Scaling an Atom
Nothing Matters

By making a scale model of an atom's nucleons (protons and neutron) and electrons, students can see that most of matter is just empty space.

<u>Materials:</u>
Straight pin with small pinhead
Chalk dust, talc or other powder
Meter stick

<u>What to do:</u>
The typical atom has a diameter of 10^{-10} meters. The typical nucleus has an average diameter of 10^{-15} meters. This means, that on average, an atom has a diameter that is 10^{5} or 100,000 times bigger than its nucleus.

The pinhead will represent the size of an atomic nucleus. A proton is **1836** times heavier than the electron so the smallest speck of powder can represent the electron.

Now that you know this ratio, in small groups, make your atom.

1. Figure out the diameter of the pinhead.
2. Divide that in half to get the radius
3. Figure out how far the speck of powder should be orbiting the nucleus.
4. Have some one walk that distance (radius to the electron cloud) with the speck in hand.
5. Notice this distance.

<u>What's going on:</u>
Although Electrons orbit in a random, statistical cloud, they form a shell around the nucleus, that on average, is a long, long ways from the nucleus.

Eric Muller - Exploratorium 2002

An atom has over well over a trillion times more volume than the nucleus, yet all of the mass of an atom is in the nucleus. So most matter is really just empty space….nothing.

Etc.
If you have several groups doing this activity, have them make scale models next to each other. Notice the size of this formation.

• Have some one with another pinhead run through the atoms. This can represent Rutherford's experiment where he shot alpha particles (a He nucleus) at gold atoms (gold leaf).

•Have several electrons (students) orbit the nucleus. They can make a spherical pattern for an "s-orbital," or dumbbell shaped patter for "p-orbitals," etc…

• Have the electrons crash into their respective nucleus (protons) and have all pinheads in all groups meet in one location. This is analogous to the density of a neutron star. Neutron stars have a density 10^{15} times that of water or about a billion tons per cm^3.

•Have students calculate the difference in volume of a nucleus and the entire atom. Use the formula $4/3\pi r^{-3}$.