AP CHEMISTRY SUMMER ASSIGNMENT AND FIRST WEEK ASSESSMENT MATERIAL

This is your official welcome to AP Chemistry! Your summer assignment is quite simple (but <u>not</u> easy). Advanced Placement Chemistry is a college-level course and rather than memorizing how to do a particular type of problem, you must really understand the chemistry! Because of the amount of material we must cover before the AP exam in May, students must complete much of the work outside of class. Homework will include online practice problems, sample AP questions and reading assignments! With hard work you will not only be successful in the AP Chemistry exam and course, but also be prepared for college level coursework!

Like most AP classes, AP Chemistry comes with a summer assignment. Previous AP students have helped design this assignment – it is what they think is important to review and know before starting class in the fall. The assignment will be collected the first day of class in August and there will be a quiz on some material the first day of school. You will need to know material from this packet for the quiz and a test during the first week of school! Doubtless, there will be some students who will procrastinate and try to finish the entire summer packet and all of this studying just before the start of school. Those students may even cram well enough to do well on the initial quiz. However, they will quickly forget the information and ions, and struggle every time that these formulas are used in lecture, homework, quizzes, tests and labs. All research on human memory shows us that frequent, short periods of study, spread over long periods of time will produce much greater retention than long periods of study of a short period of time.

Check off each part of the assignment as you complete it and be sure to bring the appropriate items for collection the first day of school. Do not just complete the material in the summer assignment-make sure that you know and understand the material for the first class.

In addition, you can view the NMSI vodcasts by Rene McCormick and take notes on the following topics for additional help if needed: (These will NOT be collected for a grade!)

*Chemical Foundations *Atoms, Molecules and Ions *Stoichiometry

These Vodcasts cover a great deal of information. Please try your best! The NMSI notes along with companion videos (vodcasts) regarding the topics can be accessed through Google Classroom.

You will need to enroll into my AP Chemistry Google Classroom using the following class code: 2bt36zh

I look forward to seeing you all at the beginning of the next school year. If you need to contact me during the summer, you can email me and I will get back to you quickly.

Best of luck to you, Mr.Thomas Email: <u>thomasje@wsd3.org</u> Collect the materials needed for the course

Materials: 1 ½ inch 3-ring binder Highlighters

Scientific calculator 10 divider tabs (one for each topic listed on the Course Content sheet)

Chemical Bonding – Cations and Anions

Pages 5-6 Complete the exercise and question sections.

Prepare flashcards as described in the Assignment and study the ion names and formulas. Be prepared for a quiz on the first day of school!

Chemical Bonding - Compound Formulas & Names

Page 7	Go over the examples of ionic and covalent compound nomenclature:
Page 8	Complete the exercise

Chemical Bonding – Rules for Naming Acids

Page 9	Read through the examples of acid naming rules
Page 10	Complete the exercise

Reactions – Solubility Rules

Page 11	Answer the questions
	Prepare the flashcards as described in the Assignment and study the solubility rules. Be prepared for a quiz on the first day of school.
Page 13	Use the examples provided to complete the exercise on page

Reactions – Chemical Equations

Page 14	Go over the types of equations in the examples provided
Page 15	Complete the exercise. Be sure to balance each equation.

Bring these items with you to class the first day of school:

- 1. Flashcards for common ions
- 2. Flashcards for solubility rules
- 3. Completed summer packet staple or paper clip the entire packet together to turn in.

Quiz – First day of School: Know common ion names and formulas and the solubility rules.

Test – First week of School:

- 1. Compound Formulas and Names
- 2. Acid Nomenclature
- 3. Applying Solubility Rules
- 4. Chemical Equations

AP Chemistry Course Content

1st Semester

Unit 1 – Reactions

- A. Structure of Matter
 - a. Evidence of atomic theory
 - b. Atomic masses; determination by chemical and physical means
 - c. Atomic number and mass number; isotopes
- B. Reaction Types
 - 1. Ionic and Molecular species present in chemical systems; net ionic equations
 - 2. Precipitation reactions
 - 3. Acid-base reactions; concepts of Arrhenius, Bronsted-Lowry and Lewis; Coordination complexes, amphoterism
 - 4. Redox reactions
 - a. Oxidation numbers
 - b. The role of the electron in oxidation-reduction
 - 5. Nuclear equations, half-lives and radioactivity, chemical applications
- C. Stoichiometry
 - 1. Balancing of equations, including those for redox reactions
 - 2. Mass and volume relations with emphasis on the mole concept, including empirical formulas and limiting reactants

