# BASIC CONCEPTS OF CHEMISTRY 2012-2013
# Review Worksheet for Final Exam – Chapters 7 - 12, 17 (part)

## Chapters 1 - 6

1) Be able to recognize the five basic kinds of reaction: single replacement, double replacement, combination, decomposition, and combustion.

2) Use the Solubility Table (double replacement) and Activity Series (single replacement) to determine if reactions occur.

3) Be able to balance ANY chemical equation.

4) Remember (from any chapter) how to write formulas for compounds (ionic and molecular) in order to be able to write the chemical equations.

5) Recognize acid-base reactions (that produce water as a product).

6) Remember how to calculate the molar mass of a compound.

## Chapter 7

1) Steps to Doing a Stoichiometry Calculation.
   a) Write a balanced chemical equation describing the reaction that occurs.

   b) Calculate the number of moles (n) for what is given.

      1) Mass (convert to grams if necessary): $n = \frac{\text{mass (g)}}{\text{mol mass}}$
      2) Volume of a liquid (use density to get mass in grams): $\text{density} = \frac{\text{mass (g)}}{\text{volume (mL)}}$
      3) Molecules: $n = \frac{\text{\# of molecules}}{6.02 \times 10^{23} \text{ molecules/mole}}$
      4) Volume of a gas at STP (Convert volume to liters if necessary): $n = \frac{\text{volume (L)}}{22.4 \text{ L/mole}}$

   c) Use the reaction coefficients (a and b) and the moles of the given to calculate the moles of the unknown (Multiply by the ratio): $\frac{\text{b moles of unknown}}{\text{a moles of given}}$

   d) Convert the moles of the unknown into the desired quantity using the equations given in part b.

2) a) Limiting Reagent limits or determines the amount of product that can be formed in a reaction.

   b) Excess Reagent is present in an amount that is more than enough to react with all of the limiting reagent. Some of the excess reagent is left over.

3) a) Theoretical Yield is the maximum amount of product that can be produced from the stated amounts of reactants. It is a calculated number.

   b) Actual Yield is the amount of product actually obtained when the reaction is actually done in the laboratory. It is an experimentally measured value. It can never be greater than the theoretical yield.

c) $\underline{\text{Percent Yield}} = \frac{\text{actual yield}}{\text{theoretical yield}} \times 100$

4) How many liters of chlorine gas, at STP, can be produced by the electrolysis 0f 23.4 g of NaCl?

$NaCl \longrightarrow Na + Cl_2$

5) What volume of carbon dioxide, at STP, is produced when 180 L of acetylene gas, $C_2H_2$, at STP, is burned? (Assume complete combustion.)

6) What volume of oxygen, at STP, would be required to burn 5 gallons of gasoline? (Gasoline, $C_8H_{18}$, is a liquid with a density of 0.70 g/mL.) $C_8H_{18} + O_2 \longrightarrow CO_2 + H_2O$

7) A 20 g sample of Ca reacts with 6.0 L of $NH_3$ gas at STP. $Ca + NH_3 \longrightarrow CaH_2 + Ca_3N_2$
   a) What is the theoretical yield of $Ca_3N_2$?

   b) What is the percent yield if 8.0 g of $Ca_3N_2$ is actually produced?

8) Calculate the formula/molecular mass of the following compounds:
   a) $(NH_4)_3PO_4$ (ammonium phosphate) b) $Ca(C_6H_{12}NSO_3)_2$

9) Epsom salts is hydrated magnesium sulfate, $MgSO_4 \bullet 7\ H_2O$. Hydrated compounds will lose their water of hydration when heated.
   a) Using the above formula calculate the theoretical percentage of water in the compound.

   b) When 2.000 g of the compound were heated a residue with a mass of 0.925 g was formed. What is the experimental percentage of water in the compound?

   c) What is the percentage error in the experiment?

10) Given the old gasoline additive tetraethyl lead, $Pb(C_2H_5)_4$,
   a) What is the percentage of lead in the compound?

   b) How many grams of lead are present in 1.0 lb (454 g) of the additive?

