Name _____
Print out and solve all problems.
Show all work in an organized manner on separate sheets of paper.
Place final answers with units here on this sheet where directed.

Matter and Measurement

DIMENSIONAL ANALYSIS PROBLEMS

- As AP chemistry students you should always be able to show others WHY and/or HOW your answer is correct.
- Dimensional analysis meets both goals.
- Dimensional analysis is always a **Given** value and one or more **conversion factors** that allow you to determine the **Desired** value.
- Any mathematical fact can serve as a conversion factor. 1 hour = 60 minutes = $\boxed{\frac{1\text{ hour}}{60\text{ min}}}$ or $\boxed{\frac{60\text{ min}}{1\text{ hour}}}$

1. Convert 2.83 days into seconds.

2. Convert 180 days into minutes.

Density is often used as a conversion factor between the mass and volume of a sample. For example, the density of liquid mercury is 13.6 g/mL.

3. What is the volume of a 175 gram sample of mercury?

4. What is the mass of 1.00 gallon of mercury? [1 cup = 236.588 mL]

5. When I carry in a 5-gallon container of water, I always wonder how much it weighs. I found that 1 lb = 0.453542 kg and 1 qt = 0.946353 Liter. Calculate a gallon of water's weight in pounds.

6. 1 cc (cubic centimeter) = 1 mL. How many cubic feet in 20.0 liters (2.54 cm = 1 inch)

Atoms, Molecules, Ions & Isotopes

Isotopic Abundance

1. Which of the following atoms are isotopes of the same element? Use grouping (Your choice).

$^{15}_{7}X$ $^{12}_{6}X$ $^{13}_{7}X$ $^{18}_{8}X$ $^{14}_{7}X$ $^{14}_{6}X$ $^{16}_{8}X$ $^{13}_{6}X$ $^{17}_{8}X$

2. Strontium consists of four isotopes with masses of 84 (abundance 0.50%), 86 (abundance of 9.9%), 87 (abundance of 7.0%), and 88 (abundance of 82.6%). Calculate the average atomic mass of strontium.

3. Titanium has five common isotopes: ^{46}Ti (8.0%), ^{47}Ti (7.8%), ^{48}Ti (73.4%), ^{49}Ti (5.5%), ^{50}Ti (5.3%). What is the average atomic mass of titanium?

4. Uranium has an atomic mass equal to 238.0289. It consists of two isotopes: uranium-235 with an isotopic mass of 235.044 amu and uranium-238 with an isotopic mass of 238.051. Calculate the % abundance of the uranium-235 isotope.

CHEMICAL FORMULAS AND NOMENCLATURE

For each formula, determine if the compound is Ionic or Molecular (Covalent).		**Write the name for each ionic compound (Don't forget Roman Numerals, where necessary) or molecular compound.**	
	Ionic or Molecular (Covalent)		
1. $CuCl_2$		9. $CuCl_2$	
2. NaCl		10. NaCl	
3. $FeBr_3$		11. $FeBr_3$	
4. H_2O		12. H_2O	
5. $(NH_4)_2CO_3$		13. $(NH_4)_2CO_3$	
6. HCl		14. HCl	
7. NH_4OH		15. NH_4OH	
8. CCl_4		16. CCl_4	

Write the formula for each ionic compound.		Write the formula for each molecular compound.	
17. iron (II) nitrate		29. diphosphorus pentoxide	
18. aluminum oxide		30. dihydrogen dioxide	
19. potassium iodide		31. sulfur dioxide	
20. sodium nitrate		32. carbon tetrachloride	
21. copper (I) nitrate		33. pentacarbon decoxide	
22. iron (III) oxide		34. silicon hexachloride	
23. iron (III) hydroxide		35. diphosphorus monobromide	
24. ammonium sulfate		36. selenium trioxide	
25. zinc nitrate		37. tribismuth heptafluoride	
26. hydrogen sulfide		38. nonacarbon decahydride	
27. lead (II) sulfate		29. diphosphorus pentoxide	
28. potassium chlorate		30. dihydrogen dioxide	

PERCENT COMPOSITION PROBLEMS

Calculate the percent composition of the compounds that are formed from these reactions:

1. 9.03 g of Magnesium combine completely with 3.48 g of Nitrogen.
2. 29.0 g of Argon combine completely with 4.30 g of Sulfur.
3. 222.6 g of Sodium combine completely with 77.4 g of Oxygen.

