

Chapter 3 has concepts crossing Big Ideas 1, 2, and 3 in the AP Chemistry curriculum. These concepts are foundational to all the other big ideas. Naming compounds, balancing equations, and the mathematical routines to use data to determine formulas are important to have mastered. Differentiating between the different types of compounds by name or by formula will be imperative to success in later chapters and on the AP Chemistry exam. Applications of concepts addressed in the cross domains of the AP science practices are also included in this reading guide.

3.1 Hydrogen, Oxygen, and Water

1. What are the three properties of hydrogen gas? Classify each property as chemical or physical.
 - a.
 - b.
 - c.
2. What are the three properties of oxygen gas? Classify each property as chemical or physical.
 - a.
 - b.
 - c.
3. Explain how the properties of the components of water (hydrogen and oxygen) differ from the properties of water.
4. In the reaction of sodium metal with chlorine gas to form sodium chloride, how does sodium form a cation? Write an equation to support your answer.
5. In the reaction of sodium metal with chlorine gas to form sodium chloride, how does chlorine form an anion? Write an equation to support your answer.
6. Using figure 3.2 in your textbook, make two observations about sodium, two observations about chlorine, and two observations about sodium chloride.
7. Why aren't the properties of sodium chloride the same as the elements it is composed of?

3.2 Chemical Bonds

8. What two basic components of atoms are responsible for chemical bonding?
9. Name the two main types of chemical bonds.
10. Usually ionic bonds are formed between what types of elements?
11. Generally speaking, what makes a bond ionic in nature? How do the components you named in your response to question #8 explain what is happening?
12. Covalent bonds are formed between what general class of elements?
13. What makes a bond covalent? How do the components you named in your response to question #8 explain what is happening?
14. Explain which types of elements form the anion and the cation in an ionic bond.
15. What holds an ionic bond together?
16. Explain what an ionic lattice is. Include a diagram in your answer.
17. Draw a diagram showing how the constituent elements, Na and Cl₂, combine to form NaCl.
18. What happens to the potential energy of an electron when it is shared in a covalent bond? Why?
19. Explain what a molecule is.
 - a. Identify an element consisting of molecules.
 - b. Identify a compound consisting of molecules.

20. Explain why covalently bonded compounds are called molecular compounds. Provide two examples.

3.3 Representing Compounds: Chemical Formulas and Molecular Models

21. Explain how the formulas for H_2O and NaCl provide different information about the composition of these two compounds.

22. Using an example, explain the differences between a structural formula, an empirical formula, and a molecular formula.

23. In a structural formula, how are single bonds and double bonds depicted? What does each represent?

24. Select a compound and explain the advantages and disadvantages of using ball-and-stick molecular models, space-filling molecular models, and Lewis structures to represent a compound. Make a table to support your answer.

3.4 An Atomic-Level View of Elements and Compounds

25. Explain the difference between atomic elements and molecular elements.

26. Identify and write the formulas of the diatomic elements and polyatomic elements.

27. Explain the difference between molecular compounds and ionic compounds.

28. Explain why ionic compounds are not called molecules.

29. What is a formula unit and when is the term useful?
30. What is a polyatomic ion? Give an example of one polyatomic cation and one polyatomic anion. Show how these two ions combine to form a compound.

3.5 Ionic Compounds: Formulas and Names

31. Why are ionic compounds generally stable?
32. Summarize the three parts of writing an ionic formula. Include examples.
- a.
 - b.
 - c.
33. What is the difference between a common name and a systematic name? Why do chemists prefer the use of the systematic name over the common name?
34. What is a binary compound?
35. Select a binary compound and explain the necessary steps to name it as an ionic binary compound.
36. Explain the basic format and the steps needed to name an ionic compound composed of a cation that has a possibility of existing in more than one oxidation state.
37. Select two compounds and explain when Roman numerals are used in the name of an ionic compound and when Roman numerals are not used.
38. How are ionic compounds with polyatomic ions named?

