Chapter 2 study guide

2.1 Chemical Elements

Element – a substance that can not be broken down into simpler substances with different properties by ordinary chemical means. Each element corresponds to one kind of **atom**.

Know the name, charges, location, and masses of the subatomic particles listed in **figure 2.2**. Each element has an **atomic number** that corresponds to the number of protons in the nucleus of that element. Hydrogen is atomic number 1 and has 1 proton. Uranium is number 92 and has 92 protons. The **atomic mass** is the total number of protons + neutrons. **Mass** refers to the amount of matter present.

Know how to read the **periodic table**. Figure 2.3

Isotopes are atoms of the same element (same number of protons) but with differing number of neutrons. Some are **radioactive** – they give off radiation because the nucleus is unstable. Radioactive isotopes can be used as **tracers** in studying cellular processes and in diagnosis and treatment of diseases. They can also cause diseases.

Electrons are negatively charged low-mass particles that exist in shells around the nucleus. There is a maximum of two electrons in the first shell, eight in the next couple of shells. Atoms that we will be studying are most stable with eight electrons in their outer shell (except hydrogen which just needs two). This is called the octet rule.

2.2 Compounds and Molecules

Molecule – two or more atoms bound together.

Compound – two or more elements bound together.

Know how to read a **formula** p.26.

Electronegativity – the ability of an atom to attract electrons towards itself. In any given period, electronegativity increases from left to right. This is because the number of protons increases while all the electrons are in the same shell (same distance away from the nucleus).

Bonds

Ionic – this is where one atom completely loses one or two electrons while another gains them. This typically happens when the very electronegative group 7 is combined with the low electronegative group 1 or group 2. Example is Sodium (Na)and Chlorine(Cl) to give NaCl, common table salt. The positively charged sodium ion is attracted to the negatively charged chlorine ion (ion is a charged atom or molecule). A sodium ion is not attached to any particular chlorine.

Covalent – this is where two or more atoms share electrons to fill their outer (valence) electron shell. They are physically bound, one to another. When two atoms share one pair of electrons is called a single bond, two pairs a double bond, three pairs a triple bond. If one of the atoms is more electronegative than the other, the shared electrons will be more associated with it. This bond is called a **polar covalent bond**. If the molecule is asymmetric, then one end will be slightly positive and the other end slightly negative due to the unequal sharing. Molecules that plus and minus ends are said to be **polar** molecules, otherwise they are **nonpolar**. This is hugely important in the interactions between and within biological molecules.

2.3 Chemistry of Water

Water is H_2O. It is asymmetric because the hydrogen atoms are not directly across from each other. Oxygen is much more electronegative than hydrogen and so it carries a little negative charge while the hydrogen atoms carry a little positive charge. This causes the hydrogen of one molecule of water to be attracted to the oxygen of another water molecule. This is transient but contributes greatly to the properties of water. This attraction between a partially positive hydrogen and a partially negative oxygen (or any negative atom in other biological molecules) is called a **hydrogen bond**.

This gives water some interesting properties:

High heat capacity – figure 2.10

High heat of evaporation

Ability to dissolve other polar molecules (be a good solvent)

http://www.northland.cc.mn.us/biology/Biology1111/animations/dissolve.html

Cohesion and Adhesion

Surface tension

Water has the unusual property (for a liquid) in that it is less dense when it freezes. See figure 2.12 for why this is a good thing.

2.4 Acids and Bases

Water will rarely dissociate into H^+ (hydrogen ion) and OH^- (hydroxide ion). A mole is a really big number (6.02×10^{23}). In a liter of pure water there will be about 55 moles of H_20 and 10^{-7} (0.0000001) moles of each of these ions. The concentration of the H^+ is very important in biology and is referred to it's pH. A pH of 7 is said to be neutral. An acidic solution will have a higher concentration of H^+ and a lower pH. A pH of 6 has 10 times more H^+ than pH 7, a pH of 5 has 100 times higher concentration. Acids are compounds that increase the concentration of H^+ while bases decrease it's concentration. Biological systems are very sensitive to pH changes. Your blood must be kept very close to 7.4 to live. Acid rain and ocean acidification can have negative effects on living organisms.

Buffers are chemicals that help maintain a given pH. They are generally weak acids that can donate H^+ if a base is added or absorb H^+ if an acid is added to a solution.