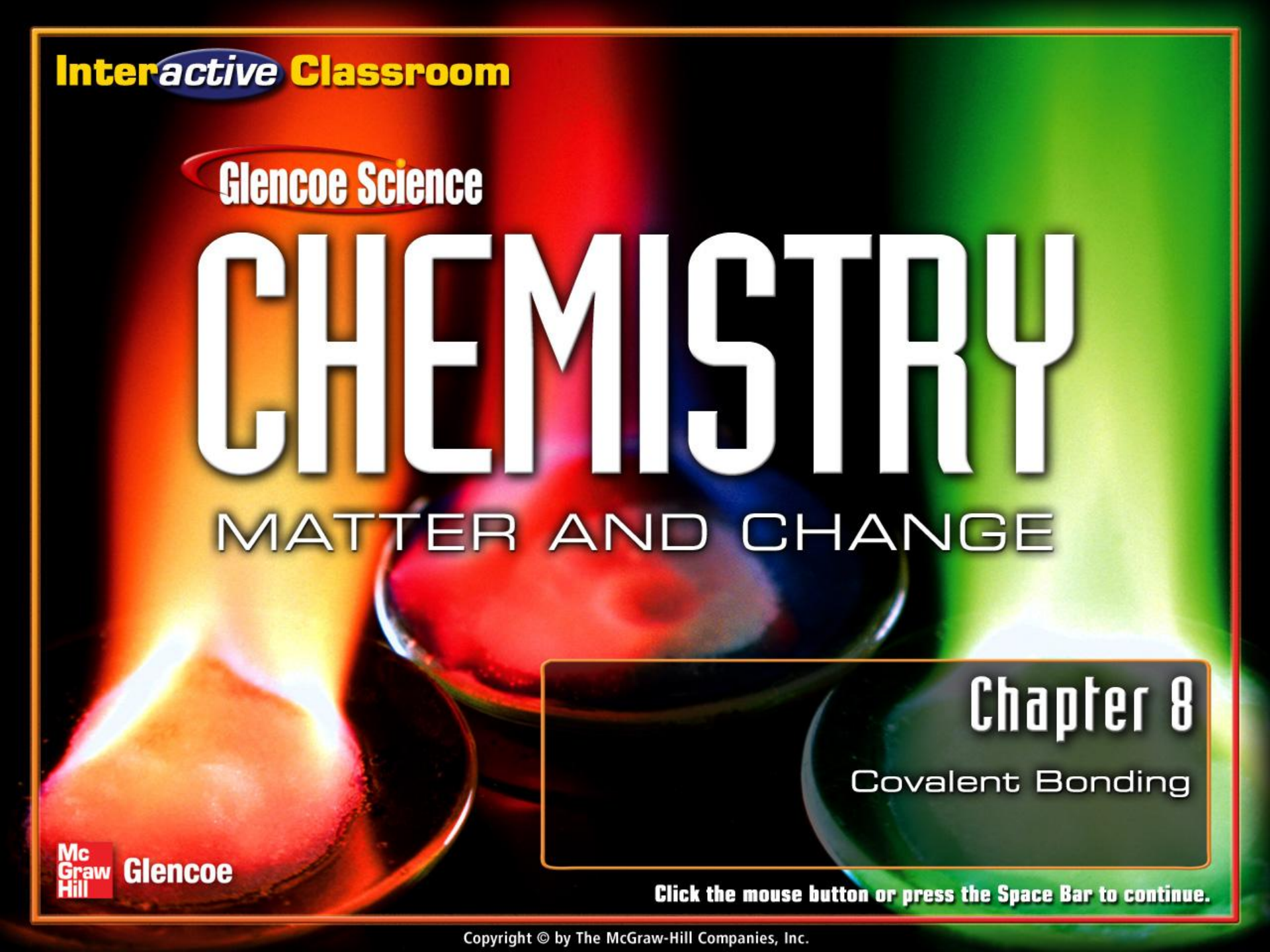


Section 8.1 The Covalent Bond

Objectives

- **Apply** the octet rule to atoms that form covalent bonds.
- **Describe** the formation of single, double, and triple covalent bonds.
- **Contrast** sigma and pi bonds.
- **Relate** the strength of a covalent bond to its bond length and bond dissociation energy.

Review Vocabulary

chemical bond: the force that holds two atoms together

Section 8.1 The Covalent Bond (cont.)

New Vocabulary

covalent bond

molecule

Lewis structure

sigma bond

pi bond

endothermic reaction

exothermic reaction

MAIN Idea **Atoms gain stability when they share electrons and form covalent bonds.**

Why do atoms bond?