39. What are oxyanions? Choose two oxyanions and list their chemical formulas and names.

40. Fill in the following chart for oxyanions formed by bromine and oxygen atoms

Ionic Ending	Per_____ate	_____ate	_____ite	Hypo_____ite
Formula		Bromate BrO_3^-		
# of oxygens compared to the -ate ending		same		

41. What are hydrates and how are waters of hydration indicated in a formula?

42. Fill in the following chart on the prefixes used in naming to identify the number of waters in a hydrate

1/2	1	2	3	4	5	6	7	8	9

3.6 Molecular Compounds: Formulas and Names

43. What is the basic format used in naming a binary molecular compound?

44. Fill in the following table with the prefixes used in molecular compound naming:

1	2	3	4	5	6	7	8	9	10

45. Use the compounds CO and CO_2 to explain the rules for naming a molecular compound.

46. What does (aq) mean in the formula of a substance?

47. What are acids?

48. What are three characteristics of acids?

a.

b.

c.

49. What are the two main types of acids?

a.

b.

50. What is the basic format for writing the name of a binary acid?

51. What is the basic format used for writing the names of the two types of oxyacids?

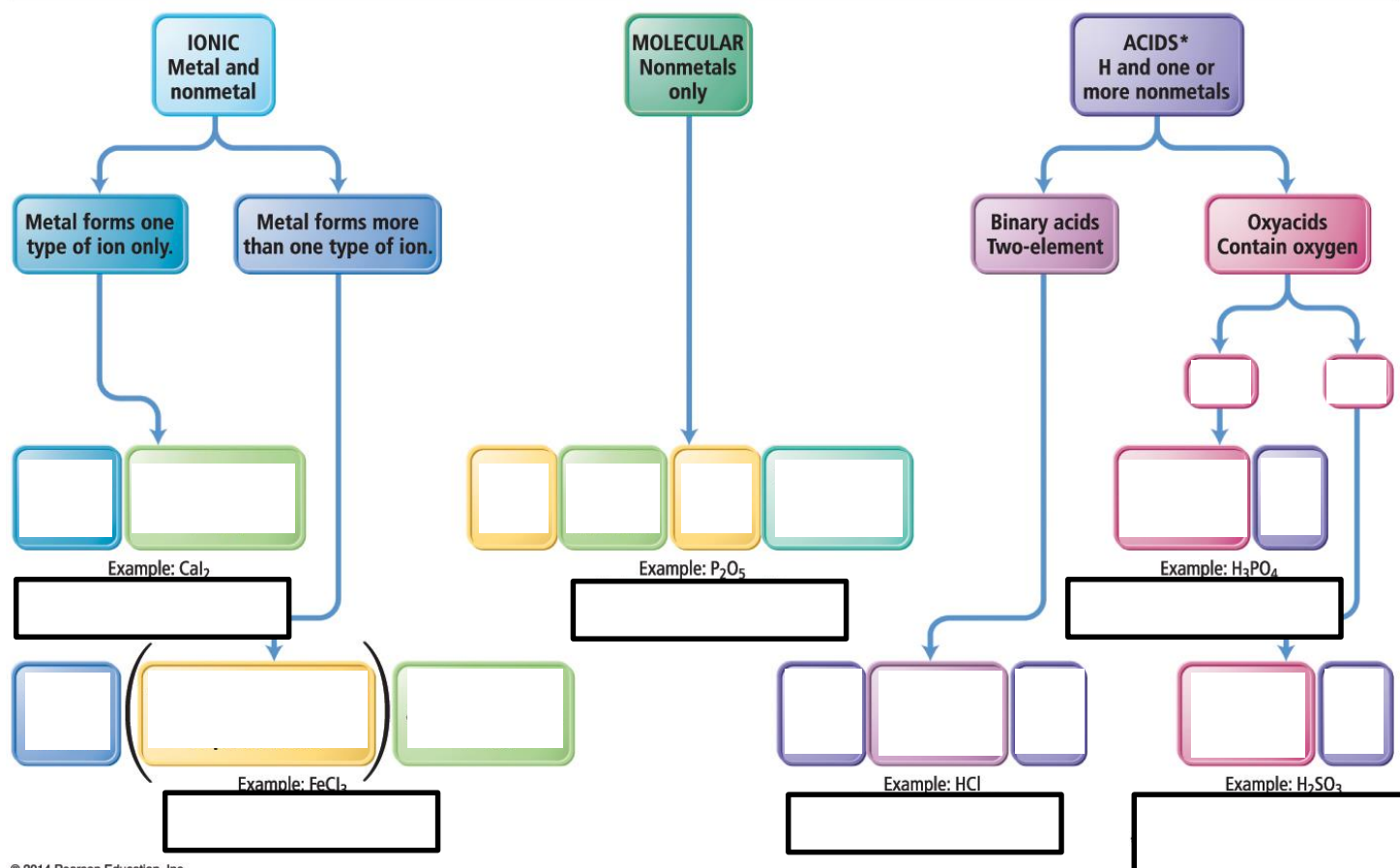
52. What is acid rain? Identify three environmental problems it can cause.

