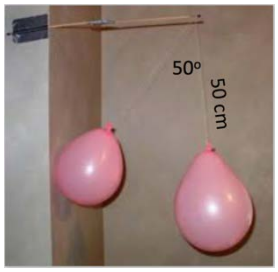
Homework #1. Due September 19.

1. A charge of 5 μC is on the *y*-axis at y = 3 cm, and a second charge of -5 μC is on the *y*-axis at y = -3 cm. Find the force on a charge of 2 μC on the x-axis at x = 8 cm.

2. The configuration of the NH_3 molecule is approximately that of a regular tetrahedron, where three H^+ ions forming the base and an N^{3-} ion at the apex of the tetrahedron. The length of each side is 1.64×10^{-10} m. (a) Calculate the force that acts on each ion. (b) If the N^{3-} ion is somehow 'released', what would be the initial acceleration?

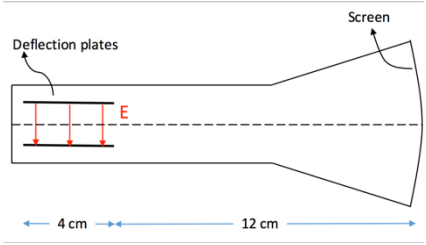
3. You have two inflated balloons. You rub them against your hair and hang them as shown in the figure. The length of the strings is 50 cm and the angle between them is 50^o. For each balloon, what is the percentage of atoms that are ionized? Provide a rough estimate. You may find necessary information from the internet.



4. A charge +q is on the *x*-axis at x_0 and another charge of –q is on the *x*-axis at $-x_0$. A test charge of Q is moving on the *y*-axis. (a) Obtain the force on the test charge as a function of *y*, the position on the *y*-axis. (b) When the text charge moves far away from the origin ($y >>> x_0$), you may simplify the expression for the force. What is it?

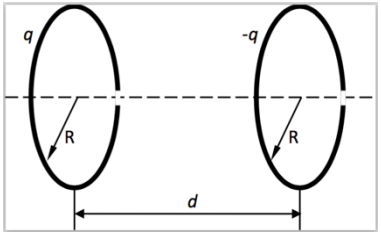
5. Two neutral polar molecules attract each other. Suppose that each molecule has a dipole moment $\boldsymbol{p}$ and that these dipoles are aligned along the *x*-axis and separated by a distance *d*. Derive an expression for the force of attraction in terms of *p* and *d*.

6. An electron with kinetic energy of 2×10^{-16} J is moving to the right along the axis of a cathode ray tube as shown in the figure. There is an electric field of $E = 2 \times 10^4$ N/C along the +*y* direction in the region between the deflection plates. Everywhere else, E = 0. (a) How far is the electron from the axis of the tube when it reaches the end of the plates? (b) At what angle is the electron moving with respect to the axis? (c) At what distance from the axis will the electron strike the screen?



7. (a) Sketch the electric field on the *xy*-plane from charges of +q at (*d*,0,0), +q at (-*d*,0,0), -q at (0,*d*,0) and –q at (0,-*d*,0). (b) What is approximate electric field at *r* far away from the origin, $r >>> d$?

8. The figure on the right shows two parallel non-conducting rings with their central axes along a common line (*x*-axis). Ring on the left is at x=-d/2 and the other ring is at x=d/2. (a) What is the field on the *x*-axis?



9. A 2.75 μC charge is uniformly distributed on a ring of radius 8.5 cm. Find the electric field on the axis at (a) 1.2 cm, (b) 3.6 cm, and (c) 4.0 m from the center of the ring. (d) Find the field at 4.0 m using the approximation that the ring is a point charge at the origin, and compare your results with that for part (c).

10. You have a dumbbell consisting of two identical masses *m* attached to the ends of a thin (massless) rod of length *d*. The masses carry charges of +q and –q. You place the dumbbell in a uniform electric field *E*. Show that for small values of the angle θ between the direction of the dipole and the electric field, the system displays harmonic motion. Obtain an expression for the period of the motion.