Al-Mustaqbal University College

Department of Medical Laboratory Techniques

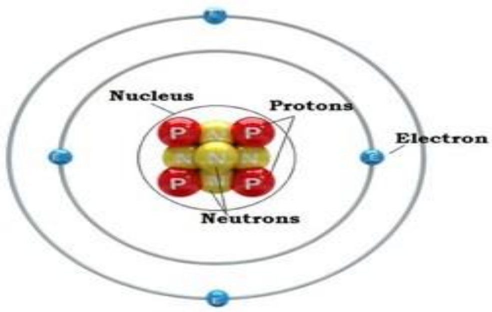
Subject: - General Chemistry (1) lecture (1)

ATOMS AND ELEMENTS

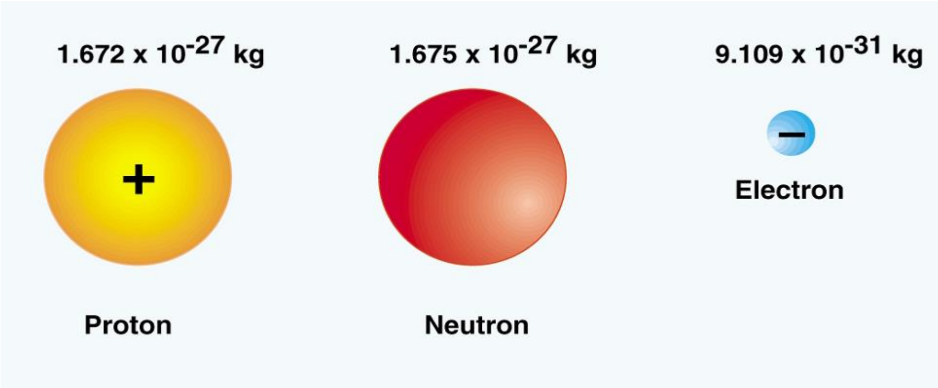
An atom is the basic structure from which all matter is composed.

Atoms are made of small particles called protons, neutrons, and electrons. Each of these particles is described in terms of measurable properties, including mass and charge. An **atom** is composed of two regions: the nucleus, which is in the center of the atom and contains protons and neutrons, and the outer region of the atom, which holds its electrons in orbit around the nucleus.

- **Proton** is a positively charged particle in an atom
- **Elctron** is a negatively charged particle in an atom
- **Neutron** is a neutral (neither negative nor positive) particle in an atom
- **The Atomic Number** is the number of protons in an atom
- **The Atomic Mass Number** is the number of protons and the number of neutrons in an atom



Mass is the amount of matter that an object contains. The proton and neutron have roughly the same mass and have approximately one thousand times the mass of the electron. The proton and electron have equal, but opposite, electrical charges. A neutron does not have an electrical charge.



Model of Proton, Neutron and Electron

If the proton and neutron were enlarged, and each had the approximate mass of a panda, the electron, enlarged to the same scale, would have less mass than an owl.
In an atom, the protons and neutrons clump together in the center and are called the nucleus. Because the protons are positively charged, the nucleus has a positive electric charge.

The electrons of the atom move rapidly around the nucleus. If we attempt to detect an electron in an atom, we might find evidence of it located almost anywhere around the nucleus. However, if we repeat this experiment many times, it will be found that the electron is much more likely to be located in certain regions of space surrounding the nucleus than in other regions of space. We might think that the electron is rapidly moving around the nucleus and our experiment "catches" the electron as an instantaneous "snapshot" of it in motion. The probability of finding the electron in any region of space can then be described by a cloud that rapidly thins out as one goes farther from the nucleus. The density of the cloud at any point is the probability of finding the electron at that point.

The attractive electric force between the positively-charged protons in the nucleus and the negatively-charged electrons around the nucleus holds the atom together. Atoms containing the same number of protons and electrons have no net charge. Atoms that have extra electrons or are missing electrons have a net electrical charge and are called ions. Ions can interact with other ions due to the electrical attraction between opposite charges.

