George Washington Carver Engineering and Science High School
2026 Summer Enrichment

Chem 2 Honors / AP Chem

Project Due Date: August 24th (first day of school)
Project Requirements: Notebook containing your work for each section
Internet (so you can log into the Google Classroom)

Register for the Google Class site for Summer Assignment Materials: **CODE**: pdzojle

(you must be logged into your school district email – if you don't have one, please email me and I can keep you up to date!!!)
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Summer Assignment

Welcome to Chemistry 2 / AP Chemistry! This course will build upon the foundations of chemistry and introduce a more nuanced look at chemical systems, reactions, and the interactions of molecules. To help prepare for the new content this year, you will complete this review packet which covers the major topics from your first chemistry class. This review packet should be the start of your **new notebook** for our year (alternatively, you can continue your notebook where you left off in chemistry 1). The topics are broken up into different sections. You are asked to do the following:

- Get a notebook, continue from your old chemistry notebook, or a binder to organize your summer work. This will be the start of your new notebook for chemistry 2 / AP chemistry.
- Complete each question from the packet in order:
  - Label each major section and question type
  - Complete the problems that are provided – be sure to show all of your work when needed
  - You do not need to rewrite the problems, but it is suggested for some of them, especially if you want to use these notes as intended!
  - Leave space if you are unsure of an answer or are unable to complete the work
- Resources will be posted for each section as well for review – you can choose to get some notes, resources, and/or ideas in your notebook to reference

The assignment will be due **August 25th** when we get back to school – please make sure you save some time during the summer to complete this. I will be posting resources online on the summer Google Classroom page that you can use and reference for each of the major sections.

The assignment must be in a notebook, handwritten, neatly completed, and all work shown!

Summer Packet

Section 1: Chemical Foundations

1. Nomenclature

a. Write the name of the following compounds:

KBr	NaI	$BaCl_2$	ZnO	Fe_2S_3
$CaCO_3$	Li_3PO_4	$Mg_3(AsO_4)_2$	$CuSO_4$	$NiClO_3$
HBr	HF	HNO_3	H_2SO_4	H_2SO_3

b. Predict the formula of the following compounds. Be sure to use your predicted oxidation numbers (charges):

Aluminum Oxide	Iron (III) Chloride	Sodium Bicarbonate
Phosphoric Acid	Hydrochloric Acid	Nickel (II) Phosphite
Strontium Nitrate	Lithium Hydroxide	Ammonium Chlorate

2. Significant Figures

a. Report the number of significant figures in the following measurements:

Digital Balance: 12.50 grams	Graduated Cylinder: 32.5 milliliters
Volumetric Flask: 100.00 milliliters	Buret: 13.45 milliliters
Analytical Balance: 0.0050 grams	Spectrophotometer: 3.58×10^{-7} meters

b. Complete the following math problems, and report the answer to the correct number of significant figures.

- Density is known to be mass per unit volume. Determine the density of a 10.05 gram object occupying 2.40 cm^3 of space.

- Heat, a form of energy, is found by multiplying an object's mass by its heat capacity by its temperature. An 8.6 gram sample of aluminum with a heat capacity of 0.90 J/g˚ C is held in an oven at 160.0 ˚ C. Determine the heat content of the aluminum.

- Volume is found by multiplying length, width, and height together. Determine the volume of an irregularly shaped cuboid that has a length of 2.68 cm, a width of 5.438 cm, and a height of 105.67 cm.

3. Laboratory Procedure and Tools

a. Devise a simple procedure to determine the amount of salt that is dissolved in a sample of water. Write your procedure in a step-by-step form, and indicate the specific tools that you would use for this task.

Section 2: Atomic Theory

4. **Atoms, Ions, Isotopes**

a. Report the number of protons, neutrons, electrons in the following neutral atoms:

^{65}Cu ^{20}Ne ^{184}W ^{39}K

b. Report the number of protons, neutrons, electrons in the following isotopes:

Uranium–235 Carbon–14 Deuterium (aka Hydrogen–2)

c. Report the number of protons, neutrons, electrons in the following ions:

$^{23}Na^{+1}$ $^{16}O^{-2}$ $^{16}P^{-3}$ $^{24}Mg^{+2}$

d. Report the number of valence electrons in the following s and p block elements:

Lithium Chlorine Xenon Arsenic Lead Gallium

5. **Wavelength, Frequency, Energy**

a. Using the speed of light ($c = 2.998 \times 10^8$ m/s), convert the following wavelengths into frequency using the equation $\upsilon = c/\lambda$ (note: υ is frequency, s^{-1} and λ is wavelength, m)

Radio wave: 14.50 meters X–ray: 8.55 nanometers Ultraviolet: 3.25×10^{-7} meters

b. Determine the energy in joules of one photon of radiation using Planck's constant ($h = 6.626 \times 10^{-34}$ J*s) by using the equation $E = h\upsilon$

