Recitation Worksheet 1

Tuesday, September 8, 2020 2:40 PM

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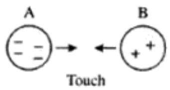
Problem 1: Metal sphere A has 4 units of negative charge and metal sphere B has 2 units of positive charge. The two spheres are brought into contact. What is the final charge state of each sphere? Explain.



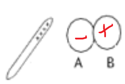
$-4 + 2 = -2$

$\frac{-2}{2} = \boxed{-1}$

Problem 2a: Metal sphere A is initially neutral. A positively charged rod is brought near, but not touching. Is A now positive, negative or neutral? Explain.

Neutral, but in a polar state.

Problem 2b: Metal spheres A and B are initially neutral and are touching. A positively charged rod is brought near A, but not touching. Is A now positive, negative, or neutral? Explain.



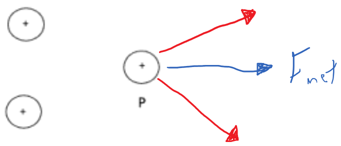
Negative charges collect in A.

Problem 2c: Metal sphere is initial neutral. It is connected by a metal wire to the ground. A positively charged rod is brought near, but not touching. Is A now positive, negative, or neutral? Explain.

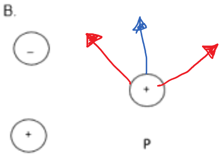
Negative

Problem 3: For each group of charged particles, draw and label the forces acting on particle P in the following figures, also draw and label the net force.

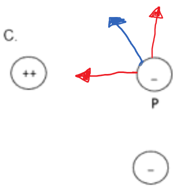
A.



B.



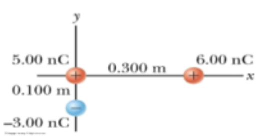
C.



Problem 4: Three point charges are arranged as shown in the figure. Find

a) The magnitude of the force on the particle at the origin

b) The direction of the force on the particle at the origin



x-direction

$$k\frac{q_1 q_2}{r^2}\hat{r} = 9\times10^{9}\left(\frac{5.0\times10^{-9}\cdot 6.0\times10^{-9}}{.3^2}\right)$$

$$F = 3\times10^{-6}\ N$$

y-direction

$$9\times10^{9}\left(\frac{5.0\times10^{-9}\cdot 3.0\times10^{-9}}{.1^2}\right)$$

$$F = 1.35\times10^{-5}\ N$$

$$F_R = \sqrt{(3\times10^{-6})^2 + (1.35\times10^{-5})^2}$$

$$F_R = 1.38\times10^{-5}\ N$$

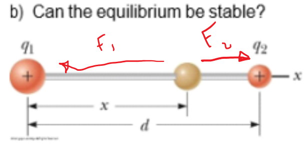
$$\phi = \tan^{-1}\left(\frac{3\times10^{-6}}{1.35\times10^{-5}}\right)$$

$$\phi = 12.53^{\circ}\ S\ of\ W$$

Problem 5: Two small beads having positive charges $\mathbf{q_1} = 3q$ and $\mathbf{q_2} = 1q$ are fixed at the opposite ends of an insulating rod of length **d**=1.50 m. the bead with charge $\mathbf{q_1}$ is at the origin. As shown in the figure a third small, charged bead is free to slide on the rod.

a) At what position **x** is the third bead in equilibrium?

b) Can the equilibrium be stable?



$$F_1 = k\left(\frac{q_1 c}{x^2}\right)$$

$$F_2 = k\left(\frac{q_2 c}{(d-x)^2}\right)$$

$$\cancel{k}\left(\frac{q_1 c}{x^2}\right) = \cancel{k}\left(\frac{q_2 c}{(d-x)^2}\right)$$

$$q_1 c = \frac{x^2 (q_2 c)}{(d-x)^2}$$

$$\left(\frac{q_2}{q_1}\right) = \frac{d^2}{x^2} - \frac{2dx}{x^2}$$

$$\left(\frac{q_2}{q_1}\right) = \frac{d^2 - 2dx}{x^2}$$

$$\frac{1}{3} = \frac{2.25 - 3x}{x^2}$$

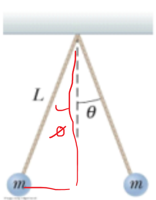
Yes it can be stable

$$\frac{x^2}{3} = 2.25 - 3x$$

$$x^2 + 9x - 6.75 = 0$$

$$x = .69 \text{ m}$$

Problem 6: Two small metallic spheres, each of mass **m**=0.200 grams, are suspended as pendulums by light strings of length **L** as shown in the figure. The spheres are given the same electric charge **q** of 7.2 nC, and they come to equilibrium when each string is at an angle of $\boldsymbol{\theta}$ =5.00° with the vertical. How long are the strings?



$r/2$

θ F_g F_c

$$\tan(\theta) = \frac{F_c}{F_g}$$

$$F_c = F_g \tan(\theta)$$

$$F_g = mg\cos(\theta)$$

$$F_g = 2\times10^{-4}(9.8)\cos(\theta)$$

$$F_g = .00196\cos(\theta)$$

$$F_g = .00189 \text{ N}$$

$$F_c = (.00189)\tan(5)$$

$$F_c = 1.66\times10^{-4} \text{ N}$$

$$1.66\times10^{-4} = 9\times10^{9}\left(\frac{(7.2\times10^{-9})^2}{r^2}\right)$$

$$r^2 = \frac{9\times10^{9}((7.2\times10^{-9})^2)}{1.66\times10^{-4}}$$

$$r = \sqrt{.0028}$$

$$r = .053 \text{ m}$$

$$\frac{(r/2)}{\sin(\theta)} = L$$

$$L = \frac{\left(\frac{.053}{2}\right)}{\sin(5)}$$

$$L = .304 \text{ m.}$$