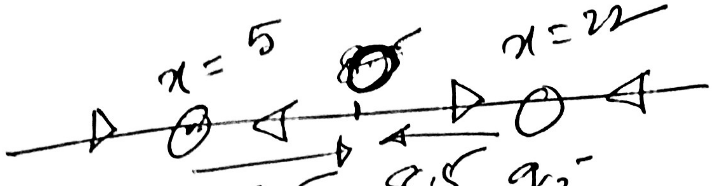
Electrostatic force, $F_C = \frac{Cq^2}{r^2}$

$\Rightarrow r = \sqrt{\frac{Cq^2}{F_C}}$

$= \sqrt{\frac{Cq^2}{F_G}}$

$\therefore r = \cancel{0.0}\ 0.119$ m.

9.



Electric field at O due to q_1, $E_1 = \frac{Cq}{r_1^2} =$

$E_2 = \frac{Cq}{r_2^2} =$

$E_{net} = E_1 - E_2$

$= 0$

So there will be no electric field lines and the net electric field at midway between the particles will be "0".

10. $E = C\frac{q}{r^2}$ $\therefore q = \frac{Er^2}{C} = \frac{5 \times (1.6)^2}{9 \times 10^9}$

$=$

11. $E = 5.4 \times 10^{-8}$ N/C

for a dipole the electric field, $\cancel{E = \frac{1}{2\pi\epsilon_0} \cdot \frac{P}{z^3}}$

$P = qd$

$= 2 \times 1.6 \times 10^{-19} \times 0.75 \times 10^{-9}$

torque,

$\tau = PE \sin\theta$

for parallel

$\tau_{\parallel} = PE \sin 0 = 0$

for perpendicular

$\tau_{\perp} = PE \sin 90^\circ = PE$

$= 5.4 \times 10^{-8} \times 2 \times 1.6 \times 10^{-19} \times 0.75 \times 10^{-9}$

$=$

12: ~~Soln~~

$\phi = \bar{E}.\bar{A}$

(a) $\bar{E} = 4\hat{i}$; $\bar{A} = 2\hat{i} + 3\hat{j}$

$\phi_a = (4\hat{i}).(2\hat{i}+3\hat{j})$

$= (4\times 2)(\hat{i}.\hat{i}) + (2\times 3)(\hat{i}.\hat{j}) = 8$

(b) $\bar{E} = 6\hat{k}$; $\bar{A} = 2\hat{i} + 3\hat{j}$

$\phi_b = \bar{E}.\bar{A} = (6\times 2)(\hat{k}.\hat{i}) + (6\times 3)(\hat{k}.\hat{j})$

$= 0.$

13. $U_{65^\circ} = PE\cos\theta_1 = 3.2\times 10^{-24} \times 56 \times \cos 65^\circ$

$U_{180^\circ} = PE\cos\theta_2 = 3.2\times 10^{-24} \times 56 \times \cos 180^\circ$

$\therefore W = -\Delta U = -(U_{180^\circ} - U_{65}) =$

14. a) radius of the sphere, $r = 0.6m$.

$\therefore$ (a) Net charge ~~de~~ on the sphere, $Q = A\sigma$

$= 4\pi r^2 \times \sigma$

$= 4\pi (0.6)^2 \times 8.1 \times 10^{-6}$

$=$

(b) Construct a gaussion surface.
from Gauss law, $\epsilon_0 \phi = q_{enclosed}$

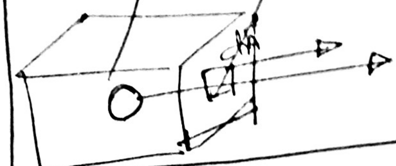
$\therefore \phi = \frac{q_{enclosed}}{\epsilon_0}.$

closed charge, $q = 1.8 \times 10^{-6}$ C

edge of each side, $a = 0.55$ m

~~area of the cube, $A, 6a^2 = 6 \times (0.55)^2$~~

~~electric flux $\Rightarrow \phi = \oint \vec{E} \cdot d\vec{A} = E \cdot 6a^2$~~

