AP Chemistry Summer Assignment

Welcome to AP Chemistry. I am eagerly anticipating a great year of Chemistry. In order to ensure the best start for everyone next fall, I have prepared a summer assignment that reviews basic chemistry concepts.

There are a multitude of tremendous chemistry resources available via the Internet. With easy access to hundreds of websites, I am confident that you will have sufficient resources to prepare adequately.

Much of the material in this summer packet will be familiar to you. It will be important for everyone to come to class the first day prepared. While I will review, extensive remediation is not an option as we work towards our goal of being 100% prepared for the AP Exam in early May. There will be a test covering the basic concepts included in the summer packet during the first or second week of school.

You may contact me by email: (<u>cgrasso@wyoarea.org</u>) this summer. I will do my best to answer your questions ASAP.

This assignment is designed to be worked on throughout the summer. I have broken it into 6 parts. Please do not try to complete it all in the final week of the summer. Many of the pages are for reference or read only.

Chemistry takes time to process and grasp at a level necessary for success in AP Chemistry. Remember, AP Chemistry is an equivalent course to two semesters of introductory Chemistry in college. Taking a college level course in high school is difficult, requires dedication, and is a great investment in your education so prepare yourself and arrive ready to learn.

Have a great summer.

Mr. Grasso

SUMMER ASSIGNMENT #1

Significant Figures - Rules

Single Number

Significant figures are critical when reporting scientific data because they give the reader an idea of how well you could actually measure/report your data. Before looking at a few examples, let's summarize the rules for significant figures.

1) ALL non-zero numbers (1,2,3,4,5,6,7,8,9) are ALWAYS significant.

2) ALL zeroes between non-zero numbers are ALWAYS significant.

3) ALL zeroes which are SIMULTANEOUSLY to the right of the decimal point AND at the end of the number are ALWAYS significant.

4) ALL zeroes which are to the left of a written decimal point and are in a number >= 10 are ALWAYS significant.

A helpful way to check rules 3 and 4 is to write the number in scientific notation. If you can/must get rid of the zeroes, then they are NOT significant.

Number	# Significant Figures	Rule(s)
48,923	5	1
3.967	4	1
900.06	5 1,2	
0.0004 (= 4 E-4)	1	1,4
8.1000	5 1	
501.040	6	1,2,3,4
3,000,000 (= 3 E+6)	1	1
10.0 (= 1.00 E+1)) 3 1,3,4	

Examples: How many significant figures are present in the following numbers?

This gives you some idea of how to determine the number of significant figures in a single number.

SCIENTIFIC NOTATION

Change the following to Scientific Notation (maintain the number of significant figures):

1. 5.280 = _____ 2. 2,000 = 3. 15 = 6,589,000 = 4. 5. 70,400,000,000 = _____ 6. .00263 = 7. .00589 = 8. .006 = 9. .400 = 10. .08060 =

Metric Unit Conversions

<u>RULES</u>

- For 1 dimentional units each step on the staircase below represents one decimal place.
 - **o** For example convert 3.5 mm to cm.
 - mm and cm are 1 dimentional units. Whereas mm² is a two dimentional unit.
 - Start at mm, the bottom of the staircase. cm are one step to the left. Move the decimal point one place to the left.
 - 3.5 becomes 0.35. Therefore 3.5 mm=0.35 cm
 - If no decimal point is present, assume there is a decimal point after the number. For example 3 cm = 30 mm
- For 2 dimentional units each step on the staircase below represents two decimal places.
 - **o** For example convert 3.5 mm^2 to cm².
 - mm² and cm² are 2 dimentional units.
 - Start at mm, the bottom of the staircase. cm are one step to the left. Move the decimal point two place to the left.
 - 3.5 becomes 0.035. Therefore 3.5 mm²=0.035 cm²
 - If no decimal point is present, assume there is a decimal point after the number. For example 3 cm² = 300 mm²
- For 3 dimentional units each step on the staircase below represents three decimal places.
 - **o** For example convert 3.5 mm³ to cm³.
 - mm³ and cm³ are 3 dimentional units.
 - Start at mm, the bottom of the staircase. cm are one step to the left. Move the decimal point three place to the left.
 - 3.5 becomes 0.0035. Therefore 3.5 mm³=0.0035 cm³
 - If no decimal point is present, assume there is a decimal point after the number. For example 3 cm³ = 3000 mm³



UNIT ANALYSIS

Make the following Metric System conversions using "unit analysis" (you may use scientific notation):

		Standard Notation	Scientific Notation
1.	100 mg	g	g
2.	20 cm	m	m
3.	50 L	dm ³	dm ³
4.	22 g	cg	cg
5.	825 cm	km	km
6.	2,350 kg	g	g
7.	19 mL	cm ³	cm ³
8.	52 km	m	m
9.	36 m ²	cm ²	cm ²
10.	18 cm ³	mm ³	mm ³
11.	6 g	mg	mg
12.	4,259 mL	dm ³	dm ³

Significant Figures - Rules

Math Operations

ADDITION AND SUBTRACTION:

When adding or subtracting numbers, count the NUMBER OF DECIMAL PLACES to determine the number of significant figures. The answer cannot CONTAIN MORE PLACES AFTER THE DECIMAL POINT THAN THE SMALLEST NUMBER OF DECIMAL PLACES in the numbers being added or subtracted. Example:

23.112233	(6 places after the decimal point)
1.3324	(4 places after the decimal point)
+ 0.25	(2 places after the decimal point)
24.694633	(on calculator)
24.69	(rounded to 2 places in the answer)

Note: There are 4 significant figures in the answer.

