CHAPTER 7 REVIEW

Chemical Formulas and Chemical Compounds

SECTION 1

SHORT ANSWER Answer the following questions in the space provided.

1. __c__ In a Stock system name such as iron(III) sulfate, the Roman numeral tells us

   (a) how many atoms of Fe are in one formula unit.
   (b) how many sulfate ions can be attached to the iron atom.
   (c) the charge on each Fe ion.
   (d) the total positive charge of the formula unit.

2. __c__ Changing a subscript in a correctly written chemical formula

   (a) changes the number of moles represented by the formula.
   (b) changes the charges on the other ions in the compound.
   (c) changes the formula so that it no longer represents the compound it previously represented.
   (d) has no effect on the formula.

3. The explosive TNT has the molecular formula $C_7H_5(NO_2)_3$.

   ____4 elements____ a. How many elements make up this compound?

   ____6 oxygen atoms____ b. How many oxygen atoms are present in one molecule of $C_7H_5(NO_2)_3$?

   ____21 atoms____ c. How many atoms in total are present in one molecule of $C_7H_5(NO_2)_3$?

   ____4.2×10^{24} atoms____ d. How many atoms are present in a sample of 2.0×10^{23} molecules of $C_7H_5(NO_2)_3$?

4. How many atoms are present in each of these formula units?

   ____11 atoms____ a. $Ca(HCO_3)_2$

   ____45 atoms____ b. $C_{12}H_{22}O_{11}$

   ____10 atoms____ c. $Fe(ClO_2)_3$

   ____9 atoms____ d. $Fe(ClO_3)_2$

5. ____N_2O_5____ a. What is the formula for the compound dinitrogen pentoxide?

   ____iron(II) oxide____ b. What is the Stock system name for the compound FeO?

   ____H_2SO_3____ c. What is the formula for sulfurous acid?

   ____phosphoric acid____ d. What is the name for the acid H_3PO_4?

6. Some binary compounds are ionic, others are covalent. The type of bond favored partially depends on the position of the elements in the periodic table. Label each of these claims as True or False; if False, specify the nature of the error.

a. Covalently bonded binary molecular compounds are typically composed of nonmetals.

True

b. Binary ionic compounds are composed of metals and nonmetals, typically from opposite sides of the periodic table.

True

7. Refer to **Table 2** on page 226 of the text and **Table 5** on page 230 of the text for examples of names and formulas for polyatomic ions and acids.

a. Derive a generalization for determining whether an acid name will end in the suffix -*ic* or -*ous*.

In general, if the anion name ends in -*ate*, the corresponding acid name will end in a

suffix of -*ic*. In general, if the anion name ends in -*ite*, the corresponding acid name

will end in a suffix of -*ous*.

b. Derive a generalization for determining whether an acid name will begin with the prefix *hydro-* or not.

In general, if the anion name ends in -*ide*, the corresponding acid name will end in a

suffix of -*ic* and begin with a prefix of *hydro-*. The prefix *hydro-* is never used for

anions ending in -*ate* or -*ite*.

8. Fill in the blanks in the table below.

Compound name	Formula
Aluminum sulfide	Al_2S_3
Cesium carbonate	Cs_2CO_3
Lead(II) chloride	$PbCl_2$
Ammonium phosphate	$(NH_4)_3PO_4$
Hydroiodic acid	**HI**

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SECTION 2

SHORT ANSWER   Answer the following questions in the space provided.

1. Assign the oxidation number to the specified element in each of the following examples:

<u>+4</u>   **a.** S in H_2SO_3

<u>+6</u>   **b.** S in $MgSO_4$

<u>−2</u>   **c.** S in K_2S

<u>+1</u>   **d.** Cu in Cu_2S

<u>+6</u>   **e.** Cr in Na_2CrO_4

<u>+5</u>   **f.** N in HNO_3

<u>+4</u>   **g.** C in $(HCO_3)^-$

<u>−3</u>   **h.** N in $(NH_4)^+$

2. <u>SCl₂</u>   **a.** What is the formula for the compound sulfur(II) chloride?

