

Name: _____

Period: _____

Part I – Intro to Chemistry

Measurements- Measure each of the following using correct significant figures. Include units in your answer.

1) _____

2) _____

3) _____

4) _____

5) _____

6) _____

7) _____

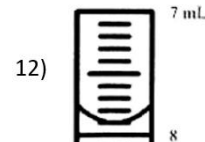
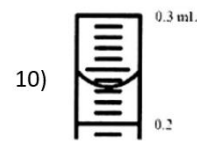
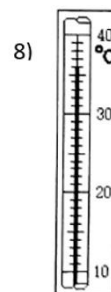
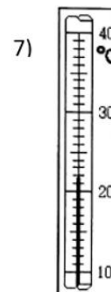
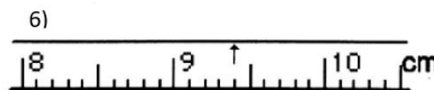
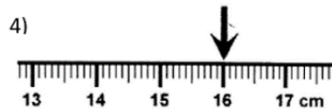
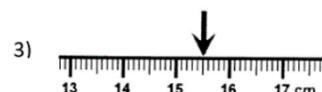
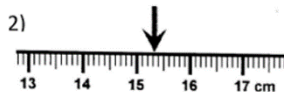
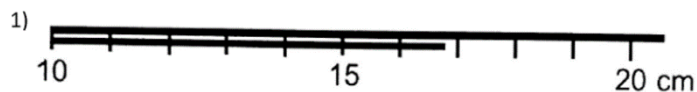
8) _____

9) _____

10) _____

11) _____

12) _____



Significant Figures and Scientific Notation

How many sig figs are in the following numbers?

1) 420.0 _____

2) 7589 _____

3) 432506.43 _____

4) 0.0000476 _____

5) 4.30000×10^{-22} _____

6) 35.17 _____

7) 0.0000004 _____

8) 8671.5 _____

9) 460.046 _____

10) 0.008000 _____

11) 45.00 _____

12) 3.1 _____

13) 600 _____

14) 7.0101010 _____

Express your answers with the appropriate number of sig figs:

15) $422.6 + 23.135 + 310.04 =$

16) $123.009 + 16.001 + 22.6 =$

17) $44.79 - 2.3 - 0.0045 =$

18) $2.90 \times 0.01733 \times 920 =$

19) $(72)(4.022) / 9.03$

20) $(657.89) / 32.9 =$

21) $(34.567)(89.2)(54) =$

22) $789.235 / 47.36 =$

23) $0.300 \times 120 \times 678 =$

26) $1.58 \times 10^{12} / 9.44 \times 10^9 =$

24) $(350.1 - 19) \times 30.0 =$

27) $(3 \times 10^{-3}) (3.21 \times 10^5) =$

25) $890 / 0.500 =$

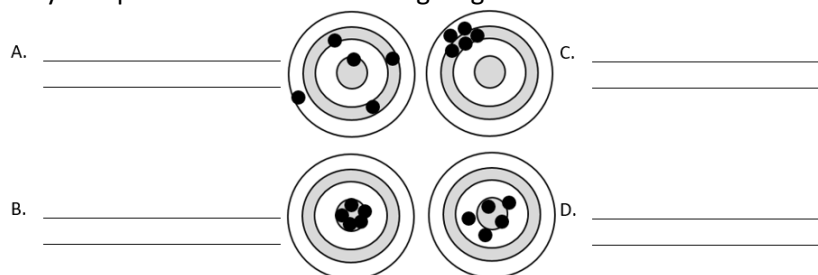
28) $4.000 \times 10^{15} / 6.02 \times 10^{23} =$

Accuracy and Precision

- 1) A student experimentally determined the density of copper and recorded data in the table below. The actual density of copper is 8.96 g/mL. Describe the accuracy and precision of the student's data:

Trial #	Density of Copper
Trial 1	4.95 g/mL
Trial 2	4.98 g/mL
Trial 3	4.98 g/mL
Trial 4	4.96 g/mL

- 2) Describe the accuracy and precision for the following targets:

**Conversions**

- Express the following in the units asked for.
 - Speed of light, 3×10^8 m/s, in miles per hour.
 - Speed of sound, 740 mph, in kilometers per hour and meters/sec.
 - Length of a C-C bond in diamond, 1.54452 Å, in cm, m, and inches ($1 \text{ Å} = 10^{-10} \text{ m}$)
 - Temperature
 - Liquid nitrogen -195 C, in F and K
 - Body Temp, 98 F, in C and K
 - Paper Flashpoint, 450 F, in C and K
- A pitcher can throw a fastball that is clocked at 91.2 miles per hour. How many seconds does it take the fastball to travel from the pitcher's mound to home plate, a distance of 18.44 meters? (hint: start with 18.44 m)
- Assume a milliliter of water contains 20. Drops. How many drops of water are there in 2.50 gallons of water?
- Chloroform is a liquid with a sticky sweet odor that was once used as a surgical anesthetic. If the density of chloroform is 1.49 g/mL, what is the volume in (liters) of 2.50 pounds of chloroform? (1 lb = 454g)

Part II – Atomic Theory and Periodic Trends

Fill in the chart below.

Nuclear Symbol	Atomic Number	Mass Number	# of Protons	# of Neutrons	# of Electrons	Family	Period
	1				1		
${}^6_6\text{C}$							
		32		16			
			19		18		
${}^3_3\text{Li}^{+1}$							
	30				28		
						Halogen	2
${}^{17}_{17}\text{Cl}^{-}$							
	92						
	8				10		
${}^{12}_{12}\text{Mg}^{2+}$							
	7				10		
${}^{33}_{33}\text{As}^{3-}$							
	47				46		

Average atomic mass calculations

- 1) Are there more Bromine-79 atoms or more Bromine-80 atoms on earth? (Hint: look at the periodic table.) Bromine has two isotopes, Br-79 (mass 78.9183, 50.5% abundant) and Br-81 (mass 80.9163, 49.5% abundant). Calculate the average mass of bromine.
- 2) Calculate the atomic mass of an element if 60.4% of the atoms have a mass of 68.9257 amu and the rest have a mass of 70.9249 amu. Identify the element in the periodic table.
- 3) Nitrogen is made up of two isotopes, N-14 and N-15. N-14 has a mass of 14.003074 and 99.3% abundant. N-15 has a mass of 15.000108 and 0.7%. Calculate the average mass of nitrogen.
- 4) Chlorine is made up of two isotopes, Cl-35 and Cl-37. Cl-35 has a mass of 34.9689 and is 75.77% abundant. Cl-37 has a mass of 36.9659 and is 24.23% abundant. Calculate the average mass of chlorine.

Electron Configurations and Orbital Diagrams

Write the complete electron for the following atoms or ions.

	Symbol	# e ⁻	Full Electron Configuration
1)	Mg		
2)	P		
3)	V		
4)	Ge		
5)	Kr		
6)	Al ⁺³		
7)	Fe ⁺²		
8)	Cl ⁻¹		
9)	O ⁻²		

Write the shorthand electron configurations for the following.

	Symbol	# e ⁻	Shorthand Electron Configuration
1)	Ag		
2)	Se ⁻²		
3)	N ⁻³		
4)	Na ⁺¹		
5)	Zn		
6)	Ca		
7)	Pb		
8)	U		
9)	Ti		
10)	Au		
11)	Ne		

Draw the orbital diagram for the following. You may use shorthand:

	Symbol	Orbital Diagram
1)	As	
2)	Hg	
3)	Be	
4)	Ni	
5)	Cu	

Which of the following “rules” is being violated in each electron configuration below? **Explain** your answer for each.

