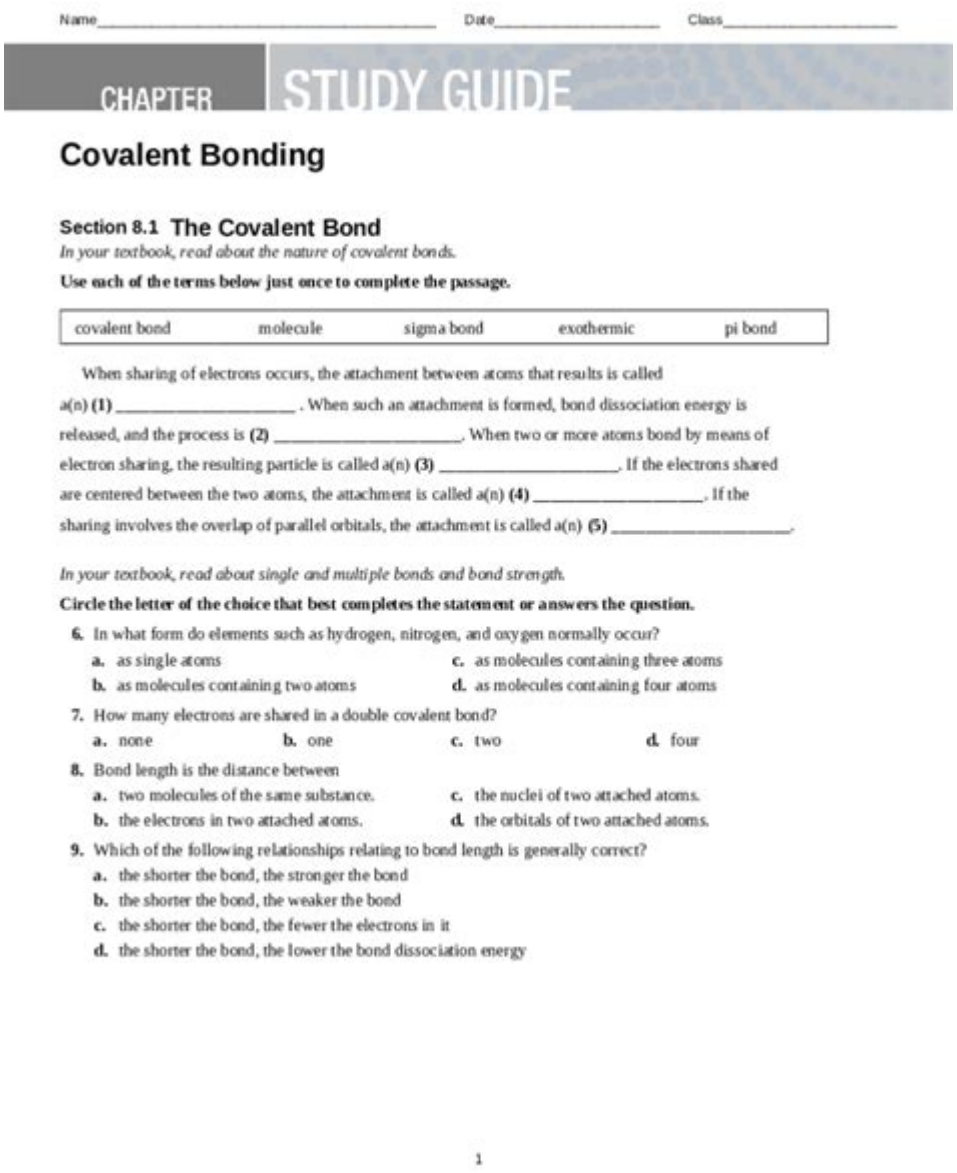
Chapter 8 Study Guide Covalent Bonding



Name_____ Date_____ Class_____

CHAPTER STUDY GUIDE

Covalent Bonding

Section 8.1 The Covalent Bond

In your textbook, read about the nature of covalent bonds.