<u>nitrogen(IV) oxide</u>   **b.** What is the Stock system name for NO_2?

3. <u>fluorine</u>   **a.** Use electronegativity values to determine the one element that always has a negative oxidation number when it appears in any binary compound.

<u>0; F₂</u>   **b.** What is the oxidation number and formula for the element described in part **a** when it exists as a pure element?

4. Tin has possible oxidation numbers of $+2$ and $+4$ and forms two known oxides. One of them has the formula SnO_2.

<u>tin(IV) oxide</u>   **a.** Give the Stock system name for SnO_2.

<u>SnO</u>   **b.** Give the formula for the other oxide of tin.

5. Scientists think that two separate reactions contribute to the depletion of the ozone, O_3, layer. The first reaction involves oxides of nitrogen. The second involves free chlorine atoms. The equations that represent the reactions follow. When a compound is not stated as a formula, write the correct formula in the blank beside its name.

a. <u>NO</u> (nitrogen monoxide) + O_3 → <u>NO₂</u> (nitrogen dioxide) + O_2

SECTION 2 continued

  b. $Cl + O_3 \rightarrow$ __**ClO**__ (chlorine monoxide) $+ O_2$
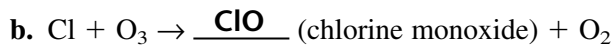
6. Consider the covalent compound dinitrogen trioxide when answering the following:

  _____**N_2O_3**_____ **a.** What is the formula for dinitrogen trioxide?

  _____**+3**_____ **b.** What is the oxidation number assigned to each nitrogen atom in this compound? Explain your answer.

  The three oxygen atoms have oxidation states of −6 total, and because the algebraic

  sum of the oxidation states in a neutral compound must be zero, the two nitrogen

  atoms must have oxidation states of +6 total, therefore +3 each.

  __**nitrogen(III) oxide**__ **c.** Give the Stock name for dinitrogen trioxide.

7. The oxidation numbers assigned to the atoms in some organic compounds have unexpected values. Assign oxidation numbers to each atom in the following compounds: (Note: Some oxidation numbers may not be whole numbers.)

  a. CO_2

  Carbon is +4 and each oxygen is −2.

  b. CH_4 (methane)

  Carbon is −4 and each hydrogen is +1.

  c. $C_6H_{12}O_6$ (glucose)

  Each carbon is 0, each hydrogen is +1, and each oxygen is −2.

  d. C_3H_8 (propane gas)

  Each carbon is −8/3 and each hydrogen is +1.

8. Assign oxidation numbers to each element in the compounds found in the following situations:

  a. Rust, Fe_2O_3, forms on an old nail.

  Each iron is +3 and each oxygen is −2.

  b. Nitrogen dioxide, NO_2, pollutes the air as a component of smog.

  Nitrogen is +4 and each oxygen is −2.

  c. Chromium dioxide, CrO_2, is used to make recording tapes.

  Chromium is +4 and each oxygen is −2.

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Chemical Formulas and Chemical Compounds

SECTION 3

SHORT ANSWER   Answer the following questions in the space provided.

1. Label each of the following statements as True or False:

_____**True**_____ **a.** If the formula mass of one molecule is x amu, the molar mass is x g/mol.

_____**False**_____ **b.** Samples of equal numbers of moles of two different chemicals must have equal masses as well.

_____**True**_____ **c.** Samples of equal numbers of moles of two different molecular compounds must have equal numbers of molecules as well.

2. How many moles of each element are present in a 10.0 mol sample of $Ca(NO_3)_2$?

10 mol of calcium, 20 mol of nitrogen, 60 mol of oxygen

PROBLEMS   Write the answer on the line to the left. Show all your work in the space provided.