Calculate the percent composition of each of the following compounds:

4. C_2H_6

5. $NaHSO_4$

Calculate the mass of the element in the given mass of compound:

6. Mass of Oxygen in 20.2 g of $NaHSO_4$

7. Mass of Hydrogen in 124 g of $Ca(C_2H_3O_2)_2$

EMPIRICAL AND MOLECULAR FORMULA

1. Calculate the empirical formula of each compound with the following percent composition.

   a. 94.1% O, 5.9%

   b. 79.9% C, 20.1% H

2. The compound meythl butanoate smells like apples. Its percent composition is 58.8% C, 9.8% H, and 31.4% O. If its gram molecular mass is 102 g/mole, what is its molecular formula?

3. a. A compound of carbon and hydrogen has the composition of 92.25% carbon and 7.75% hydrogen by mass. What is the empirical formula of this composition?

   b. If the compound has a mass of 52.03 g/mole, what is the molecular formula of the compound?

HYDRATES & COMPOSITION PROBLEMS

Print out and solve the following by showing all work.

1. Cupric chloride, $CuCl_2$, when heated to 100°C is dehydrated. If 0.235 g of $CuCl_2 \cdot x\ H_2O$ gives 0.185 g of $CuCl_2$ on heating, what is the value of x?

2. If "Epsom salt," $MgSO_4 \cdot x\ H_2O$ is heated to 250°C, all the water of hydration is lost. On heating a 1.687-g sample of the hydrate, 0.824 g of $MgSO_4$ remains. What is the formula of Epsom salt?

3. When $CaSO_4 \cdot x\ H_2O$ is heated, all the water is driven off. If 34.0 g of $CaSO_4$ (molar mass = 136) is formed from 43.0 g of $CaSO_4 \cdot x\ H_2O$, what is the value of x?

MOLE CONCEPT PROBLEMS

There are three mole equalities. They are:

1 mol = 6.02×10^{23} particles
1 mol = g-formula-mass (periodic table)
1 mol = 22.4 L for a gas at STP

Each equality can be written as a set of two conversion factors. They are:

$$\left(\frac{1\ mole}{6.02x10^{23}\ particles}\right) \qquad \left(\frac{6.02x10^{23}\ particles}{1\ mole}\right)$$

$$\left(\frac{1\ mole}{g-formula-mass}\right) \qquad \left(\frac{g-formula-mass}{1\ mole}\right)$$

$$\left(\frac{1\ mole}{22.4\ L}\right) \qquad \left(\frac{22.4\ L}{1\ mole}\right)$$

MOLE-PARTICLE CONVERSIONS

1. How many moles of magnesium is 3.01×10^{22} atoms of magnesium?

2. How many atoms are in 0.750 moles of zinc?

3. How many molecules are in 0.400 moles of N_2O_5?

MOLE-MASS CONVERSIONS

1. How many moles in 28 grams of CO_2 ?
2. What is the mass of 5 moles of Fe_2O_3 ?
3. Find the number of moles of argon in 452 g of argon.

MOLE-VOLUME CONVERSIONS

1. How many moles of argon atoms are present in 11.2 L of argon gas at STP?
2. What is the volume of 0.05 mol of neon gas at STP?
3. What is the volume of 1.2 moles of water vapor at STP?

MIXED MOLE CONVERSIONS

1. How many oxygen molecules are in 3.36 L of oxygen gas at STP?
2. Determine the volume in liters occupied by 14 g of nitrogen gas at STP.
3. Find the mass, in grams, of 1.00×10^{23} molecules of N_2.

TYPES OF REACTIONS

To help make sense of all the different chemical reactions that exist, we classify reactions into several types. There are four types of reactions besides ***Combustion***.

Types	Pattern	Example
Double Replacement	$XY + AB \rightarrow XB + AY$	$2AgNO_3 + K_2CrO_4 \rightarrow Ag_2CrO_4 + 2KNO_3$
Single Replacement	$XY + A \rightarrow AY + X$	$Zn + 2HCl \rightarrow H_2 + ZnCl_2$
Synthesis	$X + Y \rightarrow XY$	$2H_2 + O_2 \rightarrow 2H_2O$
Decomposition	$AB \rightarrow A + B$	$H_2CO_3 \rightarrow H_2O + CO_2$
Combustion	$C_nH_m(R)_x + O_2 \rightarrow H_2O + CO_2$	$2\ C_7H_6O_2 + 15\ O_2 \rightarrow 14\ CO_2 + 6H_2O$

Print out, classify each of the following reactions as **DR**, **SR**, **S**, **D** or **C** and then balance the equation.

