Science 9 - Unit 2 - Atoms, Elements and Compounds

*Demonstrate a knowledge of WHMIS Standards:*

**WHMIS** - Workplace Hazardous Materials Information System.

**MSDS** - Material Safety Data Sheet.

**Hazard Symbol -** A symbol that indicates a particular danger of a chemical. WHMIS has a total of 8 hazard symbols.

Toxic Material, Contents Under Pressure, Highly Toxic Material

Biohazardous Material, Oxidizing Material

Flammable, Corrosive, Dangerously Reactive

*Define Matter:*

**Matter**: Anything that has mass and occupies space.

Not all things on earth are considered matter. Things like light, sound and heat are types of energy, but are not matter. The three main states of matter are gas, liquid and solid.

*Investigate materials and describe them in terms of their chemical and physical properties*

* Physical Properties that are observable about a material include **colour, malleability, electrical conductivity, magnetism, luster, density, melting and boiling points, texture.**
* Chemical Properties describe how a material may react with other materials. They include **combustibility, reactivity and toxicity.**

*Explain the importance of using the terms law and theory in science*

* A **law** is well supported by scientific evidence, rarely changes over the course of time and may refer to only what is happening, not necessarily why.
* A **Theory** is less well supported, and often change over time as new evidence is found. A theory attempts to answer why things occur.

*Use models in describing the structure and components of atoms*

* An **Atom** is the basic unit of matter. It consists of three main parts known as **sub –atomic particles:**
  + - **Protons:** Positively charged particles found in the nucleus of the atom. They have a mass similar to a neutron, and much heavier than an electron
    - **Neutrons:** Neutral particles found in the nucleus of the atom. They have a mass similar to a proton, and much heavier than an electron.
    - **Electrons:** Negatively charged particles that orbit the atom. They have very little mass, but their orbits take up large amounts of space in an atom.

The **nucleus** of the atom is a tiny region in it`s center and is made of protons and neutrons. It has an overall positive charge.

*Identify Changes in atomic theory up to and including the Bohr Model*

* **Empodeceles** and **Aristotle** believed the world to be made of 4 elements; wind, water, fire, earth.
* **Democritus** said if a material was cut into smaller and smaller pieces, eventually that material could no longer be divided. This was the atom.
* **John Dalton** put forth his atomic theory nearly 2000 years later. It had 4 main points
  + All matter is made up of atoms
  + Atoms cannot be created, destroyed or divided into smaller pieces
  + All atoms of the same element are identical in mass and size, and are different in mass and size than other elements.
  + Compounds are formed when atoms combine in exact amounts.
* **J.J. Thompson** proposed the `raisin bun` model of the atom
  + Negative electrons were scattered throughout the positive part of the atom.
  + Atoms were made up of smaller particles called electrons.
* **Ernest Rutherford** proposed the planetary model of the atom
  + Electrons circle the nucleus like planets orbit the sun
  + He found the nucleus of the atom, and discovered it was made of protons and neutrons
  + He discovered the nucleus in his famous `gold foil` experiment
    - He shot particles through a thin gold foil, most particles passed through, but others were deflected when the nucleus of 2 particles came close together.
* **Niels Bohr** discovered the energy levels of electrons.
  + Electrons orbit the nucleus in set patterns, known as energy levels
  + Electrons have specific energy, and when they move, energy is released

*Define Element*

* **Element:** A substance that contains only one kind of matter and cannot be broken down into simpler substances.

*Identify and write the chemical symbols for 20 common elements*

Hydrogen (H) , Carbon (C) , Oxygen (O) , Nitrogen (N) , Magnesium (Mg) , Calcium (Ca) , Nickel (Ni) , Zinc (Zn) , Neon (Ne) , Helium (He) , Chlorine (Cl) , Silicon (Si) , Sodium (Na) , Potassium (K) , Iron (Fe) , Copper (Cu) , Silver (Ag) , Gold (Au) , Mercury (Hg) , Lead (Pb)

Elements are written as 1 or 2 letter combinations that are agreed upon by the International Union of Pure and Applied Chemistry (IUPAC) as a form of shorthand, and are used in all languages and nations.

*Describe and explain the role of collecting evidence, finding relationships, and proposing explanations in the development of the periodic table*

* **The Periodic Table** lists all of the known elements in a pattern based upon their properties.
* **Dmitri Mendeleev** created the periodic table and had 2 main contributions.
  + He organized the elements based on their physical and chemical characteristics
  + He left gaps in the table for elements that were not yet found. This led to the discovery of other elements in the future.

*Distinguish between the atomic number and atomic mass. Using atomic mass and atomic number, determine the number of protons, neutrons and electrons.*

* In a neutral atom the  **atomic number** tells us the number of protons in an atom, as well as the number of electrons. Eg. Oxygen has an atomic number of 8, so it has 8 protons, and 8 electrons
* The **Atomic Mass** tells us the number of protons and neutrons in an atom. If we know the atomic number as well, we can find the number of neutrons.
  + Example: Lithium has an atomic number of 3, so it has 3 protons. The atomic mass is 7, so Lithium must have 4 neutrons since 3 + 4 = 7.