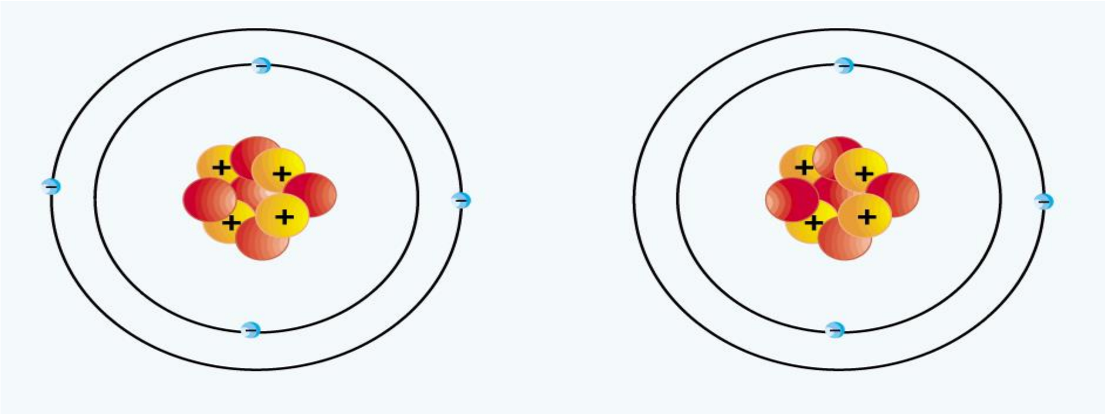


Diagram Comparing a Beryllium Atom and a Positively-Charged Beryllium Ion

Atoms interact with other atoms by sharing or transferring electrons that are farthest from the nucleus. These electrons are sometimes called valence electrons . These outer electrons determine the chemical properties of the element, such as how readily it interacts with other elements and the allowable ratios for its combinations with other substances.

ISOTOPES

When an element has atoms that differ in the number of neutrons in the nuclei, these atoms are called different isotopes of the element. All isotopes of one element have identical chemical properties. This means it is difficult to separate isotopes from each other by chemical processes. However, the physical properties of the isotopes, such as their masses, boiling points, and freezing points, are different. Isotopes can be most easily separated from each other using physical processes.

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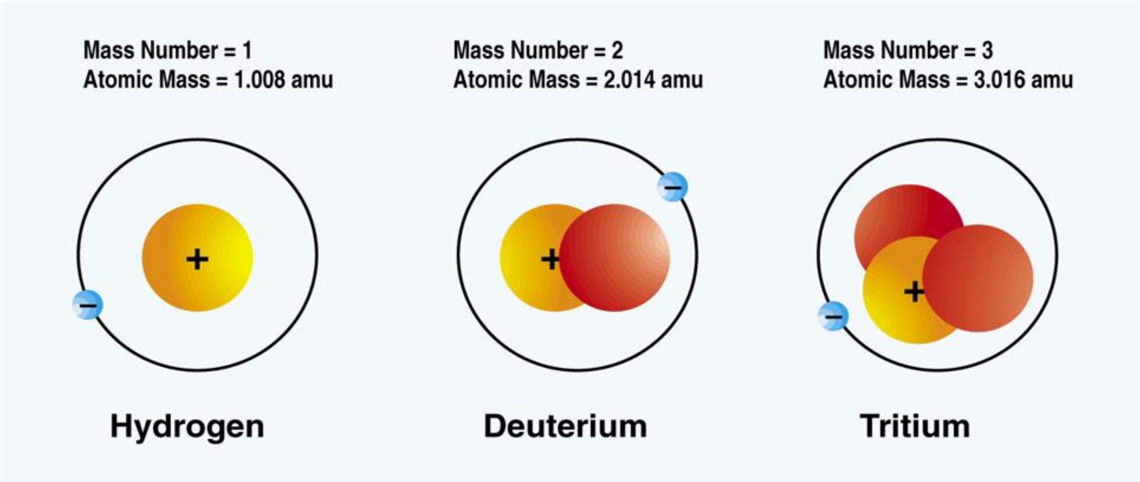


Mass Number and Atomic Mass of Hydrogen, Deuterium, and Tritium

The sum of the number of protons and neutrons in the nucleus of an atom is called that element's mass number. This is not the same as the element's mass. Since different isotopes of an element contain different numbers of neutrons in the nuclei of their atoms, isotopes of the same element will have different atomic masses. This was shown above for the three isotopes of hydrogen. The symbol for an isotope is the symbol for the element followed by the mass number. Hydrogen is symbolized as H^1, while deuterium is symbolized as H^2.and tritium is H^3.