_____ 1. ____ZnS + ____$HCl \rightarrow$ ____$ZnCl_2$ + ____H_2S

_____ 2. ____$H_2CO_3 \rightarrow$ ____H_2O + ____CO_2

_____ 3. ____Al + ____$Fe_3O_4 \rightarrow$ ____Al_2O_3 + ____Fe

_____ 4. ____$NaCl$ + ____$I_2 \rightarrow$ ____NaI + ____Cl_2

_____ 5. ____$AlCl_3$ + ____$Na_2CO_3 \rightarrow$ ____$Al_2(CO_3)_3$ + ____$NaCl$

_____ 6. ____$H_2O \rightarrow$ ____H_2 + ____O_2

_____ 7. ____$Ca(OH)_2$ + ____$H_3PO_4 \rightarrow$ ____$Ca_3(PO_4)_2$ + ____H_2O

_____ 8. ____$NH_4OH \rightarrow$ ____H_2O + ____NH_3

_____ 9. ____$NaOH$ + ____$(NH_4)_2SO_4 \rightarrow$ ____Na_2SO_4 + ____H_2O + ____NH_3

_____ 10. ____P_4O_{10} + ____$H_2O \rightarrow$ ____H_3PO_4

_____ 11. ____Fe + ____$HCl \rightarrow$ ____H_2 + ____$FeCl_2$

_____ 12. ____C_4H_{10} + ____$O_2 \rightarrow$ ____CO_2 + ____H_2O

_____ 13. ____$C_6H_{12}(OH)_2$ + ____$O_2 \rightarrow$ ____CO_2 + ____H_2O

_____ 14. ____$H_2O_2 \rightarrow$ ____H_2O + ____O_2

_____ 15. ____Fe_2O_3 + ____$H_2SO_4 \rightarrow$ ____$Fe_2(SO_4)_3$ + ____H_2O

FOR NOTE:

COMBUSTION EQUATIONS

For burning to occur, you need a fuel, an oxidizer, and heat. When hydrocarbons are the fuel and O_2 in the air is the oxidizer, then CO_2 and H_2O are the products.

Example: Write the balanced equation for the complete combustion of propane, C_3H_8, in air.

Solution: First, set up the basic equation. You memorize the "+ $O_2 \rightarrow CO_2 + H_2O$" part.

$$C_3H_8 + O_2 \rightarrow CO_2 + H_2O$$

Next, balance. 3 C's in C_3H_8 result in $3CO_2$'s; 8 H's in C_3H_8 result in 4 H_2O's;

$$C_3H_8 + \_\_ O_2 \rightarrow 3\ CO_2 + 4\ H_2O$$

Total O's on the product side = 10 [(3 x 2) + (4 x 1)] = total O's on the reactant side.

This would mean that 5 O_2's was involved.

Tip: If an UNEVEN number of O's need to be represented, a fraction should be used. 7 O's = $^7/_2\ O_2$

Tip: Consider fuels that contain oxygen. Subtract the O's from that represented as O_2's

STOICHIOMETRY PROBLEMS

GENERAL

1. Several brands of antacid tablets use aluminum hydroxide to neutralize excess acid.

$$Al(OH)_3(s) + 3\ HCl(aq) \rightarrow AlCl_3(aq) + 3\ H_2O(l)$$

[Molar masses: 78.01 36.46 133.4 18.02]

a) What quantity of HCl, in grams, can a tablet with 7.50 g of $Al(OH)_3$ consume?

b) What quantity of water is produced?

2. If 10.0 g of carbon is combined with an exact, stoichiometric amount of oxygen (26.6 g) to produce carbon dioxide, what mass, in grams, of CO_2 can be obtained? That is, what is the theoretical yield of CO_2?

3. The equation for one of the reactions in the process of reducing iron ore to the metal is

$$Fe_2O_3(s) + 3\ CO(g) \rightarrow 2\ Fe(s) + 3\ CO_2(g)$$

(a) What is the maximum mass of iron, that can be obtained from 454 g of iron(III) oxide?

(b) What mass of CO is required to reduce the iron(III) oxide to iron metal?

4. Burning coal and oil in a power plant produces pollutants such as sulfur dioxide, SO_2. The sulfur-containing compound can be removed from other waste gases, however, by the following reaction:

$$2\ SO_2(g) + 2\ CaCO_3(s) + O_2(g) \rightarrow 2\ CaSO_4(s) + 2\ CO_2(g)$$

(a) Name the compounds involved in the reaction.

