

General Chemistry  
Midterm Review  
Packet



## General chemistry Midterm Study Guide Problems

The following problems can be found in the supplementary study guide for your text book. Answers are available in the back of the study guide to check your work. This assignment will be graded on completeness and effort. Please show all work NEATLY, circle final answer with units and significant figures where applicable.

### Chapter 1

Skim chapter 1 look at the sample exercises and work

Do the following exercise problems on pg 17-22

1-9, 14 (a & e), 15, 18, 20

### Chapter 2

Skim chapter 2 look at the sample exercises and work

Skim chapter 2

Do the following exercise problems on pg 34-39

1-6, 7(a-c), 8(a-c), 9, 10, 11, 15, 16, 20

### Chapter 3

Skim chapter 3 look at the sample exercises and work

Skim chapter 3

Do the following exercise problems on pg 62-64

2, 3, 4, 6, 7, 9, 11, 12 (a, b), 13, 15, 18, 19, 20, 22, 23, 26,

### Chapter 4

Skim chapter 4 look at the sample exercises and work

Skim chapter 4

Do the following exercise problems on pg 87-88

1, 2, 3, 4, 6, 7, 8, 11, 12, 13, 14, 15, 16, 18, 19, 20, 22, 23, 24, 25, 27(hint they give you grams can't you find moles from that and use mole ratios), 29

### Chapter 5 Gas Laws

Skim chapter 5 look at the sample exercises and work

Do the following exercise problems on pg 112 : 1,3,4,8,16, 20

## General Chemistry Midterm Review (12-13)

This is a general outline to help guide your study. All text chapters and supplementary materials should be studied as well.

### Chapter 1

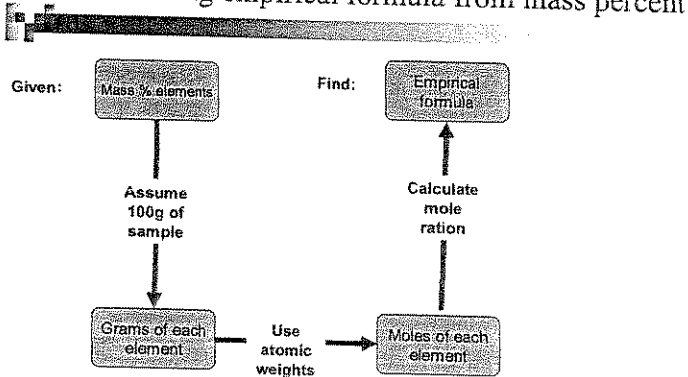
1. Classification of matter
  - a. States of matter, pure substances, elements, compounds, mixtures (wks)
2. Properties of matter (you have a practice wks you can do in your binders)
  - a. chemical /physical change
  - b. extensive vs. intensive properties
  - c. separation o mixtures
3. Units of measure
  - a. SI units
  - b. dimensional analysis (note questions that gave you a hard time!!!)
  - c. Qualitative vs. quantitative
  - d. volume, density, temperature ( K  $\rightarrow$  °F  $\rightarrow$  °C)
  - e. Green sheet of conversion factors
4. Uncertainty in measurement
  - a. precision vs. accuracy
  - b. significant figures (add/subtract divide/multiply)

### Chapter 2

1. Atomic theory of matter
  - a. Law of conservation of mass
  - b. Law of definite proportions
  - c. Law of multiple proportions
  - d. Dalton's Atomic Theory
2. Atomic Structure
  - a. Protons, neutrons, electrons
  - b. Millikan, Rutherford and their experiments
  - c. Radiation
  - d. isotopes, atomic mass, atomic number, complete chemical symbol
3. Periodic table
  - a. organization (groups periods)
  - b. names of groups and charges in most stable state
  - c. valence electrons
4. Molecular Compounds
  - a. chemical formulas (chemical/molecular, empirical, structural)
5. ions and ionic compounds
  - a. what is an ion what are the types of ions
  - b. ionic compounds, how do they form, how do charges result
  - c. nomenclature

## Chapter 3

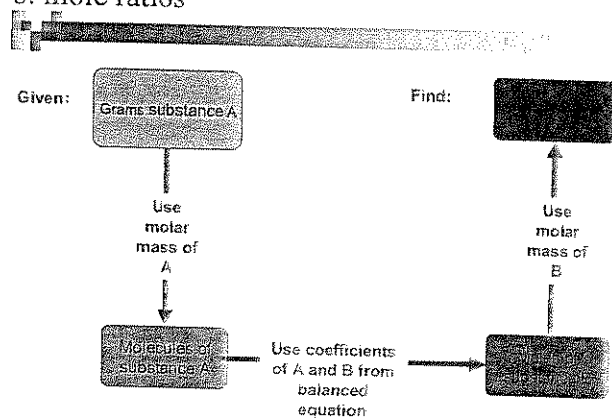
1. Chemical equations: balancing, writing, parts of a reaction, states of matter, coefficient vs. subscript
2. Types of chemical reactions
  - a. Combination, Decomposition, Single displacement, double displacement, combustion.
3. Formula Weights
  - a. Percent composition
4. MOLES!!!
  - a. Grams  $\rightarrow$  moles  $\rightarrow$  molecules  $\rightarrow$  atoms
  - b. Molar mass, molecular mass
5. Determining empirical formula from mass percent