- a.
- b.
- c.

3.7 Summary of Inorganic Nomenclature

53. Fill in the following chart summarizing how to name inorganic compounds.

Inorganic Nomenclature Flow Chart



54. How do you decide which part of the flowchart to use for naming?

55. Explain how to use the flowchart to name CuCl_2 , CO , and H_2CO_3 .

3.8 Formula Mass and the Mole Concept for Compounds

56. Explain how to calculate the molar mass of a compound.

57. Show how to calculate the molar mass of HClO_4 .

58. How is a molar mass different from atomic mass?

59. How can the molar mass and number of grams present in a sample be used to determine the number of species present in the sample?

60. Calculate the following. Be sure to show all your work and label all quantities with the correct units and explain how you obtained your answers.

a. How many molecules of CO_2 are contained in a sample of 43.5 g of CO_2 ?

b. How many oxygen atoms and carbon atoms are present in the sample?

3.9 Composition of Molecules

61. What is mass percent?

62. Explain how to calculate mass percent of species A in the compound A_2B .

63. Calculate the mass percent of hydrogen in water. Show all work.

64. Explain how to use mass percent as a conversion factor.

65. How are chemical formulas used as conversion factors?

66. Show how to calculate the empirical formula of a compound using 42.88% C and 57.12% O.

3.10 Determining a Chemical Formula from Experimental Data

67. Explain the steps to determine an empirical formula from mass percent composition.

68. Why does the calculation described in question #67 provide the empirical formula and not the molecular formula?

69. Fill in the chart below indicating the multiplier to use to find the whole-number subscripts for an empirical formula from the fractional subscripts the experimental data might provide. Explain how these multipliers are used.

Fractional Subscript	0.20	0.25	0.33	0.40	0.50	0.66	0.75	0.80
Multiplier					2			

70. What specific quantity is needed to be able to change an empirical formula to a molecular formula?

71. Explain how to calculate the molecular formula from the empirical formula.

72. Explain the concept of combustion analysis for a hydrocarbon compound.

73. If the combustion of a hydrocarbon forms 1.60 g of carbon dioxide and 0.819 g of water, write out a conceptual plan and indicate the relationships needed to calculate the empirical formula of the hydrocarbon.

3.11 Writing and Balancing Chemical Equations

74. What are chemical reactions?

75. How are chemical reactions represented by using chemical formulas?
76. Where are the reactants found in a chemical reaction?
77. Where are the products found in a chemical reaction?
78. What separates reactants and products in a chemical reaction?
79. What is the difference between a reactant and a product?
80. Explain what is meant by a balanced chemical equation.
81. Explain how you can check that a chemical equation is balanced.
82. Explain how to balance the following chemical reaction, which represents the decomposition of hydrazine. $\text{N}_2\text{H}_4(\text{l}) \rightarrow \text{NH}_3(\text{g}) + \text{N}_2(\text{g})$.
83. Explain the difference between a coefficient and a subscript in a chemical equation.
84. How are the states of matter indicated in a chemical reaction?

3.12 Organic Compounds

85. What are organic compounds and how has this definition changed over time?
86. Give two reasons why carbon chemistry is unique.
- a.
 - b.
87. What are hydrocarbons?
88. Explain the differences among an alkane, alkene, and alkyne. Refer to table 3.7 in your book for examples.

89. Fill in the following chart for the prefixes used in organic naming.

# Carbons	1	2	3	4	5	6	7	8	9	10
Prefix										

90. What is an organic chemistry functional group?

91. What functional group must be present in an alcohol? Draw methanol and circle the functional group.

92. Fill in the following chart on organic functional groups:

Family	Alcohol	Carboxylic Acid	Ketones	Esters	Ethers	Aldehydes	Amines
General Formula							
Name ending							
Example							

93. What does the R stand for in the general formulas found in the chart in question #92?

Self-Assessment Answers

- | | | | | |
|----------|----------|----------|-----------|-----------|
| 1. _____ | 4. _____ | 7. _____ | 10. _____ | 13. _____ |
| 2. _____ | 5. _____ | 8. _____ | 11. _____ | 14. _____ |
| 3. _____ | 6. _____ | 9. _____ | 12. _____ | 15. _____ |