(b) What mass of $CaCO_3$ is required to remove 155 g of SO_2?

(c) What mass of $CaSO_4$ is formed when 155 g SO_2 is consumed completely?

LIMITING REACTANTS

1. The reaction of methane and water is one way to prepare hydrogen:

$$CH_4(g) + H_2O(g) \rightarrow CO(g) + 3\ H_2(g)$$

[Molar masses: 16.04 18.02 28.01 2.02]

If you begin with 995 g of CH_4 and 2510 g of water, what is the maximum possible yield of H_2?

2. Disulfur dichloride, S_2Cl_2, is used to vulcanize rubber. It can be made by treating molten sulfur with gaseous chlorine:

$$S_8(l) + 4\ Cl_2(g) \rightarrow 4\ S_2Cl_2(l)$$

Starting with a mixture of 32.0 g of sulfur and 71.0 g of Cl_2;

Which is the limiting reactant?

What mass of S_2Cl_2 (in grams) can be produced?

What mass of the excess reactant remains when the limiting reactant is consumed?

3. Aspirin ($C_9H_8O_4$) is produced by the reaction of salicylic acid ($C_7H_6O_3$) and acetic anhydride ($C_4H_6O_3$).

$$C_7H_6O_3(s) + C_4H_6O_3(l) \rightarrow C_9H_8O_4(s) + CH_3CO_2H(aq)$$

If you mix 100. g of each of the reactants, what is the maximum mass of aspirin that can be obtained?

Percent Yield

1. Diborane, B_2H_6, is a valuable compound in the synthesis of new organic compounds. One of several ways this born compound can be made is by the reaction

$$2\ NaBH_4(s) + I_2(s) \rightarrow B_2H_6(g) + 2\ NaI(s) + H_2(g)$$

[Molar masses: 37.84 253.8 27.67 149.9 2.02]

Suppose you use 1.203 g of $NaBH_4$ with an excess of iodine and obtain 0.295 g of B_2H_6. What is the percent yield of B_2H_6?

2. Disulfur dichloride, which has a revolting smell, can be prepared by directly combining S8 and Cl2, but it can also be made by the following reaction:

$$3\ SCl_2(l) + 4\ NaF(s) \rightarrow SF_4(g) + S_2Cl_2(l) + 4\ NaCl(s)$$

Assume you begin with 5.23 g of SCl_2 and excess NaF.

What is the theoretical yield of S_2Cl_2?

If only 1.19 g of S_2Cl_2 is obtained, what is the percent yield of the compound?

Name:_____ Date_____ Per:_____

Electron Configurations Worksheet

Write the complete **ground state electron configurations** and **orbital notations** for the following:

	# of e^-	Element (atom)	e^- configuration	Orbital Notations/ diagrams
1)	_____	lithium	_____	_____
2)	_____	oxygen	_____	_____
3)	_____	calcium	_____	_____
4)	_____	nitrogen	_____	_____
5)	_____	potassium	_____	_____
6)	_____	chlorine	_____	_____
7)	_____	hydrogen	_____	_____
8)	_____	copper	_____	_____
9)	_____	neon	_____	_____
10)	_____	phosphorous	_____	_____

Write the abbreviated ground state electron configurations for the following:

	# of electrons	Element	
11)	_____	helium	_____
12)	_____	nitrogen	_____
13)	_____	chlorine	_____
14)	_____	iron	_____
15)	_____	zinc	_____
16)	_____	barium	_____
17)	_____	bromine	_____
18)	_____	magnesium	_____
19)	_____	fluorine	_____
20)	_____	aluminum	_____

Name:_____ Date_____ Per:_____

Electron Configuration Elements (atoms) and Ions

Write the **electron configuration** and **orbital notations** for the following Atoms and ions:

Element / Ions	Atomic number	# of e^-	Electron Configuration
F			
F^{1-}			
O			
O^{-2}			
Na			
Na^{1+}			
Ca			
Ca^{+2}			

Name: Date Per:

Al^{3+}			
Al			
N			
N^{3-}			
S^{2-}			
Cl^{1-}			
K^{1+}			
S			
Br^{1-}			
Mg^{2+}			

AP Chemistry Practice Test, Ch. 6: Thermochemistry

Name_____

MULTIPLE CHOICE. Choose the one alternative that best completes the statement or answers the question.