6. Determine Molecular formula from Empirical Formula
  - a. remember the short cut :  $n = \frac{\text{Molecular Weight}}{\text{Empirical Formula Weight}}$

### 7. Mass-Mass problems

- a. g given  $\rightarrow$  mol given  $\rightarrow$  mol required  $\rightarrow$  g required
- b. mole ratios



8. Limiting Reactant  
Theoretical yield

## Chapter 4

1. Aqueous Chemistry
  - a. Solution Vocabulary
2. General Properties of Solutions
  - a. solubility (Like dissolves like )
  - b. dissolve vs. ionize
3. Electrolytes (light bulb wks)
  - a. identify electrolytes
  - b. properties of electrolytes
4. Precipitate Reactions
  - a. solubility rules
5. Predicting Precipitates
  - a. chemical, complete ionic, net ionic equations (with phase designations!!!)
6. Acids/bases/salts
  - a. properties, strong acids and bases
  - b. nomenclature
  - c. Neutralization Rxn
7. Oxidation –Reduction Reactions
  - a. rules
8. Concentrations of Solutions
  - a. Molarity (M)
  - b. making solutions from powder
  - c. making solutions from stock solutions (Dilutions)
  - d. Finding Concentration of one type of atom
9. Stoichiometry of precipitation reactions
  - a. determining mass of precipitate formed
  - b. determining mass of reactant needed to form a precipitate.
  - c. titrations

## Chapter 5 Gas Laws

Pressure

Conversions of pressure units

Gas Laws: Graph, explain, use formula's

Boyle's Law

Charles's Law

Avogadro's Law

Ideal Gas Law (define also)

Combined Gas Law

Molecular weight short cut method

Gas constant

STP

Kinetic Molecular theory



$$-36.5\text{ }^{\circ}\text{C} = ({}^{\circ}\text{F} - 32\text{ }^{\circ}\text{F}) \times \frac{5\text{ }^{\circ}\text{C}}{9\text{ }^{\circ}\text{F}}$$

$$-36.5\text{ }^{\circ}\text{C} \times \frac{9\text{ }^{\circ}\text{F}}{5\text{ }^{\circ}\text{C}} = ({}^{\circ}\text{F} - 32\text{ }^{\circ}\text{F})$$

$${}^{\circ}\text{F} = -65.7\text{ }^{\circ}\text{F} + 32\text{ }^{\circ}\text{F} = -33.7\text{ }^{\circ}\text{F}$$

Work EXERCISES & PROBLEMS: 19, 20

## EXERCISES & PROBLEMS

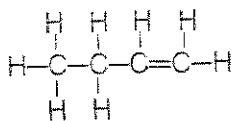
- Classify each of the following as an element, compound or mixture.
  - dry ice
  - iodine
  - beer
  - margarine
  - steel
- Consider the following and decide whether they are homogeneous or heterogeneous mixtures.
  - wood
  - wine
  - cranberry juice
  - milk
  - Italian dressing
- Identify the following as chemical or physical properties.
  - melting of iron
  - density of wood
  - reaction of wood with oxygen (burning)
  - reaction of iron with oxygen
- Identify the following as chemical or physical changes.
  - frost formation on windshield
  - steak charring on grill
  - boiling water to steam
  - fading jeans with bleach
- Calculate the volume of a brick that is 34 cm long by 7.0 cm wide by 14 cm high.
- A certain metal ingot has a mass of 3951 g, and measures 10.2 cm by 8.2 cm by 4.2 cm. Calculate the density of the metal.
- Express the following numbers in scientific notation.
  - 24,000
  - 0.00014
  - 740,000,000
  - 0.0906
- Write the following exponential numbers in standard decimal form by moving the decimal point in the proper direction.
  - $5.2 \times 10^{-3}$
  - $1.4 \times 10^3$
  - $7.5 \times 10^6$
  - $7.06 \times 10^{-5}$