6)	$\uparrow\downarrow$ $\uparrow\downarrow$ $\uparrow\downarrow$ $_ _$ 1s 2s 2p
7)	$\uparrow\downarrow$ $\uparrow\downarrow$ $\uparrow\downarrow\uparrow\downarrow\uparrow\downarrow$ $_ _$ $\uparrow\downarrow\uparrow\uparrow$ 1s 2s 2p 3s 3p
8)	$\uparrow\downarrow$ $\uparrow\downarrow$ $\uparrow\downarrow\uparrow\downarrow\uparrow\downarrow$ $\uparrow\uparrow$ $\uparrow\downarrow\uparrow\downarrow\uparrow$ 1s 2s 2p 3s 3p
9)	$\uparrow\downarrow$ $\uparrow\downarrow$ $\uparrow\downarrow\uparrow\downarrow\uparrow\downarrow$ $\uparrow\downarrow$ $\uparrow\downarrow\uparrow\downarrow\uparrow\downarrow$ $\uparrow\downarrow\uparrow\downarrow\uparrow\downarrow\uparrow\downarrow$ 1s 2s 2p 3s 3p 3d

Periodic Trends

List the following elements in order of increasing atomic radius:

- 1) Al, Mg, S _____
- 2) Sn, F, Rb _____
- 3) Kr, Xe, He _____
- 4) Se, O, S _____

List the following elements in order of decreasing ionic radius:

- 5) Pb, Pb⁺², Pb⁺⁴ _____
- 6) S, S⁻² _____
- 7) I, I⁻¹ _____
- 8) Ti, Ti⁺², Ti⁺³ _____

List the following elements in order of increasing ionization energy:

- 9) Ag, Fr, Cl _____
- 10) Si, Ca, Cs _____
- 11) V, Mn, Zn _____
- 12) Cd, Zn, Hg _____

List the following elements in order of decreasing electronegativity:

- 13) As, Li, Rb _____
- 14) F, Na, S _____
- 15) Ga, B, Ba _____
- 16) Al, Ge, Sb _____

List the following elements in order of increasing metallic characteristic:

- 17) O, Sr, Ag _____
- 18) Ne, Li, C _____
- 19) Br, Hg, Os _____
- 20) Fr, K, Cs _____

For each of the following, circle all the correct elements

21) N	P	As	Smallest ionization energy
22) O	C	N	Highest ionization energy
23) K	Ca	Ga	Largest atomic radius
24) Al	Si	P	Most electronegative
25) Cl	Br	I	Least electronegative
26) Cl	Br	I	Smallest atomic radius
27) Te	I	Xe	Largest atomic radius
28) Na	K	Rb	Smallest ionic radius
29) Cu ⁺¹	Cu ⁺²	Cu ⁺³	Largest ionic radius
30) Li	Be	B	Most metallic characteristic
31) H	Li	Na	Most electronegative
32) Hg	Tl	Pb	Smallest atomic radii
33) Pb	Bi	Te	Lowest electronegativity
34) B	C	N	Can form a diatomic molecule
35) Ca	Ge	Se	Highest ionization energy
36) Sb	Te	Sr	Smallest atomic radius
37) Br	Br ⁻¹		Largest ionic radius
38) K	Ti	Cu	Most reactive metal
39) Na	K	Li	Largest atomic radius
40) Na	Mg	Al	Smallest atomic radius
41) N	O	F	Least electronegative
42) Li	Be	B	Lowest ionization energy
43) Na	Mg	Al	Most metallic characteristic
44) H	H ⁺¹	H ⁻¹	Largest ionic radius
45) Cu	Zn	Cd	Highest Ionization Energy

46) Why does atomic radius decrease as you move left to right on the periodic table?

47) Why does atomic radius increase as you move top to bottom on the periodic table?

48) Why does ionization energy increase as you move left to right on the periodic table?

49) Why does ionization energy decrease as you move top to bottom on the periodic table?

50) Why does electronegativity increase as you move left to right on the periodic table?

51) Why does electronegativity decrease as you move top to bottom on the periodic table?

Part III – Bonding and Nomenclature

Indicate if the following are Acids (A), Ionic Compounds (I), or Molecular Compounds (M), indicate the name or formula, AND determine the molar mass of each substance (don't forget to include units).

A, I, or M	Name or formula	Molar mass
_____ 1.	KBr	_____
_____ 2.	H ₃ P	_____
_____ 3.	FeO	_____
_____ 4.	Fe ₂ O ₃	_____
_____ 5.	CuCl ₂	_____
_____ 6.	NO ₂	_____
_____ 7.	CO	_____
_____ 8.	O ₂	_____
_____ 9.	C ₂ H ₆	_____
_____ 10.	Al ₂ (SO ₄) ₃	_____
_____ 11.	HF	_____
_____ 12.	NaOH	_____
_____ 13.	FeCrO ₄	_____
_____ 14.	Pb ₃ (PO ₄) ₂	_____
_____ 15.	H ₂ CO ₃	_____
_____ 16.	P ₂ O ₅	_____
_____ 17.	H ₂ O	_____
_____ 18.	Ca(ClO ₃) ₂	_____
_____ 19.	(NH ₄) ₂ O	_____
_____ 20.	Zn(HCO ₃) ₂	_____
_____ 21.	SnBr ₄	_____
_____ 22.	HClO	_____
_____ 23.	Lithium oxide	_____
_____ 24.	Aluminum sulfide	_____
_____ 25.	Perchloric acid	_____
_____ 26.	Calcium chloride	_____
_____ 27.	Lead (IV) oxide	_____
_____ 28.	Copper (II) iodide	_____
_____ 29.	Hydroiodic acid	_____
_____ 30.	Mercury (II) hydroxide	_____
_____ 31.	Dinitrogen pentoxide	_____
_____ 32.	Carbon tetrahydride	_____
_____ 33.	Dihydrogen monoxide	_____
_____ 34.	Ammonium chloride	_____
_____ 35.	Hydrocyanic acid	_____
_____ 36.	Sulfurous acid	_____
_____ 37.	Copper (I) sulfate	_____
_____ 38.	Sodium phosphate	_____
_____ 39.	nickel(II) nitrate	_____
_____ 40.	Hydrogen gas	_____
_____ 41.	lithium chromate	_____
_____ 42.	potassium permanganate	_____
_____ 43.	silver perchlorate	_____
_____ 44.	silver sulfide	_____
_____ 45.	nickel(II) hydroxide	_____

Lewis Structures: Complete the following table. STAR any molecules that have resonance.

Molecule	Total Valence Electrons	Lewis Structure	Do all atoms have an octet or duet?	# of Single Bonds, # of Double Bonds, # of Triple Bonds	# of unshared pairs of electrons on the Central atom
1) H ₂ O					
2) N ₂					
3) NH ₃					
4) CO ₃ ⁻²					
5) CF ₄					
6) CH ₃ Cl					
7) SO ₃					

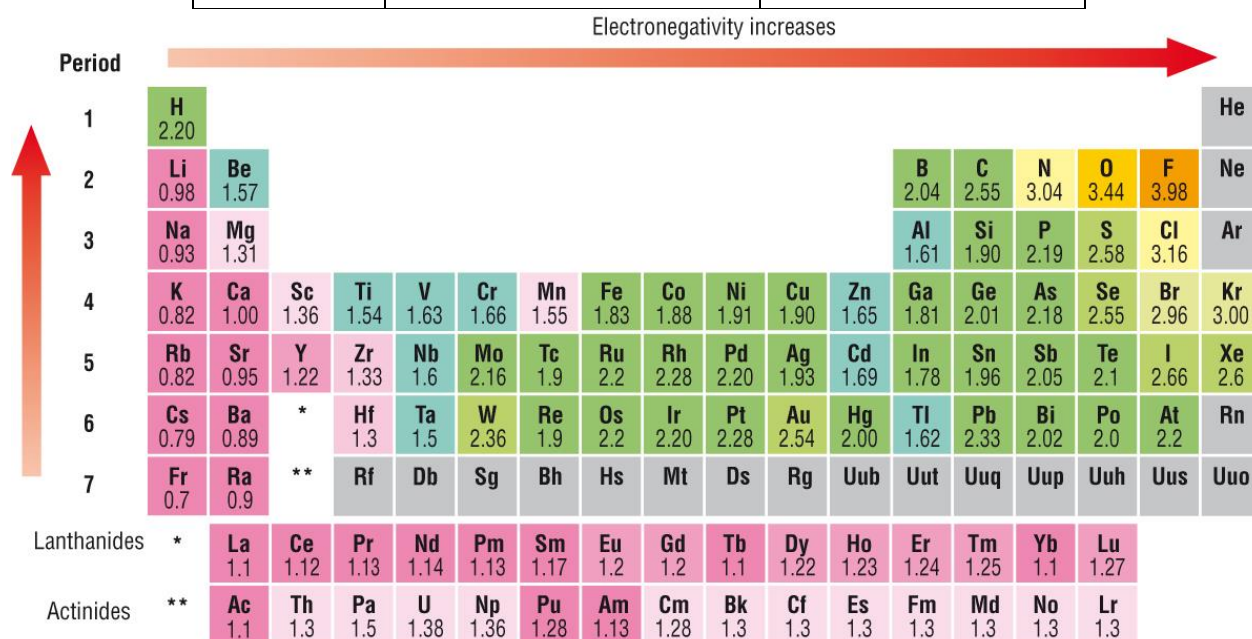
VSEPR: Determine the VSEPR geometry and bond angle for the structures in Part D of the homework packet. Redraw the structure considering VSEPR geometry.

