Physics 1302.500

Group Problems, Week 3

1. While working in a University research laboratory your group is given the job of testing an electrostatic scale, which is used to precisely measure the weight of small objects. The device consists of two very light but strong strings attached to a support so that they hang straight down. An object is attached to the other end of each string. One of the objects has a very accurately known weight while the other object is the unknown. A power supply is slowly turned on to give each object an electric charge. This causes the objects to slowly move away from each other. When the power supply is kept at its operating value, the objects come to rest at the same horizontal level. At that time, each of the strings supporting them makes a different angle with the vertical and that angle is measured. To test your understanding of the device, you first calculate the weight of an unknown sphere from the measured angles and the weight of a known sphere. Your known is a standard sphere with a weight of 2.000 N supported by a string that makes an angle of 10.00° with the vertical. The unknown sphere's string makes an angle of 20.00° with the vertical. As a second step in your process of understanding this device, estimate the net charge on a sphere necessary for the observed deflection if a string were 10 cm long. Make sure to give the assumptions you used for this estimate.

2. You have been asked to review a new apparatus, which is proposed for use at a new semiconductor ion implantation facility. One part of the apparatus is used to slow down He ions which are positive and have a charge twice that of an electron (He++). This part consists of a circular wire that is charged negatively so that it becomes a circle of charge. The ion has a velocity of 200 m/s when it passes through the center of the circle of charge on a trajectory perpendicular to the plane of the circle. The circle has a charge of 8.0 µC and radius of 3.0 cm. The sample with which the ion is to collide will be placed 2.5 mm from the charged circle. To check if this device will work, you decide to calculate the distance from the circle that the ion goes before it stops. To do this calculation, you assume that the circle is very much larger than the distance the ion goes and that the sample is not in place. Will the ion reach the sample? You look up the charge of an electron and mass of the helium in your trusty Physics text to be 1.6 x 10-19 C and 6.7 x 10-27 Kg.