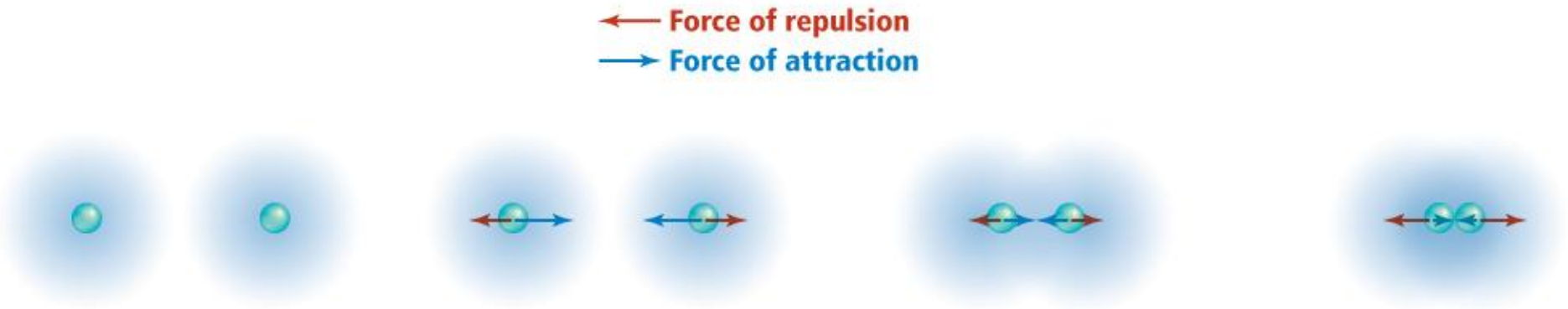
- Atoms gain stability when they share electrons and form covalent bonds.
- Lower energy states make an atom more stable.
- Gaining or losing electrons makes atoms more stable by forming ions with noble-gas electron configurations.
- Sharing valence electrons with other atoms also results in noble-gas electron configurations.

Why do atoms bond? (cont.)

- Atoms in non-ionic compounds share electrons.
- The chemical bond that results from sharing electrons is a **covalent bond**.
- A **molecule** is formed when two or more atoms bond.

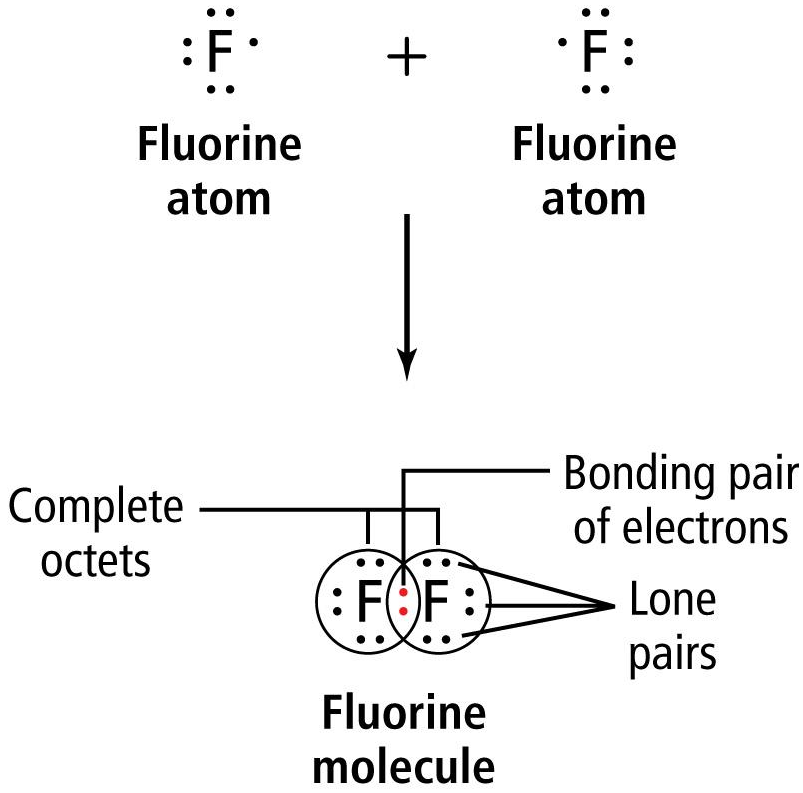
Why do atoms bond? (cont.)

