Unit 6 Exam and SLO Review

A. Properties of Ionic, Covalent, Metallic Bonds and Substances

Match the following **compounds** to the three bond types. Each answer may be used once, more than once, or not at all. If more than one bond possibly applies, indicate them.

C) Covalent Bond **I) Ionic Bond** **M) Metallic Bond**

I 1. KBr
M 2. Cu
C 3. CH_3OH
M 4. Pb
C 5. CH_4
I 6. $CaCl_2$
C 7. Br_2
I 8. Na_2O
C 9. SiO_2
M 10. brass (Cu + Zn)
I 11. ZnI_2
I, C 12. $AgNO_3$
I 13. NaCl
I, C 14. Na_2SO_4
C 15. C_3H_8

Match the following **statements** to the three bond types. Each answer may be used once, more than once, or not at all.

C) Covalent Bond **I) Ionic Bond** **M) Metallic Bond**

M 16. conducts electricity as a solid
I 17. alternating positive and negative particles
M, C 18. sharing valence electrons between atoms
M 19. stationary positive ions in a mobile "sea of electrons"
M 20. malleable, lustrous and ductile
I 21. conducts electricity when molten/dissolved in water
I 22. involves a transfer of valence electrons
I 23. Involves a large electronegativity difference
M 24. conducts electricity as a solid oops, Same as 16
I 25. brittle, rigid, high melting points, solid at room temp
C 26. soft, waxy, low melting points

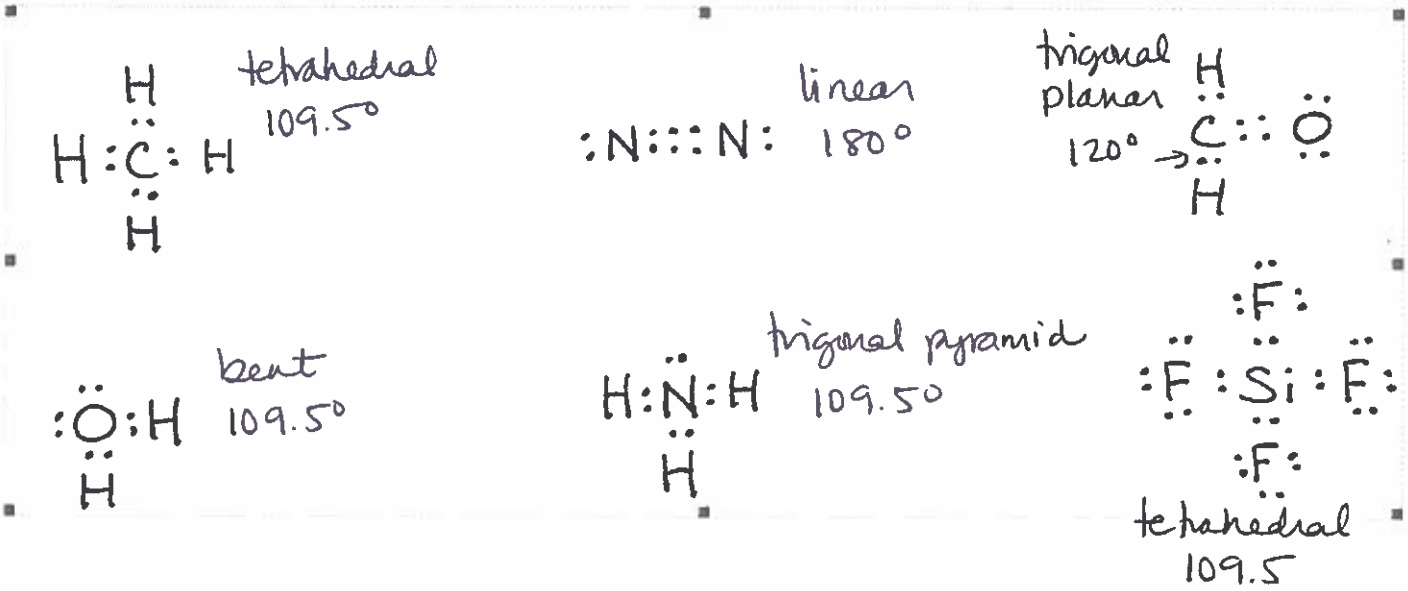
B. Nomenclature

The following random compounds need either names or formulas. Help them discover their identity!