Molecule	VSEPR Geometry	Bond Angle	Picture
1) H ₂ O			
2) N ₂			
3) NH ₃			
4) CO ₃ ⁻²			
5) CF ₄			
6) CH ₃ Cl			
7) SO ₃			

Polarity: Answer the following questions and determine the electronegativity difference and determine what type of bond (polar or nonpolar) exists between the following pairs of atoms:

- 1) Polar bonds have an electronegativity difference _____
- 2) Nonpolar bonds have an electronegativity difference _____
- 3) Ionic bonds have an electronegativity difference _____

Atoms	Electronegativity Difference	Polar or Nonpolar Bond
H and I		
Se and S		
Se and F		
S and O		
H and Br		
C and H		
Se and H		
H and Cl		
I and Br		
Si and Cl		
Cl and O		
S and Cl		
I and Cl		
Cl and Br		
P and O		



Concepts and Vocabulary: Answer the following questions using your notes and/or other resources.

- 1) What is a chemical bond?
- 2) Why do atoms form bonds?
- 3) How are types of bonds determined?
- 4) Fill out the following chart.

Type of Bond	Types of elements involved
Metallic	
	A metal and a non-metal (may contain a polyatomic ion)
Covalent	
Acid	

- 5) What type of bond involves a “sea of electrons”? _____
- 6) What is the octet rule?
- 7) Explain how an ionic bond is formed.
- 8) Ionic bonding are held together by an _____ of _____.
- 9) What is the 3D structure called that ionic compounds form? _____
- 10) List 5 properties of ionic compounds:
 - a.
 - b.
 - c.
 - d.
 - e.
- 11) How are covalent bonds formed?
- 12) List 2 ways ionic and covalent bonds are different:

13) List 5 properties of covalent bonds:

- a.
- b.
- c.
- d.
- e.

14) Why do covalent molecules have lower melting and boiling points than ionic compounds?

15) How do you know how many valence electrons an element has? _____

16) What are 3 exceptions to the octet rule? _____

17) List the 7 diatomic molecules?

18) Fill out the chart below:

Type of Bond	# of electron pairs involved	# of electrons involved	Strength (1 being strongest; 3 being weakest)
Single			
Double			
Triple			

19) What repels more: Bonding pairs or Lone pairs? (circle your answer)

20) What are electron domains? _____

21) How many electron domains would a central atom that has one single bond, one double bond, and one lone pair have? _____

22) What does the word polar mean?

23) What is a polar bond?

24) What is a nonpolar bond?

25) What do the following symbols mean? $\delta+$ _____ $\delta-$ _____

26) How is the polarity of a bond determined? _____

27) Draw a dipole moment: _____ which direction does the arrow point? _____

28) What is a net dipole?

29) What type of molecules have no net dipole? _____

30) Is water polar or nonpolar? _____

31) List 2 properties that polarity effects:

Part IV – The Mole and Chemical Compounds

Percent Composition - Determine the percent composition of each element in the substances listed below. Write your answers in the tables provided. Show ALL of your work for credit.

- 1) A 14.80g sample contains 3.83g of iron and 10.97 g bromine.

% Fe=	
% Br=	

- 2) A 9.14g sample contains 4.77 g of carbon, 1.19 g of hydrogen, and 3.18g of oxygen.

% C=	
% H=	
% O=	

- 3) A 2.85g sample contains 0.82 g of magnesium, 0.41 g of carbon, and 1.62g of oxygen.

% Mg=	
% C=	
% O=	

- 4) CaC_2O_4

% Ca=	
% C=	
% O=	

- 5) $\text{Al}_2(\text{SO}_4)_3$

% Al =	
% S =	
% O =	

- 6) $(\text{NH}_4)_3\text{PO}_4$

% N =	
% H =	
% P =	
% O =	

- 7) How many grams of oxygen can be produced from the decomposition of 100.0 g of KClO_3 ?

- 8) How much iron can be recovered from 25.0g of Fe_2O_3 ?

- 9) How much silver can be produced from 125 g of Ag_2S ?

Mole conversions - Answer the following questions, be sure to include units. Show ALL work for credit.

- 1) How many atoms are contained in 3.46 moles of magnesium?

- 2) What mass would 4.50L of helium gas be at STP?

- 3) Convert 256.3 g of Na_2CO_3 to atoms of Na.

- 4) How many molecules of bromine gas (Br_2) are in 15 L of bromine gas?
- 5) What is the mass of 12.4 molecules of carbon tetrachloride?
- 6) How many moles of carbon dioxide would be in 8.93 L of carbon dioxide?
- 7) How many moles are contained in 0.43 g of Al_2O_3 ?
- 8) The volume of 42.1g of carbon dioxide is _____.
- 9) What is the volume in liters of 9.31×10^{21} molecules of nitrogen gas (N_2)?

Empirical Formula- Determine the empirical formula for the following. Show ALL work for credit.

- 1) Determine the empirical formula from the molecular formulas:

- | | | |
|-------------------------------|--|-----------------------------------|
| a. C_6H_6 | e. $\text{C}_2\text{H}_4\text{O}_2$ | i. $\text{C}_6\text{H}_3\text{O}$ |
| b. C_2H_6 | f. N_2H_4 | j. Na_2SO_4 |
| c. C_3H_8 | g. CaBr_2 | k. $\text{C}_6\text{H}_5\text{N}$ |
| d. $\text{Fe}_3(\text{CO})_9$ | h. $\text{C}_6\text{H}_{12}\text{O}_6$ | l. LiCl |

- 2) Determine the empirical formula from the percent composition for each of the following:

- a. 40.68% carbon, 5.13% hydrogen, and 54.19% oxygen
- b. 22.1% aluminum, 25.4% phosphorous, and 52.5% oxygen
- c. 43.64% phosphorous and the remainder oxygen

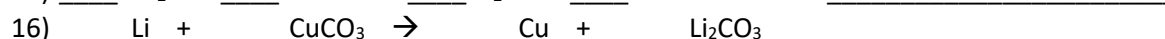
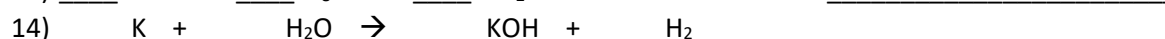
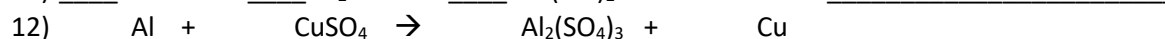
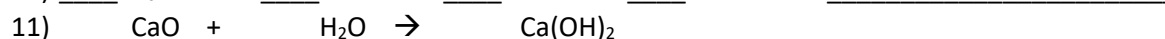
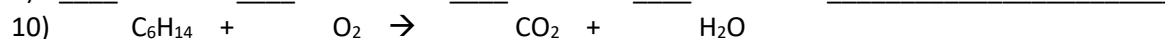
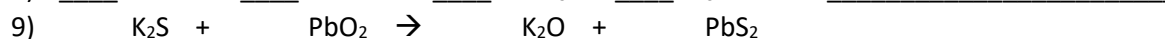
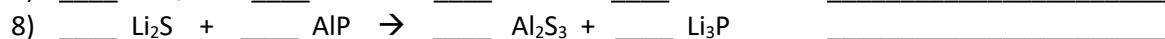
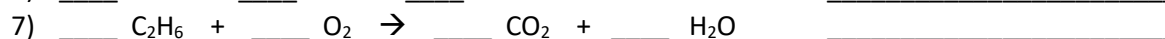
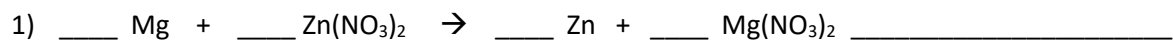
- 3) An analysis of an unknown sample was found to contain 97.56g of carbon, 4.878g of hydrogen, 52.03g of oxygen, and 45.53g of nitrogen. Find the empirical formula for this substance.

