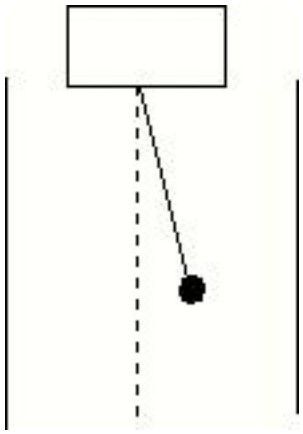
Workshop module 3 - Physics 142, Fall 2008

1. A hydrogen atom can be considered as having a central point-like proton of positive charge +e and an electron of negative charge –e that is distributed about the proton according to the volume charge density $\rho=Ae^{(-2r/a_o)}$. Here A is a constant, a_o is the Bohr radius equal to 5.3×10^{-9} m and r is the distance from the center of the atom. (a) find A. (b) Find the electric field produced by the atom at the Bohr radius.

2. A small sphere with a mass of 3.20 g hangs by a thread between two parallel vertical plates 6.00 cm apart. The charge on the sphere is $q= 7\times10^{-6}$ C. What potential difference between the plates will cause the thread to assume an angle of 20.0 degrees with the vertical.



3. If the electric field is zero in a region of space, which of the following is always true:
    a. the potential is zero
    b. the potential is constant
    c. the potential is negative
    d. the potential depends on the size of the region of space

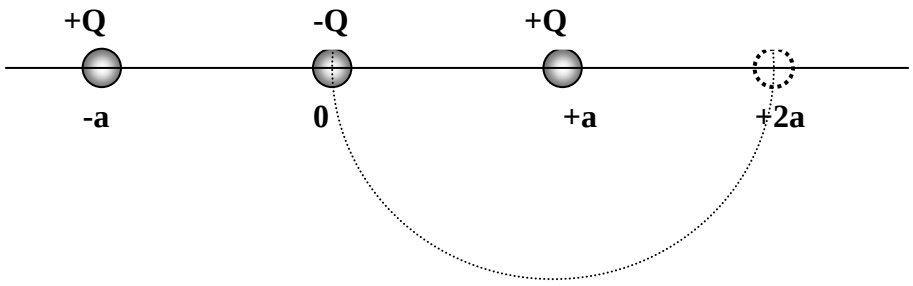
4. The source of a star's energy is thermonuclear fusion taking place in the core of the star. Estimate the temperature at the center of a star when nuclear fusion reactions begin. (*Hints: Fusion is when two protons (or nuclei) bond together due to the strong nuclear force which has an effective range of about 10^{-15} m. Assume fusion takes place if two protons approach each other within 10^{-15} m. Imagine that the protons exist as a gas.*)

5. A positive point charge +Q is located at x = -a.

(a) How much work is required to bring a second equal positive point charge +Q from infinity to x = +a?

(b) With the two equal positive point charges at x = -a and x = +a, how much work is required to bring a third charge -Q from infinity to the origin?

(c) How much work is required to move the charge -Q from the origin to the point x = 2a along the semicircular path shown in the sketch below?



6. A thin wire segment with charge +Q uniformly distributed along its length, L, is lying on the x-axis with its midpoint at the origin. Calculate the electric potential at a point P on the x axis, where P>L/2. From the electric potential, calculate the electric field. Use limiting cases to confirm that the form of the potential and the electric field that you have calculated make sense.