9. Determine the number of significant figures expressed in the following numbers.
- 0.609
  - $1.0 \times 10^3$
  - 0.000222
  - 238.0
  - $1.030 \times 10^{-2}$
10. Round off the following numbers to the number of significant figures requested.
- 0.60945 to three significant figures
  - $1.012 \times 10^3$  to two significant figures
  - 0.00022174 to three significant figures
  - 237.95 to four significant figures
  - 1.303 to two significant figures
11. Carry out the following operations and express the result to the correct number of significant figures.
- $12 \times 2143.1$
  - $3.09 + 7$
  - $(2.2 \times 10^{-3})(1.40 \times 10^6)$
  - $12.70 + 1.222$
  - $595.2 \times (24.33 - 16.271)$
12. Carry out the following operations and express the result to the correct number of significant figures.
- $125 \text{ g} + 64 \text{ g} + 10.837 \text{ g} =$
  - $11.2 \text{ cm} + 0.0093 \text{ cm} + 0.80 \text{ cm} =$
  - $$\frac{15.01 \text{ g}}{(7.13 \text{ mL} - 6.1 \text{ mL})} =$$
13. Write the following amounts in scientific notation in terms of the base SI unit.
- $7 \mu\text{g}$
  - 8.0 nm
  - 0.14 ML
  - 1.0 ks
14. Make the following conversions of metric lengths.
- $12.5 \text{ cm} = \underline{\hspace{1cm}} \text{ m}$
  - $8.0 \times 10^{-6} \text{ m} = \underline{\hspace{1cm}} \text{ nm}$
  - $445 \text{ cm} = \underline{\hspace{1cm}} \text{ km}$
  - $32.5 \text{ mm} = \underline{\hspace{1cm}} \text{ km}$
  - $5.73 \times 10^3 \text{ nm} = \underline{\hspace{1cm}} \text{ mm}$
15. Calculate the density of mercury given that a spherical droplet of mercury with a radius of 0.328 cm has a mass of 2.00 g. The volume of a sphere is  $\frac{4}{3}\pi r^3$ .
16. The world record for the 100 m dash is 9.78 s. What is the runner's average speed in miles per hour?
17. The density of a 26% salt solution is 1.199 g/mL. What is the volume, in mL, occupied by 20.0 g of this solution?
18. The displacement volume of a certain automobile engine is  $350 \text{ in}^3$ . How many liters is this?
19. The melting point of cesium metal is  $28.4^\circ\text{C}$ . What is the melting point in degrees Fahrenheit?
20. On a sunny summer day the temperature inside a closed automobile can reach  $128^\circ\text{F}$ . Convert this temperature to degrees Celsius.

**EXAMPLE 2.7 Organic Compounds**

How would the following organic compound be represented using molecular, empirical and condensed structural formulas?

• **Solution**

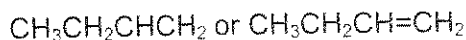
Molecular formula gives the element symbols with the number of atoms in the molecule as subscripts:



The empirical formula gives the lowest whole number ratio:



Follow each carbon in the condensed structure with the hydrogen atoms which are directly connected to the carbon:



**Work EXERCISES & PROBLEMS: 14**

**Work the rest of the EXERCISES & PROBLEMS.**

**EXERCISES & PROBLEMS**

- What is the mass number of a sodium atom that has 13 neutrons?
- How many neutrons are in an atom of  $^{109}\text{Ag}$ ?
- Write the symbol for each of the following isotopes.
  - An atom with  $Z = 30$  and 37 neutrons.
  - An atom with  $Z = 51$  and 69 neutrons.
- What are the three fundamental particles from which atoms are made? What are their electric charges. Which particles are in the atomic nucleus?
- Give the number of protons and electrons in each of the following ions.
  - $\text{Li}^+$
  - $\text{Sr}^{2+}$
  - $\text{Fe}^{3+}$
  - $\text{N}^{3-}$
  - $\text{Se}^{2-}$
  - $\text{Cl}^-$
- Styrene has the molecular formula  $\text{C}_8\text{H}_8$ . What is its empirical formula?
- What are the empirical formulas of the following compounds?
  - $\text{N}_2\text{O}_4$
  - $\text{C}_4\text{H}_6$
  - $\text{AlCl}_3$
  - $\text{Fe}_2\text{O}_3$
  - $\text{S}_2\text{F}_{10}$
- Which of the following compounds are likely to be ionic?
  - $\text{KCl}$
  - $\text{CH}_4$
  - $\text{AlCl}_3$
  - $\text{SO}_2$
  - $\text{MgO}$
  - $\text{CCl}_4$

9. Write formulas of the following binary compounds.
- barium chloride
  - magnesium nitride
  - iron(III) oxide
  - iron(II) fluoride
10. Write the formulas for the following compounds.
- ammonium chloride
  - sodium phosphate
  - potassium sulfate
  - calcium carbonate
  - potassium hydrogen carbonate
  - magnesium nitrite
  - sodium nitrate
  - ammonium perchlorate
  - strontium hydroxide
  - copper(II) cyanide
11. Name the following compounds.
- $K_3N$
  - $Ag_2CO_3$
  - $Mg(OH)_2$
  - $NaCN$
  - $NH_4I$
  - $Fe(NO_3)_2$
  - $CaSO_4 \cdot 2H_2O$
12. Name the following compounds.
- $PCl_5$
  - $SO_3$
  - $P_4O_{10}$
  - $N_2O$
  - $NO_2$
13. Name the following acids.
- $HNO_3$
  - $HNO_2$
  - $HBr$
  - $HCN$
  - $HClO_2$
14. Show the Connectivity of atoms in the following organic compounds.
- $CH_3CH_3$
  - $CH_3CH_2CH_2CH_2CF_3$
15. Summarize the four postulates of Dalton's atomic theory in your own words.
16. What evidence did Rutherford find that supported his theory of the atomic nucleus?
17. What is the difference between an atom and a molecule?
18. Give an example of: a. a monatomic cation. b. a polyatomic anion.
19. Identify the following as elements or compounds.
- $ClF_3$
  - $HCl$
  - $O_3$
  - $I_2$
  - $Se$
  - $NaI$
20. Explain the difference in the meaning of the symbols  $O_3$  and  $3O$ .
21. Why are the chemical formulas of ionic compounds the same as the empirical formulas?