Molecular Formulas- Determine the molecular formula for the following. Show ALL work for credit.

- 1) A compound is 79.08% carbon, 5.54% hydrogen, and 15.38% nitrogen. What is the molecular formula of this substance if the molar mass is 273.36 g/mol?
- 2) A compound found to be 40.0% carbon, 6.7% hydrogen, and 53.5% oxygen. Its molar mass is 60.00 g/mol. What is its molecular formula?
- 3) A compound is 64.9% carbon, 13.5% hydrogen, and 21.6% oxygen. Its molar mass is 74.14g/mol. What is its molecular formula?
- 4) If the empirical formula of a compound is NO_2 and its molar mass is 92.00 g/mole, what is its molecular formula?
- 5) The empirical formula for a compound of CH_2 has a molar mass of 70.00 g/mole. What is the molecular formula?

Part V – Chemical Reactions and Equations

Balancing Equations and Types of Reactions- Balance the following (in Part D use the blanks to the right to identify the following reactions):



17) Lithium metal reacts with hydrochloric acid to produce lithium chloride and hydrogen gas.

18) Mercury (II) oxide decomposes to produce mercury and oxygen gas.

19) Magnesium hydroxide decomposes to produce magnesium oxide and water.

20) Copper reacts with chlorine gas to produce copper (II) chloride.

21) Silver Sulfate reacts with sodium bromide to yield sodium sulfate and silver bromide.

22) Aluminum reacts with iron (III) oxide to yield aluminum oxide and iron.

23) Carbon tetrahydride burns in oxygen gas to produce carbon dioxide and water.

24) Aluminum sulfate reacts with calcium hydroxide to produce aluminum hydroxide and calcium sulfate.

Predicting the products from words - In each of the following examples: (a) State what type of reaction is expected, and (b) Write the balanced equation for those reactions.

25) aluminum reacts with hydrochloric acid

26) solutions of calcium hydroxide and nitric acid are mixed

27) a strip of magnesium is placed in a solution of zinc nitrate

28) zinc chloride reacts with hydrosulfuric acid

29) barium nitrate reacts with sodium chromate

30) sodium bromide undergoes electrolysis

31) propane is completely burned in the presence of excess oxygen

- 32) iron(III) hydroxide reacts with phosphoric acid
- 33) sodium plus nitric acid
- 34) zinc reacts with oxygen
- 35) solutions of mercury(I) nitrate and sodium carbonate are mixed
- 36) magnesium plus hydrochloric acid
- 37) lead(II) nitrate and sodium iodide
- 38) chromium(II) perchlorate and sodium sulfide
- 39) ethylene glycol ($C_2H_6O_2$) is burned in oxygen

Stoichiometry

- 1) Lithium perchlorate decomposes to produce lithium chloride and oxygen gas. What volume of oxygen gas can be produced if 100.0 g of lithium perchlorate decompose at STP?
- 2) Hydrogen gas and chlorine gas combine in a synthesis reaction. If 43g of product are produced, how many grams of hydrogen gas was used?
- 3) When 0.46 g of antimony III oxide reacts with carbon to produce antimony metal and carbon monoxide gas, determine the mass of antimony metal produced.
- 4) How many gram of carbon monoxide must react with oxygen to produce 10.0L of carbon dioxide?
- 5) When hydrogen peroxide decomposes, it produces liquid water and oxygen gas. What mass of hydrogen peroxide must decompose to produce 0.77g of liquid water?
- 6) When lithium nitride reacts with water, lithium hydroxide and ammonia gas (NH_3) are produced. Determine the mass of lithium hydroxide produced when 0.38 g of lithium nitride reacts with water.
- 7) 0.29 g Sodium iodide reacts with chlorine gas in a single replacement reaction. How much is produced of the new sodium salt made?

- 8) Ethane gas (C_2H_6) is burned in oxygen gas. What volume of oxygen gas is needed to react with 45.0g of ethane gas?

- 9) Sodium bicarbonate decomposes to produce sodium carbonate, carbon dioxide and water. What mass of each product can be made with 15.0 g of sodium bicarbonate?

Limiting and Excess Reactant

- 1) How much water can be produced when 5.87g of magnesium hydroxide reacts with 12.84g of hydrosulfuric acid to produce liquid water and magnesium sulfide.

- 2) How much $Ca(OH)_2$ will be produced when 43.25g of calcium carbide (CaC_2) reacts with 33.71g of liquid water to produce calcium hydroxide and acetylene (C_2H_2).

- 3) Identify the limiting reactant when 19.9 g of CuO are exposed to 2.02 g of H_2 to produce copper metal and water. How many grams of copper metal would be produced? How much is left of the excess reactant after the reaction is complete?

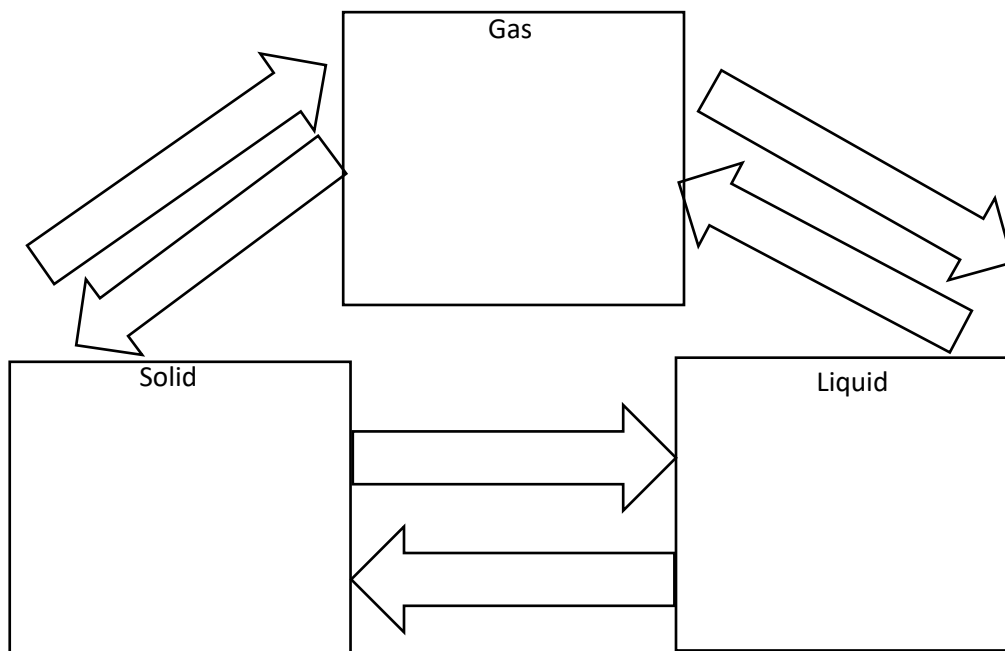
- 6) In a synthesis reaction between 3.44g of Cesium metal and 0.901 L of oxygen 2.83g of product results. What is the percent yield for this reaction?

- 7) Tetraantimony hexoxide reacts with carbon to produce antimony and carbon monoxide. If a mixture of 36.5g of tetraantimony hexoxide and 27.1g carbon produces 17.3g of antimony, what is the percent yield?

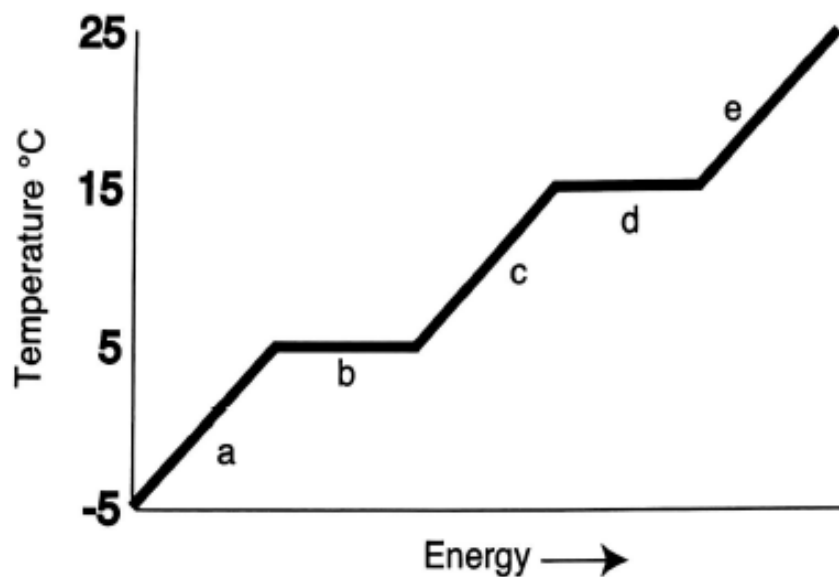
- 8) What is the percent yield for the reaction of 45.9g of sodium bromide with 33.3L chlorine gas, which produces 12.8g of the sodium chloride and an unmeasured amount of bromine gas?