- Diatomic molecules (H_2, F_2 for example) exist because two-atom molecules are more stable than single atoms.



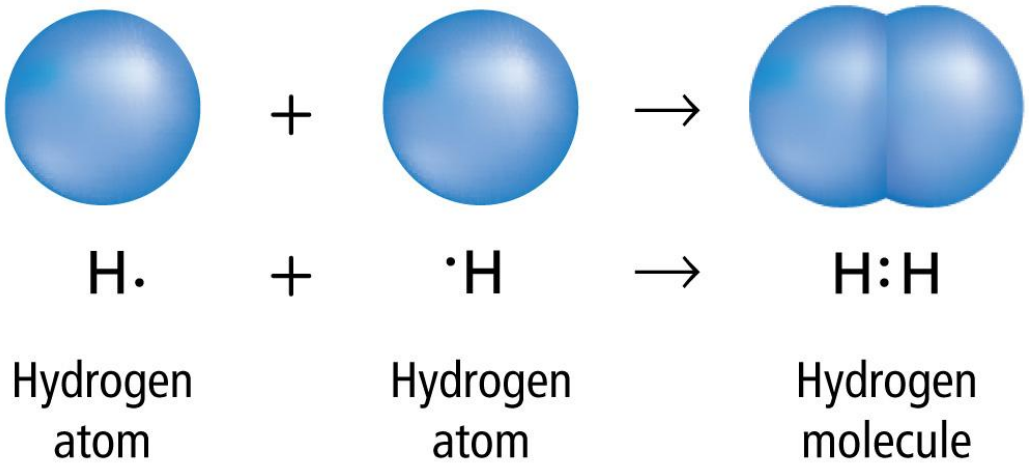
Why do atoms bond? (cont.)

- The most stable arrangement of atoms exists at the point of maximum net attraction, where the atoms bond covalently and form a molecule.



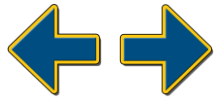
Single Covalent Bonds

- When only one pair of electrons is shared, the result is a single covalent bond.
- The figure shows two hydrogen atoms forming a hydrogen molecule with a single covalent bond, resulting in an electron configuration like helium.



Single Covalent Bonds (cont.)

- In a **Lewis structure** dots or a line are used to symbolize a single covalent bond.
- The halogens—the group 17 elements—have 7 valence electrons and form single covalent bonds with atoms of other non-metals.

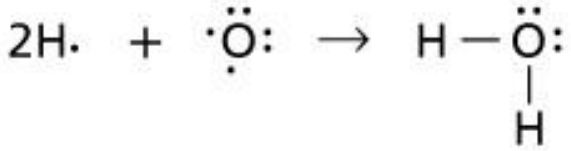


Single Covalent Bonds (cont.)

- Atoms in group 16 can share two electrons and form two covalent bonds.
- Water is formed from one oxygen with two hydrogen atoms covalently bonded to it .

Water

a



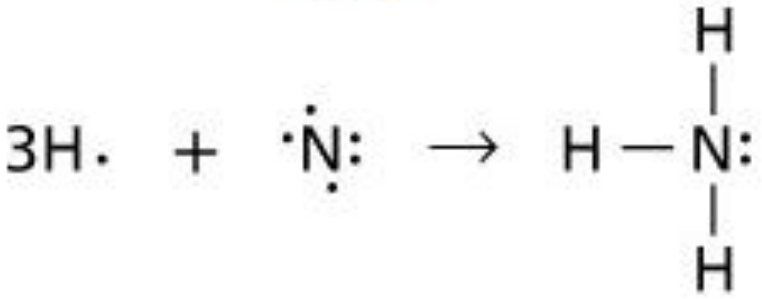
Two Single Covalent Bonds

Single Covalent Bonds (cont.)

- Atoms in group 15 form three single covalent bonds, such as in ammonia.

Ammonia

b

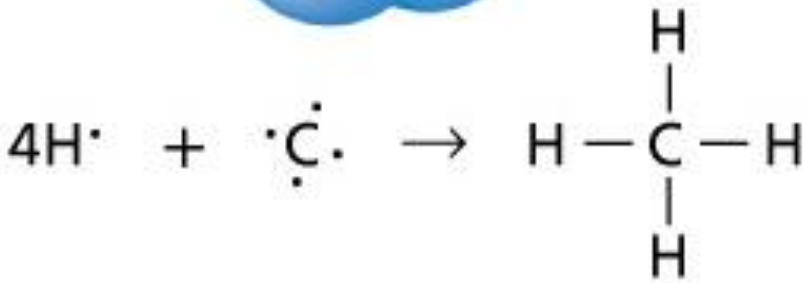


Three Single Covalent Bonds

Single Covalent Bonds (cont.)