$$6.0 \text{ mol H}_2 \times \frac{2 \text{ mol NH}_3}{3 \text{ mol H}_2} = 4.0 \text{ mol NH}_3$$

$$4.0 \text{ mol N}_2 \times \frac{2 \text{ mol NH}_3}{1 \text{ mol N}_2} = 8.0 \text{ mol NH}_3$$

Smallest amount of product; therefore the theoretical yield

The percent yield is found by dividing the actual yield by the theoretical yield and multiplying by 100 percent.

$$\% \text{ yield NH}_3 = \frac{\text{actual yield NH}_3}{\text{theoretical yield NH}_3} \times 100\%$$

$$= \frac{1.6 \text{ mol NH}_3}{4.0 \text{ mol NH}_3} \times 100\%$$

$$\% \text{ yield NH}_3 = 40\%$$

Work EXERCISES & PROBLEMS: 24, 25

Work the rest of the EXERCISES & PROBLEMS

### EXERCISES & PROBLEMS

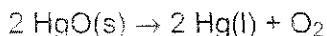
- An atom of oxygen-18 is 1.49992 times heavier than an atom of carbon-12. What is the mass of an oxygen-18 atom in amu?
- The element silver consists of two isotopes:  $^{107}_{47}\text{Ag}$  with an atomic mass of 106.905 amu and a natural abundance of 51.83%, and  $^{109}_{47}\text{Ag}$  with an atomic mass of 108.905 amu and natural abundance of 48.17%. Calculate the average atomic mass of silver.
- Calculate the molecular mass of the following.
  - carbon tetrachloride,  $\text{CCl}_4$
  - formaldehyde,  $\text{H}_2\text{CO}$
  - xenon difluoride,  $\text{XeF}_2$
- Calculate the molar mass of the following.
 

a. $\text{Na}_2\text{SO}_4$ , sodium sulfate	c. $\text{Ba}(\text{OH})_2$ , barium hydroxide
b. $\text{FeCl}_3$ , iron(III) chloride	d. $\text{SO}_3$ , sulfur trioxide
- What is the mass of 1 mole of each of the following?
 

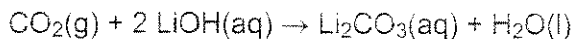
a. Cu	b. CuO	c. $\text{CuSO}_4$	d. $\text{CuSO}_4 \cdot 5\text{H}_2\text{O}$
-------	--------	--------------------	--
- How many moles of silver are in 5.00 g of Ag?
  - How many moles of sodium are in 5.00 g of Na?
- How many silver atoms are in 5.0 g of Ag?
  - How many  $\text{H}_2$  molecules are there in 4.0 g of  $\text{H}_2$ ?
  - How many molecules are in 25.0 g of methane ( $\text{CH}_4$ )?

8. a. What is the mass of 2.0 moles of  $H_2$ ?  
 b. What is the mass of  $2.79 \times 10^{22}$  atoms of Ag?  
 c. What is the average mass in grams of one atom of aluminum?
9. a. How many moles of  $NaNO_3$  are in 8.72 g of  $NaNO_3$ ?  
 b. How many moles of O atoms are in 8.72 g of  $NaNO_3$ ?
10. Calculate the percent composition by mass of the following compounds.  
 a.  $CO_2$                       b.  $H_3AsO_4$                       c.  $CHCl_3$   
 d.  $NaNO_2$                       e.  $H_2SO_4$
11. What is the empirical formula of each of the following compounds?  
 a.  $H_2O_2$     b.  $CaF_2$     c.  $C_2H_4O_2$     d.  $B_2H_6$
12. Determine the empirical formula of each compound from its percent composition.  
 a. 46.7% N, 53.3% O                      c. 55.3% K, 14.6% P, 30.1% O  
 b. 63.6% N, 36.4% O                      d. 26.6% K, 35.4% Cr, 38.1% O
13. When 2.65 mg of the substance responsible for the green color on the yolk of a boiled egg is analyzed, it is found to contain 1.42 mg of Fe and 1.23 mg of S. What is the empirical formula of the compound?
14. Ascorbic acid is a compound consisting of three elements: C, H, and O. When a 0.214 g sample is burned in oxygen, 0.320 g of  $CO_2$  and 0.0874 g of  $H_2O$  are formed. What is the empirical formula of ascorbic acid?
15. Cyclohexane has the empirical formula  $CH_2$ . Its molecular mass is 84.16 amu. What is its molecular formula?
16. Rust ( $Fe_2O_3$ ) forms readily when iron is exposed to air. Write a balanced chemical equation for the formation of rust.
17. Write a balanced chemical equation for the reaction between hydrogen gas and carbon monoxide to yield methanol ( $CH_3OH$ ).
18. Balance the following equations.  
 a.  $\underline{1} CH_4 + \underline{2} H_2O \rightarrow \underline{1} CO_2 + \underline{4} H_2$   
 b.  $\underline{\quad} H_2SO_4 + \underline{2} NaOH \rightarrow \underline{\quad} Na_2SO_4 + \underline{\quad} H_2O$   
 c.  $\underline{\quad} NH_3 + \underline{\quad} O_2 \rightarrow \underline{\quad} NO + \underline{\quad} H_2O$
19. Silicon tetrachloride ( $SiCl_4$ ) can be prepared by heating silicon in the presence of chlorine gas:  
 $Si(s) + 2Cl_2(g) \rightarrow SiCl_4(l)$   
 a. How many moles of  $SiCl_4$  are formed when 4.24 moles of  $Cl_2$  gas react?  
 b. How many grams of  $SiCl_4$  are produced when 4.24 moles of  $Cl_2$  gas react?
20. The following reaction can be used to prepare hydrogen gas:  
 $CaH_2 + 2H_2O \rightarrow Ca(OH)_2 + 2H_2$   
 How many grams of  $H_2$  will result from the reaction of 100 g of  $CaH_2$  with excess  $H_2O$ ?

