

Chapter 12 Review 1: Covalent Bonds and Molecular Structure

- 1) How are ionic bonds and covalent bonds different, and what types of elements combine to form each?

Ionic bonds result from the transfer of electrons from one atom to another (formed by a metal and a non-metal)

Covalent bonds result from two atoms sharing electrons (formed by 2 or more non-metals).

- 2) How are nonpolar covalent bonds different from covalent bonds, and what types of elements combine to form each?

polar – electrons are share unequally – between nonmetals with different electronegativities

nonpolar – electrons are shared equally – between multiple atoms of the same element

- 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, Si, C, O

$\text{Si} < \text{C} < \text{N} < \text{O} < \text{F}$

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

- | | | | |
|------------------|---------------|-----------------|---------------|
| a. H_2 | ___npc_____ | e. NF | ___pc_____ |
| b. PCl | ___pc_____ | f. MgO | ___ionic_____ |
| c. F_2 | ___npc_____ | g. CH | ___npc_____ |
| d. NaBr | ___ionic_____ | h. HCl | ___pc_____ |

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)

- | | |
|--|--|
| 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 on a separate sheet of paper. **g, h, l, m, and n**

9) Which of the above compounds are exceptions to the octet rule?
b, d, o, p, q, r

Name: KEY

Section: _____

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

CO	AB₁E₁	2	1 / 1	Linear	Linear	180°
O₃	AB₂E₁	3	2 / 1	Trigonal planar	Bent	<120°
CO₃²⁻	AB₃	3	3 / 0	Trigonal planar	Trigonal planar	120°
SO₂	AB₂E₁	3	2 / 1	Trigonal planar	Bent	<120°
PF₅	AB₅	5	5 / 0	Trigonal bipyramidal	Trigonal bipyramidal	120° and 90°
PCl₅	AB₅	5	5 / 0	Trigonal bipyramidal	Trigonal bipyramidal	120° and 90°
SF₆	AB₆	6	6 / 0	Octahedral	Octahedral	90°
TeF₆	AB₆	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.

Name: KEY

Section: _____

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