MULTIPLICATION AND DIVISION:

When multiplying or dividing numbers, count the NUMBER OF SIGNIFICANT FIGURES. The answer cannot CONTAIN MORE SIGNIFICANT FIGURES THAN THE NUMBER BEING MULTIPLIED OR DIVIDED with the LEAST NUMBER OF SIGNIFICANT FIGURES. Example:

23.123123 (8 significant figures)
x 1.3344 (5 significant figures)
30.855495 (on calculator)
30.855 (rounded to 5 significant figures)

Determining the number of significant figures in logarithms & antilogarithms:

- o The logarithm (base 10) of x, $\log x = a$, where x = 10a.
- o The antilogarithm (base 10) of a, antilog a = x, where x = 10a.
- o A logarithm is divided into two (2) parts by the decimal. The integer before the decimal is the characteristic and the numbers after the decimal are the mantissa.
- o If a number is a logarithm, since the characteristic reflects the power of 10, i.e. the exponent, it is not considered to be part of the significant figures. Only the digits in the mantissa (after the decimal) are significant.

Antilog	Antilog Sig Figs	Log	Log Sig Figs
567 (5.67 X 10²)	3	2.<u>754</u> The 2 is just a placeholder. The underlined digits are significant.	3
0.0025 (2.5 X 10 ⁻³)	2	-2.60	2
205.203 (2.05203 X 10 ²)	6	2.312183	6
3.400 X 10 ²⁰	4	20.5315	4
0.0000002 (2 X 10 ⁻⁷)	1	-6.7	1

Significant Figures Calculations Practice

1. Add-

a) 16.5 + 8 + 4.37
b) 0.0853 + 0.0547 + 0.0370 + 0.00387
c) 25.37 + 6.850 + 15.07 + 8.056

2. Subtract-

- a) 23.27 12.058
- b) 350.0 200
- c) 27.68 14.369

3. Multiply-

- a) 2.6 x 3.78
- b) 6.54 x .037
- c) 4.35 x 2.74 x 3.008
- d) 35.7 x 0.78 x 2.3

4. Divide-

- a) 35 / 0.62
- b) 39 / 24.2
- c) 0.58 / 2.1
- d) 40.8 / 5.05

5. Logs-

	answer	w/sig figs		answer	w/sig figs
a) log 5.89×10–3			b) ln 3.591		
c)10 ^{-2.22}			d) e ^{5.61}		

Uncertainty in Measurement

A. When taking **measurements** all certain digits plus the **first** uncertain number are significant.

Example: Your bathroom scale weighs in 10 Newton increments and when you step onto it, the pointer stops between 550 and 560. Your look at the scale and determine your weight to 557 N. You are certain of the first two places, 55, but not the last place 7. The last place is a guess and if it is your best guess it also is significant.

IN THE LABORATORY:

Masses should always be recorded to as many places after the decimal point as are read off the balance. Calculation of mass by difference using a tare should be reported to this same number of places.

Graduated cylinders should be read one decimal place past the smallest graduation.

40
35

EX. The Graduated cylinder to the left has a major scale of 5 mL. The minor scale is 1 mL. These values are determined by looking at the graduations (markings) and determining the valueof each line. Therefore this graduated cylinder should be red to the nearest 0.1 mL. One decimal place past the minor scal. The last decimal place should be estimated. I would read this cylinders volume as 36.4 mL. This reading has anuncertainty of +/- 0.1 mL. Thus the reading is really saying that the answer is between 36.3

mL and 36.5 mL.

UNCERTAINTIES IN CALCULATIONS

1. When adding or subtracting numbers written with the ± notation, **always add the ± uncertainties** and then <u>round off the ± value to the largest significant digit</u>. Round off the answer to match.

Example: $(22.4 \pm .5) + (14.76 \pm .25) = 37.16 \pm .75 = 37.2 \pm .8$ The uncertainty begins in the **tenths** place... it is the last significant digit.

2. When adding or subtracting numbers written in significant figures, show the uncertainty by rounding the <u>answer to match the largest place with uncertainty</u>.

Example: $26\underline{7} + 11.\underline{8} = 27\underline{8.8} = 27\underline{9}$ The least accurate original measurement is only accurate to the <u>ones</u> place.

3. When multiplying or dividing measurements written in significant figures, show the uncertainty of your calculations by <u>rounding off your answer to **match the same**</u> <u>number of significant figures as your *least* precise measurement (the measurement with the least number of significant figures).</u>

Example: 477.85 ÷ 32.6 = 14.657975 = <u>14.7</u> 32.6 is the least accurate measurement with only 3 significant figures. NOTE: There are two types of precision: "absolute precision" and "relative precision."

Example: 322.45 x 12.75 x 3.92 = 16116.051 = **<u>161</u>**00

All the measurements are accurate to the hundredth place (absolute precision) but the answer is rounded to 3 significant figures because 3.92 has only 3 significant figures (relative precision).

In Summary:

	Adding and Subtracting Multiplying and d	
#'s with ± notation	Rule 1	Don't Do This Case
#'s with significant figures	Rule 2	Rule 4

Uncertainties in Measurement

Directions: For each measurement please record the major scale, minor scale and uncertainty. Then report your answer to the appropriate value with units. If the question has any extra calculations, please do them to the proper significant figures. If there are any extra questions, please answer them completely and in complete sentences.

Volume of a Liquid



- a) What is the major scale? _____
- b) What is the minor scale? _____
- c) What is the uncertainty of this device?
- d) What is the volume of liquid? _____
- e) Based on the uncertainty, what range can we assume the "actual volume" lies between? _____



- a) What is the major scale? _____
- b) What is the minor scale? _____
- c) What is the uncertainty of this device? _____
- d) What is the volume of liquid? _____
- e) Based on the uncertainty, what range can we assume the "actual volume" lies between? _____

3. Add the volumes of the two graduated cylinders from above and record the value with proper significant figures?

- 4. What can you say about the precision of graduated cylinder 2? Explain.
- 5. How should our knowledge of uncertainty affect our selection of tools in the lab?