11) How many grams are present in the following?
   a) 0.40 moles of manganese, Mn c) $2.5 \times 10^{18}$ molecules of $CO_2$

   b) 448 mL of oxygen, $O_2$, at STP d) 1 molecule of $C_6H_{12}O$

12) How many molecules are present in the following?
   a) 2.5 moles of sucrose, $C_{12}H_{22}O_{11}$ c) 2.8 g of propane, $C_3H_8$

b) 6.72 L of carbon dioxide, $CO_2$, at STP

13) How many moles are present in the following?
a) 5.86 g of silver, Ag

c) $6.32 \times 10^{24}$ molecules of chloroform, $CHCl_3$

b) 135,500 L of helium, He, at STP

d) 3.25 kg of $(NH_4)_2CO_3$

14) What volume of gas at STP is present in each of the following?
a) 0.30 moles of carbon monoxide, CO

c) $1.20 \times 10^{22}$ atoms of neon, Ne

b) 9.2 g of nitrogen dioxide, $NO_2$

d) 5.6 g of nitrogen, $N_2$

15) How many sodium ions are there in 28.4 g of sodium sulfate, $Na_2SO_4$?

16) What volume of glycerine, $C_3H_8O_3$, (density 1.26 g/mL) should be taken to obtain 2.5 moles?

17) How many grams of copper can be recovered from 5.0 lbs of azurite, $Cu_3(CO_3)_2(OH)_2$?

18) A compound has the following elemental analysis. What is its empirical formula?
35.0% N, 5.0% H, 60.0% O

19) The hormone epinephrine is released in the human body during stress and increases the body's metabolic rate. The percent composition of this hormone is 56.8% carbon, 6.56% hydrogen, 28.4% oxygen, and 8.28% nitrogen. What is its empirical formula?

20) a) Lactic acid, the substance that causes sour milk to taste sour consists of 40.0% carbon, 6.7% hydrogen, and 53.3% oxygen. What is the empirical formula of lactic acid?

b) What is the molecular formula of lactic acid if it has a molecular mass of 90?

21. A 2.500 g sample of a compound of potassium, chlorine, and oxygen is heated to drive off the oxygen. The residue has a mass of 1.170 g. The chloride in the residue is then precipitated out by adding silver nitrate. The AgCl that is formed has a mass of 3.963 g. What is the empirical formula of the compound?

**Chapter 10**

We did not do this chapter but from earlier discussions:

1) Be familiar with the following terms
   a) heat
   b) exothermic
   c) endothermic

**Chapter 8**

1) Be familiar with the following terms:
   a) atomic emission spectrum
   b) atomic orbital
   c) electromagnetic radiation
   d) electronegativity
   e) frequency
   f) ground state
   g) Heisenberg Uncertainty Principle
   h) alkaline earth metal
   i) periodic law
   j) spectrum
   k) wavelength
   l) alkali metal
   m) group
   n) halogen
   o) ionization energy
   p) noble gas
   q) period
   r) excited state

2) Give electron configurations for each of the following elements. (Use the Noble gas simplification and show incomplete sublevels pictorially, ie., with arrows).

   a) P  b) Br  c) Pb

3) Give the symbol of the element whose atoms have the following numbers of electrons in their outermost sublevel.

   a) $3s^2$  b) $5p^5$  c) $4d^6$  d) $4f^8$

4) Classify the following elements as alkali metals, alkaline earth metals, halogens, Noble gases, or transition metals.

   a) Hg  d) Na  g) Li

   b) Ca  e) Mg  h) F

   c) Br  f) Ne  i) Zn

5) Which member of the following pairs would you predict to be larger?

   a) K or Ca  c) Ag or $Ag^{+1}$  e) Mg or Ca

   b) S or Cl  d) F or $F^{-1}$  f) $Au^{+1}$ or $Au^{+3}$

6) Which member of the following pairs has the lowest first ionization energy (forms +1 ions the easiest)?

   a) Na or Cs  b) K or Fe  c) P or Bi

7) Which of the third row elements (Na through Cl):
   a) is the largest?
   d) forms -1 ions the easiest?

b) is the smallest?

c) forms +1 ions the easiest?

e) forms +2 ions the easiest?

f) is the most electronegative?