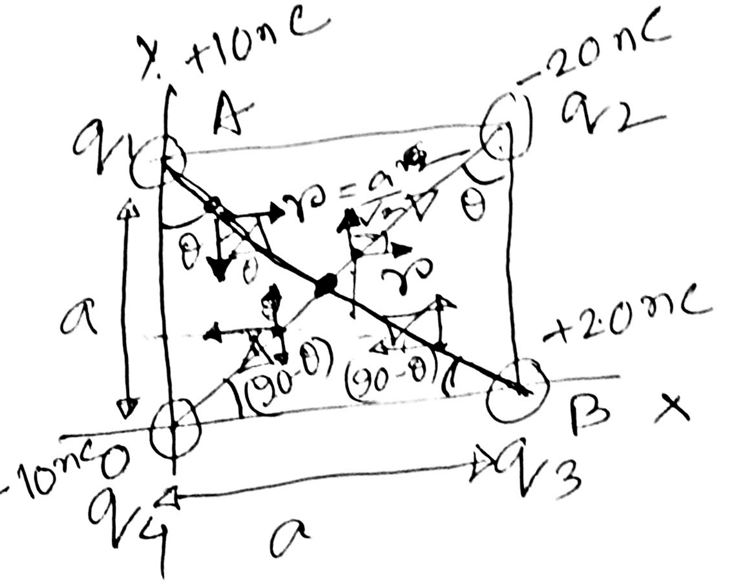


~~area of one side, $A = a^2$~~

Total flux through the surface, $\phi = \dfrac{q}{\epsilon_0}$

$$= \frac{1.8 \times 10^{-6}}{8.85 \times 10^{-12}}$$

$$= 2 \times 10^{5}\ \mathrm{Nm^2/C}$$



(16)

$\triangle OAB$,

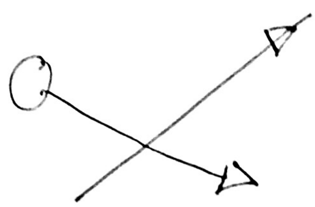
$OA^2 + OB^2 = AB^2$

$\Rightarrow a^2 + a^2 = AB^2$

$\Rightarrow 2a^2 = AB^2$

$\therefore AB = \sqrt{2}\, a$

$\therefore r = \dfrac{a}{\sqrt{2}}$



$E_{x\,net} = E_{1x} + E_{2x} + E_{3x} + E_{4x}$

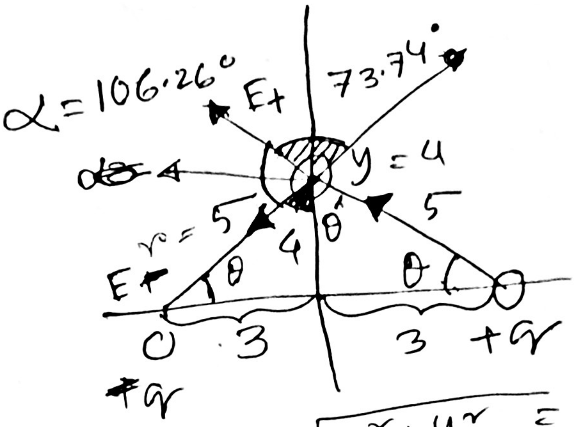
$= \cancel{\frac{C\,10}{r^2} + \frac{C(20)}{r^2} - \frac{C(20)}{r^2} - C}$

$= \dfrac{C\,10}{r^2}\cos(90-\theta) + \dfrac{C(20)}{r^2}\cos(90-\theta) + \dfrac{C(20)}{r^2}\cos(90-\theta) - \dfrac{C(10)}{r^2}\cos(90-\theta)$

17. $\Delta U = e \Delta V$

$= 1.6 \times 10^{-19} \times 1.2 \times 10^{9} V$

$=$



18. $E_+ = \frac{cq}{r^2}$

$E_- = \frac{cq}{r^2}$

$r = \sqrt{3^2 + 4^2} = 5$

$\theta = \sin^{-1}\left(\frac{4}{5}\right) = 53.13^\circ$

E_{net}

$= \sqrt{(E_+)^2 + (E_-)^2 + 2(E_+)(E_-)\cos 106.26^\circ}$

$\theta' = (90^\circ - 53.13)^\circ$

$= 36.87^\circ$

$\therefore 2\theta' = 73.74^\circ$

$\alpha = 180^\circ - 2\theta'$

$= 106.26.$

$=$

let Resultant produce θ with E_+

$\tan\theta = \frac{E_+ \sin\theta}{E_- + E_+ \cos\theta}$