Measuring length



- a) What is the major scale? _____
- b) What is the minor scale? _____
- c) What is the uncertainty of this device? _____
- d) What is the length of the screw? _____
- e) Based on the uncertainty, what range can we assume the "actual length" lies between? _____

7. If a cube with a mass of 21.56g and sides measuring 2.04 cm in length, what is its density? Show all work.

8. What substance is the cube in number 7 made out of?

Material	Density (g/cm ³)
Aluminum	2.64
Brass	8.55
Brick (red, common)	1.92
Coal (anthracite)	1.51

9. Calculate the percent error. Is this an acceptable range of error? Explain.

SUMMER ASSIGNMENT #2

The first 2 pages are rules and guidelines. I would print these out and put them in page protectors and keep them in my chemistry binder. They will be helpful for the entire course.

Inorganic Chemical Nomenclature

		Binary	Compound	Names	for No	n-Metal l	ons
н- н+	hydride hydrogen	N ³⁻ P ³⁻ As ³⁻	nitride phosphide arsenide	⊖ ²⁻ S ²⁻ Se ²⁻ Te ²⁻	oxide sulfide selenide telluride	F - Cl- Br ⁻ I -	fluoride chloride bromide iodide

Polyatomic Ion Names

NH ₃	ammonia	C10_	perchlorate	P04 ³⁻	phosphate
NH4 ⁺	ammonium	ClO_1	chlorate	HPO ₄ ²⁻	monohydrogen
н ₃ 0 +	hydronium	C102-	chlorite		phosphate
сн ₃ соо -	acetate	C10 -	hypochlorite	H ₂ PO ₄ -	dihydrogen
(C2H3O2)		CrO_4^{2-}	chromate		phosphate
As04 ³⁻	arsenate	$Cr_2O_7^{2-}$	dichromate	P0 ₃ ³⁻	phosphite
в0 ₃ ³⁻	borate	CN -	cyanide	SeO ₄ ²⁻	selenate
B407 ²⁻	tetraborate	OH -	hydroxide	SiO ₃ ²⁻	silicate
BrO ₃	bromate	IO_4	periodate	SiF ₆ ²⁻	hexafluorosilicate
BrO -	hypobromite	10 ₃ -	iodate	S04 ²⁻	sulfate
CO ₃ ²⁻	carbonate	IO -	hypoiodite	HSO ₄ -	hydrogen sulfate
HCO3-	hydrogen carbonate	Mn⊖_	permanganate		(bisulfate)
	(bicarbonate)	NO3 ⁻	nitrate	SO3 ²⁻	sulfite
		NO2	nitrite	HSO3	hydrogen sulfite
		C2042-	oxalate		(bisulfite)
		$O_2^{2^2}$	peroxide	$C_4 H_4 O_6^{2-}$	tartrate
		_		S2032-	thiosulfate

Common Acid Names

HC ₂ H ₃ O ₂	acetic acid	HNO3	nitric acid
CH ₃ COOH	acetic acid	H ₃ PO ₄	phosphoric acid
H ₂ CO ₃	carbonic acid	H ₂ SO ₄	sulfuric acid
HCl	hydrochloric acid		

ION FORMULA CHART

<u>1+</u>	<u>2+</u>	<u>3+</u>
ammonium, NH ₄	barium, Ba	aluminum, Al
cesium, Cs	beryllium, Be	chromium (III), Cr
copper(I) Cu	cadmium, Cd	cobalt(III), Co
gold(I) Au	calcium, Ca	gallium, Ga
hydrogen, H	chromium, Cr	gold(III) Au
lithium, Li	cobalt(II), Co	iron(III), Fe
potassium, K	copper(II), Cu	
rubidium, Rb	iron(II), Fe	
silver, Ag	lead(II), Pb	
sodium, Na	magnesium, Mg	4
	mercury(I), Hg ₂	<u>4+</u>
	mercury(II) Hg	lead(IV), Pb
	nickel, Ni	tin(IV), Sn
	strontium, Sr	
	tin(II), Sn	
	Zinc, Zn	
<u>1-</u>	<u>2-</u>	<u>3-</u>
acetate, $C_2H_3O_2$	carbonate, CO ₃	borate, BO_3
bromate, BrO ₃	chromate, CrO ₄	nitride, N
bromide, Br	dichromate, Cr ₂ O ₇	phosphate, PO ₄
chlorate, ClO ₃	hydrogen phosphate, HPO ₄	phosphide, P
chloride, Cl	oxide, O	
chlorite, ClO ₂	oxalate, C_2O_4	
cyanide, CN	peroxide, O ₂	
Fluoride, F	selenide, Se	
dihydrogen phoshate, H ₂ PO ₄	sulfate, SO ₄	
bicarbonate, HCO ₃	sulfide, S	
hydrogen sulfate, HSO ₄	sulfite SO ₂	Λ
hudrowido OU	Sume, 503	<u>4-</u>
liyuloxide, On	tartrate, $C_4H_4O_6$	<u>4-</u>
iodate, IO ₃	tartrate, $C_4H_4O_6$ telluride, Te	carbon, C silicon Si
iodate, IO ₃ iodide, I	tartrate, $C_4H_4O_6$ telluride, Te thiosulfate, S_2O_3	carbon, C silicon, Si
iodate, IO_3 iodide, I nitrate, NO_3	tartrate, $C_4H_4O_6$ telluride, Te thiosulfate, S_2O_3	carbon, C silicon, Si
iodate, IO_3 iodide, I nitrate, NO_3 nitrite, NO_2	tartrate, $C_4H_4O_6$ telluride, Te thiosulfate, S_2O_3	carbon, C silicon, Si

COVALENT PREFIXES

1- mono	2 – di	3 – tri	4 – tetra	5 – penta
6 – hexa	7 – hepta	8 – oct	9 – nona	10 - deca

HYDROCARBONS

Prefixes	1 – meth	2 – eth	3 – prop	4 – but
<u>Suffixes</u>	- ANE – C_nH_{2n+2}	- ENE	$-C_nH_{2n}$	- YNE = $C_n H_{2n-2}$

Naming

Type of Compound	lonic	Acids	Molecular
How To Recognize	Recognize + and - ion	H+ and - ion	Not Ionic
How To Name	names of + ion then - ion	"ides" \rightarrow hydroic acid "ates" \rightarrow ic acid "ites" \rightarrow ous acid S (add "ur") P (add "or")	mono, di, tri, tetra, penta, hexa, hepta, octa, nona ,deca names ends with "ide" pent ao xide → pentoxide, etc.