Use each of the terms below just once to complete the passage.

covalent bond	molecule	sigma bond	exothermic	pi bond

When sharing of electrons occurs, the attachment between atoms that results is called a(n) **(1)** _____. When such an attachment is formed, bond dissociation energy is released, and the process is **(2)** _____. When two or more atoms bond by means of electron sharing, the resulting particle is called a(n) **(3)** _____. If the electrons shared are centered between the two atoms, the attachment is called a(n) **(4)** _____. If the sharing involves the overlap of parallel orbitals, the attachment is called a(n) **(5)** _____.

In your textbook, read about single and multiple bonds and bond strength.

Circle the letter of the choice that best completes the statement or answers the question.

6. In what form do elements such as hydrogen, nitrogen, and oxygen normally occur?
- **a.** as single atoms
- **b.** as molecules containing two atoms
- **c.** as molecules containing three atoms
- **d.** as molecules containing four atoms

7. How many electrons are shared in a double covalent bond?
- **a.** none
- **b.** one
- **c.** two
- **d.** four

8. Bond length is the distance between
- **a.** two molecules of the same substance.
- **b.** the electrons in two attached atoms.
- **c.** the nuclei of two attached atoms.
- **d.** the orbitals of two attached atoms.

9. Which of the following relationships relating to bond length is generally correct?
- **a.** the shorter the bond, the stronger the bond
- **b.** the shorter the bond, the weaker the bond
- **c.** the shorter the bond, the fewer the electrons in it
- **d.** the shorter the bond, the lower the bond dissociation energy

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Chapter 8 Study Guide Covalent Bonding provides an essential understanding of one of the fundamental concepts in chemistry. Covalent bonding occurs when two atoms share one or more pairs of electrons, allowing them to achieve a more stable electronic configuration. This chapter delves into the nature of covalent bonds, their properties, and the types of molecules they form. Understanding covalent bonding is crucial for comprehending molecular structures, chemical reactions, and the behavior of substances in various states.

Understanding Covalent Bonds

Covalent bonds are primarily characterized by the sharing of electrons between atoms. This section explores the fundamental concepts that underpin covalent bonding.

1. Definition and Characteristics

- Definition: Covalent bonds form when two nonmetal atoms come together and share electrons to achieve a full outer shell, often referred to as the octet rule.
- Characteristics:
- Directional Nature: Covalent bonds have a specific orientation in space, which influences molecular shape and geometry.
- Bond Length and Strength: The distance between the nuclei of the bonded atoms is known as the bond length, while bond strength is determined by the energy required to break the bond.
- Polarity: Depending on the difference in electronegativity between the bonded atoms, covalent bonds can be classified as polar or nonpolar.

2. Electronegativity and Bond Type

Electronegativity is a measure of an atom's ability to attract shared electrons.

- Nonpolar Covalent Bonds: Formed between atoms with identical or very similar electronegativities (e.g., H_2, O_2).
- Polar Covalent Bonds: Occur when there is a significant difference in electronegativity between the two atoms, leading to an unequal sharing of electrons (e.g., H_2O).

Types of Covalent Bonds

Covalent bonds can be classified based on the number of shared electron pairs.

1. Single, Double, and Triple Bonds

- Single Bonds: Involve the sharing of one pair of electrons (e.g., H-Cl).
- Double Bonds: Consist of two pairs of shared electrons (e.g., C=O).
- Triple Bonds: Involve three pairs of shared electrons (e.g., N≡N).

Each type of bond affects molecular properties such as bond length, bond strength, and reactivity:

- Single Bonds: Longer and weaker than double and triple bonds.
- Double Bonds: Shorter and stronger than single bonds but weaker than triple bonds.
- Triple Bonds: The shortest and strongest of the three types.

2. Coordinate Covalent Bonds

- Definition: A coordinate covalent bond occurs when both electrons in the bond come from the same atom.
- Example: The formation of ammonium ion (NH_4^+) from ammonia (NH_3) and a proton (H^+).

