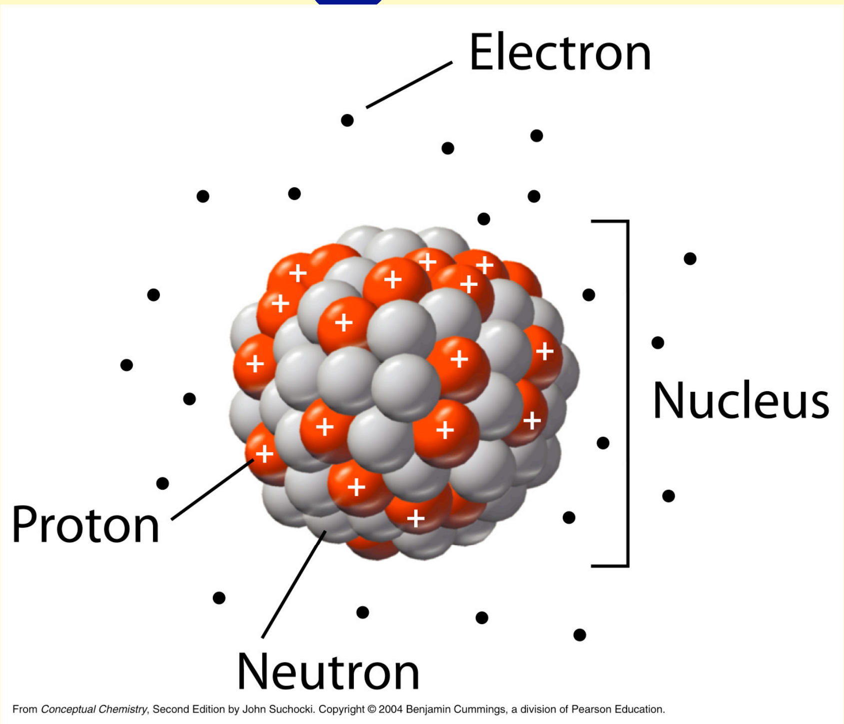
# What’s Inside the Atom?

(Honors Chem Text Section 3.6)