Unit 2 – Electrochemistry

- 1. Galvanic and electrolytic cells
- 2. Faraday's law
- 3. Standard half-cell potentials; Nernst equation; prediction of direction of redox reactions
- 4. Gibb's Free Energy

Unit 3 – Thermochemistry / Thermodynamics

- 1. State functions
- 2. First law: change in enthalpy, heat of formation, heat of reaction, Hess' law, heats of vaporization and fusion, calorimetry
- 3. Second law: entropy, free energy of formation, free energy of reaction, dependence of change in free energy on enthalpy and entropy changes
- 4. Relationship of change in free energy in equilibrium constants and electrode potentials

Unit 4 – Kinetics

- 1. Concept of rate of reaction
- 2. Use of experimental data and graphical analysis to determine the reactant order, rate constants and reaction rate laws
- 3. Effect of temperature change on rates
- 4. Energy of activation, the role of catalysts
- 5. The relationship between the rate-determining step and a mechanism

Take-Home Unit – Gases

- 1. Laws of ideal gases
- 2. Equation of state for an ideal gas
- 3. Partial pressures

2nd Semester

Unit 1 – General Equilibrium

- 1. Concept of dynamic equilibrium, physical and chemical, LeChatlier's principle, equilibrium constants
- 2. Quantitative treatment: Equilibrium constants for gaseous reactions: K_p, K_c

Unit 2 – Solution and Acid/Base Equilibrium

- 1. Equilibrium constants for reactions in solution
 - Solubility product constants and their application to precipitation and the dissolution of slightly soluble compounds
 - Common ion effect and hydrolysis
 - Constants for acids and bases, pK and pH
 - Buffers

Unit 3 – Atomic Theory/Structure

- 1. Electron energy levels, atomic spectra, quantum numbers, atomic orbitals
- 2. Periodic relationships, atomic radii, ionization energies, electron affinities, electronegativity, oxidation states
- 3. PES

Unit 4 – Chemical Bonding and IMFs

- 1. Binding forces
 - a. Types: ionic, covalent, metallic, hydrogen bonding, van der Waals (including LDF)
 - b. Relationships to states, structure, and properties of matter
 - c. Polarity of bonds, electronegativities
- 2. Molecular models
 - a. Lewis structures
 - b. Valence bond: hybridization of orbitals, resonance, sigma and pi bonds
 - c. VSEPR
- 3. Geometry of molecules and ions, structural isomerism of simple organic molecules and coordination complexes, dipole moments of molecules, relation of properties to structure
- 4. Organic chemistry: hydrocarbons and functional groups, structure, nomenclature, chemical properties

Take-Home Unit: Solutions

- 1. Types of solutions and factors affecting solubility
- 2. Methods of expressing concentration
- 3. Non-ideal behavior (qualitative aspects)

Chemical Bonding – Cations and Anions

Common Ions with One Oxidation State

<u>Name</u>	<u>Formula</u>	<u>Name</u>	<u>Formula</u>
Lithium	Li ⁺¹	Sodium	Na^{+1}
Potassium	\mathbf{K}^{+1}	Magnesium	Mg^{+2}
Calcium	Ca ⁺²	Strontium	Sr^{+2}
Barium	Ba^{+2}	Silver	Ag^{+1}
Zinc	Zn^{+2}	Aluminum	Al^{+3}
Hydrogen	$\mathrm{H}^{\mathrm{+1}}$ or $\mathrm{H}^{\mathrm{-1}}$	Nitride	N ⁻³
Oxide	O ⁻²	Sulfide	S ⁻²
Fluoride	F ⁻¹	Chloride	Cl ⁻¹
Bromide	Br ⁻¹	Iodide	I ⁻¹

Exercise: Locate the elements listed above on your periodic table and observe the trend. Label the top of each column involved with the appropriate ion charge.

Common Ions with More Than One Oxidation State

Name	<u>Formula</u>	Name	<u>Formula</u>
Copper (I)	Cu^{+1}	Mercury (I)	$\mathrm{Hg_2}^{+1}$
Copper (II)	Cu^{+2}	Mercury (II)	Hg^{+2}
Iron (II)	Fe^{+2}	Chromium (I)	Cr^{+1}
Iron (III)	Fe ⁺³	Chromium (III)	Cr^{+3}
Manganese (II)	Mn^{+2}	Cobalt (II)	Co^{+2}
Manganese (III)	Mn^{+3}	Cobalt (III)	Co ⁺³
Tin (II)	Sn^{+2}	Lead (II)	Pb^{+2}
Tin (IV)	Sn^{+4}	Lead (IV)	Pb^{+4}

Questions: Locate the elements listed above on your periodic table.