- Atoms of group 14 elements form four single covalent bonds, such as in methane.

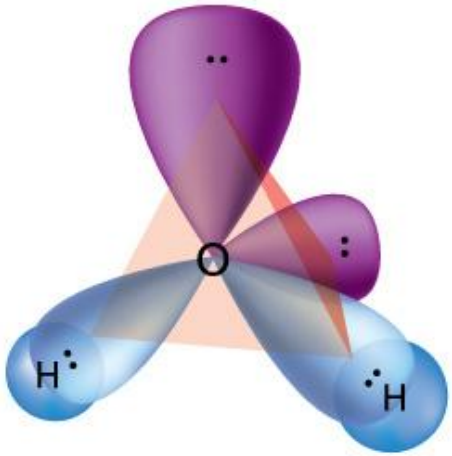
Methane



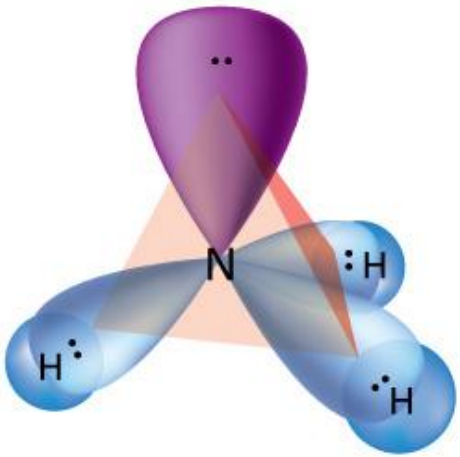
Four Single Covalent Bonds

Single Covalent Bonds (cont.)

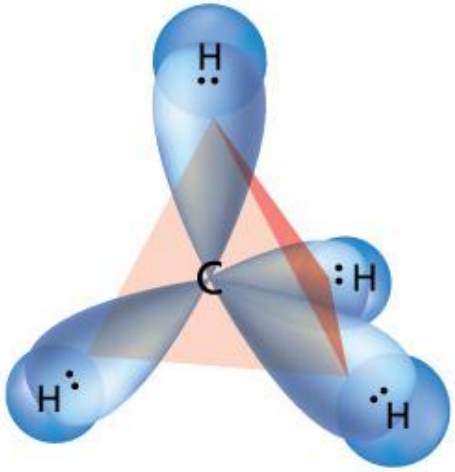
- **Sigma bonds** are single covalent bonds.
- Sigma bonds occur when the pair of shared electrons is in an area centered between the two atoms.



Water (H_2O)



Ammonia (NH_3)

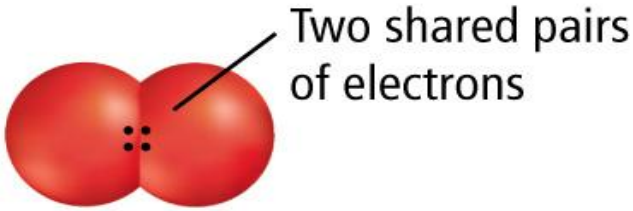


Methane (CH_4)

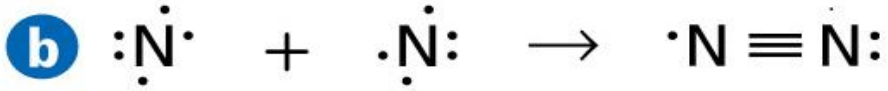
Multiple Covalent Bonds

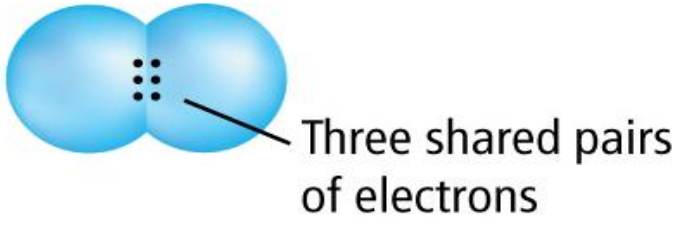
- Double bonds form when two pairs of electrons are shared between two

