p. 333 # 1–10

1. $F_{12} = 0.080 N$
$r = 3r_{12}$

$$F = \frac{kq_1q_2}{(3r_{12})^2} = \frac{kq_1q_2}{9r_{12}^2}$$

$$F = \frac{1}{9} F_{12}$$

$$= \frac{1}{9}(0.080 N)$$

$$= 0.0089 N$$

2. $F = 0.080 N$
$q = 3q_1$
$r = 3r_{12}$

$$F = \frac{kq_1q_2}{r_{12}^2} = \frac{3}{9}\frac{kq_1q_2}{r_{12}^2} = \frac{1}{3}\frac{kq_1q_2}{r_{12}^2}$$

$$F = \frac{1}{3}(0.080 N)$$

$$= 0.027 N$$

3. $q_1 = q_2 = 1.602 \times 10^{-19} C$
$r = 0.10 nm$
$= 0.10 \times 10^{-9} m$

$$F = \frac{kq_1q_2}{r^2}$$

$$F = \frac{(9.0 \times 10^9 Nm^2/C^2)(1.602 \times 10^{-19} C)^2}{(0.10 \times 10^{-9} m)^2}$$

$$F = 2.3 \times 10^{-8} N \text{ repulsive}$$

4. Reduced by a factor of 1.50 → Multiplied by a factor of 1.50 $r = 1.50r$

$$\therefore F = \frac{kq_1q_2}{(1.50r)^2} = \frac{1}{2.25} F_e$$

p. 333 # 1-10

5. $q_1 = q_2 = 1.00\times10^{-6}C$

$F_e = F_g$

$= (1.00kg)(9.8N/kg)$

$= 9.8\ N$

$r = ?$

$$F_e = \frac{kq_1q_2}{r^2}$$

$$r = \sqrt{\frac{kq_1q_2}{F_e}}$$

$$r = \sqrt{\frac{(9.0\times10^9\ Nm^2/C^2)(1.00\times10^{-6}C)^2}{9.8N}}$$

$r = 3.0\times10^{-2}m$

6. $q_1 = -q_2 = 1.602\times10^{-19}C$

$r = 1.0\times10^{-9}m$

a) $F_g = ?$

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

$m_p = 1.673\times10^{-27}kg$

$$F_g = \frac{Gm_1m_2}{r^2}$$

$$= \frac{(6.67\times10^{-11}Nm^2/kg^2)(9.11\times10^{-31}kg)(1.673\times10^{-27}kg)}{(1.0\times10^{-9}m)^2}$$

$= 1.0\times10^{-49}N$

b) $F_e = ?$

$$F_e = \frac{kq_1q_2}{r^2}$$

$$= \frac{(9.0\times10^9\ Nm^2/C^2)(1.602\times10^{-19})^2}{(1.0\times10^{-9}m)^2}$$

$= 2.3\times10^{-10}N$

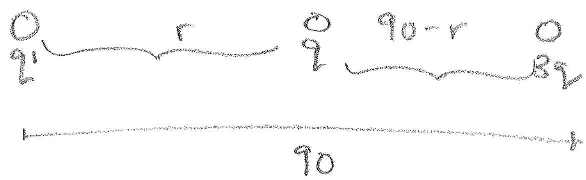
c)

p. 333 #1-10

6c) Current ratio: $\frac{F_e}{F_g} = 2.3 \times 10^{49}$

If r for both was increased 9x (1000000000) the ratio would still be the same.

7. q_1
$3q_1$
$q = q_1$



$d_q = ?$
$F_{NET\,q} = 0$ N

$F_{q_1} = \frac{k q_1 q}{r^2}$ $F_{3q} = \frac{k\, 3q\, q}{(90-r)^2}$

$F_{q_1} = F_{3q}$

$\frac{\cancel{k q^2}}{r^2} = \frac{3 k q^2}{(8100 - 180r + r^2)}$

$3r^2 = 8100 - 180r + r^2$
$2r^2 + 180r - 8100 = 0$

$r = \frac{-180 \pm \sqrt{180^2 - 4(2)(-8100)}}{2(2)}$ $\leftarrow r \geq 0$

$r = 66$

∴ q must be ~~at~~ $-40 + 66 = 26$.

p. 333 #1–10

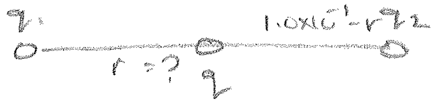
8 $q_1 = 2.0\times10^{-6}\,C$

$q_2 = -1.0\times10^{-6}\,C$

$r_T = 10\,cm$

$= 1.0\times10^{-1}\,m$

$r = ?$



$$F_{NET} = 0$$

$$\therefore \quad F_{NET} = 0 = F_1 + F_2$$

$$F_1 = -F_2$$

$$\frac{kq_1q}{r^2} = -\frac{kq_2q}{(0.10-r)^2}$$

$$\frac{(2.0\times10^{-6}C)}{r^2} = \frac{-(-1.0\times10^{-6}C)}{(0.010 - 0.20r + r^2)}$$