21. Oxygen gas can be produced by the decomposition of mercury(II) oxide, HgO. How many grams of O<sub>2</sub> will be produced by the reaction of 24.2 g of the oxide?

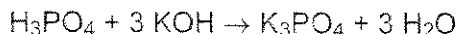


22. Carbon dioxide in the air of a spacecraft can be removed by its reaction with lithium hydroxide.

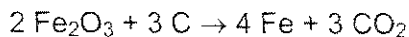


On average, a person will exhale about one kg of CO<sub>2</sub> per day. How many kg of LiOH are required to react with 1.0 kg of CO<sub>2</sub>?

23. Given 5.00 mol of KOH and 2.00 mol of H<sub>3</sub>PO<sub>4</sub>, how many moles of K<sub>3</sub>PO<sub>4</sub> can be prepared?

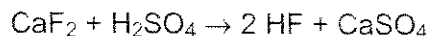


24. The reaction of iron ore with carbon follows the equation:



- a. How many grams of Fe can be produced from a mixture of 200 g of Fe<sub>2</sub>O<sub>3</sub> and 300 g of C?  
b. If the actual yield of Fe is 110 g, what is the percent yield of iron?

25. Hydrofluoric acid (HF) can be prepared according to the reaction:



In one experiment 42.0 g of CaF<sub>2</sub> was treated with excess H<sub>2</sub>SO<sub>4</sub> and a yield of 14.2 g of HF was obtained.

- a. What is the theoretical yield of HF?  
b. Calculate the percent yield of HF.
26. The density of silver is 10.5 g/cm<sup>3</sup>. How many Ag atoms are present in a silver bar that measures 0.10 m × 0.05 m × 0.01 m?
27. The pesticide malathion has the chemical formula C<sub>10</sub>H<sub>19</sub>O<sub>6</sub>PS<sub>2</sub>.
- a. What is the molar mass of malathion?  
b. The dose that is lethal to 50 percent of a human population is about 1.25 g per kilogram of body mass. How many molecules are in a dose lethal to an adult male weighing 70 kg? To an adult female weighing 58 kg?

28. An unknown element M combines with oxygen to form a compound with a formula MO<sub>2</sub>. If 25.0 g of the element combines with 4.50 g of oxygen, what is the atomic mass of M?

29. Describe why the atomic mass unit scale is referred to as a relative scale.

30. Sulfur atoms, on average, have twice the mass of O oxygen atoms. Why is it important to stress the wording "on average"?

Notice that this road map is virtually identical to the road map in the previous example. A titration problem doesn't change between redox titrations and acid-base titrations.

$$31.0 \text{ mL MnO}_4^- \times \frac{1 \text{ L MnO}_4^-}{1000 \text{ mL MnO}_4^-} \times \frac{0.150 \text{ mol MnO}_4^-}{1 \text{ L MnO}_4^-} \times \frac{5 \text{ mol H}_3\text{AsO}_3}{2 \text{ mol MnO}_4^-} = 1.16 \times 10^{-2} \text{ mol H}_3\text{AsO}_3$$

The concentration of  $\text{H}_3\text{AsO}_3$  is:

$$\begin{aligned} \text{molarity} &= \frac{\text{mol H}_3\text{AsO}_3}{\text{liters soln}} \\ &= \frac{1.16 \times 10^{-2} \text{ mol}}{50.0 \text{ mL} \times \frac{1 \text{ L}}{1000 \text{ mL}}} = 0.232 \text{ M} \end{aligned}$$

