1.1 A brief overview of Atomic Structure

An atom is the smallest unit of matter that retains all of the chemical properties of an element. Atoms combine to form molecules, which then interact to form solids, gases, or liquids. For example, water is composed of hydrogen and oxygen atoms that have combined to form water molecules. Many biological processes are devoted to breaking down molecules into their component atoms so they can be reassembled into a more useful molecule.

1.1.1 Atomic Particles

Atoms consist of three basic particles: protons, electrons, and neutrons. The nucleus (center) of the atom contains the protons (positively charged) and the neutrons (no charge). The outermost regions of the atom are called electron shells and contain the electrons (negatively charged). Atoms have different properties based on the arrangement and number of their basic particles.

The hydrogen atom (H) contains only one proton, one electron, and no neutrons. This can be determined using the atomic number and the mass number of the element (see the concept on atomic numbers and mass numbers).

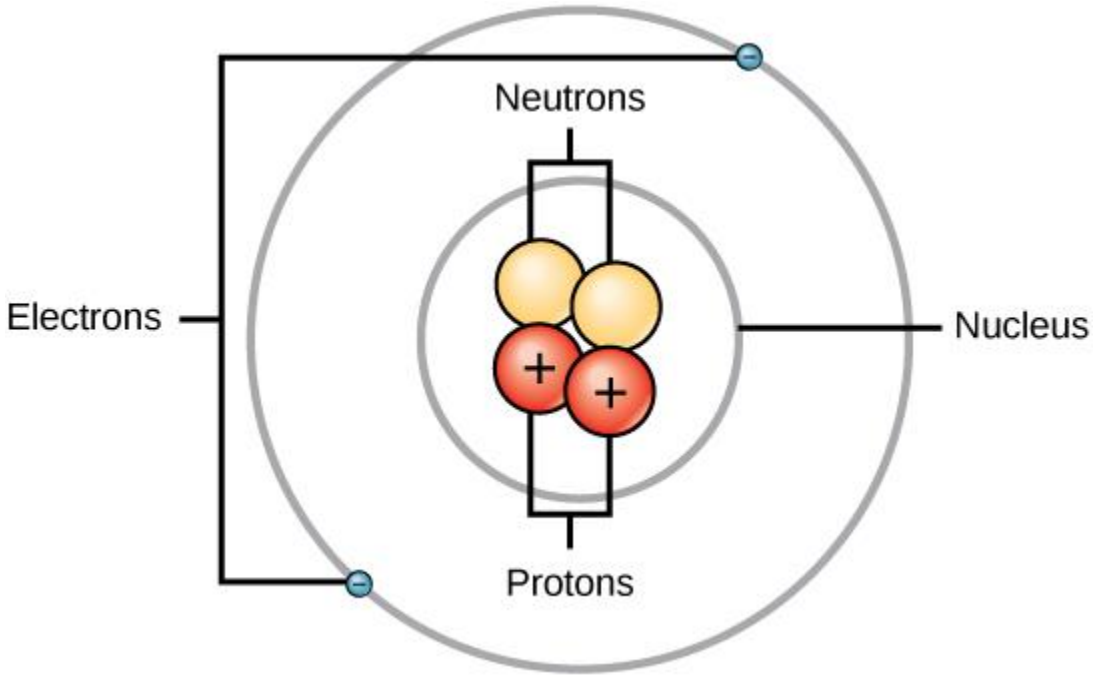

Fig. 1.1 Structure of an atom

Elements, such as helium, depicted here, are made up of atoms. Atoms are made up of protons and neutrons located within the nucleus, with electrons in orbitals surrounding the nucleus.

1.1.2 Atomic Mass

Protons and neutrons have approximately the same mass, about 1.67×10^{-24} grams. Scientists define this amount of mass as one atomic mass unit (amu) or one Dalton. Although similar in mass, protons are positively charged, while neutrons have no charge. Therefore, the number of neutrons in an atom contributes significantly to its mass, but not to its charge.

Electrons are much smaller in mass than protons, weighing only 9.11×10^{-28} grams, or about 1/1800 of an atomic mass unit. Therefore, they do not contribute much to an element's overall atomic mass. When considering atomic mass, it is customary to ignore the mass of any electrons and calculate the atom's mass based on the number of protons and neutrons alone.

Electrons contribute greatly to the atom's charge, as each electron has a negative charge equal to the positive charge of a proton. Scientists define these charges as "+1" and "-1. " In an uncharged, neutral atom, the number of electrons orbiting the nucleus is equal to the number of protons inside the nucleus. In these atoms, the positive and negative charges cancel each other out, leading to an atom with no net charge.

