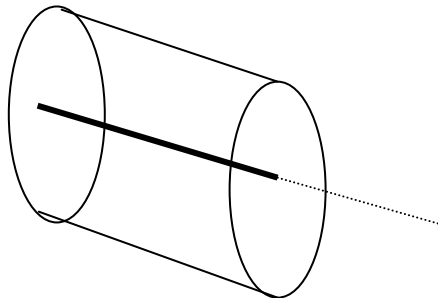
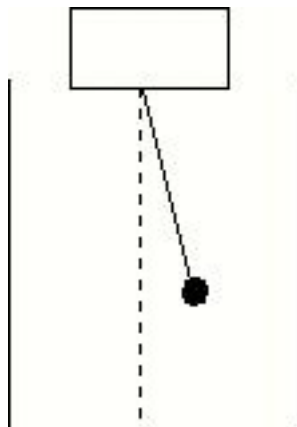


### Workshop module 3 - Physics 142, Fall 2014

1. A Geiger counter is a device used to detect ionizing radiation such as beta or alpha particles. It consists of a thin, positively charged central wire surrounded by a concentric circular conducting cylinder with an equal negative charge. The cylinder contains a low-pressure inert gas. When ionizing radiation enters the cylinder, it ionizes gas atoms along its path. The resulting free electrons are drawn toward the positive wire at the center of the device. However, the electric field is so intense that the initially liberated electrons gain enough energy to ionize more gas atoms which release electrons that ionize more atoms and so forth. The resulting avalanche of electrons is collected by the central wire and yield a measurable electrical pulse on the wire. Suppose that the radius of the central wire is 25 micrometers, the radius of the cylinder is 1.4 cm and the length of the tube is 16 cm. If the electric field at the cylinder's inner wall is  $2.9 \times 10^4$  N/C, what is the total positive charge on the central wire?



2. 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  $\rho = A \exp(-2r/a_0)$ . Here  $A$  is a constant,  $a_0$  is the Bohr radius equal to  $5.3 \times 10^{-9}$  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.
3. 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  $q = 7 \times 10^{-6}$  C. What potential difference between the plates will cause the thread to assume an angle of 20.0 degrees with the vertical.



4. If the electric field is zero in a region of space, which of the following is always true:
- the potential is zero
  - the potential is constant
  - the potential is negative
  - the potential depends on the size of the region of space
5. 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.*)

6. 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?