**Chapter 9**

1) Be familiar with the following terms or concepts (some we have talked specifically, and some are in the book):
   a) electron dot structure
   b) Lewis structures
   c) valence electron
   d) covalent bond
   e) ionic bond
   f) metallic bond
   g) structural formula
   h) octet rule
   i) VESPR theory
   j) unshared electron pairs
   k) double covalent bond
   l) triple covalent bond
   m) bond angle
   n) tetrahedral shape
   o) pyramidal shape
   p) bent shape
   q) linear shape
   r) trigonal planar shape
   s) nonpolar covalent bond
   t) polar covalent bond
   u) dipole
   v) intermolecular attractions
   w) dispersion forces
   x) dipole interaction
   y) hydrogen bonds

2) List the two basic types of chemical bonding. Describe what happens to the valence electron(s) when two atoms combine by each of the two types of bonding.

3) Based on the positions in the periodic table of the following pairs of elements predict whether the bonding between the two would be ionic or covalent.
   a) Ba and S
   b) P and O
   c) Cl and Br
   d) Li and I
   e) Si and Cl
   f) Ca and F

4) Classify the following compounds as ionic or covalent.
   a) $SO_2$
   b) $NiCl_2$
   c) $H_2CO_3$
   d) $NCl_3$
   e) $Li_2O$
   f) $SOCL_2$

5) How many protons, neutrons and electrons are contained in one ion of the following?
   a) $^{209}Bi^{+3}$
   b) $^{80}Br^{-1}$

6) Draw electron dot formulas for the following elements.
   a) Na
   b) Ca
   c) Al
   d) Si
   e) As
   f) P
   g) Se
   h) I
   i) C

7) Give the charge of the ion that is most likely to be formed by the following and then give the electron configuration of the ion.
   a) Na
   c) Sr
   e) O
   g) Ag

b) Al d) Cl f) Zn h) Fe

8) Write the formula of the ionic compound that forms between each of the following pairs of elements:

a) Cs and Cl b) Ba and F c) K and S d) Al and O e) Ag and Br f) Zn and S

9) How many electrons are shared between two atoms in:

a) a single covalent bond?

b) double covalent bond?

c) a triple covalent bond?

10) Use Lewis dot structures to predict the formula of the covalent molecules formed by each of the following pairs of elements.

a) P and H c) Se and Br e) C and F

b) As and F d) I and Cl f) O and F

11) Show the bonding in the following by giving the Lewis dot structures. Give a name or drawing of the molecular or ionic shape. For the neutral species, tell if they are polar or nonpolar. Also tell what is the most important type of intermolecular attraction that exists between the molecules of the neutral species.

a) $H_2S$ c) $HCBr_3$ e) $(CLO_4)^{-1}$ g) $(NO_3)^{-1}$

b) $PCl_3$ d) $(NH_4)^{+1}$ f) $Cl_2CO$ h) $H_3CCl$

12) Classify the bonding between the following pairs of atoms as ionic, polar covalent or nonpolar covalent.

a) Si and O b) N and O c) Sr and F d) Cl and Cl e) Ca and Br f) C and H

13) Fill in the following table which attempts to show differences between ionic and covalent compounds. (This stuff is in the book.)

| Characteristics | Ionic Compounds | Covalent Compounds |
|---|---|---|

a) Type of bond holding species together

b) What types of elements are present

c) Physical state most likely to be found in

d) Melting point if solid

e) Electrical conductivity as solids

f) Electrical conductivity as liquids

g) Type of solvent they are soluble in

h) Electrical conductivity in aqueous solution

**Chapter 10**

1) When you work with gases, standard conditions (STP) are defined as a temperature of 0°C (273°K) and a pressure of 760 mm of Hg = 1 atm = 101 kPa = 14.7 lbs/in$^2$.

2) Boyle's Law, Charles' Law, Gay-Lussac's Law, Gay-Lussac's Law of Combining Gases

3) The Combined Gas Law $\frac{P_1V_1}{T_1} = \frac{P_2V_2}{T_2}$

4) Collecting Gases Over Water $P_{gas} = P_{measured}$ - V.P. of water

The vapor pressure of water varies with the temperature of the water.

5) The Ideal Gas Law $PV = nRT$ P = pressure in atm, V = volume in Liters
n = moles of gas, R = 0.0821 L-atm/mole-°K, T = temperature in °K

since $n = \frac{m}{MW}$ then $PV = \frac{mRT}{MW}$ m = mass in grams, MW molar mass (g/mole)

6) The volume of a gas thermometer is 150 mL at 25°C and 1 atm. When immersed in boiling ammonia, its volume at 1 atm falls to 121 mL. Find the boiling point of ammonia in °C.