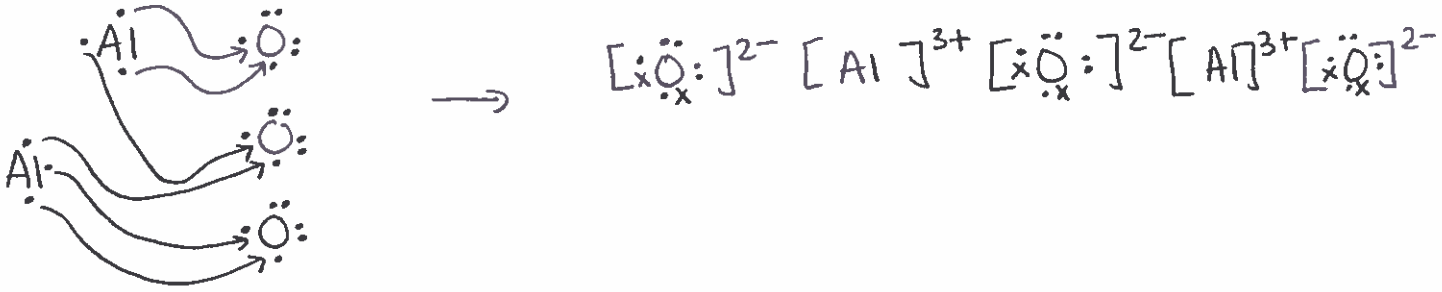
27. Cs_3P cesium phosphide
28. $SiCl_4$ silicon tetrachloride
29. lead (IV) chlorate $Pb(ClO_3)_4$
30. calcium nitrite $Ca(NO_2)_2$
31. stannous chloride $SnCl_2$
32. H_2CO_3 carbonic acid
33. sulfur trioxide SO_3 (not SO_3^{2-}!)
34. $Fe(NO_3)_2$ iron(II) nitrate or ferrous nitrate
35. $(NH_4)_2SO_4$ ammonium sulfate
36. hydrochloric acid HCl
37. mercury (II) oxalate ~~HgO~~ HgC_2O_4
38. sulfurous acid H_2SO_3
39. CO carbon monoxide
40. $Cu(ClO_4)_2 \cdot 6H_2O$ copper(II) or cupric perchlorate hexahydrate
41. B_2Br_4 diboron tetrabromide
42. selenium hexafluoride SeF_6
43. iron (III) chloride trihydrate $FeCl_3 \cdot 3H_2O$
44. N_2O_3 dinitrogen trioxide
45. $HC_2H_3O_2$ acetic acid

46. An ionic compound has the formula X_2O. Which group does X come from? Group 1A
so X could be any 1+ ion

57. Identify the molecular geometry and bond angle(s) for each molecule. Justify each answer.



58. Show all work, then draw the Lewis structure for aluminum oxide. Make sure to include all arrows necessary to show the full transfer of electrons.



D. Percent Composition and Empirical/Molecular Formula

59. Which compound has the higher percentage by mass of copper, copper (I) sulfate (Cu_2SO_4) or copper (II) sulfate ($CuSO_4$)? Support your answer with calculations.

$$\%\,Cu \text{ in } Cu_2SO_4 = \frac{2(63.546)}{223.154} \times 100\% = 56.952\%\ Cu$$

$$\%\ Cu \text{ in } CuSO_4 = \frac{63.546}{223.154} \times 100\% = 28.476\%\ Cu$$

$\therefore$ Cu_2SO_4 has the higher % of Cu

60. A compound has the empirical formula CH_2. The molar mass of the compound is 84 g/mol. What is the molecular formula of this compound?

Find "n"

$$n = \frac{84\ g/mol}{14.027\ g/mol}$$ → formula mass of CH_2

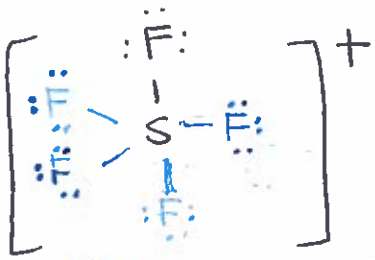
$n = 6$

thus the molecular formula is C_6H_{12}

C. Lewis Structures

Write the Lewis structure, molecular geometry, and bond angle(s) for each covalent compound or covalently bonded ion. Indicate resonance structures wherever appropriate.