Indicate the Type of Compound and then name the compound using the appropriate rules:

1.	NaF	<u>I</u>	Sodium fluoride	19.	MnO_2	
2.	FeCl ₃			20.	H_2S	
3.	CO ₂			21.	CuCl ₂	
4.	MgCl ₂			22.	AgNO ₃	
5.	HF			23.	СО	
6.	SF_4			24.	H_3PO_4	
7.	$HC_2H_3O_2$			25.	NaCl	
8.	H_2O			26.	N_2O_5	
9.	NH ₃			27.	NO ₂	
10.	CaO			28.	HNO ₃	
11.	NH ₄ NO ₃			29.	NaOH	
12.	NaI			30.	SnCl ₂	
13.	PbCO ₃			31.	CaSO ₄	
14.	Na ₂ O			32.	HBr	
15.	$Ba(NO_3)_2$			33.	Cu(OH) ₂	
16.	K ₂ CrO ₄			34.	Zn(OH) ₂	
17.	NO			35.	BaCl ₂	
18.	HCl			36.	PCl ₅	

Organic Naming

Organic Nomenclature - Alkanes, Alkenes, Alkynes

Naming organic compounds can be a challenge to any chemist at any level. Historically, chemists developed names for new compounds without any systematic guidelines. In this century, the need for standardization was recognized. For simple molecules, the nomenclature system worked out by the International Union of Pure and Applied Chemists (IUPAC) works well. For complex molecules, the IUPAC names are so long that no one in their right mind would use them. The net result is that a hodgepodge of IUPAC names and historic or common names is used. Any one compound may have five or six different names.

So, what we want to accomplish in this module is simply to establish the fundamentals of the IUPAC system and apply them to naming **alkanes**, **alkenes** and **alkynes**. These groups are **hydrocarbons**, compounds made of the elements carbon and hydrogen.

Numerical Prefixes = Number of Backbone Carbon Atoms

The prefix in the name of an organic molecule indicates the number of carbon atoms found in the longest continuous chain of carbon atoms in the molecule. You need to memorize the following prefixes:

Prefix	# C atoms
meth-	1
eth-	2
prop-	3
but-	4
pent-	5
hex-	6
hept-	7
oct-	8
non-	9
dec-	10

Alkanes = -ane ending

The alkanes are the least complex hydrocarbons. The alkane family uses the *prefix for the number of carbons* and an *-ane ending*. An alkane can be recognized by its general formula, C_nH_{2n+2} , where *n* is the number of carbon atoms in the compound. For example, C_5H_{12} has five carbon atoms pentane. Each member of the alkane family differs from the next by a — CH_2 — group, and all the carbons are connected by single bonds.

Example 1:

Name the following compounds:

- a. CH₄
- b. C_2H_6 or CH_3CH_3
- c. C_3H_8 or $CH_3CH_2CH_3$
- d. C_4H_{10} or $CH_3 CH_2CH_2CH_3$

Solution 1:

All of the formulas fit into general formula, $C_n H_{2n+2}$, therefore the bonds in these compounds are single bonds; they are alkanes. Use the numerical prefix for the number of carbon atoms with the -ane ending.

- a. one C atom = methane
- b. two C atoms = ethane
- c. three C atoms = propane
- d. four C atoms = butane

Alkenes = -ene ending

Hydrocarbons that contain multiple bonds are called **unsaturated hydrocarbons**. If the hydrocarbon has **one double bond**, its general formula will be C_nH_{2n} , where *n* is the number of carbon atoms in the compound. The alkene family uses the *-ene ending*. The double bond is stronger than a single bond, and the bond length between the carbon atoms is shorter in the double bond. It is also more reactive than a single bond since the π bond (the second pair of electrons) is farther from the nuclei.

Naming is a little bit more complex for alkenes than alkanes. Since the double bond could appear at various sites in a typical molecule, we have to specify where it is. To do so, number the carbon backbone so that the **lowest possible number** is used to describe the double bond position. The lowest number of the two C atoms involved in the double bond is used in front of the name to indicate the C=C position. The number is place at the beginning of the name and is separated with a dash.

In the expanded structure formulas shown below, it is understood that since H only forms one bond, any double bonds are between carbon atoms. The expanded structures give a bit more information about how many H atoms are attached to each C atom.

Example 2:

Name the following compounds.

- a. C_2H_4 or $H_2C=CH_2$
- b. C_3H_6 or $CH_3CH=CH_2$
- c. C_4H_8 or $H_2C=CHCH_2CH_3$
- d. C_4H_8 or $CH_3CH_2=CH_2CH_3$
- e. C_5H_{10} or $CH_3CH_2CH_2CH=CH_2$

Solution 2:

a. 2 C atoms = ethene (since there are no options for the position of the C=C, we do not need to specify the position, as in 1-ethene)

b. 3 C atoms = propene (again, since there are no options for the position of the C=C, we do not need to specify 1-propene. Convince yourself that 1-propene and 2-propene are really the same molecule.)

c. 4 C atoms with the C=C after the #1 C atom = 1-butene

d. 4 C atoms with the C=C after the #2 C atom = 2-butene

e. 5 C atoms with the C=C after the #1 C atom = 1-pentene (Did you say 4-pentene? Remember that we want to number the backbone of C atoms so that the lowest numbers are used in the name. In this case, you want to number the C backbone from right to left. This same molecule could also be written $H_2C=CHCH_2CH_2CH_3$).

Alkynes = -yne ending

The alkyne family contains a **triple bond** between two C atoms. If the hydrocarbon has one triple bond, its general formula will be C_nH_{2n-2} , where *n* is the number of carbon atoms in the compound. The alkyne family uses the -yne ending. The triple bond is stronger than either the double or single bond, therefore it is also shorter and more reactive than the single or double bond.