1) A chemical reaction that absorbs heat from the surroundings is said to be _____ and has a _____ ΔH at constant pressure.
   A) endothermic, positive
   B) endothermic, negative
   C) exothermic, negative
   D) exothermic, positive
   E) exothermic, neutral

2) The reaction

   $4Al\,(s) + 3O_2\,(g) \rightarrow 2Al_2O_3\,(s) \qquad \Delta H^\circ = -3351\ kJ$

   is _____, and therefore heat is _____ by the reaction.
   A) exothermic, released
   B) exothermic, absorbed
   C) endothermic, released
   D) endothermic, absorbed
   E) thermoneutral, neither released nor absorbed

3) The value of ΔH° for the reaction below is -126 kJ. How much heat (in kJ) is released when 2.00 mol of NaOH is formed in the reaction?

   $2Na_2O_2\,(s) + 2H_2O\,(l) \rightarrow 4NaOH\,(s) + O_2\,(g)$

   A) 252 B) -126 C) 7.8 D) 63 E) 3.9

4) The value of ΔH° for the reaction below is -790 kJ. The enthalpy change accompanying the reaction of 0.95 g of S is _____ kJ.

   $2S\,(s) + 3O_2\,(g) \rightarrow 2SO_3\,(g)$

   A) -23 B) 12 C) -12 D) 23 E) -790

5) The value of ΔH° for the reaction below is -6535 kJ. How many kJ of heat are released in the combustion of 16.0 g of C_6H_6 (l)?

   $2C_6H_6\,(l) + 15O_2\,(g) \rightarrow 12CO_2\,(g) + 6H_2O\,(l)$

   A) 673 B) 2.68×10^3 C) 5.23×10^4 D) -6535 E) 1.34×10^3

6) The value of ΔH° for the reaction below is -336 kJ. Calculate the heat (kJ) released to the surroundings when 23.0 g of HCl is formed.

$$CH_4\,(g) + 3Cl_2\,(g) \rightarrow CHCl_3\,(l) + 3HCl\,(g)$$

A) 211 B) 177 C) 70.7 D) -336 E) 2.57×10^3

7) The specific heat capacity of lead is 0.13 J/g-K. How much heat (in J) is required to raise the temperature of 15 g of lead from 22°C to 37°C?

A) 29 B) 5.8×10^{-4} C) -0.13 D) 2.0 E) 0.13

8) The specific heat of liquid bromine is 0.226 J/g-K. How much heat (J) is required to raise the temperature of 10.0 mL of bromine from 25.00°C to 27.30°C? The density of liquid bromine: 3.12 g/mL.

A) 16.2 B) 10.4 C) 32.4 D) 5.20 E) 300

9) The specific heat capacity of methane gas is 2.20 J/g-K. How many joules of heat are needed to raise the temperature of 5.00 g of methane from 36.0°C to 75.0°C?

A) 22.9 B) 88.6 C) 429 D) 0.0113 E) 1221

10) The ΔH for the solution process when solid sodium hydroxide dissolves in water is -44.4 kJ/mol. When a 13.9-g sample of NaOH dissolves in 250.0 g of water in a coffee-cup calorimeter, the temperature increases from 23.0°C to _____°C. Assume that the solution has the same specific heat as liquid water, i.e., 4.18 J/g-K.

A) 14.0°C B) 37.8°C C) 40.2°C D) 37.0°C E) 35.2°C

11) Given the following reactions

$$Fe_2O_3\,(s) + 3CO\,(s) \rightarrow 2Fe\,(s) + 3CO_2\,(g) \qquad \Delta H = -28.0\ kJ$$

$$3Fe\,(s) + 4CO_2\,(s) \rightarrow 4CO\,(g) + Fe_3O_4\,(s) \qquad \Delta H = +12.5\ kJ$$

the enthalpy of the reaction of Fe_2O_3 with CO

$$3Fe_2O_3\,(s) + CO\,(g) \rightarrow CO_2\,(g) + 2Fe_3O_4\,(s)$$

is _____ kJ.

A) 40.5 B) +109 C) -15.5 D) -109 E) -59.0

12) Given the following reactions

$N_2(g) + 2O_2(g) \rightarrow 2NO_2(g)$ $\Delta H = 66.4$ kJ

$2NO(g) + O_2(g) \rightarrow 2NO_2(g)$ $\Delta H = -114.2$ kJ

the enthalpy of the reaction of the nitrogen to produce nitric oxide

$N_2(g) + O_2(g) \rightarrow 2NO(g)$

is _____ kJ.

A) -47.8 B) 47.8 C) 180.6 D) -180.6 E) 90.3

13) Calculate $\Delta H°$ (in kJ) for reaction 3.