Protons, Neutrons, and Electrons			
	Charge	**Mass (amu)**	**Location**
Proton	+1	1	nucleus
Neutron	0	1	nucleus
Electron	–1	0	orbitals

Table 1.1 Protons, neutrons, and electrons

Both protons and neutrons have a mass of 1 amu and are found in the nucleus. However, protons have a charge of +1, and neutrons are uncharged. Electrons have a mass of approximately 0 amu, orbit the nucleus, and have a charge of -1.

1.1.3 Exploring Electron Properties

Compare the behavior of electrons to that of other charged particles to discover properties of electrons such as charge and mass.

1.1.4 Volume of Atoms

Accounting for the sizes of protons, neutrons, and electrons, most of the volume of an atom—greater than 99 percent—is, in fact, empty space. Despite all this empty space, solid objects do not just pass through one another. The electrons that surround all atoms are negatively charged and cause atoms to repel one another, preventing atoms from occupying the same space. These intermolecular forces prevent you from falling through an object like your chair.

1.2 Periodic Table

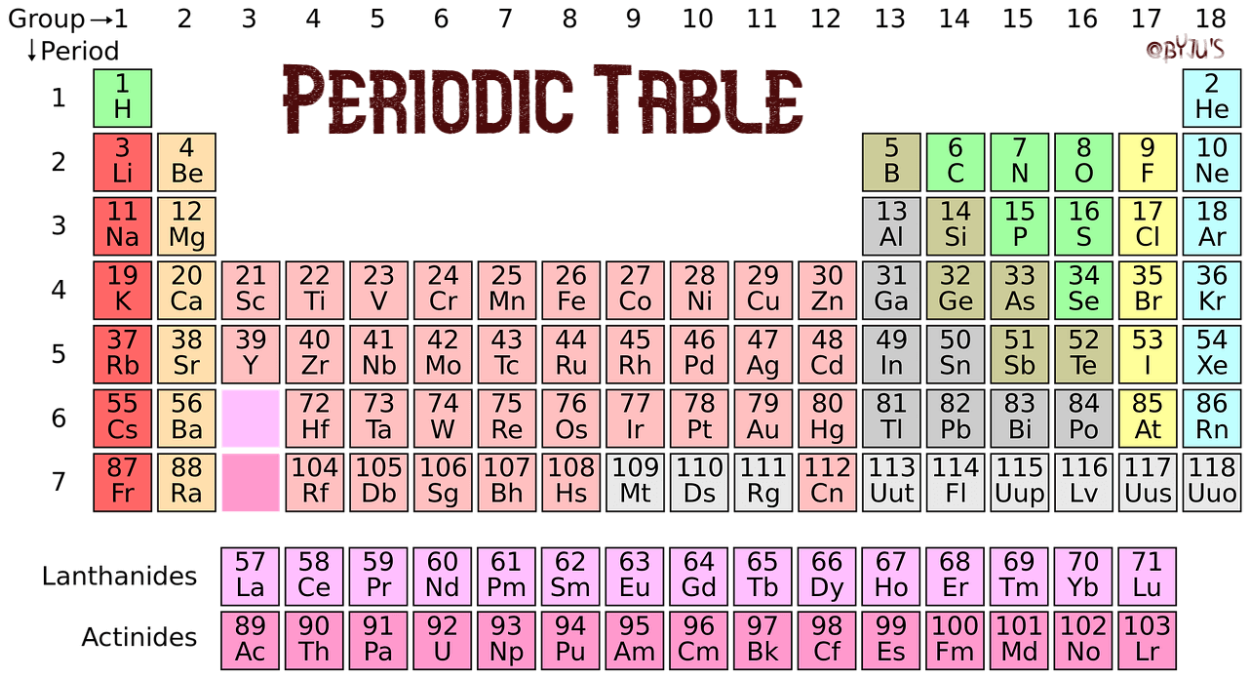

Fig.1.2 Periodic Table

1.2.1 What is the Periodic Table?

The periodic table is an arrangement of all the elements known to man in accordance with their increasing atomic number and recurring chemical properties. They are assorted in a tabular arrangement wherein a row is a period and a column is a group.

Elements are arranged from left to right and top to bottom in the order of their increasing atomic numbers. Thus,

- Elements in the same group will have the same valence electron configuration and hence, similar chemical properties.
- Whereas, elements in the same period will have an increasing order of valence electrons. Therefore, as the energy level of the atom increases, the number of energy sub-levels per energy level increases.

The first 94 elements of the periodic table are naturally occurring, while the rest from 95 to 118 have only been synthesized in laboratories or nuclear reactors.

The modern periodic table, the one we use now, is a new and improved version of certain models put forth by scientists in the 19th and 20th century. Dimitri Mendeleev put forward his periodic table based on the findings of some scientists before him like John Newlands and Antoine-Laurent de Lavoisier. However, Mendeleev is given sole credit for his development of the periodic table.