Just as in the alkene family, the position of the triple bond is specified with a number at the beginning of the name.

Example 3:

Name the following compounds.

- a. CH≡CH
- b. $CH \equiv CCH_2CH_2CH_2CH_3$
- c. $CH_3C \equiv CCH_2CH_2CH_3$
- d. $CH_3CH_2C \equiv CCH_2CH_3$
- e. $CH_3CH_2CH_2C \equiv CCH_3$
- f. $CH_3CH_2CH_2CH_2C \equiv CH$

Solution 3:

- a. 2 C atoms = ethyne (this compound is commonly known as acetylene)
- b. 6 C atoms, triple bond after the #1 C atom = 1-hexyne
- c. 6 C atoms, triple bond after the #2 C atom = 2-hexyne
- d. 6 C atoms, triple bond after the #3 C atom = 3-hexyne

e. 6 C atoms, triple bond after the #2 C atom = 2-hexyne (number the backbone from right to left)

f. 6 C atoms, triple bond after the #1 C atom = 1-hexyne (number the backbone from right to left)

NOMENCLATURE Worksheet

Draw the following organic molecules like the example.

1. Ethane	Methane:	н 	2. Propane
3. Decane			4. Propyne
5. 3-Octyne			6. 1-Propene
7. 2-Nonene			8. Nonane

- 9. 4-Nonyne 10. 3-Hexene
- 11. How many ways can you write butene? Draw them.
- 12. Why is 6-decene not possible? What would it be called? Draw it.

SUMMER ASSIGNMENT #3

This assignment is about nuclear chemistry. What I am about to say will sound odd. Nuclear Chemistry is NOT part of the AP curricula. However, it is considered prior knowledge. So you will never have an AP question directly about Nuclear Chemistry, it is expected that an AP student understands the concept and may be asked to use this knowledge in conjunction with one of the six big ideas of AP Chemistry.

The 6 Big Ideas of AP Chemistry

- Big Idea 1: Structure or Matter
- Big Idea 2: Properties of Matter Characteristics, States, and Forces of Attraction
- Big Idea 3: Chemical Reactions
- Big Idea 4: Rates of Chemical Reactions
- Big Idea 5: Thermodynamics
- Big Idea 6: Equilibrium

You may want to refer to the two videos I linked in assignment #3. This assignment delves deeper into the nucleus and nuclear reaction: fission and fusion.

Nuclear Chemistry: Crash Course Chemistry #38

https://www.youtube.com/watch?v=KWAsz59F8gA

<u>Nuclear Chemistry Part 2: Fusion and Fission - Crash Course Chemistry #39</u> https://www.youtube.com/watch?v=FU6y1XIADdg

Study Guide for Nuclear Chemistry

1. <u>Positron</u>

- - particle of charge +1 and mass equal to that of an electron.
 - ${}^{0}_{1}e \,\,{}^{0}_{+1}eta$

2. <u>Alpha particle</u>

• Emitted helium nucleus.

$${}^{4}_{2}He^{+2}$$

3. <u>Beta particle</u>

- Energetic electron from a decomposed neutron.
- $\stackrel{0}{-1}e \text{ or }\beta^{-1}$

4. Transuranium elements

• Element with atomic number greater than 92

5. Gamma radiation

- High energy electromagnetic radiation
 - ο ογ

6. Transmutation

• . conversion of an atom of one element to an atom of another element

7. <u>Fission</u>

• Splitting of nucleus into two similar – sized pieces.

8. <u>Fusion</u>

• combination of two nuclei to form a large nucleus

9. <u>Radioisotope</u>

• Element with unstable nucleus

Nuclear Particles

Particle	Symbol	Charge
Proton	p+ ¹ ₁ H	+1
Neutron	n ¹ ₀ n	0
Electron/Beta	β- ⁰ ₋₁ e	-1
Positron	β+ ⁰ ₊₁ e	+1
Alpha particle	α ⁴ ₂ He	+2
Gamma ray	γ	0

10. What is the charge on an alpha particle?

11. How many neutrons are there in an alpha particle?

12. What is the change in the atomic number when an atom emits an alpha particle?

13. What is the change in atomic mass when an atom emits an alpha particle.

14. What is the change in the atomic number when an atom emits a beta particle.

15. What is the change in the atomic number when an atom emits gamma radiation?

16. What particle is emitted in alpha radiation?

17. Which symbol is used for an alpha particle.

18. What is the minimum thickness needed to stop an alpha particle?

- A sheet of paper can stop an alpha particle.
- Alpha particles are the weakest form of radiation.

19. What symbol is used for beta radiation?

20. What is the minimum thickness needed to stop a beta particle?

• A sheet of aluminum foil.

21. What is the minimum thickness needed to stop gamma radiation

- Three inches of lead.
- 22. The most penetrating form of radiation is
- 23. Which type of ionizing radiation can be blocked by clothing?
- 24. If the half life of a radioactive material is 8 years, how many years will it take for one half of the original amount to decay.
- 25. A piece of wood found in an ancient burial mound contains only half as much carbon-14 as a piece of wood cut from a living tree growing nearby. If the half-life for carbon-14 is 5730 years, what is the approximate age of the ancient wood
- 26. After 42 days, 2 g of phosphorus-32 has decayed to . 25 g. What is the half-life phosphorus-32.
- 27. Above what atomic number are all atoms radioactive?





NUCLEAR EQUATIONS

Example: ²³⁸₉₂ U



Complete these nuclear reactions:





SUMMER ASSIGNMENT #4

Assignment #4 deals with reactions and bonding. I have attached an activity series, solubility rules, electronegativity table and a VSPER Cheat Sheet. You WILL NOT be given these reference sheets on the AP test. However, you DO NOT have to memorize these rules. On the AP exam you will be given enough information to answer the questions. You will need to know your VSPER shapes for the AP exam. We will be learning some new VSPER shapes this year too.

