Atomic Structure

**Atomic Structure**

The text provides a historical perspective of how the internal structure of the atom was discovered. It is certainly one of the most important scientific discoveries of this century, and I recommend that you read through it. However, we will begin our discussion of the atom from the modern day perspective.

All atoms are made from three subatomic particles

**� Protons, neutron & electrons.**

These particles have the following properties:

|  |  |  |  |
| --- | --- | --- | --- |
| Particle | Charge | Mass (g) | Mass (amu) |
| Proton | +1 | 1.6727 x 10-24 g | 1.007316 |
| Neutron | 0 | 1.6750 x 10-24 g | 1.008701 |
| Electron | -1 | 9.110 x 10-28 g | 0.000549 |

In the above table I have used a unit of mass called the atomic mass unit (amu). This unit is much more convenient to use than grams for describing masses of atoms. It is defined so that both protons and neutrons have a mass of approximately 1 amu. Its precise definition will be given later.

The important points to keep in mind are as follows:

* Protons and neutrons have almost the same mass, while the electron is approximately 2000 times lighter.
* Protons and electrons carry charges of equal magnitude, but opposite charge. Neutrons carry no charge (they are neutral).

It was once thought that protons, neutrons and electrons were spread out in a rather uniform fashion to form the atom but now we know the actual structure of the atom to be quite different.

**What does an atom look like?**

Protons and neutrons are held together rather closely in the center of the atom. Together they make up the nucleus, which accounts for nearly all of the mass of the atom.

Electrons move rapidly around the nucleus and constitute almost the entire volume of the atom. Although quantum mechanics are necessary to explain the motion of an electron about the nucleus, we can say that the distribution of electrons about an atom is such that the atom has a spherical shape.

Atoms have sizes on the order of 1-5 angstrom or 1-5 x 10-10 m) and masses on the order of 1-300 amu.

To put the mass and dimensions of an atom into perspective consider the following analogies. If an atom were the size of the University of Georgia stadium, the nucleus would only be the size of a small marble. However, the mass of that marble would be ~ 115 million tons.

**What holds an atom together?**

The negatively charged electron is attracted to the positively charged nucleus by a Coulombic attraction.

The protons and neutrons are held together in the nucleus by the strong nuclear force.

**How many electrons, protons and neutrons are contained in an atom?**

Atoms in their natural state have no charge, that is they are neutral. Therefore, in a neutral atom the number of protons and electrons are the same. If this condition is violated the atom has a net charge and is called an **ion.**

The number of protons in the nucleus determines the identity of the atom. For example all carbon atoms contain six protons, all gold atoms contain 79 protons, all lead atoms contain 82 protons.

Two atoms with the same number of protons, but different numbers of neutrons are called **isotopes**.

**How does the structure of the atom relate to its properties?**

Chemical reactions involve either the transfer or the sharing of electrons between atoms. Therefore, the chemical reactivity/ properties of an element is primarily dependent upon the number of electrons in an atom of that element. Protons also play a significant role because the tendency for an atom to either lose, gain or share electrons is dependent upon the charge of the nucleus.

Therefore, we can say that the chemical reactivity of an atom is dependent upon the number of electrons and protons, and independent of the number of neutrons.

The mass and radioactive properties of an atom are dependent upon the number of protons and neutrons in the nucleus.

Note: The number of protons, neutrons and electrons in an atom completely determine its properties and identity, regardless of how and where the atom was made. So it is inaccurate to speak of synthetic atoms and natural atoms. In other words a lead atom is a lead atom, end of story. It doesn’t matter if was mined from the earth, produced in a nuclear reactor, or came to earth on an asteroid.