Work EXERCISES & PROBLEMS: 31, 32  
Work the rest of the EXERCISES & PROBLEMS

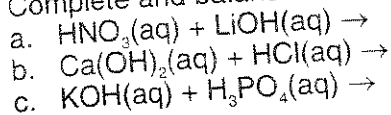
### EXERCISES & PROBLEMS

- Which of the following are ionic compounds and, therefore, are strong electrolytes?  
a.  $\text{CaF}_2$  b.  $\text{C}_6\text{H}_{12}\text{O}_6$  c.  $\text{KBr}$  d.  $\text{LiNO}_3$  e.  $\text{CuSO}_4$
- Which of the following compounds are strong electrolytes?  
a.  $\text{KOH}$  b. sucrose c.  $\text{MgI}_2$  d. methyl alcohol e.  $\text{HBr}$  f.  $\text{AgCl}$
- What ionic species are present in aqueous solutions of the following?  
a.  $\text{Mg}(\text{NO}_3)_2$  b.  $\text{KOH}$  c.  $\text{CaF}_2$
- Which of the following compounds are soluble in water?  
a.  $\text{BaCl}_2$  b.  $\text{PbSO}_4$  c.  $\text{Ni}(\text{OH})_2$  d.  $\text{Ca}_3(\text{PO}_4)_2$  e.  $\text{NH}_4\text{NO}_3$
- According to the solubility rules, which of the following compounds are insoluble in water?  
a.  $\text{NH}_4\text{CO}_3$  b.  $\text{AgBr}$  c.  $\text{CaCO}_3$  d.  $\text{FeCl}_3$  e.  $\text{ZnS}$
- Predict whether a precipitate will form when aqueous solutions of the following are mixed. Write the formulas for any precipitates.  
a.  $\text{MgBr}_2$  and  $\text{NaOH}$  b.  $\text{NaI}$  and  $\text{AgNO}_3$
- Identify the spectator ions in parts (a) and (b) of number 6.
- Write net ionic equations for the reactions that occur when solutions of the following compounds are mixed.  
a.  $\text{MgBr}_2$  and  $\text{Pb}(\text{NO}_3)_2$  b.  $\text{NaBr}$  and  $\text{AgNO}_3$
- Write the equations for the ionization of the following acids in aqueous solution.  
a.  $\text{HBr}$  b.  $\text{HClO}_4$  c.  $\text{H}_2\text{SO}_4$

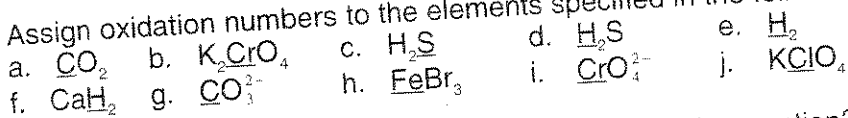
10. Write the equations for the dissociation of the following bases in aqueous solution.  
 a.  $\text{Ca}(\text{OH})_2$  b.  $\text{HN}(\text{CH}_3)_2$  c.  $\text{CsOH}$

11. Write balanced molecular equations for the reaction of  $\text{NaOH}(\text{aq})$  with the following.  
 a.  $\text{HClO}_4(\text{aq})$  b.  $\text{H}_2\text{SO}_4(\text{aq})$

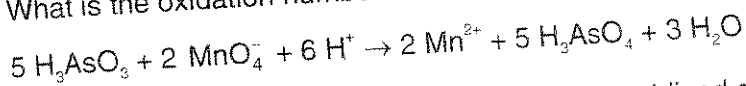
12. Complete and balance the following molecular equations.



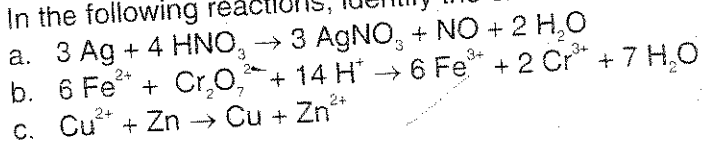
13. Assign oxidation numbers to the elements specified in the following molecules and ions.



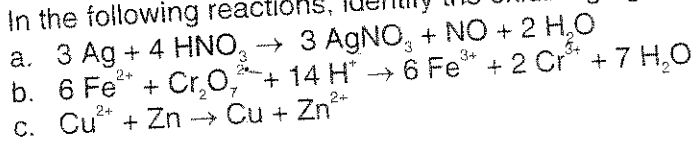
14. What is the oxidation number of Mn before and after the reaction?



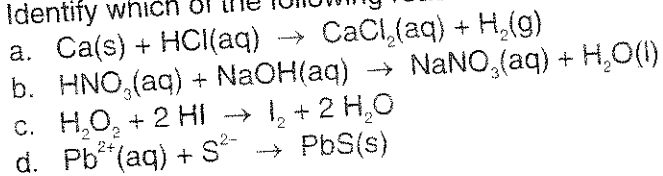
15. In the following reactions, identify the elements oxidized and the elements reduced.



16. In the following reactions, identify the oxidizing agents and reducing agents.



17. Identify which of the following reactions are oxidation-reduction reactions.



18. What is the molarity of a solution consisting of 11.8 g of  $\text{NaOH}$  dissolved in enough water to make 300 mL of solution?

19. How many moles of  $\text{H}_2\text{SO}_4$  are contained in 225 mL of 0.750 M  $\text{H}_2\text{SO}_4$ ?

20. How many grams of  $\text{HCl}$  are contained in 250 mL of 0.500 M  $\text{HCl}$ ?

21. Consider 125 mL of 0.110 M  $\text{MgCl}_2$  solution.

- a. How many moles of  $\text{MgCl}_2$  are contained in 125 mL of 0.110 M  $\text{MgCl}_2$ ?  
 b. What is the concentration of  $\text{Mg}^{2+}$  ion?  
 c. What is the concentration of  $\text{Cl}^-$  ion?

22. When 147 mL of 4.25 M  $\text{NH}_3$  solution is mixed with 353 mL of  $\text{H}_2\text{O}$ , what is the concentration of the final solution?

23. Describe how you would prepare  $2.50 \times 10^2$  mL of 0.666 M  $\text{KOH}$  solution, starting with a 5.0 M  $\text{KOH}$  solution.