Part VI - Matter and Energy

- 1) Model a substance in its solid, liquid, and gaseous phase below. Write the name of the phase change on the appropriate arrow.



Heating Curve and Q



- 1) What is the freezing Point of the substance? _____
- 2) What is the boiling point of the substance? _____
- 3) What is the melting point of the substance? _____
- 4) What letter represents the range where the solid is increasing in temperature? _____
- 5) What letter represents the range where the liquid is increasing in temperature? _____

- 6) What letter represents the range where the gas is increasing in temperature? _____
- 7) What letter represents the melting of the solid? _____
- 8) What letter represents the vaporization of the liquid? _____
- 9) What letter(s) show a change in potential energy? _____
- 10) What letter(s) show a change in kinetic energy? _____
- 11) What letter represents condensation? _____
- 12) What letter represents crystallization? _____
-
- 1) How much energy (in calories and in Joules) will it take to raise the temperature of 75.0 g of water from 20.0 to 55.0 °C? (specific Heat = 1 cal / (g °C) and 4.184 J / (g °C))
- 2) 350 J are released as ice (specific Heat = 2.1 J/(g °C)) cools from - 5.0 °C to -32 °C. What is the mass of ice?
- 3) By January, the 3.0 kg of water in the birdbath in the backyard has frozen to a temperature of -7.0°C. As the season changes, how much heat must be added to the water to make it a comfortable 25°C for the birds? ($c_{\text{water}} = 4.184 \text{ J/(g °C)}$ ($c_{\text{ice}} = 2.1 \text{ J/(g °C)}$) (ΔH_{fus} of water = $3.35 \times 10^5 \text{ J/kg}$))
- 4) Consider a 0.63-kg sample of metal at room temperature of 20°C. The addition of $6.42 \times 10^5 \text{ J}$ increases its temperature to its melting point (782°C). An additional $5.94 \times 10^4 \text{ J}$ causes the sample to completely liquefy. (a) What is the specific heat capacity of the sample? (b) What is the heat of fusion of the metal?
- 5) How much energy would be required to melt 10.0 g of ice (Specific Heat = 2.1 J/(g °C)) at 0 °C, warm the resulting liquid (Specific Heat = 4.184 J/(g °C)) to 100 °C, and change it to steam at 100 °C? (ΔH_{fus} of water = $3.35 \times 10^5 \text{ J/kg}$; $\Delta H_{\text{vap}} = 2.3 \times 10^6 \text{ J/kg}$)
- 6) How many grams of steam could be condensed at 100 °C with the removal of 307 kJ of energy? $\Delta H_{\text{vap}} = 2.3 \times 10^6 \text{ J/kg}$.

Hess's Law- Include units and show ALL WORK!

1) Calculate the heat of reaction for: $\text{PbCl}_2(\text{s}) + \text{Cl}_2(\text{g}) \rightarrow \text{PbCl}_4(\text{l})$ $\Delta H = ?$

Given the following: $\text{Pb}(\text{s}) + \text{Cl}_2(\text{g}) \rightarrow \text{PbCl}_2(\text{s})$ $\Delta H = -359.40 \text{ kJ}$

$\text{Pb}(\text{s}) + 2 \text{Cl}_2(\text{g}) \rightarrow \text{PbCl}_4(\text{l})$ $\Delta H = -329.30 \text{ kJ}$

2) From the following heats of reaction: $2 \text{SO}_2(\text{g}) + \text{O}_2(\text{g}) \rightarrow 2 \text{SO}_3(\text{g})$ $\Delta H = -196.00 \text{ kJ}$

$2 \text{S}(\text{s}) + 3 \text{O}_2(\text{g}) \rightarrow 2 \text{SO}_3(\text{g})$ $\Delta H = -790.00 \text{ kJ}$

Calculate the heat of reaction for: $\text{S}(\text{s}) + \text{O}_2(\text{g}) \rightarrow \text{SO}_2(\text{g})$ $\Delta H = ? \text{ kJ}$

3) Given the following equations: $4 \text{NH}_3(\text{g}) + 5 \text{O}_2(\text{g}) \rightarrow 4 \text{NO}(\text{g}) + 6 \text{H}_2\text{O}(\text{l})$ $\Delta H^\circ = -1170 \text{ kJ}$

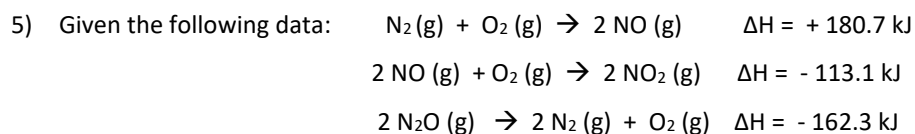
$4 \text{NH}_3(\text{g}) + 3 \text{O}_2(\text{g}) \rightarrow 2 \text{N}_2(\text{g}) + 6 \text{H}_2\text{O}(\text{l})$ $\Delta H^\circ = -1530 \text{ kJ}$

Using these two equations, determine the heat of formation, ΔH_f , for nitrogen monoxide. $\text{N}_2(\text{g}) + \text{O}_2(\text{g}) \rightarrow 2\text{NO}(\text{g})$

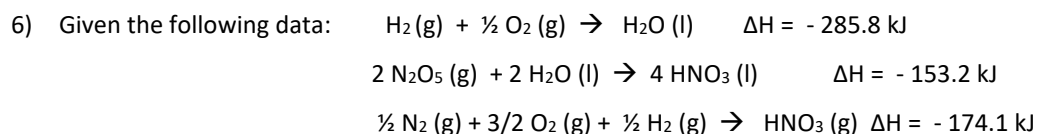
4) From the following heats of reaction: $2 \text{H}_2(\text{g}) + \text{O}_2(\text{g}) \rightarrow 2 \text{H}_2\text{O}(\text{g})$ $\Delta H = -483.6 \text{ kJ}$

$3 \text{O}_2(\text{g}) \rightarrow 2 \text{O}_3(\text{g})$ $\Delta H = +284.6 \text{ kJ}$

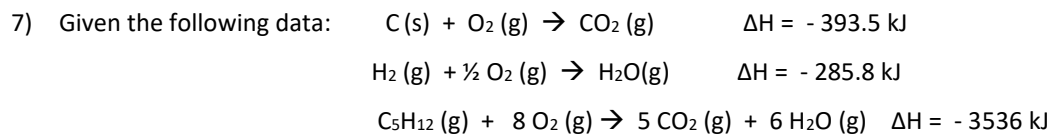
Calculate the heat of the reaction for: $3 \text{H}_2(\text{g}) + \text{O}_3(\text{g}) \rightarrow 3 \text{H}_2\text{O}(\text{g})$



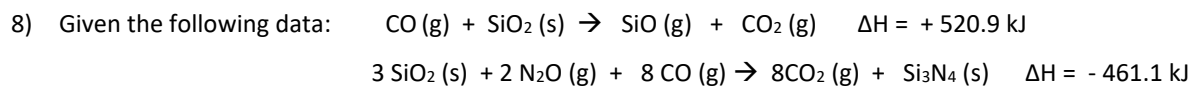
Use Hess's law to calculate ΔH for the following reaction: $\text{N}_2\text{O}(\text{g}) + \text{NO}_2(\text{g}) \rightarrow 3 \text{NO}(\text{g})$



Use Hess's law to calculate ΔH for the following reaction: $2 \text{N}_2(\text{g}) + 5 \text{O}_2(\text{g}) \rightarrow 2 \text{N}_2\text{O}_5(\text{g})$