$2S(s) + 3O_2(g) \rightarrow 2SO_3(g)$ $\Delta H = -790$ kJ

$S(s) + O_2(g) \rightarrow SO_2(g)$ $\Delta H = -297$ kJ

the enthalpy of the reaction in which sulfur dioxide is oxidized to sulfur trioxide

$2SO_2(g) + O_2(g) \rightarrow 2SO_3(g)$

is _____ kJ.

A) -196 B) -543 C) 1087 D) 196 E) -1384

14) The value of $\Delta H°$ for the following reaction is -3351 kJ:

$2Al(s) + 3O_2(g) \rightarrow 2Al_2O_3(s)$

The value of $\Delta H_f^°$ for $Al_2O_3(s)$ is _____ kJ.

A) -3351 B) -1676 C) +3351 D) -16.43 E) -32.86

15) Given the data in the table below, $\Delta H°_{rxn}$ for the reaction

$Ca(OH)_2 + 2H_3AsO_4 \rightarrow Ca(H_2AsO_4)_2 + 2H_2O$

is _____ kJ.

Substance	$\Delta H_f^°$ (kJ/mol)
$Ca(OH)_2$	-986.6
H_3AsO_4	-900.4
$Ca(H_2AsO_4)_2$	-2346.0
H_2O	-285.9

A) -4219 B) -130.4 C) -4519 D) -76.4 E) -744.9

16) Given the data in the table below, ΔH°_{rxn} for the reaction

$$IF_7\,(g) + I_2\,(g) \rightarrow IF_5\,(g) + 2IF\,(g)$$

is _____ kJ.

Substance	ΔH_f° (kJ/mol)
IF (g)	-95
IF_5 (g)	-840
IF_7 (g)	-941

A) 311 kJ

B) 69 kJ

C) -1991 kJ

D) -69 kJ

E) The ΔH_f° of I_2 (g) is needed for the calculation.

Chemical Bonding

For each of the following, write the formula, draw the Lewis dot structure, and draw the model, and determine the type of bond

Chemical Formula	Total Number of Valence Electrons	Lewis Dot Structure
1. CH_4		
2. NH_3		
3. CF_4		
4. CO_2		
5. BF_3		
6. C_4H_6		
7. H_2O		
8. H_2		
9. Cl_2		
10. PF_3		
11. HF		
12. HCl		
13. N_2		
14. C_2H_4		

VSEPR Worksheet

1) What is the main idea behind VSEPR theory?

2) For each of the following compounds, determine the bond angles, molecular shapes, and hybridizations for all atoms:

a) carbon tetrachloride

b) BH_3

c) silicon disulfide

d) C_2H_2

e) PF_3

AP Chemistry Syllabus

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Course Overview:

The purpose of this AP Chemistry course is to provide a freshman-level college course to ensure that the student is prepared to succeed in college chemistry. This is accomplished by teaching all the topics detailed in the AP Chemistry Course and Exam Description. The course is organized around the four big ideas and is aligned with the six science practices. Laboratory experiments are conducted to compliment the material being learned. The experiments will include at least 16 labs, of which at least 6 will be inquiry-based labs. Lab time will account for over 25% of the instructional time—some labs are completed in one class period, but many labs require multiple periods.

Prerequisites:

Successfully completed:

1. General Highschool Chemistry
2. Algebra II

Textbook:

- Tro, Nivaldo. Chemistry: A Molecular Approach AP Edition 5Th edition. Pearson, 2020
- AP Chemistry Guided-Inquiry Experiments: Applying the Science Practices Student Manual

Laboratory Requirements:

This course requires that 25 percent of instructional time engages students in lab investigations. This includes a minimum of 16 hands on labs with at least 6 guided inquiries. It is required that students keep a lab notebook throughout.

Students will collect both quantitative and qualitative data, analyze, and mathematically manipulate the data, and then draw conclusions from the data. All the labs are written up in a lab notebook, which then can be produced as evidence to a college that the student has indeed had a suitable lab experience. A completed lab report that consists of the following:

1. Title
2. Introduction (Including objectives)
3. Experimental Procedures
4. PreLab questions (If available)
5. Qualitative and Quantitative data
6. Calculations and Chemical equations
7. Error analysis- Which addresses percent error as well as sources of error
8. Discussion and Conclusion- which explains and illustrates how the evidence supports the conclusion.

