PHYS 262 **Homework 10 (Ch23)** Spring '03

1. (SB 1) (a) no. of electrons = no. of atoms × 47

$$= \frac{\text{mass}}{\text{molar mass}} N_A \times 47$$

$$= 2.62 \times 10^{24} \#$$

(b) no. of electrons needed $= \frac{1 \times 10^{-3}\,C}{1.6 \times 10^{-19}\,C} = 6.24 \times 10^{15}\,C$

no. of electrons needed for every 10^9 electrons already present $= 6.24 \times 10^{15}\,C \div \frac{2.62 \times 10^{24}}{10^9}$

$$= 2.38 \#$$

2. (SB 2) (a) charge of proton $= e \approx 1.6 \times 10^{-19}\,C$

$$F_e = k_e \frac{e^2}{r^2} = 1.59 \times 10^{-9}\,N \#$$

(b) mass of proton $= m_p \approx 1.67 \times 10^{-27}\,kg$

$$F_g = G \frac{m_p^2}{r^2} = 1.29 \times 10^{-45}\,N$$

$$\therefore \frac{F_e}{F_g} = 1.24 \times 10^{36} \#$$

(c) If $F_e = F_g$

$$k_e \frac{e^2}{r^2} = G \frac{m_p^2}{r^2}$$

$$\frac{e}{m_p} = \sqrt{\frac{G}{k_e}}$$

$$= 8.61 \times 10^{-11}\,C/kg \#$$

3. (SB 6) (a) $|\vec{F}_e| = k_e \frac{|q_1 q_2|}{r^2} = (8.99 \times 10^9) \frac{|(12 \times 10^{-9})(-18 \times 10^{-9})|}{(0.3)^2}\,N$

$$= 2.16 \times 10^{-5}\,N \#\ \text{(attractive)}$$

(b) When the spheres are connected, the charges are shared between the two spheres such that both spheres will have charge $q = \frac{1}{2}(q_1 + q_2) = -3\,nC$

$$\therefore |\vec{F}_e| = k_e \frac{q^2}{r^2} = 8.99 \times 10^{-11}\,N \#\ \text{(repulsive)}$$

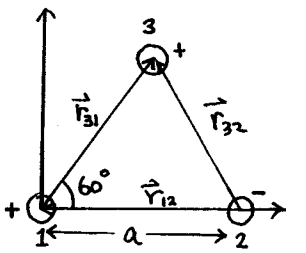
4. (SB 7) $\vec{F}_e = k_e \frac{q_1 q_2}{r^2} \hat{r} = k_e \frac{q_1 q_2}{r^3} \vec{r}$

$\therefore \vec{F}_3 = \vec{F}_{13} + \vec{F}_{23}$ (see Eq. 23.2)

$$= k_e \frac{q_1 q_3}{|\vec{r}_{31}|^3} \vec{r}_{31} + k_e \frac{q_2 q_3}{|\vec{r}_{32}|^3} \vec{r}_{32}$$

$$= \frac{k_e q_3}{a^2} \left[\frac{1}{2}(q_1 - q_2)\hat{i} + \frac{\sqrt{3}}{2}(q_1 + q_2)\hat{j} \right]$$

$$= 0.76\,\hat{i} - 0.44\,\hat{j} \#$$



$\vec{r}_{31} = \frac{a}{2}\hat{i} + a\sin 60°\,\hat{j}$

$\vec{r}_{32} = -\frac{a}{2}\hat{i} + a\sin 60°$

$\vec{r}_{12} = -a\hat{i}$

$|\vec{r}_{31}| = |\vec{r}_{32}| = |\vec{r}_{12}| = a$

5. (SB 15) (a) $\vec{E} = k_e \frac{q}{r^2} \hat{r} = k_e \frac{q}{r^3} \vec{r}$

$\vec{E}$ at the origin $= \vec{E}_2 + \vec{E}_3$

$$= k_e \frac{q_2}{|\vec{r}_{12}|^3} \vec{r}_{12} + k_e \frac{q_3}{|\vec{r}_{13}|^3} \vec{r}_{13} \quad (\vec{r}_{13} = -\vec{r}_{31})$$

$$= \frac{k_e}{a^2} \left[-(q_2 + \tfrac{q_3}{2})\hat{i} - \frac{q_3\sqrt{3}}{2}\hat{j} \right] = (18.0\,\hat{i} - 218\,\hat{j})\ kN/C \#$$

(b) $\vec{F} = q_1 \vec{E}$

$$= (36\,\hat{i} - 436\,\hat{j})\ mN \#$$