

Chapter 7 Practice Worksheet: Covalent Bonds and Molecular Structure

1) How are ionic bonds and covalent bonds different?

Ionic bonds result from the transfer of electrons from one atom to another; Covalent bonds result from two atoms sharing electrons.

2) Describe the relationship between the length of a bond and the strength of that bond.

Strength of a bond increases as the bond gets shorter (inverse relationship)

3) Identify the type(s) of bond(s) found in the following molecules:

- a. CCl_4 covalent
- b. Li_2O ionic
- c. NF_3 covalent
- d. CaSO_4 ionic and covalent
- e. SO_2 covalent
- f. $\text{Mg}(\text{OH})_2$ ionic and covalent

4) Define electronegativity.

Electronegativity is the ability for an atom in a molecule to attract electrons to itself.

5) Use electronegativity values to place the following elements in **increasing** order: F, N, H, P, Si, C, O

$\text{Si} < \text{H} = \text{P} \approx \text{C} < \text{N} < \text{O} < \text{F}$

6) Determine if the bond between atoms in each example below is nonpolar covalent, polar covalent, or ionic.

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|------------------|--------------|-----------------|--------------|
| a. H_2 | <u>npc</u> | e. NF | <u>pc</u> |
| b. PCl | <u>pc</u> | f. MgO | <u>ionic</u> |
| c. F_2 | <u>npc</u> | g. CH | <u>npc</u> |
| d. NaBr | <u>ionic</u> | h. HCl | <u>pc</u> |

7) Draw Lewis Structures for the following molecules: (the descriptions below indicate the number and types of bonds on central atoms (first one listed except in H₂O; outer atoms have complete octets with lone pairs)

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|--|--|
| a. CO ₂ (double bonds from C to each O, no lone pairs) | j. NF ₃ (3 single bonds, 1 lone pair) |
| b. BeCl ₂ (single bond to each Cl, no lone pairs) | k. CO (triple bond, lone pair on C and O) |
| c. H ₂ O (single bond to O, 2 lone pairs on O) | l. O ₃ (1 single bond, 1 double bond, 1 lone pair) |
| d. BF ₃ (single bonds to F, no lone pairs) | m. CO ₃ ²⁻ (2 single bonds, 1 double bond) |
| e. CCl ₄ (single bonds to Cl, no lone pairs) | n. SO ₂ (1 single bond, 1 double bond, 1 lone pair) |
| f. NH ₃ (single bonds to H, 1 lone pair on N) | o. PF ₅ (5 single bonds, no lone pairs) |
| g. NO ₃ ⁻ (2 single bonds, 1 double bond, no lone pairs) | p. PCl ₅ (5 single bonds, no lone pairs) |
| h. SO ₃ (2 single bonds, 1 double bond, no lone pairs) | q. SF ₆ (6 single bonds, no lone pairs) |
| i. SO ₃ ²⁻ (3 single bonds, 1 lone pair) | r. TeF ₆ (6 single bonds, no lone pairs) |

8) Which of the above compounds (in number 7) require resonance structures to describe the structure properly? Draw them.

g, h, l, m, and n

9) Which of the above compounds (in number 7) are exceptions to the octet rule?

b, d, o, p, q, r

10) Fill in the table below to determine the molecular geometry for the following molecules:

Formula	ABE formula	Number of e ⁻ domains on central atom	# e ⁻ domains/ # non-bonding domains on central atom	Electron-Domain Geometry (name)	Molecular Geometry (name)	Bond angle(s) on central atom
CO ₂	AB ₂	2	2 / 0	Linear	Linear	180°
BeCl ₂	AB ₂	2	2 / 0	Linear	Linear	180°
H ₂ O	AB ₂ E ₂	4	2 / 2	Tetrahedral	Bent	<109.5°
BF ₃	AB ₃	3	3 / 0	Trigonal planar	Trigonal planar	120°
CCl ₄	AB ₄	4	4 / 0	Tetrahedral	Tetrahedral	109.5°
NH ₃	AB ₃ E ₁	4	3 / 1	Tetrahedral	Trigonal pyramidal	<109.5°
NO ₃ ⁻	AB ₃	3	3 / 0	Trigonal planar	Trigonal planar	120°
SO ₃	AB ₃	3	3 / 0	Trigonal planar	Trigonal planar	120°
SO ₃ ²⁻	AB ₃ E ₁	4	3 / 1	Tetrahedral	Trigonal pyramidal	<109.5°
NF ₃	AB ₃ E ₁	3	3 / 1	Tetrahedral	Trigonal pyramidal	<109.5°

Formula	ABE formula	Number of e ⁻ domains on central atom	# e ⁻ domains/ # non-bonding domains on central atom	Electron-Domain Geometry	Molecular Geometry (name)	Bond angle(s) on central atom
<u>CO</u>	AB ₁ E ₁	2	1 / 1	Linear	Linear	180°
O ₃	AB ₂ E ₁	3	2 / 1	Trigonal planar	Bent	<120°
CO ₃ ²⁻	AB ₃	3	3 / 0	Trigonal planar	Trigonal planar	120°
SO ₂	AB ₂ E ₁	3	2 / 1	Trigonal planar	Bent	<120°
PF ₅	AB ₅	5	5 / 0	Trigonal bipyramidal	Trigonal bipyramidal	120° and 90°
PCl ₅	AB ₅	5	5 / 0	Trigonal bipyramidal	Trigonal bipyramidal	120° and 90°
SF ₆	AB ₆	6	6 / 0	Octahedral	Octahedral	90°
TeF ₆	AB ₆	6	6 / 0	Octahedral	Octahedral	90°

11) a. Identify the molecules in the table above that are polar.

H₂O, NH₃, SO₃²⁻, NF₃, CO, O₃, SO₂

b. How many nonbonding pairs of electrons did the polar molecules have? 1 or 2

c. How many nonbonding pairs of electrons did the nonpolar molecules have? none

12) Give one example of a polar molecule that has nonpolar bonds. O₃

Give one example of a nonpolar molecule that has polar bonds. CCl₄

13) Indicate the hybridization of the **central atom**. Also indicate the **total number** of sigma (σ) and pi (π) bonds in the following molecules.

Formula	Hybridization of central atom	# of σ bonds	# of π bonds
CO ₂	sp	2	2
BeCl ₂	sp	2	0
H ₂ O	sp ³	2	0
BF ₃	sp ²	3	0
CCl ₄	sp ³	4	0
NH ₃	sp ³	3	0
NO ₃ ⁻	sp ²	3	1
SO ₃	sp ²	3	1
SO ₃ ²⁻	sp ³	3	0
NF ₃	sp ³	3	0
CO	sp	1	2
O ₃	sp ²	2	1
CO ₃ ²⁻	sp ²	3	1
SO ₂	sp ²	2	1
PF ₅	sp ³ d	5	0
PCl ₅	sp ³ d	5	0
SF ₆	sp ³ d ²	6	0
TeF ₆	sp ³ d ²	6	0