Grading System for Lab

- Pre labs 40%
- Lab Reports 50%
- Participation 10%

PreLabs:

This must be done BEFORE the experiment

- Title
- Objective
    - What is the purpose you are trying to accomplish
- Introduction
    - Must include overall information on the experiment, key ideas, instrumentation set up and equations that will be used.
- Pre lab Q/A
- Experimental Procedures
    - Numbered format on what you did during the experiment
- Data Table(s)

Lab Reports:

Remember this is an add on to the Pre-lab

- Completed Data Table(s)
- Calculations
    - Clearly detailing each step, you took to reach your answer with correct units
- Post Lab Q/A
- Discussion
    - Error analysis is written here, what errors were made and how they could be avoided for next time. Was the objective reached what does your data tell you about the purpose of the experiment.

Possible Experiments:

1. Percentage of Water in an Unknown Hydrate (GI)
2. Determination of the Percentage of $NaHCO_3$ in a Mixture (GI)
3. Empirical Formula of Copper Iodide
4. Molecular Geometry with Modeling Kits and Modeling Software
5. Inquiry Investigation into Behavior of Gases (GI)
6. Molar Volume of a Gas
7. Determination of the Percentage of Copper in Brass (GI)
8. Airbag Inflation (GI)
9. Standardization of Base and Titration of a Solid Acid
10. Rate Law Determination for Decomposition of Crystal Violet (GI)

11. Determination of the Order, Rate Constant, and Activation Energy for a Clock Reaction
12. The Hand Warmer Lab (GI)
13. Heat of Formation of Magnesium Oxide
14. Le Châtelier's Principle—the Rainbow Lab (GI)
15. Determination of the Equilibrium Constant of FeSCN2+ System
16. Calculation of the K sp of Calcium Hydroxide
17. Preparation and Examination of Buffers (GI)
18. Determination of K a by Half-Titration Method
19. Examination of the Titration Curves for Weak and Strong Acids and Bases
20. Comparison of Acid Strength and Salt Hydrolysis Using Indicators
21. Microvoltaic Cells
22. Redox Titration of Hydrogen Peroxide

Course Content:

The course content is organized into nine commonly taught units, which have been arranged in the following suggested, logical sequence:

- Unit 1: Atomic Structure and Properties (9%)
- Unit 2: Molecular and Ionic Compound Structure and Properties (9%)
- Unit 3: Intermolecular Forces and Properties (22%)
- Unit 4: Chemical Reactions (9%)
- Unit 5: Kinetics (9%)
- Unit 6: Thermodynamics (9%)
- Unit 7: Equilibrium (9%)
- Unit 8: Acids and Bases (15%)
- Unit 9: Applications of Thermodynamics (9%)

Course Outline (Subject to change)

Numbers next to each topic is the corresponding Science Practices

Unit 1: Atomic Structure and Properties

1. Moles and Molar mass (5)
2. Mass Spectroscopy and Elements (5)
3. Elemental Composition and Pure Substances (2)
4. Composition of Mixtures (5)
5. Atomic Structure and Electron Configuration (1)
6. Photoelectron Spectroscopy (4)
7. Periodic Trends (4)
8. Valence Electrons and Ionic Compounds (4)

Unit 2: Molecular and Ionic Compound Structure and Properties

1. Types of Chemical Bonds (6)

2. Intramolecular Force and Potential Energy (3)
3. Structure of Ionic Solids (4)
4. Structure of Metals and Alloys (4)
5. Lewis Diagrams (3)
6. Resonance and Formal charge (6)
7. VSPER and Bond Hybridization (6)

Unit 3: Intermolecular Forces and Properties

1. Intermolecular Forces (4)
2. Properties of Solids (4)
3. Solids, Liquids and Gases (3)
4. Ideal Gas law (5)
5. Kinetic Molecular Theory (4)
6. Deviation from Ideal gas Law (6)
7. Solutions and Mixtures (5)
8. Representations of Solutions (3)
9. Separation of Solutions and Mixtures Chromatography (2)
10. Solubility (4)
11. Spectroscopy and Electromagnetic Spectrum (4)
12. Photoelectric Effect (5)
13. Beer-Lambert Law (2)

Unit 4: Chemical Reactions

1. Introduction for Reactions (2)
2. Net Ionic Equations (5)
3. Representations of Reactions (3)
4. Physical and Chemical Changes (6)
5. Stoichiometry (5)
6. Introduction to Titration (3)
7. Types of Chemical Reactions (1)
8. Introduction to Acid-base Reactions (1)
9. Oxidation-Reduction (Redox) Reactions (5)