24. Calculate the number of moles of NaBr that must be added to 450 mL of 0.250 M AgNO<sub>3</sub> solution in order to precipitate all the Ag<sup>+</sup> ions as AgBr.
25. In order to precipitate AgCl, excess AgNO<sub>3</sub> was added to 10.0 mL of a solution containing Cl<sup>-</sup> ion. If 0.339 g of AgCl was formed, what was the concentration of Cl<sup>-</sup> in the original solution?
26. A 0.198 g sample of an ionic compound containing the Br<sup>-</sup> ion was dissolved in water and treated with excess AgNO<sub>3</sub>. If the mass of silver bromide precipitate that forms was 0.0964 g, what is the percent of Br<sup>-</sup> by mass in the original compound?
27. How many milliliters of 1.00 M H<sub>2</sub>SO<sub>4</sub> solution are required to neutralize 2.10 g KOH?
28. What volume of 0.210 M H<sub>2</sub>SO<sub>4</sub> solution is needed to exactly neutralize 50.0 mL of 0.082 M NaOH?
29. What volume of 0.0824 M NaOH solution is needed to titrate 9.8 mL of 0.210 M H<sub>2</sub>SO<sub>4</sub> to the equivalence point?
30. What is the molarity of an oxalic acid (H<sub>2</sub>C<sub>2</sub>O<sub>4</sub>) solution if 22.50 mL of this solution requires 35.72 mL of 0.198 M NaOH for complete neutralization?
31. What volume of 0.200 M K<sub>2</sub>Cr<sub>2</sub>O<sub>7</sub> will be required to oxidize 4.0 g of H<sub>3</sub>AsO<sub>3</sub>?
- $$14 \text{ H}^+ + \text{Cr}_2\text{O}_7^{2-} + 3 \text{ H}_3\text{AsO}_3 \rightarrow 2 \text{ Cr}^{3+} + 3 \text{ H}_3\text{AsO}_4$$
32. In an experiment, 52.0 mL of K<sub>2</sub>Cr<sub>2</sub>O<sub>7</sub> solution was required to oxidize 4.0 g of H<sub>3</sub>AsO<sub>3</sub>. What was the molarity of the dichromate solution?
- $$14 \text{ H}^+ + \text{Cr}_2\text{O}_7^{2-} + 3 \text{ H}_3\text{AsO}_3 \rightarrow 2 \text{ Cr}^{3+} + 3 \text{ H}_3\text{AsO}_4$$
33. Explain how an ionic compound can have a low solubility, but be a strong electrolyte.
34. What makes molarity a convenient concentration unit for use in chemistry?
35. Suggest a precipitation reaction and a redox reaction by which barium sulfate can be prepared.

$$\% \text{ error} = \frac{41 \text{ atm} - 30.0 \text{ atm}}{30.0 \text{ atm}} \times 100\%$$

$$\% \text{ error} = 37\%$$

We conclude that under these conditions  $\text{C}_5\text{H}_{12}$  behaves in a nonideal manner.

b. In this case, write the van der Waals equation

$$\left( P_{\text{real}} + \frac{an^2}{V^2} \right) (V - nb) = nRT$$

and substitute into it, but first calculate the correction terms.

$$\frac{an^2}{V^2} = \frac{(17.0 \text{ L}^2 \cdot \text{atm/mol}^2)(1.0 \text{ mol})^2}{1.0 \text{ L}^2} = 17 \text{ atm}$$

$$nb = 1.0 \text{ mol} (0.136 \text{ L/mol}) = 0.14 \text{ L}$$

$$nRT = (1.0 \text{ mol})(0.0821 \text{ L}\cdot\text{atm/K}\cdot\text{mol})(503 \text{ K}) = 41 \text{ L atm}$$

Now substitute using the van der Waals equation.

$$(P + 17.0 \text{ atm})(1.0 \text{ L} - 0.14 \text{ L}) = 41 \text{ L atm}$$

$$(P + 17.0 \text{ atm})(0.9 \text{ L}) = 41 \text{ atm}$$

$$P + 17.0 \text{ atm} = 50 \text{ atm}$$

$$P = 33 \text{ atm}$$

Thus, the pressure calculated by the van der Waals equation is much closer to the actual value of 30.0 atm. The percent error is only 10 percent.

Work EXERCISES & PROBLEMS: 25, 26

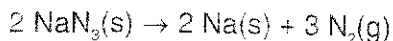
Work the rest of the EXERCISES & PROBLEMS

## EXERCISES & PROBLEMS

- Convert a pressure of 645 mmHg into its value in
  - atmospheres.
  - kilopascals.
- Do the following unit conversions.
  - 125 mmHg to torr
  - 725 mmHg to kilopascals
- A sample of gas has a volume of 200  $\text{cm}^3$  at 25 °C and 700 mmHg. If the pressure is reduced to 280 mmHg, what volume would the gas occupy at the same temperature?
- Two liters of oxygen gas at -15 °C are heated and the volume expands. At what temperature will the volume reach 2.31 L?

