Homework 21.1

Of the charge Q initially on a tiny sphere, a portion q is to be transfered to a second, nearby sphere. Both spheres can be treated as particles and are fixed with a certian separation. For what value of q/Q will the electrostatic force betwee the two spheres be maximized?

$$F = \frac{q_1 q_2}{4\pi\epsilon_0 r^2}$$

$$q_1 = q \qquad q_2 = Q - q$$

$$F = \frac{1}{4\pi\epsilon_0 r^2}\left[q(Q-q) \right] =$$

$$= \frac{1}{4\pi\epsilon_0 r^2}\left[Qq - q^2 \right]$$

$$\frac{dF}{dq} = \frac{1}{4\pi\epsilon_0 r^2}\left[Q - 2q \right] = 0$$

$$Q - 2q = 0$$

$$\boxed{\frac{q}{Q} = \frac{1}{2}}$$

Homework 21.3

What must be the distance between a point charge q_1 = 26.0 *u*C. and a point charge q_2 = - 47.0 *u*C for the electrostatic force between them to have a magnitude of 5.70 N?

$$5.7 = \frac{8.8_2}{4\pi\epsilon_0 r^2}$$

$$r = \sqrt{\frac{8.8_2}{4\pi\epsilon_0 5.7}}$$

$$r = \sqrt{\frac{26 * 47 \times 10^{-12}}{4\pi\ 8.854 \times 10^{-12} * 5.7}}$$

$$= \sqrt{\frac{26 * 47}{4\pi\ 8.85 * 5.7}}$$

$$= 1.388\ m$$

Homework 21.7

In Fig. 21.23, three charged particles lie on an x axis. Particles 1 and 2 are fixed in place. Particle 3 is free to move, but the net electrostic force on it from particles 1 and 2 happens to be zero. If $L_{23} = L_{12}$, what is the ratio q_1 / q_2 ?

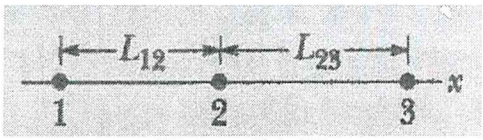


Figure 21-23

$$F = 0 = \frac{q_1 q_3}{4\pi\epsilon_0 (L_{12}+L_{23})^2} + \frac{q_2 q_3}{4\pi\epsilon_0 L_{23}^2}$$

$$\frac{q_1}{(L_{12}+L_{23})^2} + \frac{q_2}{L_{23}^2} = 0$$

$$\frac{q_1}{q_2} = -\left(\frac{L_{12}+L_{23}}{L_{23}}\right)^2 = -4$$

Homework 21.17

In fig. 21-28a, particles 1 and 2 have charge 20.0 *uC* each and are held at a separation distance *d = 1.50 m.*

a. What is the magnitude of the electrostatic force on particle 1 due to particle 2?

   in Fig 21-28*b*, particle 3 charge *20.0 uC* is positioned so as to complete an equilateral triangle.

b. What is the magnitude of the net electrostatic force on particle 1 due to particles 2 and 3?

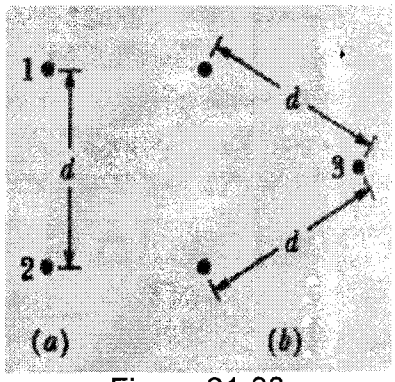


Figure 21-28

a) $F = \frac{q^2}{4\pi\epsilon_0 r^2}$

$= \frac{4\times10^{-10}}{4\pi\, 8.854\times10^{-12} * \left(\frac{9}{4}\right)}$

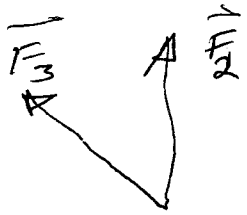
$q = 20\times10^{-6} = 2\times10^{-5}\,C$

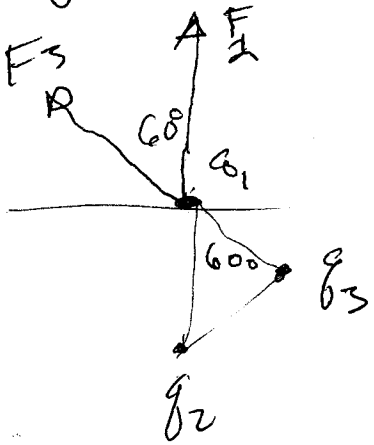
$r = 1.5 = \frac{3}{2}$

$r^2 = \frac{9}{4}$

a) $F_2\hat{y} = \frac{10^6 * 4}{\pi\, 8.85\times 9}\hat{y} = 1.597\,\hat{y}$

b)





$|F_3| = |F_2|$

$\vec{F_3} = |F_2|\angle 60^\circ$

$= 1.597(-\cos 30^\circ \hat{x} + \sin 30^\circ \hat{y})$

$\sin 30^\circ = 0.5$

$\cos 30^\circ = 0.866$

$\vec{F} = \vec{F_1} + \vec{F_3}$

$= 1.597(\hat{y} + 0.5\hat{y} - 0.866\hat{x})$

$\vec{F} = 1.597[1.5\hat{y} - 0.866\hat{x}]$

$|\vec{F}| = 1.597\left[1.5^2 + 0.866^2\right]$

$|F| = 2.766\,N$

Homework 21.65

The initial charges on the three identical metal spheres in Fig 21-24 are the following: Sphere A, Q; sphere B, - Q/4; and sphere C, Q/2, where Q = 2.00 x 10^{-14} C. Spheres A and B are fixed in place, with a center to center separation of *d = 1.20 m*, which is much larger than the spheres. Sphere C is touched first to sphere A and then to sphere B and is then removed. What then is the magnitude of the electrostatic force between spheres A and B?

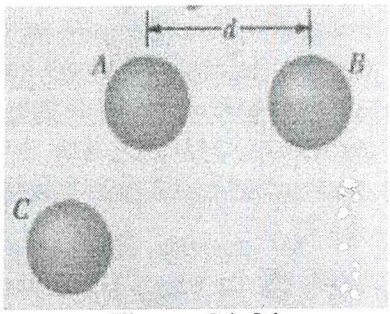


Figure 21-24

Initially $Q_A = Q$, $Q_B = -Q/4$ $Q_C = Q/2$

Touch C to A their Total charge divides equally

$$Q_C = Q_A = \frac{Q + Q/2}{2} = \frac{3}{4}Q$$

Then Touch C To B

$$Q_C = Q_B = \frac{\left(\frac{3}{4}Q + \frac{Q}{4}\right)}{2} = \frac{Q}{4}$$

$$F = \frac{Q_A Q_B}{4\pi\epsilon_0 r^2} = \frac{\left(\frac{3}{4}Q\right)\left(\frac{Q}{4}\right)}{4\pi\epsilon_0 r^2} = \frac{\frac{3}{16} * 4\times10^{-28}}{4\pi\epsilon_0 (1.2)^2}$$

$\epsilon_0 = 8.854\times10^{-12}$

$$F = 4.68\times10^{-19}\ N$$