8.2 The Nature of Covalent Bonding

**Essential Understanding**
Covalent bonds form when atoms share electrons.

**Reading Strategy**

**Cluster Diagram** Cluster diagrams help you know how concepts are related. Write the main idea or topic on a sheet of paper. Circle it. Draw lines branching off the main idea, connected to circles that contain concepts related to the main concept. Continue adding facts and details to the branches.

Use the cluster diagram below to show how each section of the lesson relates to covalent bonding. Add circles if necessary.

![Cluster Diagram](image)

**Extension** Draw a cluster diagram for each type of bond.

**Lesson Summary**

**The Octet Rule in Covalent Bonding** Covalent compounds are most stable when each atom has eight electrons.

- Single, double, and triple covalent bonds depend on the number of pairs of electrons shared between two atoms.
- Atoms form double or triple covalent bonds if they can attain a noble gas structure by doing so.

<table>
<thead>
<tr>
<th>Type of Covalent Bond</th>
<th>Attributes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Single</td>
<td><strong>One</strong> shared electron pair with <strong>one</strong> electron from each atom</td>
</tr>
<tr>
<td>Double</td>
<td><strong>Two</strong> shared electron pairs with <strong>two</strong> electrons from each atom</td>
</tr>
<tr>
<td>Triple</td>
<td><strong>Three</strong> shared electron pairs with <strong>three</strong> electrons from each atom</td>
</tr>
</tbody>
</table>
Coordinate Covalent Bonds In a coordinate covalent bond, one atom contributes both electrons in the bonding pair.

- One atom may contribute a pair of unshared electrons to a bond to give both atoms an inert gas configuration.
- Coordinate covalent bonds can also occur in polyatomic ions, such as NH₄⁺.

Exceptions to the Octet Rule Some molecules have fewer, or more, than a complete octet of valence electrons.

- Molecules that have an odd number of total valence electrons cannot satisfy the octet rule.
- Some molecules that have an even number of valence electrons may also fail to follow the octet rule.

Bond Dissociation Energies The energy needed to break a covalent bond depends on the strength of the bond.

- A large bond dissociation energy corresponds to a strong covalent bond.
- Double and triple bonds are stronger than single bonds.
- Reactivity is linked to the strength or weakness of the covalent bonds.

Resonance The bonding in some molecules is a blend of several valid electron dot structures.

- The possible electron dot structures are called resonance forms.
- Electron pairs do not move back and forth between resonance forms.

After reading Lesson 8.2, answer the following questions.

**The Octet Rule in Covalent Bonding**

1. What usually happens to the electron configuration of an atom when it forms a covalent bond?

2. Is the following sentence true or false? In a structural formula a shared pair of electrons is represented by two dashes. ________________

3. Structural formulas show the arrangement of ________________ in molecules.

4. Use the electron dot structure below. Circle each unshared pair of electrons in a water molecule.

   \[ \text{O} \quad \text{H} \quad \text{H} \]
5. Complete the electron dot structure for each molecule. Each molecule contains only single covalent bonds.

\[
\begin{align*}
\text{H} & \quad \text{H} & \quad \text{H} \\
\text{N} & \quad \text{H} & \quad \text{O} & \quad \text{O} & \quad \text{H} & \quad \text{C} & \quad \text{H} \\
\text{H} & \quad \text{H} & \quad \text{H} & \quad \text{H} \\
\end{align*}
\]

a. NH\(_3\)  

b. H\(_2\)O\(_2\)  

c. CH\(_4\)

6. A chemical bond formed when atoms share two pairs of electrons is called a(n) ____________________________.

7. How many covalent bonds are in a nitrogen molecule?

8. Is the following sentence true or false? All diatomic molecules contain double bonds.

\[\text{______________}\]

**Coordinate Covalent Bonds**

9. What is a coordinate covalent bond?

\[\text{______________}\]

10. Look at Table 8.2. Which nitrogen compounds contain coordinate covalent bonds?

\[\text{______________}\]

11. Complete the electron dot structure for the chlorate ion (ClO\(_3\)\(^-\)) by filling in the bonds and unpaired electrons.

\[
\begin{align*}
\text{O} & \quad \text{Cl} & \quad \text{O} \\
\text{O} & \\
\end{align*}
\]

**Exceptions to the Octet Rule**

12. Why does the NO\(_2\) molecule not follow the octet rule?

\[\text{______________}\]
**Bond Dissociation Energies**

13. What is bond dissociation energy?

14. Is the following sentence true or false? Molecules with high bond dissociation energies are relatively unreactive. ________________

15. What is the bond dissociation energy for a typical C — C covalent bond?

**Resonance**

16. The actual bonding in ozone is a ________________ of the extremes represented by its ________________.

17. When can resonance structures be written for a molecule?