Is there a trend based on the oxidation states for each of the transition elements?

What does the Roman number indicate about the ion?

Why is it not necessary to give a Roman number when writing the name for silver and zinc ions?

Write the charges above in the box on your periodic table for each of the transition elements listed above.

Polyatomic Ions

- a charge particle which has two or more atoms held together by covalent bonds

Common Polyatomic Ions					
1- Cl	narge	2- Charge		3- Charge	
Formula	Name	Formula	Name	Formula	Name
CN-	Cyanide	CO3 ²⁻	Carbonate	PO ₃ ³⁻	Phosphite
OH-	Hydroxide	SO ₃ ²⁻	Sulfite	PO ₄ ³⁻	Phosphate
$C_2H_3O_2^-$	Acetate	SO ₄ ²⁻	Sulfate		
NO_2^-	Nitrite CrO ₄ ²⁻ Chromate		Chromate	1+ Charge	
NO ₃ -	Nitrate	$Cr_2O_7^{2-}$	Dichromate	Formula	Name
ClO-	Hypochlorite	SiO ₃ ²⁻	Silicate	NH4 ⁺	Ammonium
ClO_2^-	Chlorite	$C_2O_4^{2-}$	Oxalate	H_2O^+	Hydronium
ClO ₃ -	Chlorate	O_2^{2-}	Peroxide	11,0	iryaromam
ClO ₄ -	Perchlorate	$S_2O_3^{2-}$	Thiosulfate		
MnO ₄ -	Permanganate				
SCN ⁻	Thiocyanate				
BrO ₃ -	Bromate				
IO ₃ -	Iodate				

Questions:

What do the prefixes hypo-, per-, bi- and thio- mean in terms of polyatomic ion?

What is the significance of the suffixes -ate and -ite in terms of the formula of the ions?

Assignment: Students taking the AP Chemistry exam are given several reference sheets to use during the test. Monoatomic and polyatomic ions are **not** included on those reference sheets so students are required to memorize them. Make flashcards of the ions from the lists above – write the ion formula with charge on one side of the flashcard and the name of the ion on the other side of the card. You can also use the free website quizlet.com to make, learn and print your flashcards.

First day of class – have the ion names and formulas memorized (there will be a quiz) and bring your flashcards to class!

Chemical Bonding – Compounds Formulas and Names

Use the examples below to complete the chart on the following page:

	Ionic Compounds	
	metal + nonmetal or containing a polyatomic io	on
	total ions charges must equal ()
potassium oxide ions = $K^{+1} O^{-2}$ formula = K_2O	calcium nitrate ions = Ca^{+2} NO ₃ ⁻¹ formula = $Ca(NO_3)_2$	iron III hydroxide ions = Fe^{+3} OH ⁻¹ formula = $Fe(OH)_3$
BaBr ₂ barium bromide	(NH ₄) ₂ CO ₃ ammonium carbonate	Cu2O copper (I) oxide



Compound Nomenclature

Exercise: Complete this section by givi	ng the correct formula or name for each compound
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Write	Write the formulas for the following:		Name each of the following:	
a.	barium sulfate	a.	CuSO ₄	
b.	ammonium chloride	b.	PCl ₃	
c.	chlorine monoxide	c.	Li ₃ N	
d.	silicon tetrachloride	d.	BaSO ₃	
e.	magnesium fluoride	e.	N_2F_4	
f.	sodium oxide	f.	KClO ₄	
g.	sodium peroxide	g.	NaH	
h.	copper (I) oxide	h.	(NH ₄) ₂ Cr ₂ O ₇	
i.	zinc sulfide	i.	Ba(NO ₂) ₂	
j.	potassium carbonate	j.	Sr ₃ P ₂	
k.	manganese (II) phosphate	k.	Mg(OH) ₂	
1.	silicon tetrabromide	1.	Al_2S_3	
m.	lead (II) acetate	m.	AgBr	
n.	sodium permanganate	n.	P ₄ O ₁₀	
0.	lithium oxalate	0.	$Pb(C_2H_3O_2)_4$	
p.	potassium cyanide	p.	CaI ₂	
q.	iron (III) hydroxide	q.	MnO ₂	

Chemical Bonding – Rules for Naming Acids

Acids are covalent compound that ionize or form ions in water:

HCl + H₂O \rightarrow H₃O⁺¹ + Cl⁻¹ (chloride)

Acid names are linked to the anion formed when the acid reacts with water.