a 



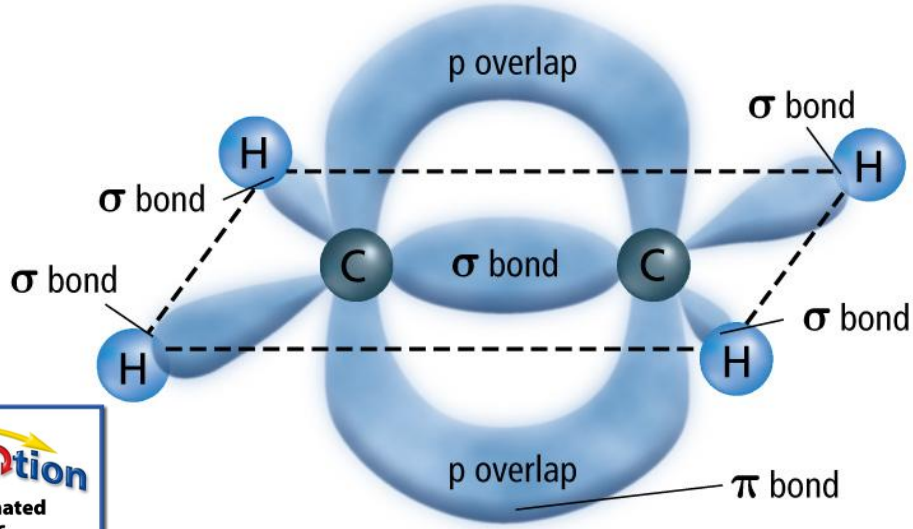
- Triple bonds form when three pairs of electrons are shared between two atoms.

b 

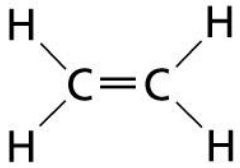


Multiple Covalent Bonds (cont.)

- A multiple covalent bond consists of one sigma bond and at least one pi bond.
- The **pi bond** is formed when parallel orbitals overlap and share electrons.



Ethene



Concepts In Motion
Click here to view an animated version of this graphic.

The Strength of Covalent Bonds

- The strength depends on the distance between the two nuclei, or bond length.
- As length increases, strength decreases.

Table 8.1 Covalent Bond Type and Bond Length

Molecule	Bond Type	Bond Length
F_2	single covalent	1.43×10^{-10} m
O_2	double covalent	1.21×10^{-10} m
N_2	triple covalent	1.10×10^{-10} m

The Strength of Covalent Bonds (cont.)

- The amount of energy required to break a bond is called the bond dissociation energy.
- The shorter the bond length, the greater the energy required to break it.

Table 8.2 Bond-Dissociation Energy

Molecule	Bond-Dissociation Energy
F_2	159 kJ/mol
O_2	498 kJ/mol
N_2	945 kJ/mol

The Strength of Covalent Bonds (cont.)

- An **endothermic reaction** is one where a greater amount of energy is required to break a bond in reactants than is released when the new bonds form in the products.
- An **exothermic reaction** is one where more energy is released than is required to break the bonds in the initial reactants.

Study Guide Section 8.1 The Covalent Bond

Key Concepts

- Covalent bonds form when atoms share one or more pairs of electrons.
- Sharing one pair, two pairs, and three pairs of electrons forms single, double, and triple covalent bonds, respectively.
- Orbitals overlap directly in sigma bonds. Parallel orbitals overlap in pi bonds. A single covalent bond is a sigma bond but multiple covalent bonds are made of both sigma and pi bonds.
- Bond length is measured nucleus-to-nucleus. Bond dissociation energy is needed to break a covalent bond.

Section 8.1 Assessment

CheckPoint

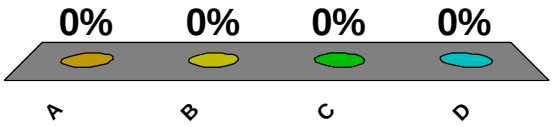
What does a triple bond consists of?

A. three sigma bonds

B. three pi bonds

C. two sigma bonds and one pi bond

D. two pi bonds and one sigma bond



Section 8.1 Assessment

CheckPoint

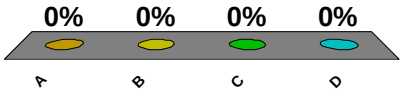
Covalent bonds are different from ionic bonds because:

A. atoms in a covalent bond lose electrons to another atom

B. atoms in a covalent bond do not have noble-gas electron configurations

C. atoms in a covalent bond share electrons with another atom

D. atoms in covalent bonds gain electrons from another atom



Chapter Assessment

CheckPoint

What type of bond results from two atoms sharing electrons?

A. hydrogen bond

B. covalent bond

C. ionic bond

D. dipole bond