**Patterns in Element Properties (History):**

Elements vary widely in their properties, but in an orderly way. In 1869, the Russian chemist Dmitri Mendeleev produced the first orderly arrangement, or periodic table, of all 63 elements known at the time. Mendeleev wrote the symbol for each element, along with the physical and chemical properties and the relative atomic mass of the element. Mendeleev arranged the elements in order of increasing atomic mass. Mendeleev started a new row each time he noticed that the chemical properties of the elements repeated. He placed elements in the new row directly below elements of similar chemical properties in the preceding row. Amazingly, Mendeleev predicted the properties of the missing elements in his table, leaving blanks to be filled in later. Mendeleev did not have knowledge of atomic numbers or electron configuration. Families were arranged according to increasing atomic mass and their observed properties.

Forty years after Mendeleev published his periodic table, an English chemist named Henry Moseley found a different physical basis for the arrangement of elements. Moseley discovered that appropriate structure of the periodic table correlated to the atomic number.

**Periodic Law**

• Mendeleev’s principle of chemical periodicity is known as the **periodic law,** which states that when the elements are arranged according to their atomic numbers, elements with similar properties appear at regular intervals.

**Organization of the Periodic Table**

• Elements in each column of the periodic table have the same number of electrons in their outer energy level (valence electrons).

• The electrons in the outer shell are called valence electrons.

• Valence electrons are found in the outermost shell of an atom and that determines the atom’s chemical properties**.**

• Elements with the same number of valence electrons tend to react in similar ways.

• The periodic table provides information about each element.

• atomic number

• symbol

• name

• average atomic mass

• electron configuration

**The Main Group Elements**

• Elements in groups 1, 2, and 13–18 are known as the main-group elements.

Main-group elements are in the s- and p-blocks of the periodic table.

• The electron configurations of the elements in each main group are regular and consistent: the elements in each group have the same number of valence electrons.

• Four groups within the main-group elements have special names. These groups are:

• alkali metals (Group 1)

• alkaline-earth metals (Group 2)

• halogens (Group 17)

• noble gases (Group 18)

**The Alkali Metals Make Up Group 1**

• Elements in Group 1 are called **alkali metals.**

• lithium, sodium, potassium, rubidium, cesium, and francium

• Alkali metals are so named because they are metals that react with water to make alkaline solutions.

• Because the alkali metals have a single valence electron, they are very reactive.

• In losing its one valence electron, potassium achieves a stable electron configuration.

• Alkali metals are never found in nature as pure elements but are found as compounds.

**The Alkaline-Earth Metals Make Up Group 2**

• Group 2 elements are called **alkaline-earth metals.**

• The alkaline-earth metals are slightly less reactive than the alkali metals.

• They are usually found as compounds.

• The alkaline-earth metals have two valence electrons and must lose both their valence electrons to get to a stable electron configuration.

• It takes more energy to lose two electrons than it takes to lose just the one electron that the alkali metals must give

up to become stable.

**The Halogens, Group 17, Are Highly Reactive**

• Elements in Group 17 of the periodic table are called the **halogens.**

• The halogens are the most reactive group of nonmetal elements.

• When halogens react, they often gain the one electron needed to have eight valence electrons, a filled outer energy level.

• Because the alkali metals have one valence electron, they are ideally suited to react with the halogens.

• The halogens react with most metals to produce salts.

**The Noble Gases, Group 18, Are Unreactive**

• Group 18 elements are called the **noble gases.**

• The noble gas atoms have a full set of electrons in their outermost energy level.

• The low reactivity of noble gases leads to some special uses.

• The noble gases were once called inert gases because they were thought to be completely unreactive.

• In 1962, chemists were able to get xenon to react, making the compound

XePtF6.

• In 1979, chemists were able to form the first xenon-carbon bonds.

**Hydrogen Is in a Class by Itself**

• Hydrogen is the most common element in the universe.

• It is estimated that about three out of every four atoms in the universe are hydrogen.

• Because it consists of just one proton and one electron, hydrogen behaves unlike any other element.

• Hydrogen is in a class by itself in the periodic table.

• With its one electron, hydrogen can react with many other elements, including oxygen.

• The majority of elements, including many main-group ones, are metals.

• Metals are recognized by its shiny appearance, but some nonmetal elements, plastics, and minerals are also shiny.

**Metals Share Many Properties**

• All metals are excellent conductors of electricity.

• Electrical conductivity is the one property that distinguishes metals from the nonmetal elements.

• Some metals, such as manganese, are brittle.

• Other metals, such as gold and copper, are ductile and malleable.

• Ductile means that the metal can be squeezed out into a wire.

• Malleable means that the metal can be hammered or rolled into sheets.

**Transition Metals Occupy the Center of the Periodic Table**

• The **transition metals** constitute Groups 3 through 12 and are sometimes called the d-block elements because of their position in the periodic table.

• A transition metal is one of the metals that can use the inner shell before using the outer shell to bond.

• A transition metal may lose one, two, or even three valence electrons depending on the element with which it reacts.

• Generally, the transition metals are less reactive than the alkali metals and the alkaline-earth metals are.

• Some transition metals are so unreactive that they seldom form compounds with other elements.

**Other Properties of Metals**

• An **alloy** is a solid or liquid mixture of two or more metals.

• The properties of an alloy are different from the properties of the individual elements.

• Often these properties eliminate some disadvantages of the pure metal.

• A common alloy is brass, a mixture of copper and zinc.

• Brass is harder than copper and more resistant to corrosion.

**Metalloids**

• Metalloids are found on the periodic table between the metals and nonmetals.

• A metalloid is an element that has some characteristics of metals and some characteristics of nonmetals. All metalloids are solids at room temperature.

• Metalloids are less malleable than metals but not as brittle as nonmetals.

• Metalloids tend to be semiconductors of electricity.

**Nonmetals**

• Many nonmetals are gases at room temperature. (Bromine is a liquid at room temperature).

• Solid nonmetals include carbon, phosphorus, selenium, sulfur, and iodine. These solids are brittle at room temperature.

• A nonmetal is an element that is a poor conductor of heat and electricity.

• Nonmetals are found on the right hand side of the periodic table.