CHEMISTRY READING GUIDE

Elements

Humans and other organisms and everything around them are examples of matter. Matter is anything that occupies space and has mass—the physical "stuff" of the universe. Rock, wood, air, metal, water, and animals are all matter.

1. What do we call anything that has mass and take up space?

The various forms of matter are composed of one or more chemical elements. An element is a pure substance that cannot be broken down into other substances by chemical means. Examples of naturally occurring elements include some you have probably heard of, such as gold, helium, mercury, and oxygen. Elements are often described as the "basic ingredients" of matter because the more complex forms of matter (including you) are made from elements.

2. What is an element?

About 25 elements are essential to life .Four of these elements—oxygen (O), carbon (C), hydrogen (H), and nitrogen (N)—make up about 96 percent of the living matter in your body. Calcium (Ca), phosphorus (P), potassium (K), sulfur (S), and a few other elements account for most of the remaining 4 percent. Trace elements, elements that make up less than 0.01 percent of your body mass, are nevertheless critical to your health. For example, you need about 0.15 milligram (mg) of the trace element iodine each day. If you don't get enough iodine, your thyroid gland (a gland in your throat that regulates certain chemical processes in your body) does not function properly. Another trace element, iron, makes up only about 0.004 percent of your body mass, but it is essential for carrying oxygen in your blood.

3. List the four elements found in the greatest quantity in an organism.

Atoms

Atoms of all elements are made up of even smaller components called subatomic particles. A proton is a subatomic particle with a single unit of positive electrical charge (+). An electron is a subatomic particle with a single unit of negative electrical charge (-). A third type of subatomic particle, the neutron, is electrically neutral, meaning it has no electrical charge. An element's physical and chemical properties depend on the number and arrangement of its subatomic particles. For example, the shiny luster of copper metal and the boxy crystals of sulfur are based on the structure and interactions of the atoms that make up those elements.

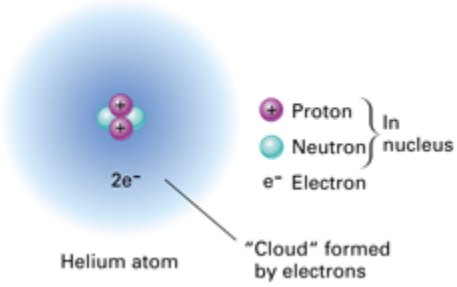
4. What are the 3 subatomic particles and what are their charges?

An atom's protons and neutrons are tightly packed together, forming a central core called the nucleus. Electrons, which have much less mass than neutrons and protons, continually move about the outside of the nucleus at great speed. The attraction between the negatively charged electrons and the positively charged protons keeps the electrons close to the nucleus.

5. Where are the subatomic particles located

Notice that the model of the helium atom on the next page. It has 2 protons and 2 neutrons in its nucleus. This model, which is not drawn to scale, represents the moving electrons as a spherical "cloud" of negative charge surrounding the nucleus. Because the exact path of any electron cannot be determined, the cloud model is helpful. An electron may visit every point around a nucleus over time. Thus you can think of the electron's negative charge

as spread out, like a cloud, in all the places the electron might be. In a real atom, the electron cloud is much larger than the nucleus. To give you an idea of the difference, consider that if the electron cloud of an atom were big enough to fill a baseball stadium, the nucleus would be only the size of a housefly on the field!



6. Why is the diagram above a poor depiction of an actual atom

An important difference among elements is the number of protons in their atoms. All atoms of a particular element have the same number of protons, known as the element's atomic number. Thus, a helium atom, with 2 protons, has an atomic number of 2. Left alone, an atom tends to hold as many electrons as protons. In that state, the atom is electrically neutral—the positive charges on the protons exactly balance the negative charges on the electrons. However, the number of electrons is not constant like the number of protons. Certain atoms can lose one or more electrons, while some atoms can gain one or two electrons. As you'll see later, the number of electrons determines how the atom interacts with other atoms. Indirectly then—by setting the usual number of electrons—the number of protons determines the atom's properties. No two elements have the same atomic number (proton number), so no two elements have the exact same chemical behavior.

7. What determines an elements identity?

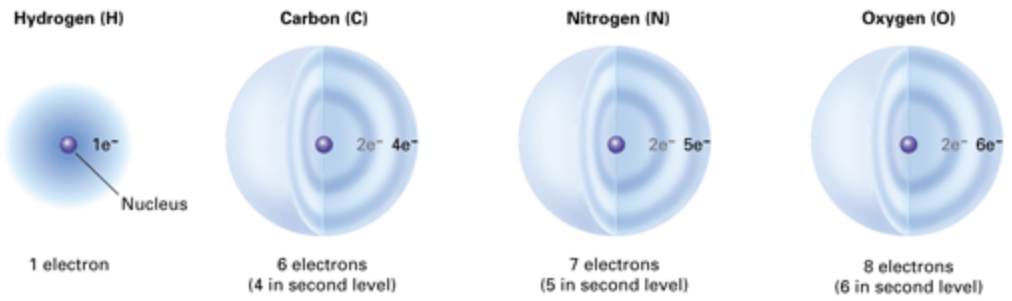
8. Why are atoms electrically neutral?

Electrons and Reactivity

How does an atom's structure determine how it reacts with other atoms? The key is the atom's electrons. Electrons differ in the amount of energy they have and how tightly they are held by the protons in the nucleus. Based on these properties, chemists describe an atom's electrons as belonging to certain energy levels. Usually it is the electrons in the highest energy level of an atom that determine how that atom reacts.

9. What two properties determine an element's atoms react?

The first, or lowest, energy level (nearest the nucleus) can hold 2 electrons, while the second energy level can hold 8 electrons. For example, a hydrogen atom has 1 electron. Since electrons fill the lowest energy level first, hydrogen's electron occupies its first energy level (Figure 4-7).



-7
's lowest (first) energy level can hold up to 2 electrons. The second level can hold up to 8. N
second energy levels of carbon, nitrogen, and oxygen atoms are unfilled with 4, 5, and 6 elec
vely. (Remember that atomic models are limited in what they can represent. Energy levels ar
ıysical locations.)

Helium (modeled in Figure 4-4) has 2 electrons, filling its lowest energy level. Carbon has 2 electrons in its lowest energy level, and 4 more electrons in its second level. Note that both hydrogen and carbon have a partly-filled energy level, as do nitrogen and oxygen. That condition makes these atoms chemically reactive—they tend to react with other atoms, filling their highest occupied energy levels. In contrast, a helium atom, which has no partly-filled energy levels, is inert—it does not tend to react. In the next section, you'll read more about the ways electrons are involved in the reactions among atoms.

10. How many electrons our found in the first energy level?

11. How many electrons does it take to fill the second energy level?

12. Helium is inert. What does inert mean?

13. Why is helium inert?

14. Why will carbon, hydrogen, nitrogen and oxygen react and form compounds?