Molecular Geometry and VSEPR Theory

The spatial arrangement of atoms within a molecule is crucial for understanding its chemical behavior. The Valence Shell Electron Pair Repulsion (VSEPR) theory provides insights into molecular shapes.

1. Basic Principles of VSEPR Theory

- Electron Pair Repulsion: Electron pairs around a central atom will arrange themselves as far apart as possible to minimize repulsion.
- Types of Electron Regions: These include bond pairs and lone pairs which influence the shape of the molecule.

2. Common Molecular Geometries

- Linear: 180° bond angle (e.g., CO_2).
- Trigonal Planar: 120° bond angles (e.g., BF_3).
- Tetrahedral: 109.5° bond angles (e.g., CH_4).
- Trigonal Bipyramidal: 90° and 120° bond angles (e.g., PCl_5).
- Octahedral: 90° bond angles (e.g., SF_6).

Polar and Nonpolar Molecules

Understanding whether a molecule is polar or nonpolar is essential for predicting its interactions with other substances.

1. Determining Polarity

To determine the polarity of a molecule, consider the following:

- Electronegativity Differences: Assess the electronegativity of the atoms involved in the bond.
- Molecular Shape: Symmetrical molecules are often nonpolar, while asymmetrical ones tend to be polar.

2. Effects of Polarity

- Solubility: Polar molecules tend to dissolve in polar solvents (e.g., water), while nonpolar molecules dissolve in nonpolar solvents (e.g., oil).
- Intermolecular Forces: Polar molecules experience dipole-dipole interactions and hydrogen bonding, affecting boiling and melting points.

Covalent Bonding in Real-World Applications

Covalent bonding is not just a theoretical concept; it has practical implications in various fields.

1. Biological Molecules

- Proteins: Composed of amino acids linked by peptide bonds (a type of covalent bond).
- Nucleic Acids: DNA and RNA are formed by covalent bonds between nucleotides.

2. Material Science

- Polymers: Many materials, like plastics, are made from long chains of covalently bonded monomers.
- Semiconductors: The properties of materials like silicon are determined by covalent bonds, impacting electronics.

3. Environmental Science

- Pollutants: Understanding the covalent bonds in various pollutants helps in developing methods for their detection and remediation.

Conclusion

Chapter 8 Study Guide Covalent Bonding serves as a gateway to understanding the intricacies of molecular interactions. From the basic principles of electron sharing to the complexities of molecular geometry and real-world applications, covalent bonds are fundamental to the structure and behavior of matter. Mastery of this chapter enables students and enthusiasts alike to appreciate the subtleties of chemistry and its relevance in everyday life. Understanding covalent bonding is not merely an academic exercise; it is a vital tool for anyone aspiring to delve deeper into the sciences, whether in chemistry, biology, environmental science, or materials engineering.

Frequently Asked Questions

What is a covalent bond and how is it formed?

A covalent bond is a type of chemical bond where two atoms share one or more pairs of electrons. This sharing allows each atom to attain the electron configuration of a noble gas, leading to a more stable arrangement.

What are the differences between polar and nonpolar covalent bonds?

Polar covalent bonds occur when there is an unequal sharing of electrons between atoms with different electronegativities, resulting in a dipole moment. Nonpolar covalent bonds occur when electrons are shared equally between atoms with similar electronegativities.

How do you determine the polarity of a molecule?

To determine the polarity of a molecule, you must assess the electronegativity differences between the bonded atoms and the overall molecular geometry. A molecule with polar bonds can be nonpolar if its shape is symmetrical, canceling out the dipoles.

What role do lone pairs play in covalent bonding?

Lone pairs are pairs of valence electrons that are not involved in bonding. They can influence the shape and polarity of a molecule by repelling bonding pairs of electrons, thus affecting molecular geometry according to VSEPR theory.

What is resonance in covalent compounds?

Resonance occurs when a molecule can be represented by two or more valid Lewis structures that differ only in the placement of electrons. This indicates that the actual structure is a hybrid of these forms, providing a more accurate representation of electron distribution.

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