

2026

AP CHEMISTRY SUMMER ASSIGNMENT AND FIRST WEEK ASSESSMENT MATERIAL

This is your official welcome to AP Chemistry! Your summer assignment is quite simple (but not 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! With hard work you will not only be successful in the AP Chemistry exam and course, but also be prepared for college level coursework!

As you are aware, AP Chemistry comes with a summer preparation 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. **While this assignment is entirely optional and will not be collected for a grade, completing it is highly recommended to set yourself up for success.** There will be an **ungraded, formative diagnostic quiz** on some of this material on the first day of school to help identify any content gaps and guide our early instruction. You will need to know the material from this packet for the quiz! Doubtless, there will be some students who will procrastinate and try to look over the entire summer packet and all of this studying just before the start of school. Those students may even cram well enough to do decently on the initial diagnostic 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 over a short period of time.

Check off each part of the assignment as you complete it to monitor your own readiness. 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: thomasje@wsd3.org

Summer Work Check-List

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.

Net-Ionic Equations

___ Page 16 Go over the structure of net-ionic equations

___ Page 17 Complete the exercise.

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 (both monatomic and polyatomic ions) and the solubility rules.

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

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	K^{+1}	Magnesium	Mg^{+2}
Calcium	Ca^{+2}	Strontium	Sr^{+2}
Barium	Ba^{+2}	Silver	Ag^{+1}
Zinc	Zn^{+2}	Aluminum	Al^{+3}
Hydrogen	H^{+1} or H^{-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

<u>Name</u>	<u>Formula</u>	<u>Name</u>	<u>Formula</u>
Copper (I)	Cu^{+1}	Mercury (I)	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?

Polyatomic Ions

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

<i>Common Polyatomic Ions</i>					
1- Charge		2- Charge		3- Charge	
Formula	Name	Formula	Name	Formula	Name
CN ⁻	Cyanide	CO ₃ ²⁻	Carbonate	PO ₃ ³⁻	Phosphite
OH ⁻	Hydroxide	SO ₃ ²⁻	Sulfite	PO ₄ ³⁻	Phosphate
C ₂ H ₃ O ₂ ⁻	Acetate	SO ₄ ²⁻	Sulfate	1+ Charge	
NO ₂ ⁻	Nitrite	CrO ₄ ²⁻	Chromate		
NO ₃ ⁻	Nitrate	Cr ₂ O ₇ ²⁻	Dichromate	Formula	Name
ClO ⁻	Hypochlorite	SiO ₃ ²⁻	Silicate	NH ₄ ⁺	Ammonium
ClO ₂ ⁻	Chlorite	C ₂ O ₄ ²⁻	Oxalate	H ₃ O ⁺	Hydronium
ClO ₃ ⁻	Chlorate	O ₂ ²⁻	Peroxide		
ClO ₄ ⁻	Perchlorate	S ₂ O 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 ion

total ions charges must equal 0

potassium oxide

ions = K^{+1} O^{-2}

formula = K_2O

calcium nitrate

ions = Ca^{+2} NO_3^{-1}

formula = $Ca(NO_3)_2$

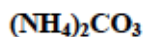
iron III hydroxide

ions = Fe^{+3} OH^{-1}

formula = $Fe(OH)_3$



barium bromide



ammonium carbonate



copper (I) oxide

Covalent Compounds

nonmetal + nonmetal
or acid (HX)

prefixes in name indicate number of each element

sulfur trioxide



phosphorus pentachloride



dinitrogen tetraoxide



boron trichloride



sulfur hexachloride



oxygen dichloride

Compound Nomenclature

Exercise: Complete this section by giving the correct formula or name for each compound

Write the formulas for the following:

- a. barium sulfate
- b. ammonium chloride
- c. chlorine monoxide
- d. silicon tetrachloride
- e. magnesium fluoride
- f. sodium oxide
- g. sodium peroxide
- h. copper (I) oxide
- i. zinc sulfide
- j. potassium carbonate
- k. manganese (II) phosphate
- l. silicon tetrabromide
- m. lead (II) acetate
- n. sodium permanganate
- o. lithium oxalate
- p. potassium cyanide

Name each of the following:

- a. CuSO_4
- b. PCl_3
- c. Li_3N
- d. BaSO_3
- e. N_2F_4
- f. KClO_4
- g. NaH
- h. $(\text{NH}_4)_2\text{Cr}_2\text{O}_7$
- i. $\text{Ba}(\text{NO}_2)_2$
- j. Sr_3P_2
- k. $\text{Mg}(\text{OH})_2$
- l. Al_2S_3
- m. AgBr
- n. P_4O_{10}
- o. $\text{Pb}(\text{C}_2\text{H}_3\text{O}_2)_4$
- 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:



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: $\text{HCl} = \text{hydrochloric acid}$ [$\text{Cl}^{-1} = \text{chloride}$]

$\text{HCN} = \text{hydrocyanic acid}$ [$\text{CN}^{-1} = \text{cyanide}$]

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: $\text{HNO}_2 = \text{nitrous acid}$ [$\text{NO}_2^{-1} = \text{nitrite}$]

$\text{H}_2\text{SO}_3 = \text{sulfurous acid}$ [$\text{SO}_3^{-2} = \text{sulfite}$]

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: $\text{HNO}_3 = \text{nitric acid}$ [$\text{NO}_3^{-1} = \text{nitrate}$]

$\text{H}_2\text{SO}_4 = \text{sulfuric acid}$ [$\text{SO}_4^{-2} = \text{sulfate}$]

Acids Names and Formulas

Exercise: Complete the page using the rules on page 9.