1.2.2 Mendeleev Periodic Table

Dimitri Mendeleev, widely referred as the father of the periodic table put forth the first iteration of the periodic table similar to the one we use now. Mendeleev's periodic law is different from the modern periodic law in one main aspect.

- Mendeleev modeled his periodic table on the basis of increasing atomic mass, whereas, the modern periodic law is based on the increasing order of atomic numbers.

Even though Mendeleev's periodic table was based on atomic weight, he was able to predict the discovery and properties of certain elements. During his time only around half of the elements known to us now were known, and most of the information known about the elements were inaccurate. Mendeleev's Periodic Table was published in the German Journal of chemistry in 1869.

Table 1.2 List of Periodic Table Elements

118 Elements Of Periodic Table
Element 1: H-Hydrogen Element 2: He-Helium Element 3: Li-Lithium Element 4: Be-Beryllium Element 5: B-Boron Element 6: C-Carbon Element 7: N-Nitrogen Element 8: O-Oxygen Element 9: F-Fluorine Element 10: Ne-Neon Element 11: Na-Sodium Element 12: Mg-Magnesium Element 13 : Al-Aluminum Element 14 : Si-Silicon Element 15 : P-Phosphorus

Element 16 : S-Sulfur Element 17 : Cl-Chlorine Element 18 : Ar-Argon Element 19 : K-Potassium Element 20 : Ca-Calcium Element 21 : Sc-Scandium Element 22 : Ti-Titanium Element 23 : V-Vanadium Element 24 : Cr-Chromium Element 25 : Mn-Manganese Element 26 : Fe-Iron Element 27 : Co-Cobalt Element 28 : Ni-Nickel Element 29 : Cu-Copper Element 30 : Zn-Zinc Element 31 : Ga-Gallium Element 32 : Ge-Germanium Element 33 : As-Arsenic Element 34 : Se-Selenium Element 35 : Br-Bromine Element 36 : Kr-Krypton Element 37 : Rb-Rubidium Element 38 : Sr-Strontium Element 39 : Y-Yttrium Element 40 : Zr-Zirconium Element 41 : Nb-Niobium Element 42 : Mo-Molybdenum Element 43 : Tc-Technetium Element 44 : Ru-Ruthenium Element 45 : Rh-Rhodium Element 46 : Pd-Palladium Element 47 : Ag-Silver Element 48 : Cd-Cadmium Element 49 : In-Indium Element 50 : Sn-Tin Element 51 : Sb-Antimony Element 52 : Te-Tellurium Element 53 : I-Iodine Element 54 : Xe-Xenon Element 55 : Cs-Cesium Element 56 : Ba-Barium Element 57 : La-Lanthanum Element 58 : Ce-Cerium Element 59 : Pr-Praseodymium Element 60 : Nd-Neodymium Element 61 : Pm-Promethium Element 62 : Sm-Samarium Element 63 : Eu-Europium Element 64 : Gd-Gadolinium Element 65 : Tb-Terbium Element 66 : Dy-Dysprosium Element 67 : Ho-Holmium Element 68 : Er-Erbium Element 69 : Tm-Thulium Element 70 : Yb-Ytterbium Element 71 : Lu-Lutetium Element 72 : Hf-Hafnium Element 73 : Ta-Tantalum Element 74 : W-Tungsten Element 75 : Re-Rhenium Element 76 : Os-Osmium Element 77 : Ir-Iridium Element 78 : Pt-Platinum Element 79 : Au-Gold Element 80 : Hg-Mercury Element 81 : Tl-Thallium Element 82 : Pb-Lead Element 83 : Bi-Bismuth Element 84 : Po-Polonium Element 85 : At-Astatine Element 86 : Rn-Radon Element 87 : Fr-Francium Element 88 : Ra-Radium Element 89 : Ac-Actinium Element 90 : Th-Thorium Element 91 : Pa-Protactinium Element 92 : U-Uranium Element 93 : Np-Neptunium Element 94 : Pu-Plutonium Element 95 : Am-Americium Element 96 : Cm-Curium Element 97 : Bk-Berkelium Element 98 : Cf-Californium Element 99 : Es-Ensteinium Element 100 : Fm-Fermium Element 101 : Md-Mendelevium Element 102 : No-Nobelium Element 103 : Lr-Lawrencium Element 104 : Rf-Rutherfordium Element 105 : Db-Dubnium Element 106 : Sg-Seaborgium Element 107 : Bh-Bohrium Element 108 : Hs-Hassium Element 109 : Mt-Meitnerium Element 110 : Ds-Darmstadtium Element 111 : Rg-Roentgenium Element 112 : Cn-Copernicium Element 113 : Nh-Nihonium Element 114 : Fl-Flerovium Element 115 : Mc-Moscovium Element 116 : Lv-Livermorium Element 117 : Ts-Tennessine Element 118 : Og-Oganesson