

ANSWERS TO PRACTICE QUESTIONS

Chapter 2

Practice 2.2

1. What are elements?

Elements are pure substances, either found in nature or artificially produced, which represent the simplest forms of matter that have certain chemical characteristics.

2. Which elements are the most common in the human body?

The 4 most common elements are oxygen, carbon, hydrogen, and nitrogen. Together, they make up about 95% of the human body.

3. Where are electrons, protons, and neutrons located in an atom?

Protons and neutrons are found in the centrally located nucleus of an atom, while electrons are in constant motion around the nucleus.

4. What is the difference between atomic number and atomic weight?

The atomic number of an atom is the number of protons in its nucleus. All atoms of a particular element have the same atomic number. The atomic weight is approximately equal to the number of protons plus the number of neutrons. Atoms of the same element may have different numbers of neutrons, and therefore, different atomic weights.

Practice 2.3

1. What is an ion?

An ion is an atom that has gained or lost one or more electrons in a chemical reaction, and now carries a positive or negative charge.

2. Describe two ways that atoms bond with other atoms.

Atoms can form ionic bonds, in which oppositely charged ions attract each other and unite, forming arrays or crystals, instead of discrete molecules. Atoms can also share electrons, forming covalent bonds. As the shared electrons move around the nuclei of both atoms, both achieve stability.

3. Distinguish between an ion and a polar molecule.

An ion contains unequal numbers of protons and electrons. A polar molecule contains equal numbers of protons and electrons, but the shared electrons reside closer to the nucleus of one of the bonded atoms than to the other. This results in the polar molecule having one slightly negative end and one slightly positive end.

Practice 2.4

1. Distinguish between a molecule and a compound.

A molecule is any particle formed by the bonding of two or more atoms. The atoms may be either identical or different. If the bound atoms are different elements, the molecule is called a compound.

2. What is a molecular formula? A structural formula?

A molecular formula shows the types of atoms in a particular molecule, and the number of each type of atom. The formula for water is H_2O ; this shows that a water molecule contains two atoms of hydrogen and one atom of oxygen. A structural formula shows the arrangement of atoms within a molecule, and uses lines to represent pairs of shared electrons. The structural formula for a molecule of hydrogen is $\text{H} - \text{H}$; this shows that two atoms of hydrogen are bound together by sharing one pair of electrons.

3. Describe three types of chemical reactions.

In a synthesis reaction, two or more atoms (reactants) bond together, forming a larger or more complex particle (product). For example, two atoms of hydrogen and one atom of oxygen bind to synthesize a molecule of water. In a decomposition reaction, bonds break within a reactant molecule, resulting in the formation of smaller or simpler particles. Decomposition occurs when a large starch molecule is broken down into individual glucose molecules during the digestion process. During an exchange reaction between two molecules, chemical bonds are broken and new ones are formed. Parts of the reactants switch places, producing new molecules. When an acid and base react, producing water and a salt, this is an exchange reaction.

Practice 2.5

1. Compare the characteristics of an acid with those of a base.

Acids are electrolytes that release H^+ ions in water, and have a pH of <7 . Bases are electrolytes that release ions that can bind to H^+ ions in water, and have a pH of >7 .

2. What does pH measure?

The pH is a measurement of H^+ ion concentration in a solution. The lower the pH of the solution, the higher the H^+ concentration is, and the more acidic the solution is. The higher the pH, the lower the H^+ concentration is, and the more basic, or alkaline, the solution is.

3. What is a buffer?

A buffer is a chemical that resists or minimizes pH changes. Buffer components bind to H^+ ions when they are present in excess, and release them when they are deficient.

Practice 2.6

1. How do inorganic and organic molecules differ?

Organic molecules contain carbon and hydrogen; inorganic molecules do not.

2. How do electrolytes and nonelectrolytes differ?

Electrolytes are substances that dissolve and dissociate in water and release ions; most inorganic substances are electrolytes. Nonelectrolytes are substances that dissolve in water, but do not release ions; this includes many organic substances.

3. Name the inorganic substances common in body fluids.

Water, oxygen, carbon dioxide, and salts are common inorganic substances in cells.

4. Compare the chemical composition of carbohydrates, lipids, proteins, and nucleic acids.

Carbohydrates consist of carbon, hydrogen, and oxygen, with approximately a 2 to 1 ratio of hydrogen to oxygen atoms. Lipids (triglycerides) also consist of carbon, hydrogen, and oxygen, but they contain a much higher ratio of hydrogen to oxygen atoms. Some lipids also contain phosphorus. Proteins are also mainly composed of carbon, hydrogen, and oxygen, but they also contain nitrogen, and some contain sulfur. Nucleic acids consist of carbon, hydrogen, oxygen, nitrogen, and phosphorus.

5. How does an enzyme affect a chemical reaction?

An enzyme catalyzes a chemical reaction, meaning that it greatly increases the reaction rate. Metabolic reactions are able to occur quickly enough to support life processes only because of the presence of enzymes.

6. What is the chemical basis of the great diversity of proteins?

All proteins are composed of various combinations of 20 different amino acids. Proteins contain chains of <100 to >5000 amino acids. Some consist of only one polypeptide chain, while others consist of several. The length and order of amino acids, as well as the pleated or coiled secondary structure and the 3-dimensional shape, or conformation, of the protein, all contribute to the great diversity of proteins in the body.

7. What are the functions of nucleic acids?

Deoxyribonucleic acid, or DNA, stores the genetic information, or genetic code, on chromosomes. This information is used to construct proteins for the cell. Various types of ribonucleic acid, or RNA, function in the process of protein synthesis.