Physics 102 (S15)   Q1D

Name: —————————————— **Section:** ——————— **Score:** ——————— /20

1. Very small metal spheres A and B are with glass handles as in Fig. 1. Initially, A has no net charge and B has a net charge Q. After the metal spheres are connected, they are separated and placed as in the right-lower figure.
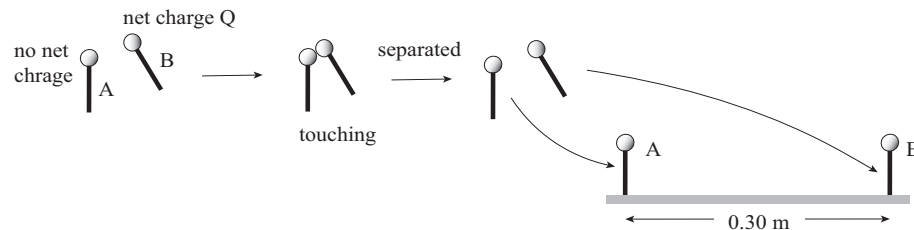

Figure 1:

(a) The magnitude of the force acting on charge at A is 16 N. What is the original net charge Q on B before touching with A. [5]

> Charge Q is now evenly distributed between A and B, so the magnitude of the force reads
> $|F| = k(Q/2)^2/r^2 = (9 \times 10^9)Q^2/(0.6)^2 = (9Q^2/16) \times 10^{9+2} = 16$
> or
> $Q^2 = [16^2/9] \times 10^{-11} = [10 \times 16^2/9] \times 10^{-12}$
> Hence Q = $(16/3)$¥sqrt{10}$\times 10^{-6}$ = 16.87 microC. Its sign cannot be determined.

(b) If the initial net Q were halved, what would have been the force acting on A after performing the same procedure in the problem? [5]

> The force is proportional to the charge squared, the force should be 1/4 of the original version: 4N.

1

2. Look at the configuration of three charges in the figure 2. A and C have $-3\ \mu C$ and B 1 μC.
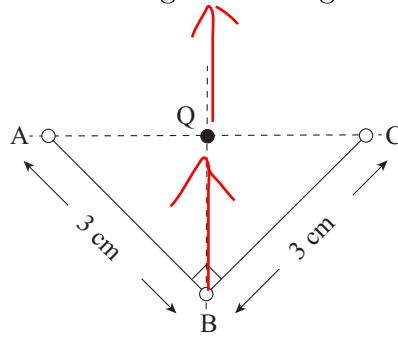

Figure 2:

(a) What is the total force acting on B from the other charges? Compute its magnitude and indicate its direction in the figure 2. [5]

The x-components of the force kill each other, so we have only to consider the y-components. The magnitude of the force due to A is

|F| = (9x10^9) (3x10^{-6}) (1x10^{-6})/(0.03^2) = 3 x 10^{9-12+4} = 30 N.
Hence, 30 x 2 cos(45deg) = 42.4 N.

(b) Q is the point equidistant from all three points A-C and on the line connecting A and C. What is the total force acting on a 4 μC charge placed at Q? Compute itsmagnitude and indicate its direction in the figure 2. [5]

The forces due to A and C cancel each other, so we have only to pay attention to the force due to B: the force is repulsive. Its magnitude is

|F| = (9x10^9) (1x10^{-6}) (4x10^{-6})/(0.03cos(45deg))^2 = 8 x 10^{9-12+4}
= 80 N.

2