THE PERIODIC TABLE AND ELEMENTS

The Periodic Table of the Elements is an organized way of displaying information that is known about the approximately 100 chemical building blocks of the universe. It often appears as a roughly rectangular chart with individual squares containing information about each element.

ATOMIC SYMBOLS: -

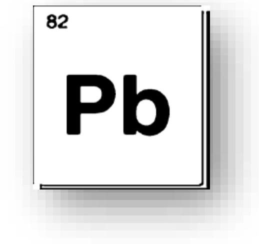
Atomic symbols are a symbolic way for people to refer to elements in the periodic table. For instance, the box on the top left contains information about the simplest chemical element, hydrogen. The symbol of this Hydrogen elements

H

Note: The atomic symbol is made up of the first letter of the word hydrogen. This is not always the case. The element helium must use the first two letters in its name to avoid confusion,. The first letter is always capitalized and the second letter is always small letters

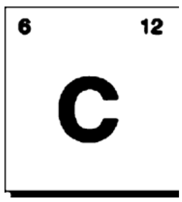
He

Lithium is third element shown on the table with an atomic symbol Li. Using this same system it would seem that lead would be Le. However, lead has the atomic symbol Pb which stands for the Latin word for lead which is plumbum.



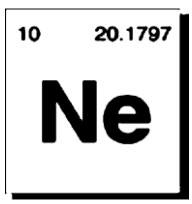
ATOMIC NUMBERS:-

The **atomic number** is the number of protons (equal to the number of electrons in a neutral atom) in the atom and the **atomic mass number** is the sum of the number of protons and neutrons in the atom. The **atomic number** (Z) is defined as the number of units of positive charges (protons) in the nucleus. It is the number of protons in the nucleus that determines the chemical properties of an atom.. For instance, the second row across the periodic table contains the elements lithium, beryllium, boron, carbon, nitrogen, oxygen, fluorine, and neon. Their symbols are Li, Be, B, C, N, O, F, and Ne. From left to right, their atomic numbers increase from three to ten, meaning that lithium atoms have three protons, beryllium atoms have four, and so on, up to neon's ten.



ATOMIC MASS AND MASS NUMBERS

If you add the number of protons and neutrons for an atom, the sum will be the atom's mass number. This does not show the actual mass of the atom, just information about the atom's nucleus. Most periodic tables show atomic mass, not mass numbers for each element. The mass of an atom or particle is expressed in **atomic massunits** or amus. One atomic mass unit is a very small amount of mass.



SOLID, LIQUID, OR GAS?

Elements can be solid, liquid, or gas at room temperature. Some periodic tables show this by use of a color code or other key. Neon is a gas at room temperature. Neon belongs to a family of elements that are all gases at room temperature. They are referred to as the noble gas family. There are eleven elements that are gaseous at room temperature. They include: hydrogen, helium, nitrogen, oxygen, fluorine, neon, chlorine, argon, krypton, xenon and radon. There are three elements that are liquids at room temperature and they include mercury, gallium, and bromine. The rest of the natural elements (76) are solid at room temperature. There are over twenty synthetic elements that have been produced by humans.

WHAT IS THE PERIODIC TABLE?