Unit 5: Kinetics

1. Reactions Rates (6)
2. Introduction to Rate Law (5)
3. Concentration Changes Over Time (5)
4. Elementary Reactions (5)
5. Collision Model (5)
6. Reaction Energy Profile (3)
7. Introduction to Reaction Mechanisms (1)
8. Reaction Mechanism and Rate Law (5)
9. Steady State Approximation (5)

10. Multistep Reaction Energy Profile (3)
11. Catalysis (6)

Unit 6: Thermodynamics

1. Endothermic and Exothermic Processes. (6)
2. Energy Diagrams (3)
3. Heat Transfer and Thermal Equilibrium (6)
4. Heat Capacity and Calorimetry (2)
5. Energy of Phase Changes (1)
6. Introduction to Enthalpy of Reaction (4)
7. Bond Enthalpies (5)
8. Enthalpy of Formation (5)
9. Hess's Law (5)

Unit 7: Equilibrium

1. Introduction to Equilibrium (6)
2. Direction of Reversible Reactions (4)
3. Reaction Quotient and Equilibrium Constant (3)
4. Calculating the Equilibrium Constant (5)
5. Magnitude of the Equilibrium Constant (6)
6. Properties of the Equilibrium Constant (5)
7. Calculating Equilibrium Concentrations (3)
8. Representations of Equilibrium (3)
9. Introduction to Le Chatelier's Principle (6)
10. Reaction Quotient and Le Chatelier's Principle (5)
11. Introduction to Solubility Equilibria (5)
12. Common Ion Effect (2)
13. pH and Solubility (2)
14. Free Energy of Dissolution (4)

Unit 8: Acids and Bases

1. Introduction to Acids and Bases (5)
2. pH and pOH of Strong Acids and Bases (5)
3. Weak Acid and Base Equilibria (5)
4. Acid-base Reactions and Buffers (5)
5. Acid-Base Titrations (5)
6. Molecular Structure of Acids and Bases (6)
7. pH and pK_a (2)
8. Properties of Buffers (6)
9. Henderson-Hasselbalch Equation (5)
10. Buffer Capacity (6)

Unit 9: Applications of Thermodynamics

1. Introduction to Entropy (6)
2. Absolute Entropy and Entropy Change (5)
3. Gibbs Free Energy and Thermodynamic Favorability (6)
4. Thermodynamic and Kinetic Control (6)
5. Free Energy and Equilibrium (6)
6. Coupled Reactions (4)
7. Galvanic (Voltaic) and Electrolytic Cells (2)
8. Cell Potential and Free Energy (5)
9. Cell Potential under Nonstandard Conditions (6)
10. Electrolysis and Faraday's Law (5)

We will have FRQ and Multiple-Choice tests that mick the actual Ap Exam to not only get you used to the type of questions they will ask, but also to test your knowledge of the content. For content class you will be required to

1. Have a notebook
2. Scientific calculator
3. Textbook
4. Folder

I will give you a packet with a lot of references that we will use throughout the year and a periodic table. You are required to have that with you every time you come to class. Apart from Schoology we will also use AP Classroom.

Grading system for Content:

- Homework 30%
- Classwork: 20%
- Tests 40%
- Participation 10%

Homework:

- Will consist of Personal Progress checks
- Notes (from reading the chapters)
- Practice Problems
- Study Guides

Classwork:

- Lecture Notes
- Practice Problems
- Working together on specific mock exams

Tests:

- Combination of multiple choice and FRQ

AP Chemistry Exam Structure:

The exam will be 3hrs and 15 min. This will include 60 multiple choice questions and 7 free response questions. A scientific or graphing calculator is recommended for use on both sections of the exam. Students are provided with the periodic table and a formula sheet that lists specific and relevant formulas for use on the exam.

Format of Assessment

- Section I
    - Multiple Choice
        - 60 questions
        - 90 minutes
        - 50% of exam score
        - Science Practices 1,2,4,5,6 are all assessed in the MC section
- Section II
    - Free Response
        - 7 questions
        - 105 minutes
        - 50% of Exam Score
        - All 6 science practices are assessed in this section
        - 3 long answer questions (10 points each)
        - 4 short answer questions (4 points each)

AP Chemistry Science Practices

1. Models and Representations: Describe models and representations, including across scales.
2. Question and Method: Determine scientific questions and methods.
3. Representing Data and Phenomena: Create representations or models of chemical phenomena.
4. Model Analysis: Analyze and interpret models and representations on a single scale or across multiple scales.
5. Mathematical Routines: Solve problems using mathematical relationships.
6. Argumentation: Develop an explanation or scientific argument.