When the name of the anion (negative ion) ends in –ide, the acid name begins with the prefix hydro- and the stem of the anion has the suffix –ic, followed by the word acid.

Pattern:	hydro ic acid	
Examples:	HCl = hydrochloric acid	$[Cl^{-1} = \underline{chlor}ide]$
	HCN = hydro <u>cyan</u> ic acid	$[CN^{-1} = cyan\underline{ide}]$

When the name of the anion ends in -ite, the acid name is the stem of the anion with the suffix -ous, followed by the word acid.

Pattern:	ous acid	
Examples:	$HNO_2 = nitrous$ acid	$[NO_2^{-1} = nitrite]$
	$H_2SO_3 = sulfurous acid$	$[SO_3^{-2} = sulfite]$

When the name of the anion ends in **-ate** the acid name is the stem of the anion with the suffix -ic, followed by the word acid.

Pattern: _____ic acid

Examples: $HNO_3 = nitric acid$ $[NO_3^{-1} = nitrate]$

 $H_2SO_4 = sulfuric acid$ [SO₄⁻² = sulfate]

Acids Names and Formulas

Exercise : Complete the page using the rules on page 9.						
1. Name the following acids:						
a. HBr	b. H ₃ PO ₄		c. HClO ₄			
d. HC ₂ H ₃ O ₂	e. HI		f. HIO ₃			
g. HClO	h. $H_2C_2O_4$					
2. Give the formula for the following acids:						
a. hydrofluoric acid		b. bromic acid				
c. chloric acid		d. carbonic acid				
e. chlorous acid		f. phosphorous acid				

Solubility Rules

These are strong electrolytes (100% ionized) and written as ions

- 1. Strong Acids: HCl, HBr, HI, H₂SO₄, HNO₃, HClO₄, HClO₃
- 2. Strong Bases: Hydroxides of group IA and IIA(Ba, Sr, Ca are marginal Be and Mg are WEAK)
- 3. Soluble Salts (see table): (ionic compounds: metal/nonmetal)

ALWAYS SOUBLE IF IN A COMPOUND	EXCEPT WITH
NO_3^- , Group IA, NH_4^+ , $C_2H_3O_2^-$, ClO_4^- , ClO_3^-	No Exceptions
Cl [°] , Br [°] , I [°]	Pb, Ag, Hg ₂ ²⁺
SO ₄ ²⁻	Pb, Ag, Hg ₂ ²⁺ Ca, Sr, Ba

If it does not fit one of the three rules above, assume it is INSOLUBLE or a WEAK ELECTROLYTE (and written together). This won't always be correct, but will cover most of the situations.

Also, GASES, PURE LIQUIDS, and SOLIDS are non-electrolytes. Remember H₂CO₃ decomposes into H₂O(l) and CO₂(g) Remember NH₄OH decomposes into H₂O(l) and NH₃(g) Remember H₂SO₃ decomposes into H₂O and SO₂

<u>Ouestions:</u> What is meant by the term solution?

What does it mean when we say a compound is soluble or insoluble?

What does the term "aqueous" mean?

Are the solubility rules different for compounds mixed with alcohol or other liquids?

What elements are included in the alkali metal group mentioned in solubility rules?

Assignment: It is important to know the rules for solubility of ionic compounds (and acids) during many of the units in AP Chemistry. Make flashcards of the solubility rules: write the formula for the ion on one side of the flashcard and the rule for its solubility on the other side of the card.

First day of class: have the solubility rules for each ion memorized (there will be a quiz) and bring your flashcards to class!

Applying Solubility Rules

Exercise:	Use the examples	below to complete the	chart on the following page.
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Compound	Soluble or Insoluble?	Ions present in solution?				
KCl	Soluble	K^{+1} and Cl^{-1}				
Potassium chloride						
Solubility Rule						
Alkali metal K^{+1} is always soluble or Cl^{-1} (chloride ion) is soluble except with Ag^{+1} , Pb^{+2} , Hg_2^{+2}						

Compound	Soluble or Insoluble?	Ions present in solution?				
Cu(NO3)2	Soluble	Cu ⁺² and NO ₃ ⁻¹				
Copper (II) nitrate						
Solubility Rule						
Nitrate is always soluble (with any positive ion)						