Use Hess's law to calculate ΔH for the following reaction: $5 \text{C}(\text{s}) + 6 \text{H}_2(\text{g}) \rightarrow \text{C}_5\text{H}_{12}(\text{g})$



Use Hess's law to calculate ΔH for the following reaction: $5 \text{CO}_2(\text{g}) + \text{Si}_3\text{N}_4(\text{s}) \rightarrow 3 \text{SiO}(\text{g}) + 2 \text{N}_2\text{O}(\text{g}) + 5 \text{CO}(\text{g})$

Heat of Formation

- 1) The standard enthalpy of formation of propane, C_3H_8 , is -103.6 kJ/mole. Calculate the heat of combustion of C_3H_8 . The heats of formation of $CO_2(g)$ and $H_2O(l)$ are -394 kJ/mole and -285.8 kJ/mole respectively. Diatomic molecules have a heat of formation of 0 kJ/mole. $C_3H_8 + 5O_2 \rightarrow 3CO_2 + 4H_2O$
- 2) The standard enthalpy of formation of propyne, C_3H_4 , is $+185.4$ kJ/mole. Calculate the heat of combustion of C_3H_4 . The heats of formation of $CO_2(g)$ and $H_2O(l)$ are -394 kJ/mole and -285.8 kJ/mole respectively.
 $C_3H_4 + 4O_2 \rightarrow 3CO_2 + 2H_2O$
- 3) The standard enthalpy of formation of ethanol, C_2H_5OH , is -277.7 kJ/mole. Calculate the heat of combustion of C_2H_5OH . The heats of formation of $CO_2(g)$ and $H_2O(l)$ are -394 kJ/mole and -285.8 kJ/mole respectively.
 $C_2H_5OH + 3O_2 \rightarrow 2CO_2 + 3H_2O$

Stoichiometry

- 1) If 245 L of chlorine gas reacts with excess phosphorous trichloride, what amount of energy is released?
 $\text{_____ } PCl_3(g) + \text{_____ } Cl_2(g) \rightarrow \text{_____ } PCl_5(g) \Delta H = -87.9 \text{ kJ}$
- 2) If 300.0 kJ of energy is absorbed, what volume of oxygen gas is produced?
 $\text{_____ } SO_3(g) \rightarrow \text{_____ } SO_2(g) + \text{_____ } O_2(g) \Delta H = 197.9 \text{ kJ}$
- 3) How many kilojoules are given off when 8.32 g of Mg react?
 $\text{_____ } Mg(s) + \text{_____ } O_2(g) \rightarrow \text{_____ } MgO(s) \Delta H = -1,213 \text{ kJ}$
- 4) Glucose is the main fuel metabolized in animal cells: $C_6H_{12}O_6 + 6O_2 \rightarrow 6CO_2 + 6H_2O \Delta H = -2,799 \text{ kJ}$
How much energy is given off when 100.0 g of $C_6H_{12}O_6$ react?

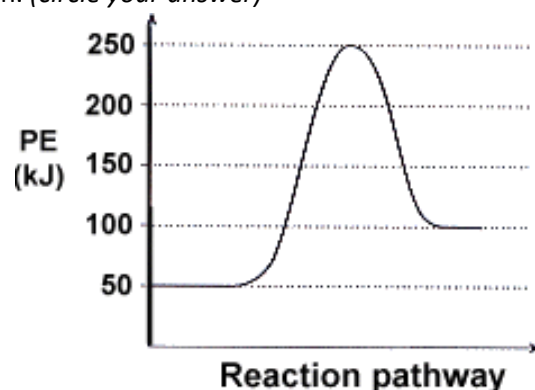
- 5) Given the thermochemical equation: $\text{___ Al(s)} + \text{___ Fe}_2\text{O}_3\text{(s)} \rightarrow \text{___ Al}_2\text{O}_3\text{(s)} + \text{___ Fe(s)}$ $\Delta H = -850.2 \text{ kJ}$
How much energy is given off when 288 g of Fe are produced?
- 6) Given the thermochemical equation: $\text{___ CO}_2\text{(g)} \rightarrow \text{___ CO(g)} + \text{___ O}_2\text{(g)}$ $\Delta H = 566 \text{ kJ}$. How much energy is absorbed when 85.2 g of CO₂ are reacted?
- 7) NaHCO₃ decomposes when exposed to heat. What mass of NaHCO₃ is decomposed by 256 kJ?
 $\text{___ NaHCO}_3\text{(s)} \rightarrow \text{___ Na}_2\text{CO}_3\text{(s)} + \text{___ CO}_2\text{(g)} + \text{H}_2\text{O(l)}$ $\Delta H = 91.5 \text{ kJ}$.

Reaction Diagrams

- 1) Answer the following questions based on the potential energy diagram shown:
- This graph represent an (**endothermic / exothermic**) reaction. (*circle your answer*)
 - Label the reactants, products, and activated complex.
 - Draw a dashed line on the diagram to indicate a potential energy curve for the reaction if a catalyst is added.
 - Determine the heat of reaction, ΔH , (enthalpy change) for this reaction. _____
 - Determine the activation energy, E_a for this reaction.

 - How much energy is required for this reaction to occur?

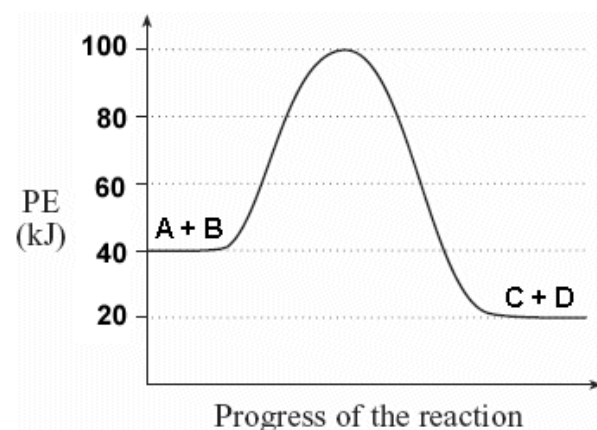
 - What is the ΔH for the reverse reaction? _____
 - What is the activation energy for the reverse reaction?



- 2) Answer the following questions based on the potential energy diagram shown here:
- This graph represent an (**endothermic / exothermic**) reaction. (*circle your answer*)
 - Label the reactants, products, and activated complex.
 - Draw a dashed line on the diagram to indicate a potential energy curve for the reaction if a catalyst is added.
 - Determine the heat of reaction, ΔH , (enthalpy change) for this reaction. _____
 - Determine the activation energy, E_a for this reaction.

 - How much energy is required for this reaction to occur?

 - What is the ΔH for the reverse reaction? _____
 - What is the activation energy for the reverse reaction? _____



Part VII - Gases

- 1) List the 5 parts of the Kinetic Molecular Theory.
 - a.
 - b.
 - c.
 - d.
 - e.

Ideal Gas Law

- 1) If I have 4.0 moles of gas at a pressure of 5.6 atm and a temperature of 25°C, what is the volume of the gas?
- 2) If I have an unknown quantity of gas at a pressure of 1.2 atm, a volume of 31 liters, and a temperature of 87 °C, how many moles of gas do I have?
- 3) If I contain 3.00 moles of gas in a container with a volume of 60.0 liters and at a temperature of 400. K, what is the pressure inside the container?
- 4) If I have 77 grams of oxygen gas at a temperature of 67 °C in a volume of 88.89 liters, what is the pressure of the gas?
- 5) If a sample of gas neon gas occupies a volume of 25 liters at a pressure of 0.50 atm and a temperature of 300. K, what is the mass of the sample?