3. Consider a sample of 10.0 g of the gaseous hydrocarbon C_3H_4 to answer the following questions.

_____**0.250 mol**_____ **a.** How many moles are present in this sample?

_____**1.50 × 10²³ molecules**_____ **b.** How many molecules are present in the C_3H_4 sample?

_____**4.51 × 10²³ carbon atoms**_____ **c.** How many carbon atoms are present in this sample?

SECTION 3 continued

___**10.1%**___ **d.** What is the percentage composition of hydrogen in the sample?

4. One source of aluminum metal is alumina, Al_2O_3.

___**52.9%**___ **a.** Determine the percentage composition of Al in alumina.

___**2100 lb**___ **b.** How many pounds of aluminum can be extracted from 2.0 tons of alumina?

5. Compound A has a molar mass of 20 g/mol, and compound B has a molar mass of 30 g/mol.

___**20 g**___ **a.** What is the mass of 1.0 mol of compound A, in grams?

___**0.17 mol**___ **b.** How many moles are present in 5.0 g of compound B?

___**4.0 mol**___ **c.** How many moles of compound B are needed to have the same mass as 6.0 mol of compound A?

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Chemical Formulas and Chemical Compounds

SECTION 4

SHORT ANSWER   Answer the following questions in the space provided.

1. Write empirical formulas to match the following molecular formulas:

   _____ CH_3O_2 _____ **a.** $C_2H_6O_4$

   _____ N_2O_5 _____ **b.** N_2O_5

   _____ $HgCl$ _____ **c.** Hg_2Cl_2

   _____ CH_2 _____ **d.** C_6H_{12}

2. _____ C_4H_8 _____ A certain hydrocarbon has an empirical formula of CH_2 and a molar mass of 56.12 g/mol. What is its molecular formula?

3. A certain ionic compound is found to contain 0.012 mol of sodium, 0.012 mol of sulfur, and 0.018 mol of oxygen.

   _____ $Na_2S_2O_3$ _____ **a.** What is its empirical formula?

   _____ neither _____ **b.** Is this compound a sulfate, sulfite, or neither?

PROBLEMS   Write the answer on the line to the left. Show all your work in the space provided.

4. Water of hydration was discussed in **Sample Problem K** on pages 243–244 of the text. Strong heating will drive off the water as a vapor in hydrated copper(II) sulfate. Use the data table below to answer the following:

Mass of the empty crucible	4.00 g
Mass of the crucible plus hydrate sample	4.50 g
Mass of the system after heating	4.32 g
Mass of the system after a second heating	4.32 g

   _____ 36% _____ **a.** Determine the mass percentage of water in the original sample.

SECTION 4 continued

_____5_____ **b.** The compound has the formula $CuSO_4 \cdot xH_2O$. Determine the value of x.

c. What might be the purpose of the second heating?

The second heating is to ensure that all the water in the sample has been driven off.

If the mass is less after the second heating, water was still present after the first

heating.

5. Gas X is found to be 24.0% carbon and 76.0% fluorine by mass.

_____CF_2_____ **a.** Determine the empirical formula of gas X.

_____C_4F_8_____ **b.** Given that the molar mass of gas X is 200.04 g/mol, determine its molecular formula.

6. A compound is found to contain 43.2% copper, 24.1% chlorine, and 32.7% oxygen by mass.

_____$CuClO_3$_____ **a.** Determine its empirical formula.

b. What is the correct Stock system name of the compound in part **a**?

copper(I) chlorate

CHAPTER 7 REVIEW

Chemical Formulas and Chemical Compounds

MIXED REVIEW

SHORT ANSWER   Answer the following questions in the space provided.

1. Write formulas for the following compounds:

_____ $CuCO_3$ _____ **a.** copper(II) carbonate

_____ Na_2SO_3 _____ **b.** sodium sulfite

_____ $(NH_4)_3PO_4$ _____ **c.** ammonium phosphate

_____ SnS_2 _____ **d.** tin(IV) sulfide

_____ HNO_2 _____ **e.** nitrous acid

2. Write the Stock system names for the following compounds:

_____ magnesium perchlorate _____ **a.** $Mg(ClO_4)_2$

_____ iron(II) nitrate _____ **b.** $Fe(NO_3)_2$

_____ iron(III) nitrite _____ **c.** $Fe(NO_2)_3$

_____ cobalt(II) oxide _____ **d.** CoO

_____ nitrogen(V) oxide _____ **e.** dinitrogen pentoxide

3. _____ 13 atoms _____ **a.** How many atoms are represented by the formula $Ca(HSO_4)_2$?