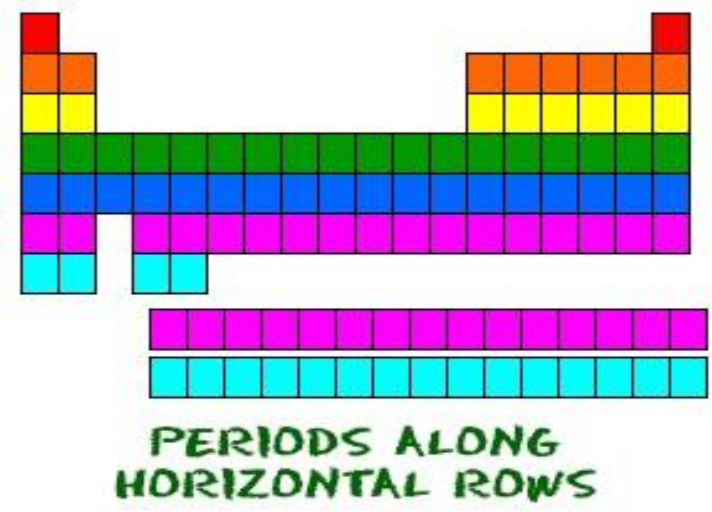
Mendeleev did not construct a table in the way described above. Rather he arranged what we call periods vertically and groups horizontally. Your students will act very much like Mendeleev in the interactive simulation of the periodic table. They will be organizing information by classifying and grouping elements based on physical and chemical properties. Students will then have the opportunity to arrange the elements in a way that makes sense to them. Afterwards they can compare their results with Mendeleev, the modern periodic table and some other variations listed below. This should help your students better understand why the periodic table exists and why it is necessary to organize data. The **periodic table** is a table that logically organize all the known elements. Each **element** has a specific location according its atomic structure. Each row and column has specific characteristics.

PERIODS

In the modern periodic table each row of the table's horizontal rows is called a period where all of the elements have the same number of atomic orbitals For example, every element in the top row (the first period) has one orbital(S orbital)for its electrons. All of the elements in the second row (the second period) have two types of orbitals (S and P orbital) for their electrons. As you move down the table, every row adds an orbital.

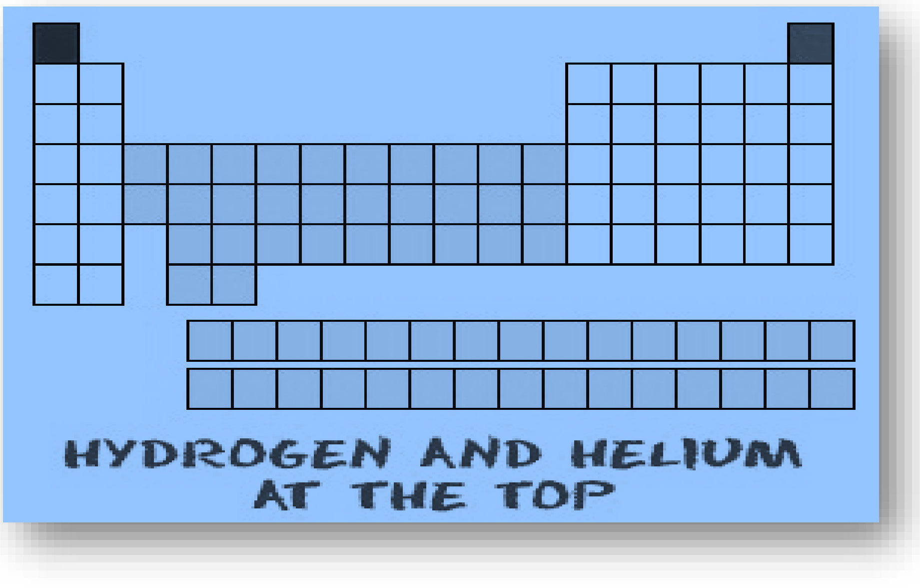
. Along a period, a gradual change in chemical properties occurs from one element to another. Changes in the properties occur because the number of protons and electrons increases from left to right across a period or row. The increase in number of electrons is important because the outer electrons

determine the element's chemical properties.
The periodic table consists of seven periods. The periods vary in length from two elements in period 1 to eighteen elements in periods 4-6. The last period is not complete yet because new exotic or synthetic elements are still being made in laboratories. The classification of elements in the periodic table helps scientists understand known elements and predict the properties of new synthetic elements.