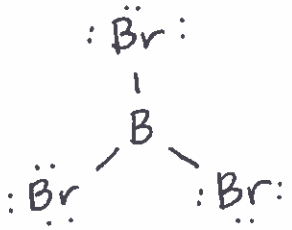
47. SF_5^+ 6+35−1 = 40



trigonal bipyramid

90°, 120°

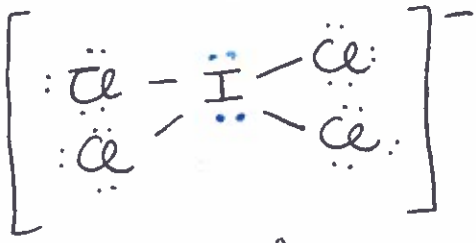
48. boron tribromide 3 + 21 = 24 e⁻



trigonal planar

120°

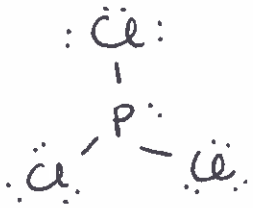
49. ICl_4^- 7+28+1 = 36 e⁻



square planar

90°

50. phosphorus trichloride 5+21 = 26 e⁻



trigonal pyramid

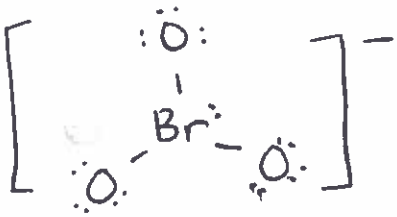
109.5°

51. N_3^- 15+1 = 16 e⁻

linear

180°

52. bromate ion BrO_3^- 7+18+1 = 26 e⁻



trigonal pyramidal

109.5°

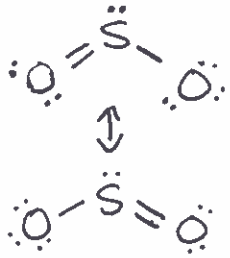
53. xenon difluoride XeF_2 22e⁻

linear

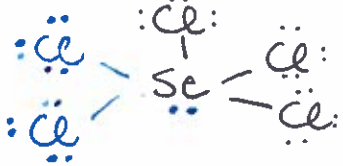
180°

54. sulfur dioxide SO_2 18e⁻

bent 120°



55. selenium pentachloride $SeCl_5^-$ (−1 ion) 6+1+35 = 42 e⁻

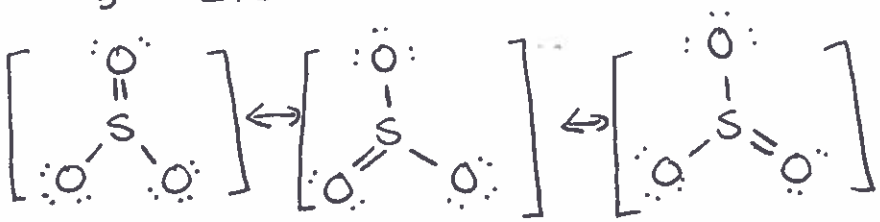


square pyramid

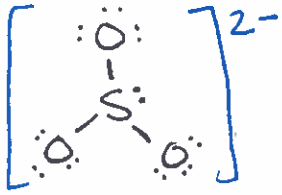
90°, 180°

56. Which molecule has shorter sulfur to oxygen bonds, SO_3 or SO_3^{2-}? Draw a Lewis structure for each ion and use them to support your conclusion.

SO_3 = 24 e⁻



SO_3^{2-} = 26 e⁻



SO_3 has (overall) shorter S–O bonds due to the double bond appearing in the resonance structures. Double bonds (2 pairs of binding electrons) are shorter than single bonds. SO_3^{2-} only has single bonds, which are longer/weaker (1 pair of e⁻)

Assume 100g of compound

62. Caffeine contains 49.5% carbon, 5.15% hydrogen, 28.9% nitrogen, and 16.5% oxygen by mass. Its molar mass is 195 g/mol. What are the empirical and molecular formulas of caffeine?

$\frac{49.5\text{ g C}}{12.011\text{ g}} \left|\frac{1\text{ mole C}}{}\right. = 4.12\text{ moles C} / 1.03 = 4$

$\frac{5.15\text{ g H}}{1.008\text{ g}} \left|\frac{1\text{ mol}}{}\right. = 5.11\text{ moles H} / 1.03 = 5$

$\frac{28.9\text{ g N}}{14.007\text{ g}} \left|\frac{1\text{ mol}}{}\right. = 2.06\text{ moles N} / 1.03 = 2$

$\frac{16.5\text{ g O}}{15.999\text{ g}} \left|\frac{1\text{ mol}}{}\right. = 1.03\text{ moles O} / 1.03 = 1$

$\therefore$ emp. formula = $C_4H_5N_2O$

molecular formula

$n = \frac{195\text{ g/mol}}{97.097} = 2$

$\therefore$ mol. formula = $C_8H_{10}N_4O_2$

63. In an experiment similar to the one you did in class, a student attempted to determine the empirical formula of an iron oxide. Here is their lab data:

Mass of crucible and lid (g)	15.765 g
Mass of crucible, lid, and iron (g)	16.120 g
Mass of crucible, lid, and iron oxide (g)	16.269 g

Fe_xO_y

a) Use the data to calculate the empirical formula of the iron oxide compound.

mass of iron = 16.120g − 15.765g = .355g Fe

mass of oxygen = 16.269g − 16.120g = .149g O

$\frac{.355\text{ g Fe}}{55.845\text{ g}} \left|\frac{1\text{ mole}}{}\right. = .00636\text{ moles} / .00636 = 1 \times 2 = 2$

$\frac{.149\text{ g O}}{15.999\text{ g}} \left|\frac{1\text{ mol}}{}\right. = .00931\text{ moles} / .00636 = 1.46 \times 2 = 3$

$\therefore$ empirical formula is Fe_2O_3

b) What would each of these errors do to the percent yield of the compound – make it too large or too small? Why?

i. Incomplete reaction (Not all of the iron reacts) of the iron oxide compound. % yield too high

The iron that does not react with oxygen adds to the mass of the iron oxide compound that is recorded, making your actual yield too high and thus your % yield too high.

ii. The iron spatters out of the crucible while it is being heated. % yield too low

Less iron undergoes the reaction, leading to less mass of product actually formed.