Chapter 6

Part B – Study Guide – Covalent Bonding – Answers

A. Covalent Bonds

1. A covalent bond is defined as a pair of electrons shared between two atoms.
2. In a triple bond between two atoms, the number of shared electrons is 6.
3. A bond in which 2 pairs of electrons are shared is called a double covalent bond.
4. In a single bond between two atoms, the number of shared pairs of electrons is 1.
5. A bond in which 3 pairs of electrons are shared is called a triple covalent bond.
6. In a triple bond between two atoms, the number of shared pairs of electrons is 3.
7. In a double bond between two atoms, the number of shared electrons is 4.
8. A bond in which 1 pair of electrons are shared is called a single covalent bond.
9. In a double bond between two atoms, the number of shared pairs of electrons is 2.
10. A bond in which 2 electrons are shared is called a single covalent bond.
11. In a single bond between two atoms, the number of shared electrons is 2.
12. What is the main difference between a covalent bond and an ionic bond? A covalent bond makes atoms stick together to form a molecule. An ionic bond is an attraction between charged particles.
13. What is the difference between an empirical formula and a molecular formula? A molecular formula describes the actual number of atoms in a molecule whereas an empirical formula represents the lowest whole number ration of atoms in a molecule or ionic compound.

B. Polarity

14. Rank the following bonded pairs from least polar to most polar.
    a. Cl-F #3
    b. B-F #6 (most)
    c. P-O #5
    d. N-Cl #2
    e. H-N #4
    f. O-O # 1 (least)
15. In order for a bond to be considered a polar bond the difference in electronegativity must be > 0.4 (over 2.0 it is considered strongly polar or ionic).
16. In order for a bond to be considered halfway between a polar bond and ionic bond the difference in electronegativity must be 1.7.
17. In order for a bond to be considered a non-polar bond the difference in electronegativity must be < 0.4
18. A true non-polar bond occurs between two atoms of the same species
19. What does the octet rule say? Atoms tend to gain, lose or share electrons in order to achieve a full valence shell.
20. How many electrons does hydrogen have when it has a complete octet? 2.
21. What are the three exceptions to the octet rule?
    Partial Octet (Boron or Beryllium for example)
    Expanded Octet (atoms of sublevel 3p or higher)
    Free Radicals (molecules with an odd number of electrons)

C. Lewis Structures

22. In a Lewis structure, there may be no more than 8 dots around an atomic symbol. (Unless it's an expanded octet.)
23. In the Lewis structure for N, there are 2 paired electrons (1 non-bonding pair) and 3 bonding sites.

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24. How many shared 6 (3 pairs) and unshared 2 (1 pair) electrons are present in the Lewis structure of NH_3?

25. How many shared pairs of electrons are present in CO_2? 4 pairs .

Draw Lewis dot diagrams for each of the following: (We can go over these in class if you like.)

26. NH_3
27. F^-
28. H_2O
29. SiO_2
30. C_2H_4
31. C_2H_2

D. Naming Substances

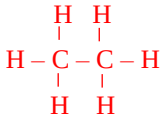
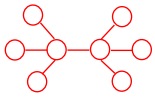
Next to each chemical name write the correct molecular formula for each of the following.

32. Diphosphorus tetrachloride P_2Cl_4
33. Nitrogen triiodide NI_3
34. Dinitrogen tetraoxide N_2O_4
35. Carbon tetrachloride CCl_4
36. Oxygen O_2

E. Valence Shell Electron Pair Repulsion

37. The VSEPR theory accounts for the shapes of molecules.

38. Fill in the following chart for C_2H_6.

Molecular Formula	Empirical Formula	Lewis Structure (Structural Formula)	Ball & Stick Model
C_2H_6	CH_3		

39. What is the primary benefit of a structural formula? It shows the number and type of bonds in a molecule.

40. How do a structural formula and a ball & stick model differ? A structural formula shows the number and type of bonds in an atom. A ball & stick model shows number and type of bonds as well as the arrangement of the atoms in space.

41. Which pairing represents the greatest valence electron pair repulsion? The least?

Least Greatest

Shared - Shared, Unshared – Unshared, Unshared – Shared

42. Fill in the following table: *(Fill in shared & unshared pairs for central atom only)*

Molecular Formula	Lewis Structure (Structural Formula)	Ball & Stick Model	Shape	Bond Angle	Shared Pairs	Unshared Pairs
H_2			Linear	N/A	1	N/A
CO_2			Linear	180°	4	0
NH_3			Trigonal Pyramidal	<109.5°	3	1
H_2O			Bent	<109.5°	2	2
BF_3			Trigonal Planar	120°	3	0

You're on your own for these.

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CCl_4			Tetrahedral	109.5°	4	0

43. Fill in the following table:

Shape	Bond Angle	Shared Pairs	Unshared Pairs
Trigonal Pyramidal	<109.5°	3	1
Trigonal Planar	120°	3	0
Linear	180°	2,3, or 4	0
Bent	<109.5°	2	2
Tetrahedral	109.5°	4	0
Bent*	<120°	2	1

* This isn't one of the basic five, but shows up on the chart in the notes.

44. When atoms with 2, 3, or 4 valence electrons form bonds, their orbitals undergo hybridization.
45. When orbitals combine there will always be only 1 's' orbital involved, but there may be as many as 3 'p' orbitals.
46. An sp^2 orbital results from the combination of one 's' orbital and two 'p' orbitals.
47. An sp^3 orbital occurs in molecules with a tetrahedral shape.
48. Which of the following bonded pairs would have the longest bond length: N-N N=N N≡N
49. Which of the following bonded pairs would have the shortest bond length: O-O O=O O≡O

F. Polarity

50. The attraction of atoms for electrons in a bond is called electronegativity.
51. When atoms share electrons equally, they form a non-polar bond.
52. When atoms share electrons unequally, they form a polar bond.
53. When electrons are distributed evenly within a molecule the molecule is non-polar.
54. When electrons are distributed unevenly within a molecule the molecule is polar.
55. The $\longrightarrow$ symbol points to the element with the highest electronegativity.
56. The longer the symbol $\longrightarrow$, the greater the difference in electronegativity between the atoms.
57. A polar molecule is also called a dipole.
58. In a polar molecule the atoms with the highest electronegativities attract / repel electrons?
59. The end of the molecule that attracts the electrons takes on a partial negative charge.
60. What accounts for the polarity of a bond? differences in electronegativity between atoms.
61. What accounts for the polarity of a molecule? polar bonds as well as a shape that distributes electrons unevenly.
62. How do the boiling points of polar molecules differ from the boiling points of non-polar molecules? Non-polar molecules have very low boiling points because they do not "stick together" well. Polar molecules stick together better because of their positive and negative ends so they have higher boiling points.
63. In simple molecules, the shape of the molecule affects its polarity.
64. In complex molecules, the shape of the molecule is affected by its polarity.
65. Draw ball & stick models of the five basic molecular shapes.

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Tetrahedron	Linear	Trigonal Pyramidal	Trigonal Planar	Bent