Gas Stoichiometry

- 1) How many liters of ozone (O₃) can be destroyed at 220.0 K and 0.550 atm if 258 g of chlorine gas react with it?
$$\underline{\hspace{1cm}} \text{Cl}_2(\text{g}) + \underline{\hspace{1cm}} \text{O}_3(\text{g}) \rightarrow \underline{\hspace{1cm}} \text{ClO}(\text{g}) + \underline{\hspace{1cm}} \text{O}_2(\text{g})$$
- 2) What mass of aluminum is consumed along with excess HCl if 8.90 L liters of hydrogen gas is collected at 300.0 K and 1.25 atm according to the following equation? $\underline{\hspace{1cm}} \text{Al}(\text{s}) + \underline{\hspace{1cm}} \text{HCl}(\text{aq}) \rightarrow \underline{\hspace{1cm}} \text{AlCl}_3(\text{aq}) + \underline{\hspace{1cm}} \text{H}_2(\text{g})$

- 11) A mass of 70 g of NaNO_3 is dissolved in 100 g of water at 10°C . The solution is heated to 35°C . How many more grams of sodium nitrate must be added to make the solution saturated? _____
- 12) A solution of KCl is saturated in 100 g of water at 80°C . The solution is cooled to 60°C to become supersaturated. How much excess KCl is dissolved in solution? _____
- 13) A solution of NaNO_3 is saturated in 100 g of water at 40°C . The solution is cooled to 20°C to become supersaturated. How much excess NaNO_3 is dissolved in solution? _____
- 14) On a solubility curve, the points on the curve indicate a _____ solution.
- 15) Values on the graph _____ a curve represent **unsaturated solutions**.

Label the following solutions as saturated, unsaturated, or super saturated. If unsaturated, write how much more solute can be dissolved in the solution.

- 16) A solution that contains 70g of NaNO_3 at 30°C (in 100 mL H_2O): _____
- 17) A solution that contains 50g of NH_4Cl at 50°C (in 100 mL H_2O): _____
- 18) A solution that contains 70g of KI at 0°C (in 100 mL H_2O): _____
- 19) A solution that contains 20g of KClO_3 at 50°C (in 100 mL H_2O): _____
- 20) A solution that contains 20g of NH_3 at 80°C (in 100 mL H_2O): _____

Molarity and Making Solutions- *Answer the following questions. Show ALL WORK and include units!*

- 1) What is the molarity of a solution with a volume of 6.700 L that contains 1.200 moles of calcium chloride?

- 2) How many moles of cesium acetate are dissolved in 890. mL of a 0.900 M solution?

- 3) What is the volume of a 0.450 M solution that contains 0.290 moles of chloric acid.

- 4) What is the molarity that was made by dissolving 250. g of hydrobromic acid in 675 mL of solution?

- 5) What mass of nickel (I) chloride is dissolved in 500.0 mL of a 1.25 M solution?

- 6) What is the volume of a solution with a molarity of 0.725 M that was made with 35.0 g of ammonium fluoride?

- 7) What mass of potassium acetate is dissolved in 25.0 mL of a 0.110 M solution?

8) Your teacher asks you to prepare 500. mL of a 2.75 molar solution of NaCl for a lab. Write a step-by-step procedure describing how you would carry out this task.

9) Your teacher asks you to prepare 250 mL of a 0.35M solution of HC₂H₃O₂ for an upcoming lab. Write a step-by-step procedure describing how you would carry out this task.

Dilutions- Answer the following questions. Show ALL WORK and include units.

1) What is a dilution?

2) Describe the step-by-step process of diluting 0.50L of a 1.0M solution of NaCl to a 0.50M solution of NaCl.

3) In question number 2, during the dilution, what happened to...

- | | |
|--------------------------------|---------------------------------------|
| a. The concentration? | Increase – Decrease – Remain the same |
| b. The volume of the solution? | Increase – Decrease – Remain the same |
| c. The amount of solvent? | Increase – Decrease – Remain the same |
| d. The amount of solute? | Increase – Decrease – Remain the same |

4) Model the solution on the molecular level from number 2 before and after the dilution. Include a key if necessary.

BEFORE	AFTER
KEY	

5) If 45 mL of water is added to 250mL of a 0.75 M K₂SO₄ solution, what will the molarity of the diluted solution be?

- 6) If water is added to 175 mL of a 0.45 M KOH solution until the volume is 250 mL, what will the molarity of the diluted solution be?
- 7) How much 0.075 M NaCl solution can be made by diluting 450 mL of 9.0 M NaCl?
- 8) If 550 mL of a 3.50 M KCl solution are set aside and allowed to evaporate until the volume of the solution is 275 mL, what will the molarity of the solution be?
- 9) How much water would need to be added to 750 mL of a 2.8 M HCl solution to make a 1.0 M solution?
- 10) If I add water to 100 mL of a 0.15 M NaOH solution until the final volume is 150 mL, what will the molarity of the diluted solution be?
- 11) How much 0.05 M HCl solution can be made by diluting 250 mL of a 10 M HCl solution?
- 12) I have 345 mL of a 1.5 M NaCl solution. If I boil the water until the volume of the solution is 250 mL, what will the molarity of the solution be?
- 13) How much water would I need to add to 500 mL of a 1.0 M KCl solution to make a 2.4 M solution?
- 14) How much of a 5.00 M stock solution of copper (II) sulfate is needed to make 500.0 mL of a 0.35 M solution?
- 15) If 6.0 L of a 1.50 M AgNO_3 solution is set aside and allowed to evaporate until the volume of the solution is 4.2 L, what will the molarity of the solution be?

Solution Stoichiometry- Answer the following questions. Show ALL WORK and include a balanced equation and units!

- 1) If 10.0 mL of a 2.25 M sodium carbonate solution reacts with excess iron (III) chloride solution, what mass of iron (III) carbonate precipitates out of solution? $___ \text{FeCl}_3(\text{aq}) + ___ \text{Na}_2\text{CO}_3(\text{aq}) \rightarrow ___ \text{Fe}_2(\text{CO}_3)_3(\text{s}) + ___ \text{NaCl}(\text{aq})$
- 2) A chemist reacts 75.0 mL of 0.200 molar iron (III) chloride solution completely with an excess of 0.250 M sodium carbonate solution. What volume of sodium carbonate solution is needed?
- 3) What volume of 0.20 M AgNO_3 will be needed to react completely with 25.0 mL of 0.50 M potassium phosphate?
- 4) What mass of precipitate is produced from the above reaction?
- 5) What mass of precipitate should result when 0.550 L of 0.500 mol/L aluminum nitrate solution is mixed with 0.240 L of 1.50 mol/L sodium hydroxide solution?
- 6) If 25.0 mL of 0.750 M Copper (II) sulfate solution is mixed with excess sodium chloride solution, what is the theoretical yield of copper (II) chloride (sodium sulfate is the other product)?
- 7) What is the limiting reactant if 0.50 L of 0.50 M Copper (II) sulfate solution is mixed with 0.50 L of 0.50 mol/L sodium chloride solution?

Part IX - Acids and Bases

- When describing an acid or a base, what do the terms strong and weak mean?
- In your own words, what is the difference between Arrhenius's definition and Bronsted-Lowry's definition of acids and bases?
- What type of substances are strong electrolytes?
- What type of substances are weak electrolytes?
- What is an amphoteric substance? Given an example of one.
- Write the reaction for the auto ionization of water:
- Explain why NH_3 is considered a Bronsted-Lowry base, but not an Arrhenius base.
- What happens to the charge of a substance if it gains a proton (H^+)? _____
- What happens to the charge of a substance if it loses a proton (H^+)? _____
- When an acid (gains/loses) a proton, it becomes the conjugate (acid/base). (circle the correct answers)
- When a base (gains/loses) a proton, it become the conjugate (acid/base). (circle the correct answers)

Conjugate Acid-Base Pairs

Acid	Conjugate Base
H_3O^{+1}	
	OH^{-1}
HCl	
	$\text{H}_2\text{PO}_3^{-1}$

Base	Conjugate Acid
NH_3	
	H_2O
H_2O	
	HBr

For the following equations, label the Bronsted-Lowry acid/base AND label the conjugate acid and conjugate base.

