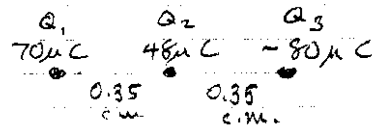
HW Set #1

21-10



Find forces

Use Eq (21-1), p. 550

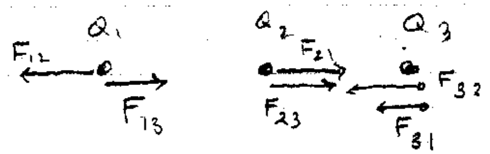
$$F_{12} = F_{21} = k\frac{Q_1 Q_2}{r^2}$$

$$= \left(8.99\times 10^9 \frac{Nm^2}{C^2}\right)\frac{(70\times 10^{-6})(48\times 10^{-6})}{(3.5\times 10^{-3} m)^2}\cdot\frac{C^2}{m^2}$$

$$= 2.47\times 10^2 N$$

This is repulsive because Q_1 and Q_2 are both positive

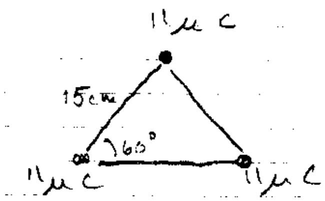
The other forces are calculated the same way. The directions of the forces are:



In Giancoli's notation F_{ij} is the force on charge i from charge j.

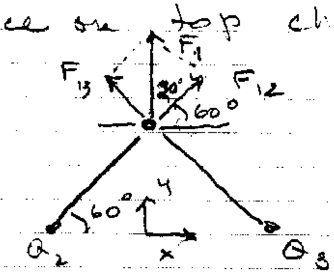
Net forces are found by vector addition

21-11



Find: magnitude and direction of forces.

Force on top charge



$\vec{F}_1 = \vec{F}_{12} + \vec{F}_{13}$

net force on Q_1

choose y axis "up" away from center of triangle

$F_{12x} = -F_{13x} \rightarrow F_{1x} = 0$

$F_{12y} = F_{13y} = F_{12}\cos 30° = \frac{1}{2} F_{12}$

So

$$F_{1y} = 2F_{12}\cos 30°$$

$$= 2k\frac{(11\times 10^{-6} C)^2}{(0.15 m)^2}\cos 30° = 83.8 N$$

away from center

Symmetry: all 3 charges feel 83.8 N away from center

21-16 For proton and electron

want: $\dfrac{F_{coulomb}}{F_{gravity}}$ at $r = 0.53 \times 10^{-10}$ m

$$F_{coulomb} = k \frac{(1.6\times10^{-16}\ C)^2}{r^2}$$

$$k = 8.99\times10^{9}\ \frac{N\,m^2}{C^2} \quad (p. 550)$$

$$F_{grav} = G\,\frac{m_{proton} m_{elec.}}{r^2} \quad (\text{Eq } 6.1,\ p. 135)$$

$$= \left(6.67\times10^{-11}\ \frac{N\,m^2}{kg^2}\right)\times \frac{(1.67\times10^{-27}\ kg)(9.11\times10^{-31}\ kg)}{r^2}$$

m_{proton} $m_{elec.}$

(masses from inner cover)

r^2 cancels in ratio

$$\frac{F_{coulomb}}{F_{grav.}} = \frac{\left(8.99\times10^{9}\ \frac{N m^2}{C^2}\right)(1.6\times10^{-16}\ C)^2}{\left(6.67\times10^{-11}\ \frac{N m^2}{kg^2}\right)(1.67\times10^{-27}\ kg)\times(9.11\times10^{-31}\ kg)}$$

$$= 2.3\times10^{39}$$

A very large ratio

21-35 Electron

$F = qE$ (p. 564)

$F = ma$ (2d law)

$a = 1.45\times10^{2}\ m/s^2$, $q = e = -1.6\times10^{-19}$ C

$m = 9.11\times10^{-31}$ kg

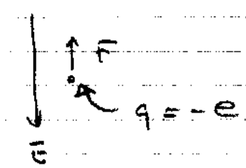
$(-e)E = ma$

$$E = -\left(\frac{m}{e}\right) a$$

$$= -\left(\frac{9.11\times10^{-31}\ kg}{1.6\times10^{-19}\ C}\right)\left(1.45\times10^{2}\ \frac{m}{s^2}\right)$$

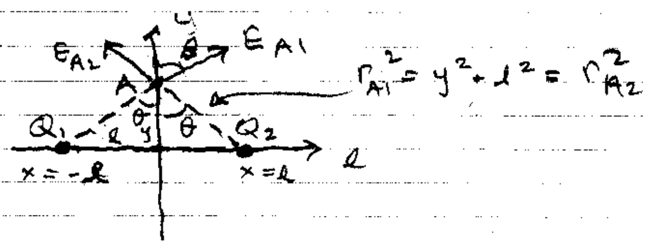
$$= -8.26\times10^{-10}\ \frac{N}{C}$$

Minus sign:
If electron accelerates north,
$\vec{E}$ field is south



21-43

a)



$Q_1 = Q_2 = Q$

$\vec{E}_A = \vec{E}_{A1} + \vec{E}_{A2}$

$E_{Ax} = 0$ because $E_{A1x} = -E_{A2x}$

$E_{Ay} = E_{A1y} + E_{A2y}$

$= \dfrac{kQ}{y^2+l^2}\cos\theta + \dfrac{kQ}{y^2+l^2}\cos\theta$

$\cos\theta = \dfrac{y}{\sqrt{y^2+l^2}}$

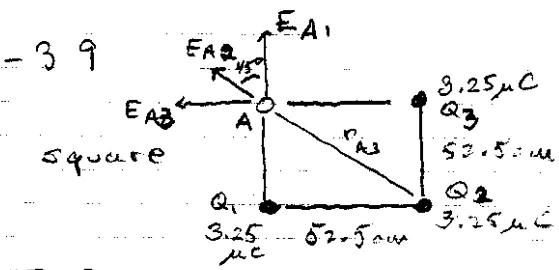
$E_{Ay} = kQ\dfrac{2y}{(y^2+l^2)^{3/2}}$

b) Compute dE/dy to find maximum, where $dE/dy = 0$

$\dfrac{dE_{Ay}}{dy} = 2kQ\left[\dfrac{1}{(y^2+l^2)^{3/2}} - \dfrac{3y^2}{(y^2+l^2)^{5/2}}\right]$

$= \dfrac{2kQ}{(y^2+l^2)^{5/2}}\left(y^2+l^2-3y^2\right) = 0$ at $y = \pm\dfrac{l}{\sqrt{2}}$

21-39



E-Directions are away from Q_1, Q_2, Q_3
Have to compute

Magnitudes: E_{A1}, E_{A2}, E_{A3}

$E_{A1} = E_{A3} = k\dfrac{(3.25\times10^{-6}C)}{(0.525\,m)^2}$

$= 2.83\times10^4\,\frac{N}{C}$

$E_{A2} = k\dfrac{(3.25\times10^{-6}C)}{r_{A3}^2}$

$r_{A3} = \sqrt{2}\,(52.5\,cm)$

$E_{A2} = 1.46\times10^4\,N/C$ (just ½ E_{A1})

Net force: away from center of square

$E_A = E_{A2} + E_{A1}\cos45° + E_{A2}\cos45°$

$= 5.61\times10^4\,N/C$