7) A balloon partially filled with air has a volume of 500 mL at 20°C and 750 mm of Hg. As the balloon rises in the air, its volume expands to 2.0 liters and the temperature decreases to -20°C. What is the new pressure exerted by the air in the balloon?

8) What is the mass, in grams, of 200 mL of $CH_4$ collected at 10°C over water at a pressure of 750 mm of Hg? (V.P. of water at 10°C = 9 mm of Hg.)

9) Analysis of a volatile liquid (one that can easily boil) shows that it contains 14.31% carbon, 1.20% hydrogen and 84.49% chlorine by mass. At 150°C and 1 atm, 500 mL of the vapor has a mass of 2.418 g. What is the molecular mass and molecular formula of the compound?

10) What mass of potassium nitrate would have to be decomposed to produce 18.4 L of oxygen gas that was collected at 740 mm of Hg and 22°C? $2\ KNO_3 \longrightarrow 2\ KNO_2 + O_2$

11) If 12 L of ammonia gas reacts with 16 L of oxygen at 500°C and 1 atm, what volume of

NO gas will be formed under the same conditions? $4\ NH_3 + 5\ O_2 \longrightarrow 4\ NO + 6\ H_2O$

## Chapters 11 & 12

1) Be familiar with the following terms:

| | | |
|---|---|---|
| a) solvent | b) dilute solution | c) molarity |
| d) saturated solution | e) water of hydration | f) solubility |
| g) solute | h) supersaturated solution | i) concentrated solution |
| j) unsaturated | k) normality | |

molarity ($M$) = $\frac{\text{moles}}{\text{liters}}$ mass % = $\frac{\text{mass solute}}{\text{mass solution}}$

moles = liters x molarity dilutions: mL x $M$ = mL x $M$

normality = equivalents per liter mL x $N$ = ml x $N$

solution stoichiometry: $M_1$ x $V_1$ = mole ratio x $M_2$ x $V_2$

2) Which of the following should dissolve in water and which should dissolve in carbon tetrachloride (a nonpolar solvent)?
a) $KNO_3$ b) $C_6H_{12}$ c) $NH_3$ d) $CH_3OH$ e) $MgCl_2$ f) $C_8H_{10}$

3) What is the molarity of silver nitrate in a solution made by dissolving 5.3 g of silver nitrate to make 81.0 mL of solution?

4) How many grams of ammonium nitrate are needed to make 440 mL of a 1.5 $M$ solution of ammonium nitrate?

5) Calculate the molarity of a solution made by dissolving 3.59 g of KI in enough water to give 50 mL of solution.

6) How many grams of sodium carbonate, $Na_2CO_3$, are needed to make 400 mL of a 0.800 $M$ $Na_2CO_3$ solution?

7) What is the molarity of a 2.0 liter solution made by diluting 100 mL of concentrated HCl (12.0 $M$)?

8) You are to prepare 750 mL of 0.50 $M$ $HNO_3$ from concentrated nitric acid (16.0 $M$). How many milliliters of the concentrated acid are required?

9) How many grams of magnesium hydroxide should be formed by the reaction of 25 mL of 0.60 $M$ $MgCl_2$ solution with excess NaOH? $MgCl_2 + 2\ NaOH \longrightarrow Mg(OH)_2 + 2\ NaCl$

10) Calculate the molarity of a solution made by dissolving 15 g of ethyl alcohol, $C_2H_5OH$, in enough water to make 200 mL of solution.

11) How many grams of glucose, $C_6H_{12}O_6$, are needed to make a 0.50 *M* glucose solution if 250 mL of solution is wanted?