Metal	Oxidation Reaction		
Lithium	$Li \longrightarrow Li^+ +$	e-	
Potassium	$K \longrightarrow K^+ +$	e-	
Barium	Ba → Ba²+ +	2e-	
Calcium	Ca → Ca²+ +	2e-	~
Sodium	Na → Na+ +	e-	
Magnesium	$Mg \longrightarrow Mg^{2+} +$	2e-	
Aluminum	$AI \longrightarrow AI^{3+} +$	3e-	88
Manganese	$Mn \longrightarrow Mn^{2+} +$	2e-	8
Zinc	Zn → Zn²+ +	2e-	ĮĮ
Chromium	$Cr \longrightarrow Cr^{3+} +$	3e-	-== 二二
Iron	Fe \longrightarrow Fe ²⁺ +	2e-	Ltio
Cobalt	$Co \longrightarrow Co^{2+} +$	2e-	lda
Nickel	$Ni \longrightarrow Ni^{2+} +$	2e-	8
Tin	Sn → Sn²+ +	2e-	e de la companya de l
Lead	$Pb \longrightarrow Pb^{2+} +$	2e-	3
Hydrogen	$H_2 \longrightarrow 2H^+ +$	2 e=	ш
Copper	$Cu^{2} \longrightarrow Cu^{2+} +$	2e-	
Silver	$Ag \longrightarrow Ag^+ +$	e-	
Mercury	$Hg \longrightarrow Hg^{2+} +$	2e-	
Platinum	$Pt \longrightarrow Pt^{2+} +$	2e-	
Gold	$Au \longrightarrow Au^{3+} +$	3e-	

TABLE 4.4Activity Series of Metals inAqueous Solution

Ion	General Solubility Rule
NO ₃ -	All nitrates are soluble
$C_2H_3O_2^{-1}$	All acetates are soluble (Ag C ₂ H ₃ O ₂ only moderately)
Cl ⁻ , Br ⁻ , I ⁻	All chlorides, bromides and iodides are soluble except Ag^{+} , Pb^{+} and $Hg_2^{2^{+}}$. (PbCl ₂ is slightly soluble in cold water and moderately soluble in hot water.)
SO4 ²⁻	All sulfates are soluble except those of Ba^{2+} , Pb^{2+} , Ca^{2+} and Sr^{2+} .
$\mathrm{CO_3}^{2-}$ and $\mathrm{PO_4}^{3-}$	All carbonates and phosphates are insoluble except those of Na ⁺ , K ⁺ and NH ₄ ⁺ . (Many acid phosphates are soluble)
OH.	All hydroxides are insoluble except those of Na ⁺ and K ⁺ . Hydroxides of Ba ²⁺ and Ca ²⁺ are slightly soluble.
S ²⁻	All sulfides are insoluble except those of Na ⁺ , K ⁺ , NH ₄ ⁺ and those of the alkaline earths: Mg ²⁺ , Ca ²⁺ , Sr ²⁺ and Ba ²⁺ . (Sulfides of Al ³⁺ and Cr ³⁺ hydrolyze and precipitate as the corresponding hydroxides.
Na ⁺ , K ⁺ and $\rm NH_4^+$	All salts of sodium ion, potassium ion and ammonium ion are soluble except several uncommon ones.

Elements and Bonding

- 1) Classify each of the following elements as an alkali metal, an alkaline-earth metal, transition metal, metalloid, halogen, or noble gas based on its position in the periodic table:
 - boron
 - gold _____
 - krypton _____
 - calcium _____
- 2) How many valence electrons do each of the following elements have?
 - carbon _____
 potassium _____
 - selenium _____
 - xenon _____

- 3) Which of the following ions are likely to be formed?
 - N⁺⁵
 - He⁺_____
 - F⁻¹_____
 - Al⁺²_____
 - P⁻³_____
 - Mg⁺² _____
- 4) Explain why oxygen is a fairly reactive element while neon is not.

5) Explain why beryllium loses electrons when forming ionic bonds, while sulfur gains electrons.

6) Explain why fluorine and chlorine have similar reactivities (the word "valence" should be somewhere in your answer!)

Bonding Review

- 1) Barium iodide contains what type of bonding?
- 2) Carbon tetrachloride contains what type of bonding?
- 3) Molecular oxygen contains what type of bonding?
- 4) Liquid mercury contains what type of bonding?
- 5) Using electronegativity differences compare the bonding in carbon tetrachloride and molecular oxygen. (*See Table Below*)
- 6) Draw Lewis structures, give molecular geometry name and indicate **molecular** polarity for the following species. (*VSPER Cheat Sheet on next page*)

A) CCl ₄	B)CO ₂	C) BCl_3	D) $H_{2}O$
)4	- J = - 2		-)2 -

Н 2.20																	He n.a.
Li	Be											B	C	N	0	F	Ne
0.98 Na	1.57 Mg											2.04	2.55 Si	3.04 P	3.44 S	5.98 Cl	n.a. Ar
0.93	1.31			-	-					-		1.61	1.90	2.19	2.58	3.16	n.a.
к	Ca	Sc	Ti	v	Cr	Mn	Fe	Co	Ni	Cu	Zn	Ga	Ge	As	Se	Br	Kr
0.82	1.00	1.36	1.54	1.63	1.66	1.55	1.83	1.88	1.91	1.90	1.65	1.81	2.01	2.18	2.55	2.96	3.00
Rb	Sr	Y	Zr	Nb	Mo	Τc	Ru	Rh	Pd	Ag	Cd	In	Sn	Sb	Te	I	Xe
0.82	0.95	1.22	1.33	1.60	2.16	1.90	2.20	2.28	2.20	1.93	1.69	1.78	1.96	2.05	2.10	2.66	2.60
Cs	Ba	La	Hf	Ta	w	Re	Os	Ir	Pt	Au	Hg	ті	Pb	Bi	Po	At	Rn
0.79	0.89	1.10	1.30	1.50	2.36	1.90	2.20	2.20	2.28	2.54	2.00	1.62	2.33	2.02	2.00	2.20	n.a.
Fr	Ra	Ac	Rf	Db	Sg	Bh	Hs	Mt	Ds	Rg	Uub	_	Uuq	_	_	_	_
0.70	0.89	1.10	n.a.		n.a.												