1. Name the following acids:

a. HBr

b. H_3PO_4

c. HClO_4

d. $\text{HC}_2\text{H}_3\text{O}_2$

e. HI

f. HIO_3

g. HClO

h. $\text{H}_2\text{C}_2\text{O}_4$

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

g. selenic 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 ₂ H ₃ O 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

Questions: 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.

Compound	Soluble or Insoluble?	Ions present in solution?
KCl Potassium chloride	Soluble	K^{+1} and Cl^{-1}
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?
$Cu(NO_3)_2$ Copper (II) nitrate	Soluble	Cu^{+2} and NO_3^{-1}
Solubility Rule Nitrate is always soluble (with any positive ion)		

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

Compound	Soluble or Insoluble?	Ions present in solution?
$Zn(OH)_2$ Zinc hydroxide	Insoluble	None Zn^{+2} and OH^{-1} ions remain bonded together in an ionic crystal
Solubility Rule Hydroxide ion is insoluble <u>except with</u> Ca^{+2} , Sr^{+2} , Ba^{+2} , or any alkalki metal		

Applying Solubility Rules

Exercise: 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		
NH ₄ NO ₃		
CuSO ₄		
Sulfurous acid		
FeI ₃		
KC ₂ H ₃ O ₂		
HNO ₃		
Copper (I) chlorate		
Al ₂ S ₃		
Lead (II) bromide		
(NH ₄) ₂ Cr ₂ O 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

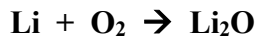
Diatomic Molecules: H₂ O₂ N₂ F₂ Cl₂ Br₂ I₂ (“Br-I-N-Cl-H-O-F”)

Examples of five types of reactions (equations are unbalanced) –

1. Synthesis / Combination / Composition

Example: lithium burns in oxygen gas

Element + Element → Compound



check to see if the elements involved are diatomic then use charges of the ions to determine the formula of the compound

2. Decomposition

Example: calcium oxide is heated

Compound → Element + Element



heat applied to the compound triggers the decomposition of the compound

3. Single Replacement / Displacement

Example: lithium reacts with sodium nitrate

Element + Compound → Compound + Element

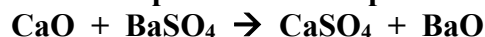


the three ions in the reactants switch partners to form a new compound (LiNO₃) and a different free element (Na)

4. Double Replacement / Displacement

Example: calcium oxide reacts with barium sulfate

Compound + Compound → Compound + Compound



the four ions in the reactants switch partners to form two new compounds as products

5. Combustion

Example: hydrocarbon react with oxygen

Hydrocarbon + Oxygen → CO₂ + H₂O



a hydrocarbon contain C, H and may also contain O

Chemical Equations

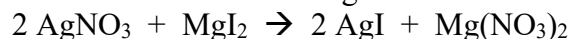
Exercise:

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.

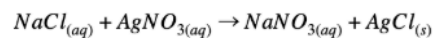


1. Ammonium sulfate reacts with barium nitrate
2. Zinc metal is added to a solution of copper (II) chloride
3. Propane gas (C_3H_8) is burned in excess oxygen
4. Magnesium and nitrogen gas are heated together.
5. Chlorine gas is bubbled through a solution of sodium bromide
6. Solutions of lead(II) nitrate and calcium iodide are mixed
7. Sulfuric acid is combined with sodium hydroxide
8. Isopropyl alcohol ($\text{C}_3\text{H}_7\text{OH}$) is burned in oxygen
9. Iron metal shavings are added to hydrochloric acid
10. Ammonium hydroxide solution is added to potassium sulfite

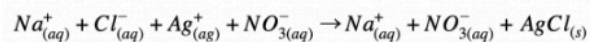
Be sure all equations are balanced.

Writing net ionic equations

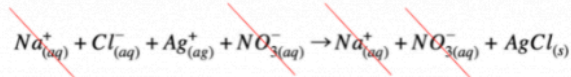
The first step to writing a net ionic equation is balancing the chemical equation present. Let's use the reaction between sodium chloride and silver nitrate as an example.



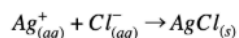
Next, we write the chemical equation as a **complete ionic equation**. This means that we separate each molecule into its ion form. (Note that only **aqueous compounds** can be separated.) If the compound is a solid or liquid, it must stay in its molecule form. The complete ionic equation for the reaction above would be as follows:



Finally, we can use the complete ionic equation to write the net ionic equation. First, we identify the spectator ions. When looking at the complete ionic equation, the spectator ions will have the same charge and state of matter in the reactants and products. In this reaction, the sodium ion and the nitrate ion do not change. As a result, these are considered spectator ions. In order to write the net ionic equation, we simply need to remove the spectator ions.



After removing the spectator ions, we are left with the net ionic equation!



We can repeat this process for any reaction and obtain the net ionic equation.

Net-Ionic Equations

Write the balanced formula equation, the balanced total ionic equation, and finally the balanced net ionic equation for each of the following chemical reactions. You must write all three balanced equations to receive full credit. Be sure to include state symbols for each component and correct charges for ions where appropriate.

1. Solutions of lead(II) nitrate and lithium chloride are mixed.
2. Copper metal is placed into a solution of silver nitrate.
3. Solid potassium chlorate decomposes upon heating.
4. Solid sodium metal is placed into distilled water.
5. Chlorine gas is bubbled into a solution of magnesium bromide.
6. Methane gas is burned in the presence of oxygen gas.
7. Solutions of silver acetate and barium chloride are mixed.
8. Solutions of sodium bicarbonate and hydrochloric acid are mixed.
9. Solutions of ammonium perchlorate and barium hydroxide are mixed.
10. Solutions of tin(II) fluoride and lithium carbonate are mixed.