- A neutron goes into a restaurant and asks the waiter…
- The waiter replies…


# What's wrong with this diagram?

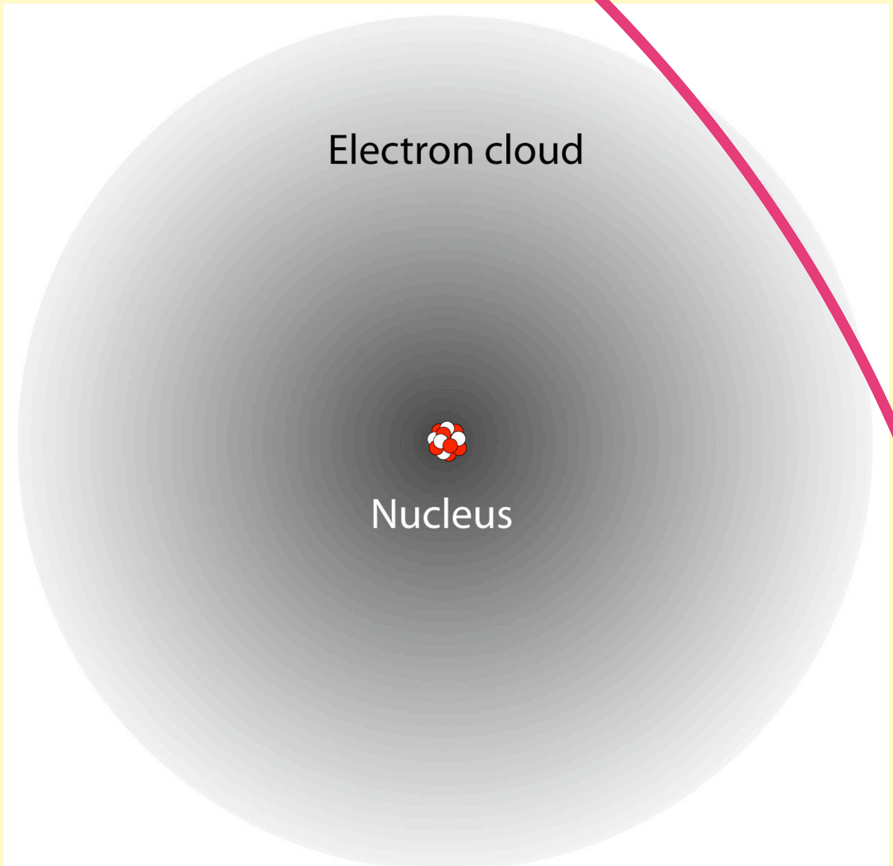




- This diagram is very misleading because it shows the nucleus to be huge and the proton and neutron particles to be huge, and this is NOT true.
- The nucleus is very SMALL SIZE, but very LARGE MASS.
- Sub atomic particles - protons, neutrons, and electrons are SOOOooooo small that most scientists don't ever really worry about their size, although it is generally accepted that protons and neutrons are about 1/3 the size of an electron.
- While the electrons are small themselves, they take up LOTS of SPACE and have very LITTLE MASS.
- For instance, if we expanded an average atom to be the size of the room…

# This is Better…

- This diagram is a bit better…
- But the size relationship demonstrated below is even better.

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· ← nucleus

- Of course the Analogy: baseball (nucleus) in Fenway park (atom) is even better.

# What about the Mass of these Particles?

- You certainly do NOT need to know the table below.
- But you should realize that while all three particles are unbelievably lightweight…
- Protons and neutrons are VERY heavy compared to the electrons - approximately 2000 times heavier.

Subatomic Particles

| | Particle | Charge | Relative Mass | Actual Mass* (kg) |
|---|---|---|---|---|
| | Electron | −1 | 1 | $9.11 \times 10^{-31}$ ** |
| Nucleons | Proton | +1 | 1836 | $1.673 \times 10^{-27}$ |
| | Neutron | 0 | 1841 | $1.675 \times 10^{-27}$ |

# In Summary: Size vs Mass

- The protons and neutrons inside the nucleus are very small in size themselves and take up VERY LITTLE SPACE as a group, but they are VERY HEAVY.
- The electrons outside the nucleus are VERY LIGHTWEIGHT, and while they are very small particles individually, together they take up MOST OF THE SPACE within the atom.

# Information in the Periodic Table

- All elements are identified by their atomic number.
  - ✓ For an atom, atomic number tells us the # of protons = # of electrons.
- The other number is the average atomic mass.
  - ✓ It is the average mass in grams of a very large bunch of atoms, a *mole* of atoms.
  - ✓ When rounded to the nearest whole number atomic mass becomes the mass number.
  - ✓ The mass # = protons + neutrons.
  - ✓ Thus mass # - atomic # = neutrons.

| 3 |
|---|
| Li |
| Lithium |
| 6.941 |

$$^{7}_{3}\mathrm{Li}$$

$$\begin{array}{r} 7 \\ -\ 3 \\ \hline 4 \end{array}$$

# Why is it an Average Atomic Mass?

- All atoms of a particular element have the same # of protons and electrons.
- However, the number of neutrons can vary from atom to atom of a particular element.
- Atoms of the same element with different number of neutrons are called isotopes.
- Since neutrons create much of the mass of the atom, these isotopes have different masses.
- The masses of the isotopes of an element are averaged to give the Average Atomic Mass.


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# It's a Weighted Average

- There are two isotopes of Chlorine
- $^{35}Cl$ and $^{37}Cl$ ($^{35}Cl$ with 18 n and $^{37}Cl$ with 20 n)
- You'd think the average would be 36, but actually the average atomic mass is 35.5
- This is because in nature there is 75% $^{35}Cl$ and only 25% $^{37}Cl$ and the weighted average reflects these amounts thus ending up closer to the more abundant isotope.
- Here's how to do the math:
- (35*0.75) + (37*0.25) = 35.5
  - ✓ 26.25 + 9.25 = 35.5