- $$\text{HC}_2\text{H}_3\text{O}_2 + \text{H}_2\text{O} \leftrightarrow \text{H}_3\text{O}^{+1} + \text{C}_2\text{H}_3\text{O}_2^{-1}$$
- $$\text{HCO}_3^{-1} + \text{H}_2\text{O} \leftrightarrow \text{H}_2\text{CO}_3 + \text{OH}^{-1}$$
- $$\text{HNO}_3 + \text{SO}_4^{-2} \leftrightarrow \text{HSO}_4^{-1} + \text{NO}_3^{-1}$$
- $$\text{HF} + \text{H}_2\text{O} \leftrightarrow \text{F}^{-1} + \text{H}_3\text{O}^{+1}$$
- $$\text{HNO}_2 + \text{H}_2\text{O} \leftrightarrow \text{H}_3\text{O}^{+1} + \text{NO}_2^{-1}$$
- $$\text{H}_2\text{O} + \text{S}^{-2} \leftrightarrow \text{HS}^{-1} + \text{OH}^{-1}$$

i.	$3.8 \times 10^{-5} \text{ M}$				
j.			13.1		
k.	$1 \times 10^{-10} \text{ M}$				
l.				2.67	

Part X - Reaction Rates and Equilibrium

- 1) List 5 factors that affect the rate of a reaction:
 - a. _____
 - b. _____
 - c. _____
 - d. _____
 - e. _____
- 2) What is a reversible reaction?
- 3) Using the collision theory explain why the rate of a reaction increases when pressure is increased.
- 4) The process of milk spoiling is a chemical reaction. Using your knowledge of rates of chemical reactions and collision theory, explain why we keep milk in the refrigerator.
- 5) It has been observed that more gas station fires occur on hot days than on cold days. Explain this phenomenon using your knowledge of collision theory.
- 6) What is chemical equilibrium?
- 7) What is equal at chemical equilibrium?
- 8) What is constant at chemical equilibrium?
- 9) At the macroscopic level a system at equilibrium appears to be unchanging. Is it also unchanging at the molecular level? Explain.

10) True or False: At equilibrium the amount of reactants is equal to the amount of products. _____

11) What is the formula for writing an equilibrium expression?

12) What do brackets [] indicate? _____

13) What are the units of K? _____

14) What does a large K value ($K > 1$) indicate?

15) What does a small K value ($K < 1$) indicate?

Calculating Reaction Rates

16) Use the data below to calculate the average rate of decomposition of H_2O_2 between 0 and 43,200 seconds.

Time (s)	$[\text{H}_2\text{O}_2]$ (mol/L)
0	1.000
21,600	0.500
43,200	0.250

17) Using the rate of decomposition calculated above, and the following chemical equation, calculate the rate of production of oxygen in mol/L's and in mol/L·min. $2\text{H}_2\text{O}_2 \rightarrow 2\text{H}_2\text{O} + \text{O}_2$

18) Consider the general reaction $a\text{A} + b\text{B} \rightarrow c\text{C}$ and the following average rate data, determine the coefficients (a, b, and c) for the reaction.

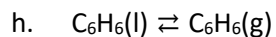
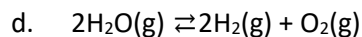
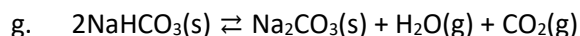
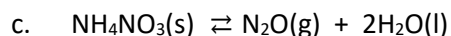
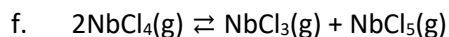
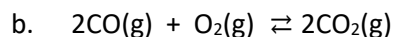
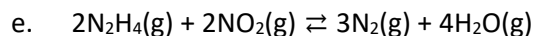
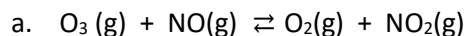
$$-\Delta\text{A}/\Delta t = 0.0080 \text{ mol/L}\cdot\text{s}$$

$$-\Delta\text{B}/\Delta t = 0.0120 \text{ mol/L}\cdot\text{s}$$

$$\Delta\text{C}/\Delta t = 0.0160 \text{ mol/L}\cdot\text{s}$$

Equilibrium Constant expressions and Calculations involving K

1. Write the equilibrium expressions for each of the following reversible reactions:



2. Consider the reversible reaction $\text{PCl}_5(\text{g}) \rightleftharpoons \text{PCl}_3(\text{g}) + \text{Cl}_2(\text{g})$. What is the equilibrium constant if the equilibrium concentrations are as follows: PCl_5 is 0.0096 mol/L, PCl_3 is 0.0247 mol/L and Cl_2 is 0.0247 mol/L?

3. At 1000°C , a 1.00 L container has an equilibrium mixture consisting of 0.102 mol of ammonia, 1.03 mol of nitrogen, and 1.62 mol of hydrogen. Calculate the K_c for the equilibrium system. $\text{N}_2(\text{g}) + 3\text{H}_2(\text{g}) \rightleftharpoons 2\text{NH}_3(\text{g})$

:

4. At a given temperature, the K_c for the reaction $\text{H}_2(\text{g}) + \text{I}_2(\text{g}) \rightleftharpoons 2\text{HI}(\text{g})$ is 54.3. If the concentration of both H_2 and I_2 at equilibrium are $4.79 \times 10^{-4}\text{M}$, find the concentration of HI.

5. If the system described in number 4 (above) were to contain an equilibrium mixture consisting of $1.83 \times 10^{-3}\text{M}$ H_2 , $3.13 \times 10^{-3}\text{M}$ I_2 , and $1.77 \times 10^{-2}\text{M}$ HI, what would be the value of the equilibrium constant?

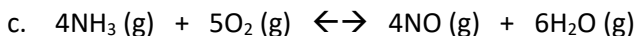
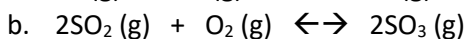
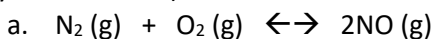
6. Acetic acid dissociates in water. If $K_c = 1.80 \times 10^{-5}$ and the equilibrium concentrations of acetic acid is 0.09986M, what is the concentration of $\text{H}^+(\text{aq})$ and $\text{C}_2\text{H}_3\text{O}_2^-(\text{aq})$? $\text{HC}_2\text{H}_3\text{O}_2(\text{aq}) \rightleftharpoons \text{H}^+(\text{aq}) + \text{C}_2\text{H}_3\text{O}_2^-(\text{aq})$

7. At 60.2°C the equilibrium constant for the reaction $\text{N}_2\text{O}_4(\text{g}) \rightleftharpoons 2\text{NO}_2(\text{g})$ is 8.75×10^{-2} . At equilibrium at this temperature a vessel contains N_2O_4 at a concentration of $1.72 \times 10^{-2}\text{M}$. What concentration of NO_2 does it contain?

LeChatelier's Principle

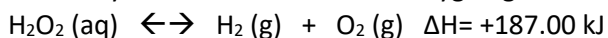
1) State Le Chatelier's Principle: _____

2) Predict which way the following equilibrium systems will shift when the total pressure is increased. (Note: some may have no shift)



3) $\text{N}_2\text{O}_4(\text{g})$ is a colorless gas and $\text{NO}_2(\text{g})$ is a dark brown gas. Use Le Chatelier's principle to explain why a flask filled with $\text{NO}_2(\text{g})$ and $\text{N}_2\text{O}_4(\text{g})$ will get darker when heated. Use the equation: $\text{N}_2\text{O}_4(\text{g}) + \text{heat} \rightleftharpoons 2\text{NO}_2(\text{g})$

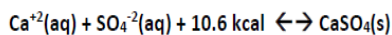
4) List at least 3 ways to increase amount of oxygen gas in the following reaction.



- a. _____
 b. _____
 c. _____

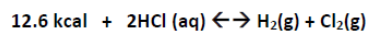
5) What does it mean if a reaction shifts towards the products? _____

6) Complete the following chart by writing left, right, or none for the equilibrium shift. Write decrease, increases, or remains the same for the concentrations of reactants and products.



(Remember that pure solids and liquids do not affect equilibrium values.)

Stress	Equilibrium Shift	Amount of CaSO ₄ (s)	[Ca ²⁺]	[SO ₄ ²⁻]
1. Add CaSO ₄ (s)		_____		
2. Add CaCl ₂ (adds Ca ²⁺)			_____	
3. Add MgSO ₄ (adds SO ₄ ²⁻)				_____
4. Remove SO ₄ ²⁻				_____
5. Increase temperature				
6. Decrease temperature				
7. Increase Pressure				
8. Decrease Pressure				



Stress	Equilibrium Shift	[H ₂]	[Cl ₂]	[HCl]
1. Add H ₂	Left	_____	decreases	increases
2. Add Cl ₂			_____	
3. Add HCl				_____
4. Remove H ₂		_____		
5. Remove Cl ₂			_____	
6. Remove HCl				_____
7. Increase Temperature				
8. Decrease Temperature				
9. Increase Pressure				
10. Decrease Pressure				