TABLE 9.2 Electron-Domain Geometries and Molecular Shapes for Molecules with Two, Three, and Four Electron Domains Around the Central Atom					
Number of Electron Domains	Electron- Domain Geometry	Bonding Domains	Nonbonding Domains	Molecular Geometry	Example
2	Linear	2	0	B B B	ö=c=ö
3	Trigonal planar	3	0	B Trigonal planar	Ë. ₽ ₽ ₽ ₽
		2	1	Bent B	
4	Tetrahedral	4	0	B B B B B Cetrabedral	H H H H
		3	1	BBB	H H H
		2	2	pyramidal B B Bent	H H

VSPER Cheat Sheet

Predicting Reaction Products

Predict the products of each of the following chemical reactions, then balance the equation. If a reaction will not occur, explain why not:

$$1) \qquad \underline{Ag_2SO_4} + \underline{NaNO_3} \rightarrow$$

2) ____ NaI + ____ CaSO₄
$$\rightarrow$$

$$3) \qquad \underline{\qquad} HNO_3 + \underline{\qquad} Ca(OH)_2 \rightarrow$$

4)
$$__ CaCO_3 \rightarrow$$

5)
$$_$$
 AlCl₃ + $_$ (NH₄)₃PO₄ \rightarrow

$$6) \qquad \underline{Pb} + \underline{Fe(NO_3)_3} \rightarrow \\$$

7)
$$C_3H_6 + 0_2 \rightarrow$$

8) ____Na + ____CaSO₄ \rightarrow

Balancing Equations and Simple Stoichiometry

Balance the following equations:

1)
$$N_2 + F_2 \rightarrow NF_3$$

- 2) $C_6H_{10} + O_2 \rightarrow CO_2 + H_2O$
- 3) _____HBr + ____KHCO₃ \rightarrow ____H₂O + ____KBr + ___CO₂

4)
$$_$$
 GaBr₃ + $_$ Na₂SO₃ \rightarrow $_$ Ga₂(SO₃)₃ + $_$ NaBr

5) $SnO + NF_3 \rightarrow SnF_2 + N_2O_3$

Using the equation from problem 2 above, answer the following questions:

6) If I do this reaction with 35 grams of C_6H_{10} and 45 grams of oxygen, how many grams of carbon dioxide will be formed?

- 7) What is the limiting reagent for problem 6? _____
- 8) How much of the excess reagent is left over after the reaction from problem 6 is finished?
- 9) If 35 grams of carbon dioxide are actually formed from the reaction in problem 6, what is the percent yield of this reaction?

Stoichiometry Practice

Solve the following stoichiometry grams-grams problems:

1) Using the following equation:

 $2 \text{ NaOH} + \text{H}_2\text{SO}_4 \rightarrow 2 \text{H}_2\text{O} + \text{Na}_2\text{SO}_4$

How many grams of sodium sulfate will be formed if you start with 200 grams of sodium hydroxide and you have an excess of sulfuric acid?

2) Using the following equation:

 $Pb(SO_4)_2 + 4 LiNO_3 \rightarrow Pb(NO_3)_4 + 2 Li_2SO_4$

How many grams of lithium nitrate will be needed to make 250 grams of lithium sulfate, assuming that you have an adequate amount of lead (IV) sulfate to do the reaction?

SUMMER ASSIGNMENT #5 Assignment #5 deals with gas laws. I have also included some more stoichiometry.

Boyle's Law	Charles' Law	Guy-Lassac's Law	Combined Gas Law
For a given mass of gas at constant temperature, the volume of a gas varies inversely with pressure	The volume of a fixed mass of gas is directly proportional to its Kelvin temperature if the pressure is kept constant.	The pressure of a gas is directly proportional to the Kelvin temperature if the volume is kept constant.	Combines Boyle's, Charles', and the Temperature-Pressure relationship into one equation. Each of these laws can be derived from this law.
$P_1V_1 = P_2V_2$	$\frac{\underline{V}_1 = \underline{V}_2}{T_1 T_2}$	$\frac{\underline{P}_1 = \underline{P}_2}{\underline{T}_1 \underline{T}_2}$	$\frac{\underline{P}_{1}\underline{V}_{1}}{\underline{\Gamma}_{1}} = \frac{\underline{P}_{2}\underline{V}_{2}}{\underline{\Gamma}_{2}}$

Dalton's Law	Ideal Gas Law
At constant volume and temperature, the total pressure exerted by a mixture of gasses is equal to the sum of the pressures exerted by each gas,	The Ideal Gas Law relates the pressure, temperature, volume, and mass of a gas through the gas constant "R".
$P_{tot} = P_1 + P_2 + P_3 \dots$	PV = nRT

Abbreviations	Standard Conditions
atm = atmosphere mm Hg = millimeters of mercury torr = another name for mm Hg Pa = Pascal kPa = kilopascal K = Kelvin °C = degrees Celsius	0°C = 273 K 1.00 atm = 760.0 mm Hg = 76 cm Hg = 760 torr =101.325 kPa = 101, 325 Pa = 29.9 in Hg

Conversions	Gas Law's Equation Symbols
K = °C + 273 °F = 1.8 * °C + 32 °C = (°F - 32) x .5556	Subscript (1) = old condition or initial condition
1 cm ³ (cubic centimeter) = 1 mL (milliliter)	Subscript (2) = new condition or final condition
1 dm ³ (cubic decimeter) = 1 L (liter) = 1000 mL	Temperature must be in Kelvins
	n = number of moles = grams/Molar mass R = 8.31 L-kPa/ mol-K = 0.0821 L-atm/mol-K = 62.4 L-Torr/mol-K
	You must have a common set of units in the problem

Ideal Gas Law Problems

Background

The ideal gas law states that PV=nRT, where P is the pressure of a gas, V is the volume of the gas, n is the number of moles of gas present, R is the ideal gas constant, and T is the temperature of the gas in Kelvins.