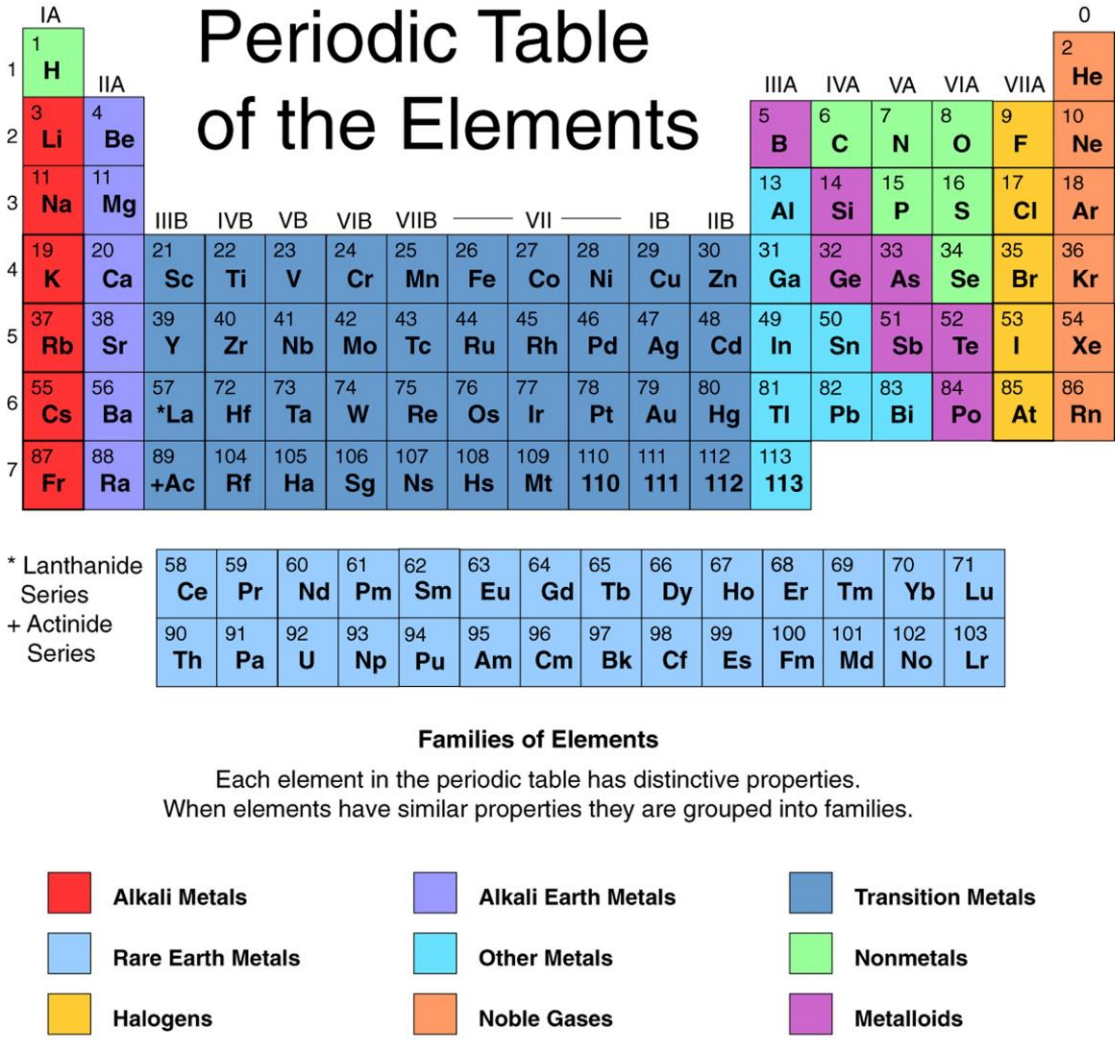


GROUPS OR FAMILIES

The modern periodic table of the elements contains 18 groups, or vertical columns. Just as members of a family have similar characteristics but are different individuals, elements in a group are different but have similar chemical and physical properties because they have the same number of outer electrons. For instance, the noble gasses have their outermost orbit filled and therefore atoms from this family do not bond with other atoms.
Each column is called a **group** where the elements have the same number of electrons in the outer **orbital**. Those outer electrons are also called **valence electrons**. They are the electrons involved in chemical bonds with other elements. Every element in the first column (group one) has one electron in its outer shell. Every element in the second column (group two) has two electrons in the outer
shell.