*Using the periodic table, develop an understanding that the elements are grouped based on similar characteristics*

* **Metals:** Some properties of metals include
  + Shiny
  + Ductile (can form a wire) and malleable (can be hammered in to a sheet)
  + Conduct Electricity
  + Conduct Heat
* **Non-metals:**Some properties of non metals are
  + Dull
  + Non-ductile and non-malleable
  + Do not conduct electricity
  + Do not conduct heat well
* **Metalloids:** Some properties of metalloids (semi-metals) are
  + Shiny or dull
  + Non-ductile, non-malleable
  + May conduct electricity
  + Do not conduct heat well

The periodic table is a series of rows and columns. The rows of the periodic table are **periods**, while the columns of a periodic table are **groups**  or **families**. For Example, Oxygen is in the 2nd row, and 16th column, so it is in Period 2, Group 16.

*Provide examples of common properties which a family of elements share:*

* **Alkali Metals Group 1**
  + - Reactive and Soft
    - React with water, oxygen, other non-metals
    - Low melting points
    - Reactivity increased down the column
  + **Alkaline Earth Metals Group 2**
    - Less Reactive than Alkali Metals
    - Burn in Air if heated, produce flames
    - Also react with water
    - Reactivity increases down the column
  + **Halogens Group 17**
    - Very reactive non-metals
    - Fluorine and Chlorine are gases, Bromine is liquid, Iodine is solid
    - Reactivity increases down the column
    - Astanine is rare, little is known about it
  + **Noble Gases Group 18**
    - Stable and unreactive
    - Colourless and Odourless
    - May be used in light fixtures

Hydrogen is considered special because it can act like a metal or a non-metal. Sometimes it is included with the alkali metals, the halogens, or by itself.

*Identify examples of common elements, and compare their characteristics and atomic structure*

* **Energy level:** The space around a nucleus where electrons are found. The number of electrons found in each energy level are as follows :
  + - * 1st energy level = 2 electrons
      * 2nd energy level = 8 electrons
      * 3rd energy level = 8 electrons
      * 4th energy level = 18 electrons
* **Valence Energy Level:** The outermost energy level of an atom. The `outside` energy level.
* **Valence Electron:** An electron found in the outermost energy level of an atom

*Draw Bohr Rutherford diagrams for elements 1 to 18*

A Bohr- Rutherford diagram should show the number of protons, neutrons and electrons in an atom. The protons and neutrons are shown in the nucleus, and the electrons are in the energy levels. Energy levels must be completely filled before electrons go into the next energy level.

*Interpret patterns and trends, and explain relationships among variables*

For elements of the same families, the pattern of valence electrons will be the same. For example, all alkali metals have 1 valence electron, and for noble gases they have a full valence shell.

*Identify and write chemical formulas of common compounds*

* **A Compound** is a pure substance made of more than one kind of element joined together
* **A molecular Compound** is a compound made of only non-metals ie. CH4 or NH3
* **An Ionic Compound** is a compound made of a metal and a non-metal

Compounds are represented by a chemical formula, which tells us what elements are present, and how many of each element there are.

**Naming Ionic Compounds**

* Start by saying the name of the metal
* Say the name of the non-metal, and add –ide to the end of it
* Example Fe2O3 Iron Oxide
* With Ionic compounds it does not matter how many of each element there are when we name them

**Naming Molecular Compounds**

* Start by finding out the number of the first element, and use the correct prefix (mono, di, tri, tetra, penta, hexa, hepta, octa, nona, deca) then the name of the element
* Find out the number of the second element, and use the correct prefix, then the name of the element and the ending –ide
* Note: If there are only 1 of the first element, do not use the prefix mono
* Examples : S2O5 Disulfur Pentaoxide NCl3 Nitrogen Trichloride

**Common formulas for compounds:**

* Common Ionic Compounds
  + Table Salt: Sodium Chloride NaCl
  + Calcium Carbonate CaCO3
  + Sodium Hydroxide NaOH
* Common Molecular Compounds
  + Sucrose C6H12O11
  + Carbon Dioxide CO2
  + Methane CH4
  + Water H2O

*Distinguish between physical and chemical changes*

* Chemical Changes result in new compounds being formed, physical changes do not
* Examples of physical changes
  + - Change of state (melting, freezing, boiling etc)
    - Cutting
    - Dissolving
* Examples of chemical changes
  + Corrosion (rusting)
  + Fruit ripening
  + Combustion
* Evidence that a chemical reaction has occurred may include
  + Heat produced or absorbed
  + A new colour appears
  + A precipitate (solid) forms
  + A gas is produced
  + The process is hard to reverse
* In a Chemical change elements are conserved, but compounds are not.