Compound	Soluble or Insoluble?	Ions present in solution?			
AgCl	Insoluble	None			
Silver chloride		Ag ⁺¹ and Cl ⁻¹ ions remain bonded			
		together in a ionic crystal			
Solubility Rule					
Cl ⁻¹ (chloride ion) is soluble except with Ag^{+1} , Pb^{+2} , Hg_2^{+2}					

Compound	Soluble or Insoluble?	Ions present in solution?			
Zn(OH) ₂	Insoluble	None			
Zinc hydroxide		Zn ⁺² and OH ⁻¹ ions remain bonded			
		together in an ionic crystal			
Solubility Rule					
Hydroxide ion is insoluble except with Ca ⁺² , Sr ⁺² , Ba ⁺² , or any alkalki metal					

Applying Solubility Rules

<u>Exercise</u>: For each compound below determine whether the compound is soluble or insoluble in water. Indicate which ions, if any, would be present in an aqueous solution.

Compound	Soluble or Insoluble?	Ions present in solution?
NaCN		
NH4NO3		
CuSO ₄		
Sulfurous acid		
FeI ₃		
KC ₂ H ₃ O ₂		
HNO ₃		
Copper (I) chlorate		
Al_2S_3		
Lead (II) bromide		
$(NH_4)_2Cr_2O_7$		
Na ₃ N		
Zinc sulfide		
BaSO ₃		
Potassium chlorate		
NaH		
Mg(OH) ₂		
Calcium iodide		
Cu ₃ (PO ₄) ₂		
K ₂ CO ₃		
ZnSiO ₃		

Reactions – Chemical Equations

Diat	omic Molecules:	H_{2}	O_2	N_2	F_2	Cl_2	Br ₂	I_2	("Br-I-N-Cl-H-O-F")
Exar	Examples of five types of reactions (equations are unbalanced) –								
1. S	ynthesis / Combinatio Example: lithium b	n / Con urns in	npositic oxygen	on gas					
	Element + Elemen Li + O ₂ -	nt → (→ Li ₂ O	Compou)	ınd		check then u formla	to see ise chai a of the	if the e rges of comp	elements involved are diatomic the ions to determine the ound
2. D	ecomposition Example: calcium o	oxide is	heated						
	Compound → Ele CaO → Ca	ment + a + O ₂	- Eleme	ent		heat a decon	pplied npositio	to the o on of th	compound trigges the ne compound
3. S	ingle Replacement / D Example: lithium re	isplace eacts wi	ment th sodiu	ım nitra	ite				
	Element + Compo Li + NaN	ound → O3 →	Comj LiNO3	pound + Na	+ Elen	nent	the th partn and a	ree ior ers to f differe	ns in the reactants switch Form a new compound (LiNO3) ent free element (Na)
4. D	Oouble Replacement / Example: calcium o	Displac oxide re	ement acts wit	h bariu	m sulfat	e			
	Compound + Con CaO + E	npound BaSO4 -	I → Co → CaS	Ompou O ₄ +	nd + C BaO	ompou	nd	the f swite	four ions in the reactants ch partners to form two new pounds as products
5. C	Combustion Example: hydrocar	bon read	ct with o	oxygen					
	Hydrocarbon + O CH₄ + O ₂ →	xygen CO2	→ CO + H ₂ O	$_{2} + H_{2}$	20		a hyd may a	rocarb also co	on contain C, H and ntain O

Exercise:

For each reaction below:

- identify the type of reaction
- predict and write the products
- balance the equation

Hint: When writing these reactions, ignore all of the information about heat, bubbling, or mixing details. These are excess words used to make complete sentences. Simply locate the chemical formulas or names in the description to find the reactants for the reaction.

Example: Solutions of silver nitrate and magnesium iodide are combined. $2 \text{ AgNO}_3 + \text{MgI}_2 \rightarrow 2 \text{ AgI} + \text{Mg(NO}_3)_2$

- 1. Ammonium sulfate reacts with barium nitrate
- 2. Zinc metal is added to a solution of copper (II) chloride
- 3. Propane gas (C3H8) is burned in excess oxygen
- 4. Magnesium and nitrogen gas are heated together.
- 5. Chlorine gas is bubbled through a solution of sodium bromide
- 6. Solutions of lead(II) nitrate and calcium iodide are mixed
- 7. Sulfuric acid is combined with sodium hydroxide
- 8. Isopropyl alcohol (C3H7OH) is burned in oxygen
- 9. Iron metal shavings are added to hydrochloric acid
- 10. Ammonium hydroxide solution is added to potassium sulfite

Be sure all equations are balanced.