Common mistakes:

- Make sure that T is expressed in Kelvins. Remember that Kelvins are degrees Celsius + 273.15.
- Using the wrong value for R. You need to make sure that you have the right value of R for the units you are using.
- In AP chemistry the value for R is 0.08206 L-Atm-mol⁻¹-K⁻¹. Make sure units agree!
- 1. How many moles of gas does it take to occupy 105 liters at a pressure of 1.3 atmospheres and a temperature of 240 K?

2. If you have a 60 liter container that holds 55 moles of gas at a temperature of 300°C, what is the pressure inside the container?

Dalton's Law

3. A metal tank contains three gasses: oxygen, helium, and nitrogen. If the partial pressures of the three gasses in the tank are 35 atm of O_2 , 5 atm of N_2 , and 25 atm of He, what is the total pressure inside of the tank?

4. Blast furnaces give off many unpleasant and unhealthy gasses. If the total air pressure is 0.99 atm, the partial pressure of carbon dioxide is 0.05 atm, and the partial pressure of hydrogen sulfide is 0.02 atm, what is the partial pressure of the remaining air?

Gas Stoichiometry

5. For the reaction $2 H_{2(g)} + O_{2(g)} \rightarrow 2 H_2O_{(g)}$, how many liters of water can be made from 5 L of oxygen gas and an excess of hydrogen?

6. How many liters of water can be made from 55 grams of oxygen gas and an excess of hydrogen at STP?

Dalton's Law of Partial Pressures

Background Info

When two or more gasses are introduced into the same container, each gas individually expands to uniformly occupy that container. Thus each gas in the mixture has the same volume but depending on how many moles of each is present, exerts a different pressure, called its partial pressure. Dalton's Law of Partial Pressures states that in a mixture of gasses, the total pressure is the sum of the individual pressures of each gas present in the mixture - i.e. the sum of the partial pressures. **THERE IS A DIRECT RELATIONSHIP BETWEEN PRESSURE AND MOLES!**

7. If 3 moles of N_2 and 4 moles of O_2 are placed in a 35L container at a temperature of 25°C, what will the pressure of the resulting mixture of gasses be?

8. Two flasks are connected with a stopcock. The first flask has a volume of 5 liters and contains nitrogen gas at a pressure of 0.75 atm. The second flask has a volume of 8 L and contains oxygen gas at a pressure of 1.25 atm. When the stopcock between the flasks is opened and the gasses are free to mix, what will the pressure be in the resulting mixture?

9. What's the partial pressure of carbon dioxide in a container that holds 5 moles of carbon dioxide, 3 moles of nitrogen, and 1 mole of hydrogen and has a total pressure of 1.05 atm?

Stoichiometry Review

10 .Determine the **formula weight** for the following:

a. N_2O_5

b. CuSO₄

11. Calculate the percentage by mass of the following compounds:

a. SO₃

b. CH₃COOCH₃

12.Determine the empirical formula of the compounds with the following compositions by mass: a.10. 4 % C, 27. 8% S , 61. 7 % Cl 13. Arsenic reacts with chlorine to form a chloride. If 1.587 g of arsenic reacts with 3.755 g of chlorine, what is the simplest formula of the chloride?

14.What is the molecular formula of the following compound?

a. empirical formula CH₂ , molar mass =84g/mol.

Summer Assignment #6

Assignment #6 deals with solutions and dilutions. I have also included some more stoichiometry.

Molarity and Dilutions Practice Problems

<u>Molarity</u>

Solution = solute + solvent Solute – thing beings dissolved Solvent – thing doing the dissolving (water is called the universal solvent)

Molarity = moles of solute/ liters of solution M=n/V Units - mol/L or M

- How many grams of potassium carbonate, K₂CO₃, are needed to make 250 mL of a 2.5 *M* solution? (*moles = molarity * volume. Make sure volume is in liters. Convert moles to grams*)
- 2) How many liters of 4.0 *M* solution can be made using 125 grams of lithium bromide, LiBr?
- 3) What is the concentration of a solution that has a volume of 2.5 L and contains 660 grams of calcium phosphate, $Ca_3(PO_4)_2$? (Molarity is a measure of concentration)
- 4) How many grams of copper (II) fluoride, CuF₂, are needed to make 6.7 liters of a 1.2 *M* solution?

Dilutions

Dilute solutions are often made by diluting concentrated solutions. The dilution formula is used for this. That formula is:

 $M_1V_1 = M_2V_2$

This formula can ONLY be used for dilution. **DO NOT USE IT FOR NEUTRALIZATION! YOU MUST USE STOICHIOMETRY FOR NEUTRALIZATION.**

- 5) What volume of concentrated hydrochloric acid (12 *M*) would be required to create a 500.0 mL solution with a concentration of 1.00 *M*?
- 6) What volume of the solution in question #10 would be required to create a 250 mL solution with a concentration of 0.100 *M*?

Chemical Equations and Stoichiometry

7. Oil paintings in which "white lead" has been used can be blackened by reaction with H_2S from air pollution or from the glaze over the painting itself. The blackening comes from the formation of lead sulfide, which may be cleaned off by washing with hydrogen peroxide, H_2O_2 . The reaction for the cleaning process is

PbS (black solid) + 4 $H_2O_2(aq) \rightarrow PbSO_4(s) + 4 H_2O(l)$

a. How many grams of H_2O_2 must be used to clean off 0.24 g of PbS?

b. If 0.072 g of H_2O forms in the reaction, how many grams of $PbSO_4$ must also have been formed?

8. Butane, which contains only C and H, is a commonly used fuel in camping stoves. To determine the formula of butane, assume you burn 0.580g of the gas and obtain 1.760g of CO_2 and 0.900g of H_2O . What is the empirical formula of butane?