$$1.0\times10^{-6}r^2 = 2.0\times10^{-8} - 4.0\times10^{-7}r + 2.0\times10^{-6}r^2$$

$$1.0\times10^{-6}r^2 - 4.0\times10^{-7}r + 2.0\times10^{-8} = 0$$

$$r = \frac{4.0\times10^{-7} \pm \sqrt{(-4.0\times10^{-7})^2 - 4(1.0\times10^{-6})(2.0\times10^{-8})}}{2(1.0\times10^{-6})}$$

$$= \frac{4.0\times10^{-7} \pm 2.8\times10^{-7}}{2\times10^{-6}}$$

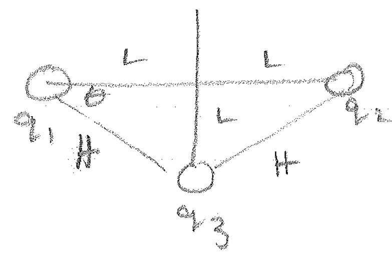
$$= 6.0\times10^{-2}\,m \quad \text{or} \quad 1.4\times10^{-1}\,m$$

But $r < 0.10\,m$ $\therefore$ $6.0\times10^{-2}\,m$

p. 333 #1–10

9. a) $q_1 = q_2 = q_3 = 7.5\times10^{-6}\,C$

$L = 25cm$
$= 0.25m$



$$F_{12} = \frac{kq_1q_2}{r^2}$$

$$= \frac{(9.0\times10^9\,Nm^2/C^2)(7.5\times10^{-6}\,C)^2}{(0.50m)^2}$$

$= 2.025N$ (repulsive)

$$H = \sqrt{L^2 + L^2}$$

$$= \sqrt{(0.25m)^2 + (0.25m)^2}$$

$= 0.35m$

$\tan\theta = \frac{L}{L}$

$\theta = 45°$

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

$$= \frac{(9.0\times10^9\,Nm^2/C^2)(7.5\times10^{-6}C)^2}{(0.35m)^2}$$

$= 4.133$ N repulsive

$$F_{23} = \frac{kq_2q_3}{H^2} = 4.133N \text{ repulsive}$$

p333 #1-10

9a) For q_3, it experiences F_x, F_y from q_1, q_2

$F_{x1} = -F_{x2} = F_{13}\cos 45° = 2.922\ N$

$F_{y1} = F_{y2} = F_{13}\sin 45° = 2.922 N$

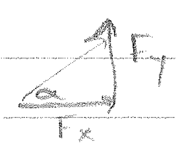
F_x cancels out, ∴ $F_{NET3} = 2F_{y1} = 2(2.922N)$
$= 5.844N$
$= 5.8N$ repulsive

b) For q_2,

$F_x = F_{12} + F_{23}\sin 45°$
$= 2.025N + (4.133N)\sin 45°$
$= 4.949N$

$F_y = F_{23}\cos 45°$
$= 2.922N$

$F = \sqrt{F_x^2 + F_y^2}$



$= \sqrt{(4.949N)^2 + (2.922N)^2}$

$= 5.7N$ repulsive

$\tan\alpha = \frac{F_y}{F_x} = \frac{2.922N}{4.949N}$

$\alpha = 30°$

∴ q_2 experiences a force of 5.7N [E 30° N]

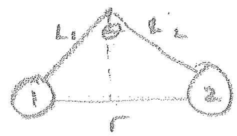
c) At the origin, $F_1 = -F_2$, ∴ only F_3

$F_3 = \frac{k q_3 q_e}{L^2} = \frac{(9.0\times10^9)(7.5\times10^{-6}C)(1.602\times10^{-19}C)}{(0.25)^2}$

$= 1.7\times10^{-13}N$ attractive.

p. 333 # 1 - 10

10. $m_1 = m_2 = 5.00\ g$
$= 5.00 \times 10^{-3}\ kg$
$L_1 = L_2 = 1.00\ m$
$q_1 = q_2 = ?$
$\theta = 30.0°$



$r = L_1 \sin\theta$

$F_g = F_e$

$$\frac{G m_1 m_2}{r^2} = \frac{k q_1 q_2}{r^2}$$

But $q_1 = q_2$, $m_1 = m_2$

$$\frac{G m^2}{r^2} = \frac{k q^2}{r^2}$$

But $r = L_1 \sin\theta$

$$\frac{G m^2}{L_1^2 \sin^2\theta} = \frac{k q^2}{L_1^2 \sin^2\theta}$$

$$q = \sqrt{\frac{L_1^2 \sin^2\theta \; G m^2}{L_1^2 \sin^2\theta \cdot k}}$$

$$q = \sqrt{\frac{G m^2}{k}}$$

$$= \sqrt{\frac{(6.67 \times 10^{-11}\ Nm^2/kg^2)(5.00 \times 10^{-3}\ kg)^2}{9.0 \times 10^9\ Nm^2/C^2}}$$

$= 4.54 \times 10^{-18}\ C$