Atom Activity Model

Matter is made up of tiny particles known as atoms. Each atom is then made up of even smaller sub-atomic particles known as protons, neutrons and electrons. The protons and neutrons reside inside the nucleus, whereas the electrons 'orbit' around the atom (as depicted by the Bohr model).

An element is where the matter consists of atoms all containing the same number of protons in their nuclei, and it is this number of protons (known as the atomic number) in the nucleus that determines the element.

- The total number of protons and neutrons in the nucleus of the atom is known as the mass number; and the number of neutrons can be calculated by subtracting the atomic number from the mass number.
- The number of electrons in a neutral atom is equal to the number of protons.

For example, Hydrogen with a mass number of 1, and an atomic number of 1, has 1 proton, 0 neutrons and 1 electron. Beryllium (mass number 9, atomic number 4) has 4 protons, 5 neutrons and 4 electrons.
Carbon (mass number 12, atomic number 6) has 6 protons, 6 neutrons and 6 electrons.

Whereas the protons and neutrons reside in the nucleus, the electrons move very rapidly around the nucleus but only in certain orbits (each of which is associated with a particular amount of energy) in what is known as an electron shell or principal energy level. These shells are normally numbered, 1^{st}, 2^{nd}, 3^{rd}, etc.
Each shell can only contain a limited number of electrons. Eg:

- The 1^{st} shell can contain a maximum of 2 electrons;
- The 2^{nd} shell can contain a maximum of 8 electrons;
- The 3^{rd} shell can contain a maximum of 18 electrons;
- The 4^{th} shell can contain a maximum of 32 electrons;

The outermost occupied shell (valence shell) determines the chemical properties of the atom.

The table below identifies the first 12 elements and the configuration of their electron shells.

Element	**Number of Protons**	**Number of Neutrons**	**Number of Electrons**	**Shells**		
				K	**L**	**M**
Hydrogen	1	0	1	1		
Helium	2	2	2	2		
Lithium	3	4	3	2	1	
Beryllium	4	5	4	2	2	
Boron	5	6	5	2	3	
Carbon	6	6	6	2	4	
Nitrogen	7	7	7	2	5	
Oxygen	8	8	8	2	6	
Fluorine	9	10	9	2	7	
Neon	10	10	10	2	8	
Sodium	11	12	11	2	8	1
Magnesium	12	12	12	2	8	2

These principles can be most ably demonstrated using the Jupiter Scientific *Atom Activity Model*.

Directions

The Atom Activity Model consists of a clear plastic base with the first three electron shells marked. Each electron shell has an appropriate number of holes to allow for the yellow pegs (electrons) to push into. A clear plastic dome is provided for containing the green and blue beads (protons and neutrons).

When building atoms with numerous protons and neutrons, it is sometimes easier to remove and invert the dome, then place the required number of protons and neutrons inside the inverted dome. Then place the dome on the base plate – prior to inverting the model the correct way up. The appropriate amount of electrons can then be plugged in.

With the assistance of a Periodic Table, students can be instructed to construct atoms ranging from Hydrogen (1 electron) to Argon (18 electrons).

The Atom Activity Model may also be used to demonstrate ionic compounds consisting of metals and non-metals such as sodium chloride. Metals have only a few electrons in their outer shell whereas non-metals have almost a full outer shell. Using sodium chloride as an example, the sodium atom (metal) has an electronic arrangement of 2, 8, 1; but the sodium ion Na^+ has an electronic arrangement of 2, 8. Likewise, the chlorine atom (non-metal) has an electronic arrangement of 2, 8, 7; but the chloride ion Cl^- has an electronic arrangement of 2, 8, 8.
The charge on the positive sodium ion corresponds with the removal of the one electron in its outer shell; and similarly the negative charge on the chloride ion corresponds with the addition of that electron to its outer shell.

Students can also investigate isotopes. Isotopes are atoms of the same element where there are the same number of protons, but a varying number of neutrons (ie differing mass numbers). For example, Hydrogen has three naturally occurring isotopes: The most common isotope of hydrogen ^1H contains 1 proton, 0 neutrons; whereas ^2H deuterium has 1 proton, 1 neutron; and ^3H tritium has 1 proton, 2 neutrons.