1. A hydrogen atom can be considered as having a central pointlike proton of positive charge +e and an electron of negative charge –e that is distributed about the proton according to the volume charge density $\rho = A \exp(-2r/a_o)$. Here $A$ is a constant, $a_o$ 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.

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 $q = 7 \times 10^{-6}$ C. What potential difference between the plates will cause the thread to assume an angle of 20.0 degrees with the vertical.

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?

![Sketch of charge distribution](image)

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.