Name Key

Homework Questions

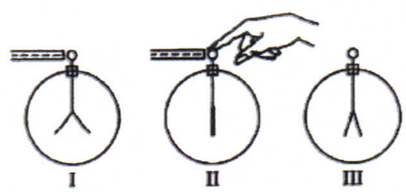
Electric Forces + Fields #1

Multiple Choice Practice

1. Two small spheres have equal charges q and are separated by a distance d. The force exerted on each sphere by the other has magnitude F. If the charge on each sphere is doubled and d is halved, the force on each sphere has magnitude

$F = \frac{kqq}{r^2}$ • $\frac{k(2q)(2q)}{\frac{1}{4}r^2} = \frac{4}{\frac{1}{4}} \cdot \frac{kqq}{r^2} = 16\frac{kqq}{r^2} = 16F$

(A) F (B) 2F (C) 4F (D) 8F (E) 16F



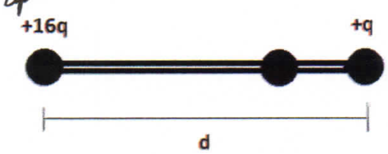
2. When a negatively charged rod is brought near, but does not touch, the initially uncharged electroscope shown above, the leaves spring apart (I). When the electroscope is then touched with a finger, the leaves collapse (II). When next the finger and finally the rod are removed, the leaves spring apart a second time (III). The charge on the leaves is

(A) positive in both I and III
(B) negative in both I and III
(C) positive in I, negative in III
(D) negative in I, positive in III
(E) impossible to determine in either I or III

I - negative rod forces all electrons to the leaves of the electroscope (polarization)

II - hand gives electron path to get away from rod, now the electroscope is all positive.

III - Electroscope is charged positive so the leaves spread apart.



Free Response Practice

Let third bead have charge of Q

3. Two small beads having positive charges $16q$ and q are fixed at the opposite ends of a horizontal insulating rod extending from the origin (the location of the larger charge) to the point $x = d$. A third small charged bead is free to slide on the rod. At what position is the third bead in equilibrium?

$\frac{(16q)(Q)}{x^2} = \frac{(q)(Q)}{(d-x)^2}$

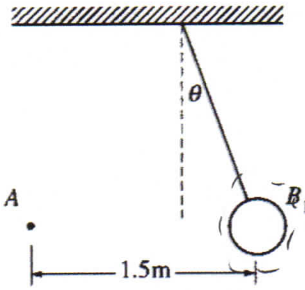
$16(d-x)^2 = x^2$

$4d - 4x = x$

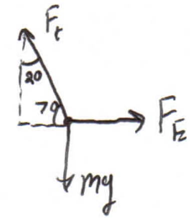
$5x = 4d$

$x = \frac{4d}{5}$

$\frac{4}{5}d$ from left.



Note: Figure not drawn to scale.



$mg = F_{ty}$ $\quad F_E = F_{tx}$

4. The small sphere A in the diagram above has a charge of 120 μC. The large sphere B_1 is a thin shell of nonconducting material with a net charge that is uniformly distributed over its surface. Sphere B_1 has a mass of 0.025 kg, a radius of 0.05 m, and is suspended from an uncharged, nonconducting thread. Sphere B_1 is in equilibrium when the thread makes an angle $\theta = 20°$ with the vertical. The centers of the spheres are at the same vertical height and are a horizontal distance of 1.5 m apart, as shown.

a. Calculate the charge on sphere B_1.

$(0.025\,kg)(9.8) = F_{ty} = 0.245\,N$

$F_{tx} = (0.245N)\tan 20 = 0.089\,N$

$F_E = 0.089\,N$

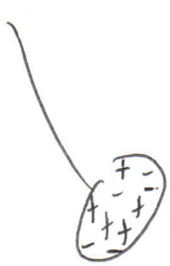
$0.089N = \dfrac{k(120\times10^{-6})(Q_2)}{1.5^2}$

$\boxed{Q_2 = 1.86\times10^{-7}\,C}$

b. Suppose that sphere B_1 is replaced by a second suspended sphere B_2 that has the same mass, radius, and charge, but that is conducting. Equilibrium is again established when sphere A is 1.5 m from sphere B_2 and their centers are at the same vertical height. State whether the equilibrium angle θ_2 will be less than, equal to, or greater than 20°. Justify your answer.

Angle will be less due to polarization

Before



After