The periodic table can be used also to estimate relatively some other properties of the atoms: electronegativity, ionization energy, electron affinity, atomic radius, melting point, and metallic character. You can use a dynamic periodic table tool to easily refer to specific elements and their atomic number, mass, orbital arrangement, etc.



Groups in the Periodic Table of Elements

The chemical and physical properties of the group to which that element belongs.

S Orbital Groups

1-Alkali Metals (Li, Na, K, Cs, Fr).

1-Less dense than other metals

2-One loosely bound valence electron

3-Highly reactive, with reactivity increasing moving down the group

4-The largest atomic radius of elements in their period
5-Low ionization energy
6-Low electronegativity

2- Alkaline Earth Metals (Be, Mg, Ca, Sr, Ba, Ra.)

1-Two electrons in the valence shell
2-Readily form divalent cations
3-Low electron affinity
4-Low electronegativity

p Orbital Groups

Metalloids or Semimetals (B ,Si, Ge ,As, Sb ,Te , Po)

1-Electronegativity and ionization energy intermediate between that of metals and nonmetals
2- May possess a metallic luster
3- Variable density, hardness, conductivity, and other properties
4-Often make good semiconductors
5-Reactivity depends on the nature of other elements in the reaction

Nonmetals:- (C , N ,O, P ,S)

The halogens and noble gases are nonmetals, although they have their own groups, too.

1-High ionization energy
2-High electronegativity
3-Poor electrical and thermal conductors
4-Form brittle solids
5-Little if any metallic luster
6-Readily gain electrons

Halogens :-(F, Cl, Br, I, At **)**

The halogens exhibit different physical properties from each other but do share chemical properties.

1-Extremely high electronegativity
2-Very reactive 3-Seven valence electrons, so elements from this group typically exhibit a -1 oxidation state

Noble Gases(He, Ne, Ar, Kr, Xe, Rn**)**

The noble gasses have complete valence electron shells, so they act differently. Unlike other groups, noble gasses are unreactive and have very low electronegativity or electron affinity.

D and f Groups Transition Metals

The lanthanides (rare earth) and actinides are also transition metals. The basic metals are similar to transition metals but tend to be softer and to hint at nonmetallic properties. In their pure state, all of these elements tend to have a shiny, metallic appearance. While there are radioisotopes of other elements, all of the actinides are radioactive.

1-Very hard, usually shiny, ductile, and malleable
2-High melting and boiling points
3-High thermal and electrical conductivity
4-Form cations (positive oxidation states)
5-Tend to exhibit more than one oxidation state
6- Low ionization energy

<u>Questions:-</u>

Q1.// What is your atom's Atomic number: 12 Atomic Mass: 24.305
Q2.// What are chlorine's Atomic number: 17 Atomic mass: 35.452 Chemical symbol: Cl Number of neutrons:18 Overall charge: Neutral (protons and electrons cancel out charges)
Q3. What are boron's Atomic number: 5 Atomic mass: 10.811 Chemical symbol: B
Number of neutrons: 6 Overall charge: Neutral

Q4.// What is the definition of an alkali metal?

The alkali metals are six chemical elements in Group 1, the leftmost column in the periodic table. They are lithium (Li), sodium (Na), potassium (K), rubidium (Rb), cesium (Cs), and francium (Fr). (Like the other elements in Group 1, hydrogen (H) has one electron in its outermost shell, but it is not classed as an alkali metal since it is not a metal but a gas at room temperature.)

Q5.// Why are they called the alkali metals?

Q6.// What are some properties of the alkali metals?

Q7.// What is the most common alkali metal?