

## Carbon

Carbon has been known since ancient times in the form of soot, charcoal, graphite and diamonds. Ancient cultures did not realize, of course, that these substances were different forms of the same element. The basic units of most biomolecules contain atoms of carbon.

Carbon atoms have four valence electrons so they can form covalent bonds with as many as four other atoms. Carbon atoms can bond with each other to form chains or rings. The carbon atoms in these chains and rings can also connect with atoms of other elements to form the basic units of most biomolecules.

Carbon's atomic number is 6. It has 6 electrons, 6 protons, and 6 neutrons. 2 of Carbon's electrons like to hang out in the nearest orbital; the other 4 hang out in the second orbital. This leaves space for 4 other electrons in that last orbital.

Carbon has a lot of friends. There are nearly ten million known carbon compounds and an entire branch of chemistry, known as organic chemistry, is devoted to their study. Many carbon compounds are essential for life as we know it. Some of the most common carbon compounds are: carbon dioxide ( $\text{CO}_2$ ), carbon monoxide ( $\text{CO}$ ), chloroform ( $\text{CHCl}_3$ ), methane ( $\text{CH}_4$ ), ethyl alcohol ( $\text{C}_2\text{H}_5\text{OH}$ ), glucose ( $\text{C}_6\text{H}_{12}\text{O}_6$ ) and acetic acid ( $\text{CH}_3\text{COOH}$ ).

About 20% of the weight of living organisms is carbon. Carbon is the fourth most abundant element in the universe.

Vocabulary Word: Compound



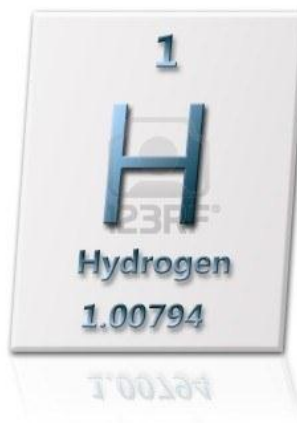
## Hydrogen

About 10 percent of the weight of living organisms is hydrogen – mainly in water, proteins and fats. Hydrogen is highly flammable and has an almost invisible flame, which can lead to accidental burns. Hydrogen is the simplest element of all, and the lightest. There is little free hydrogen on Earth because hydrogen is so light that it is not held by the planet's gravity. Any hydrogen that forms eventually escapes from the atmosphere into space.

It is also by far the most common element in the Universe. Over 90 percent of the atoms in the Universe are hydrogen. Hydrogen is a colorless, odorless gas which exists, at standard temperature and pressure, as diatomic molecules, H<sub>2</sub>. On Earth, the major location of hydrogen is in water, H<sub>2</sub>O.

Hydrogen is the only element that can exist without neutrons. In fact, in its commonest form (isotope), the hydrogen atom is made of one proton, one electron, and no neutrons. It has only one electron in its inner orbital, leaving it open to one more electron from a friend.

Vocabulary Word: Isotope



## Oxygen

Air is 78 percent nitrogen and 21 percent oxygen. Oxygen is about twice as soluble in water as nitrogen. If it had the same solubility as nitrogen, much less oxygen would be present in seas, lakes and rivers, and life would be very different. Oxygen dissolves more readily in cold water than warm water. As a result of this, our planet's cool, polar oceans are denser with life than the warmer, tropical oceans. Almost two-thirds of the weight of living things comes from oxygen, mainly because living things contain a lot of water and 88.9 percent of water's weight comes from oxygen. Oxygen ( $O_2$ ) is unstable in our planet's atmosphere and must be constantly replenished by photosynthesis in green plants. Without life, our atmosphere would contain almost no  $O_2$ . What assumption could we make if we discovered oxygen in the atmosphere of another planet?

Oxygen is the third most abundant element in the universe. Oxygen in its common form ( $O_2$ ) is a colorless, odorless and tasteless diatomic gas. Oxygen is extremely reactive and forms oxides with nearly all other elements except noble gases.

Oxygen has an atomic number of 8. It has 8 neutrons, 8 protons, and 8 electrons. Only 2 of its electrons hang out in the first orbital. The other 6 hang out in the second orbital. This leaves space for 2 more electrons in this outer orbital.

Vocabulary word: Soluble



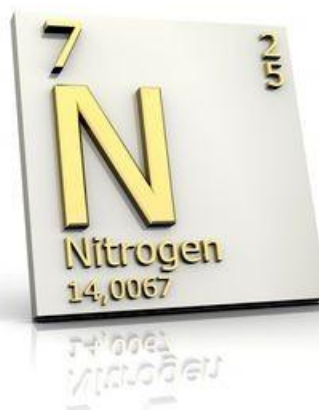
## Nitrogen

Nitrogen is a colorless, odorless, tasteless, diatomic ( $N_2$ ) and generally inert gas at standard temperature and pressure. About 2.5 percent of the weight of living organisms comes from nitrogen in organic molecules. Many of the molecules of life contain nitrogen. It is the fourth most abundant element in the human body.

The nitrogen compound nitroglycerin has two rather different uses: blowing things up, and relief of angina, a life threatening heart condition. In the natural world, the nitrogen cycle is of crucial importance to living organisms. Nitrogen is taken from the atmosphere and converted to nitrates through lightning storms and nitrogen fixing bacteria. The nitrates fertilize plant growth where the nitrogen becomes bound in amino acids, DNA and proteins. It can then be eaten by animals. Eventually the nitrogen from the plants and animals returns to the soil and atmosphere and the cycle repeats.

Nitrogen has an atomic number of 7. It has 7 electrons, 7 protons, and 7 neutrons. Only 2 of its electrons can hang out in the first orbital. Its other 5 electrons hang out in the second orbital. This leaves space for 3 more electrons from a friend.

Vocabulary Word: Diatomic



## Phosphorus

White phosphorus is highly toxic. Skin contact can result in severe burns. Red phosphorus (provided it is not contaminated with white phosphorus) is considered non-toxic. Phosphorus compounds are vital for life. Phosphorus is the sixth most abundant element in living organisms. Phosphorus is a vital plant nutrient and its main use – via phosphate compounds – is in the production of fertilizers. Just as there are biological carbon and nitrogen cycles, there is also a phosphorus cycle. Phosphorus is found in nucleic acids, and lipids. It is also found in a form of energy the body uses known as ATP.

Phosphorus is used in the manufacture of safety matches (red phosphorus), pyrotechnics and incendiary shells. Phosphorus is also used in steel manufacture and in the production of phosphor bronze. Phosphates are ingredients of some detergents. Phosphorus is used to make light-emitting diodes (LEDs).

Phosphorus has an atomic number of 15. It has 16 neutrons, 15 protons, and 15 electrons. Phosphorus has 3 orbitals, it's first has 2 electrons, the second has 8 electrons, and the third has 5. This leaves its last orbital open for 3 electrons.

Vocabulary Word: Atomic Number