12) What volume of hydrogen gas at STP should be produced by the reaction of excess zinc with 200 mL of 0.50 *M* HCl? $Zn + 2\,HCl \longrightarrow ZnCl_2 + H_2$

**Chapter 17**

1) Be familiar with the following terms:

| | | |
|---|---|---|
| a) alkanes | e) saturated | i) substitution |
| b) alkenes | f) aromatic compounds | j) systematic name |
| c) alkynes | g) structural isomer | k) alcohols, halides, amines, ethers |
| d) unsaturated | h) functional group | l) aldehydes, ketones, carboxylic acids |

2) Give structural formulas for the following:

a) 2,2-dimethylbutane

b) 2-methyl-3,4-diethylhexane

c) 2,4,6-trimethyl-1,5-heptadiene

d) 4,4-dimethyl-2-pentene

e) 2,3-diethylhexene

f) 4,4-diethyl-2-hexyne

g) ethanoic acid

h) 1,2,4-tripropylbenzene

i) 3-ethyl-2-methyl-1-pentene

j) 2,3-diethyl-1-methylbenzene

k) 2,2-diethyl-3 methylpentane

l) 2-methyl-2-propene

m) 2,2-diethylpentane

n) propyl aldehyde

3) Give structural formulas and names for the seven isomers with a molecular formula of $C_4H_4Cl_2$ that contains one triple bond.

4) Name the following compounds:

a) $CH{\equiv}C\text{-}CH_2\text{-}CH_3$

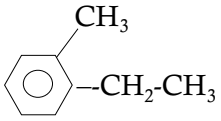
e) $CH_2{=}CH\text{-}C(CH_3)_2\text{-}CH\text{-}CH_3$

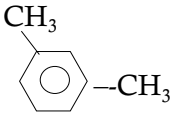
i) $CH_3\text{-}CH_2\text{-}C(CH_3)(CH_2\text{-}CH_3)\text{-}CH_3$

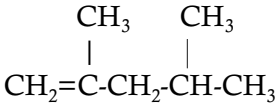
b) $CH_3\text{-}C(CH_3)(CH_2\text{-}CH_3)\text{-}CH_2\text{-}CH{=}CH_2$

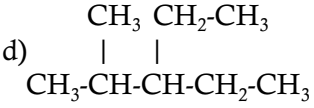
f) $CH_3\text{-}C(H_3C)=C(CH_2\text{-}CH_3)\text{-}CH_2\text{-}CH_3$

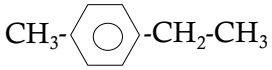
j) $CH_3\text{-}CH_2\text{-}CH(H_3C)\text{-}CH\text{-}CH_3$

c) 

g) 

k) 

d) 

h) 

**Random additional questions**

1) When the equation $Fe_2(SO_4)_3 + Ba(OH)_2 \rightarrow$ is completed and balanced, a term in the balanced equation is:
   a. $2\ Fe(OH)_3$
   b. $2\ Fe_2(SO_4)_3$
   c. $2\ Fe(OH)$
   d. $Ba_2(SO_4)_3$

2) When a strong acid reacts with a strong base, which product always forms?

3) When the following equation is balanced, what is the coefficient in front of the underlined substance?

   $C_2H_2 + \underline{O_2} \rightarrow CO_2 + H_2O$

4) The balanced equation $N_2 + 3\ H_2 \rightarrow 2\ NH_3$ can be interpreted by saying that 1 mol of $N_2$ reacts with 3 mol of $H_2$ to form 2 mol $NH_3$.
   a. True
   b. False

5) A 3.0 mol sample of $KClO_3$ was decomposed according to the balanced equation
   $2\ KClO_3 \rightarrow 2\ KCl + 3\ O_2$
   How many moles of $O_2$ are formed assuming a 100% yield?

6) Calculate the moles of oxygen needed to react completely with 11.2 g of octane, $C_8H_{18}$, in the following reaction: $2\ C_8H_{18} + 25\ O_2 \rightarrow 16\ CO_2 + 18\ H_2O$

7) The limiting reactant in a reaction is
   a. the reactant for which there is the fewest number of moles
   b. the reactant which has the lowest coefficient in a balanced chemical equation
   c. the reactant for which there is the least amount in grams
   d. the reactant for which there is the most amount in grams
   e. the reactant which controls how much product is produced in the reaction

8) Calculate the theoretical amount of iron produced in the reaction of 254 g of iron(II) oxide with 25.0 g of carbon according to the balanced equation
   $2\ Fe_2O_3 + 3\ C \rightarrow 4\ Fe + 3\ CO_2$

9) When $NH_3$ is prepared from 28 g $N_2$ and excess $H_2$, the theoretical yield of $NH_3$ is 34 g. When this reaction is carried out in a given experiment, only 30 g of $NH_3$ is produced. What is the percentage yield?