_____ 4.0 mol _____ **b.** How many moles of oxygen atoms are in a 0.50 mol sample of this compound?

_____ +6 _____ **c.** Assign the oxidation number to sulfur in the HSO_4^- anion.

4. Assign the oxidation number to the element specified in each of the following:

_+1_ **a.** hydrogen in H_2O_2

_−1_ **b.** hydrogen in MgH_2

_0_ **c.** sulfur in S_8

_+4_ **d.** carbon in $(CO_3)^{2-}$

_+6_ **e.** chromium in $Na_2Cr_2O_7$

_+4_ **f.** nitrogen in NO_2

Name _____ Date _____ Class _____

PROBLEMS Write the answer on the line to the left. Show all your work in the space provided.

5. _____ c, b, d, a _____ Following are samples of four different compounds. Arrange them in order of increasing mass, from smallest to largest.

  a. 25 g of oxygen gas   **c.** 3×10^{23} molecules of C_2H_6
  b. 1.00 mol of H_2O **d.** 2×10^{23} molecules of $C_2H_6O_2$

6. _____ NaOH _____ **a.** What is the formula for sodium hydroxide?

_____ 40.00 g/mol _____ **b.** What is the formula mass of sodium hydroxide?

_____ 10. g _____ **c.** What is the mass in grams of 0.25 mol of sodium hydroxide?

7. _____ 80% C, 20% H _____ What is the percentage composition of ethane gas, C_2H_6, to the nearest whole number?

8. _____ $C_5H_{10}O_5$ _____ Ribose is an important sugar (part of RNA), with a molar mass of 150.15 g/mol. If its empirical formula is CH_2O, what is its molecular formula?

Name _____ Date _____ Class _____

MIXED REVIEW continued

9. Butane gas, C_4H_{10}, is often used as a fuel.

_____**174 g**_____ **a.** What is the mass in grams of 3.00 mol of butane?

__**1.81 × 10²⁴ molecules**__ **b.** How many molecules are present in that 3.00 mol sample?

_____**C_2H_5**_____ **c.** What is the empirical formula of the gas?

10. _____**$C_{10}H_8$**_____ Naphthalene is a soft covalent solid that is often used in mothballs. Its molar mass is 128.18 g/mol and it contains 93.75% carbon and 6.25% hydrogen. Determine the molecular formula of napthalene from this information.

11. Nicotine has the formula $C_xH_yN_z$. To determine its composition, a sample is burned in excess oxygen, producing the following results:

1.0 mol of CO_2
0.70 mol of H_2O
0.20 mol of NO_2

Assume that all the atoms in nicotine are present as products.

_____**1.0 mol**_____ **a.** Determine the number of moles of carbon present in the products of this combustion.

MIXED REVIEW continued

_____1.40 mol_____ **b.** Determine the number of moles of hydrogen present in the combustion products.

_____0.20 mol_____ **c.** Determine the number of moles of nitrogen present in the combustion products.

_____C_5H_7N_____ **d.** Determine the empirical formula of nicotine based on your calculations.

_____162 g/mol_____ **e.** In a separate experiment, the molar mass of nicotine is found to be somewhere between 150 and 180 g/mol. Calculate the molar mass of nicotine to the nearest gram.

12. When $MgCO_3(s)$ is strongly heated, it produces solid MgO as gaseous CO_2 is driven off.

_____52.2%_____ **a.** What is the percentage loss in mass as this reaction occurs?

Mg is +2, C is +4, and O is −2 **b.** Assign the oxidation number to each atom in $MgCO_3$.

_____No_____ **c.** Does the oxidation number of carbon change upon the formation of CO_2?