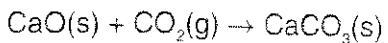
5. A 20.0-mL sample of a gas is enclosed in a gas-tight syringe at 50.0 °C. What will the volume of the gas be at the same pressure after the syringe has been immersed in ice water?
6. If 2.00 L of oxygen at -15 °C are allowed to warm to 25 °C at constant pressure, what is the new volume of oxygen gas?
7. The gas pressure in an aerosol can is 1.5 atm at 25 °C. What pressure would develop in the can if it were heated to 450 °C?
8. A sample of gas occupies 155 mL at 21.5 °C, and at 305 mmHg. What is the pressure of the gas sample when it is placed in a  $5.00 \times 10^2$ -mL flask at a temperature of -10 °C?
9. What is the pressure in atmospheres of  $1.20 \times 10^4$  moles of methane, CH<sub>4</sub>, when stored at 22 °C in a  $3.00 \times 10^3$  L tank?
10. 1.75 g sample of CO<sub>2</sub> is contained in a  $7.50 \times 10^2$ -mL flask at 35 °C. What is the pressure of the gas?
11. How many moles of CO<sub>2</sub> gas are required to fill a 5.00-L balloon to a pressure of 1.05 atm at 5.0 °C?
12. How many grams of helium are required to fill a 10.0-L balloon to a pressure of 1250 torr at 25 °C?
13. How many O<sub>2</sub> molecules occupy a 1.00-L flask at 75 °C and 777 mmHg?
14. What is the density of H<sub>2</sub>(g) at 35 °C and 650 torr?
15. Which one of the following gases will have the greatest density when they are all compared at the same temperature and pressure?  
O<sub>2</sub>   CO<sub>2</sub>   NO<sub>2</sub>   CF<sub>4</sub>
16. When 2.96 g of mercuric chloride is vaporized in a 1.00 liter bulb at 680 K, the pressure is 450 mmHg. What is the molar mass and molecular formula of mercuric chloride?
17. Determine the molar mass of Freon-11 gas if a sample weighing 0.597 g occupies  $1.00 \times 10^2$  mL at 95 °C, and 1000 mmHg.
18. The discovery of oxygen resulted from the decomposition of mercury(II) oxide.  
 $2 \text{HgO} \rightarrow 2 \text{Hg} + \text{O}_2(\text{g})$ 
  - a. What volume of oxygen will be produced by the decomposition of 25.2 grams of the oxide, if the gas is measured at STP?
  - b. How many grams of mercury(II) oxide must be decomposed to yield 10.8 L of O<sub>2</sub> gas at 1 atm and 298 K?

19. Sodium azide decomposes according to the equation:



What volume of  $\text{N}_2$  at 1.1 atm and  $50.0^\circ\text{C}$  will be produced by the decomposition of 5.0 g  $\text{NaN}_3$ ?

20. Consider the reaction of 20.0 g calcium oxide with carbon dioxide.



If you have 5.5 L of  $\text{CO}_2$  at 7.50 atm and  $22^\circ\text{C}$ , will you have enough carbon dioxide to react with all the  $\text{CaO}$ ?

21. Hydrogen and helium are mixed in a 20.0 L flask at room temperature ( $20^\circ\text{C}$ ). The partial pressure of hydrogen is 250 mmHg and that of helium is 75 mmHg. How many grams of  $\text{H}_2$  and He are present?
22. Calculate the root-mean-square speed of ozone molecules ( $\text{O}_3$ ) in the stratosphere where the temperature is  $-83^\circ\text{C}$ .
23. If  $\text{NO}_2$  molecules have a root-mean-square speed of 290 m/s, what is the temperature corresponding to this average speed?
24. If the root-mean-square speed of an  $\text{O}_2$  molecule is  $4.2 \times 10^2$  m/s at  $25^\circ\text{C}$ , what is the average speed of a  $\text{Cl}_2$  molecule at the same temperature?
25. 0.50 mol  $\text{CCl}_4$  gas is introduced into a 10.0-L flask. What fraction of the total volume of the flask is occupied by  $\text{CCl}_4$  molecules? See Table 5.3 in the text for the value of the van der Waals constant  $b$ .
26. By looking at the van der Waals constants in Table 5.3 of the text, determine which gas should have the higher strength of attractive forces between its molecules: ammonia or carbon tetrachloride?
27. Why is the density of a gas much lower than that of a solid or liquid?
28. Which sample contains more molecules: a. 1.0 L of  $\text{O}_2$  gas at  $20^\circ\text{C}$  and 2.0 atm or b. 1.0 L of  $\text{SF}_4$  gas at  $20^\circ\text{C}$  and 2.0 atm? Which sample has more mass?
29. How does the kinetic molecular theory explain Charles's law?
30. A 0.356-g sample of  $\text{XH}_2(\text{s})$  reacts with water according to the following equation:
- $$\text{XH}_2(\text{s}) + 2\text{H}_2\text{O}(\text{l}) \rightarrow \text{X}(\text{OH})_2(\text{s}) + 2\text{H}_2(\text{g})$$
- The hydrogen evolved is collected over water at  $23^\circ\text{C}$  and occupies a volume of 431 mL at 746 mmHg total pressure. Find the number of moles of  $\text{H}_2$  produced and the atomic mass of X. Vapor pressure of  $\text{H}_2\text{O} = 21$  mmHg.
31. A certain noble gas compound contains 68.8 percent Kr and 31.2 percent F by mass. Its density at STP is 5.44 g/L. What is the molecular formula of the compound?