10) A packet of energy of electromagnetic radiation is called
   a. a photon
   b. a proton
   c. a wavelength
   d. a wave

11) The volume in space that an electron might occupy in the quantum mechanical theory is called
   a. an orbit
   b. an orbital
   c. an electron configuration
   d. a photon
   e. a nucleus

12) As the principle energy level increases in an atom's orbitals, the average distance of an electron energy level from the nucleus

13) The maximum number of electrons in **each** of the *p* orbitals is _____ .

14) A *d* sublevel can hold a maximum of _____ .

15) Which of the following choices is an INCORRECT designation for an atomic orbital
   a. 1 *p*
   b. 3 *d*
   c. 1 *s*
   d. 6 *s*
   e. 4 *f*

16) The electron configuration for the phosphorus atom is _____ .

17) Which atom has the electron configuration $1s^2 2s^2 2p^6 3s^2 3p^6 4s^2 3d^1$ ?

18) Metal atoms tend to _____ electrons and form _____ ions.

19) Chemical bonds formed by the attraction of oppositely charged ions are called

20) Chemical bonds formed by the sharing of two or more electrons between atoms are called

21) Which one of the following compounds contains an ionic bond?
   a. $CCl_4$
   b. NaCl
   c. $S_8$
   d. $SO_2$
   e. $O_2$

22) Which one of the following compounds contains one or more covalent bonds?
   a. $BaBr_2$
   b. $Cs_2O$
   c. CaO
   d. $CO_2$
   e. NaCl

Use the following choices to describe the molecular structure of each of the following molecules or ions. (questions 23 through 27)
   a. linear
   b. trigonal planar
   c. tetrahedral
   d. pyramidal
   e. bent

23) $O_3$

24) $BF_3$

25) CO

26) $CO_{3-2}$

27) $SiCl_4$

28) A balloon has a volume of 1.20 L at 24.0 °C. The balloon is heated to 48.0 °C. Calculate the new volume of the balloon.

29) One mole of $CO_2$ gas at STP will occupy _____ .

30) A 25.0 L sample of gas at STP is heated to 55.0 °C at 605 mm Hg. What is the new volume?

31) Zinc metal is added to hydrochloric acid to generate hydrogen gas over a liquid whose vapor pressure is the same as pure water at 20.0 °C (18 mm Hg). The volume of the mixture is 1.7 L and its total pressure is 0.810 atm. What is the partial pressure of hydrogen gas in the mixture?

32) $C_2H_4$ reacts with $O_2$ according to the following balanced equation:

$C_2H_4 + 3\ O_2 \rightarrow 2\ CO_2 + 2\ H_2O$

What volume of oxygen at STP is needed to react with 1.50 mol of $C_2H_4$?

33) The normal freezing point of water is (in K) _____

34) The normal boiling point of water is (in K) _____

35) A 100.0 mL sample of nitric acid solution that is 16.0 *M* $HNO_3$ contains _____ _____ moles of $HNO_3$.

36) Calculate the mass (in grams) of silver nitrate in a 145 mL solution of 4.31 *M* $AgNO_3$.

37) What volume of 18.0 *M* $H_2SO_4$ sulfuric acid must be used to prepare 15.5 L of 0.195 *M* $H_2SO_4$?

38) What mass of AgCl is produced when 155 mL of a 0.104 *M* solution of NaCl is reacted with 125 mL of a 0.136 *M* solution of $AgNO_3$?

39) A triple bond involves the sharing of _____ electrons.

40) When aqueous solutions of lead (II) nitrate are treated with potassium chromate solution, a bright yellow precipitate of lead (II) chromate, $PbCrO_4$, forms. How many grams of lead (II) chromate form when a 10.0 g sample of $Pb(NO_3)_2$ is added to 25.0 mL of 1.00 *M* $K_2CrO_4$ solution?

41) An oven-cleaning solution is 40.0% (by mass) NaOH. If one jar of the product contains 454 g of solution, how many grams of NaOH does it contain?

42) What volume of a 10.0 *N* $H_2SO_4$ solution is needed to completely neutralize 575 mL of a 4.10 *M* KOH solution?

43) Assume that vinegar is a 0.852 *M* solution of acetic acid ($HC_2H_3O_2$) in water. What volume of 0.2136 *M* NaOH would be needed to completely neutralize 5.26 mL of vinegar?