Radio wave: 14.50 meters X–ray: 8.55 nanometers Ultraviolet: 3.25×10^{-7} meters

c. Determine the energy, in kilojoules per mole, of one mole of photons of the following radiation. To do this, take the energy of the radiation, then multiply it by Avogadro's number (6.022×10^{23}) to convert to Joules per mole of photons. Then, divide by 1000 to convert to kilojoules per mole of photons. **** 1 nanometer = 10^{-9} meters ****

Radio wave: 14.50 meters X–ray: 8.55 nanometers Ultraviolet: 3.25×10^{-7} meters

Section 3: Periodic Table and Periodic Trends

6. **Electron Configuration**

a. Write the electron configuration for the following elements. Bonus if you can report the 4 quantum numbers too!

Rubidium	Arsenic	Silver	Uranium

b. Write the electron configuration for the following ions. Remember, ions have a charge!

Ca^{+2}	Cl^{-1}	Pb^{+2}	N^{-3}

7. **Periodic Trends**

a. Organize the following elements (Na, Mg, Cs, Ba) from least to greatest in terms of…

Ionization Energy:

Atomic Size:

Electronegativity:

b. Which element is the most electronegative on the periodic table? Why is this?

c. Sodium is a smaller atom when compared to Rubidium. Explain this observation using your knowledge of electron shielding.

d. Aluminum has a lower first ionization energy when compared to Sulfur. Explain this observation using your knowledge of effective nuclear charge.

e. When two electrons are removed from magnesium, the ionization energy associated with each is about 700 kJ/mol and 1400 kJ/mol. When two electrons are removed from sodium, however, the energy associated with each is about 450 kJ/mol and 4500 kJ/mol. Explain why sodium's second electron requires more energy to remove compared to magnesium's using your knowledge of electron configuration and energy shells.

Section 4: Bonding

8. **Ionic Bonding**

a. Research Coulomb's Law. Write the equation for Coulomb's law and label each variable. Then, explain how Coulomb's Law helps describe the strength of ionic compounds.

9. **Covalent Bonding**

a. Draw the Lewis Structures for each of the following compounds:

NH_3	CH_4	CH_3OH	PF_3	**single bonds**
CO_2	HCN	P_2O_2	CH_2O	**double/triple**
PF_5	BrF_5	SF_6	AsF_4	**breaking octet**

b. For the above Lewis structures, provide the molecular geometry (VSEPR shape) around the central atom.

c. For the above Lewis structures, indicate if the molecule is polar or non-polar.

d. Research the term *Resonance Structures*. Get some information down about them. Afterwards, draw the following structures that demonstrate resonance:

HCO_2^{-1} CO_3^{-2} NO_2^{-1}

10. **Metallic Bonding**

a. Research the terms: *alloy, substitutional alloy, interstitial alloy*. Get some information down about them. Afterwards, describe what type of alloy brass would be classified as (brass is made up of copper and zinc).

Section 5: Molecular Composition

11. **Conversions**

a. For the following molecules, determine their molar masses.

CH_3OH Na_3PO_4 $Pb(NO_3)_2$ H_2SO_4

b. For the following molecules, determine the percent composition (aka mass percentage) of each element in the compound. To do this, find the total mass one of the elements in the compound, then divide that by the molar mass of the compound, and finally multiply by 100. Round to 2 decimal places.

CH_3OH Na_3PO_4 $Pb(NO_3)_2$ H_2SO_4

c. For the following molecules, determine the number of moles and particles in 5.00 grams of each. Round your answer to the correct number of significant figures.

CH_3OH Na_3PO_4 $Pb(NO_3)_2$ H_2SO_4

d. For the following molecules, determine the number of grams of oxygen found in 5.00 grams of each. Round your answer to the correct number of significant figures.

CH_3OH Na_3PO_4 $Pb(NO_3)_2$ H_2SO_4

12. **Empirical and Molecular Formulas**

a. A compound is known to contain 40.1% Carbon, 6.60% Hydrogen, and 53.3% Oxygen by mass. Knowing these data, determine the empirical formula of the compound.

b. A 170.0 gram sample of a compound contains 29.84 grams of Na, 67.49 grams of Cr, and the rest oxygen by mass. Knowing these data, determine the empirical formula of the compound.

c. The empirical formula of a molecule is known to be CH. The molar mass of the actual molecular formula of the molecule is known to be 78 g/mol. Knowing this information, determine the molecular formula.

Section 6: Chemical Reactions

13. **Types of Reactions and Balancing**

a. For each of the following *unbalanced* chemical reactions, label the type of reaction (synthesis, decomposition, single replacement, double displacement, combustion) and balance the chemical reaction. ***** note: states of matter are written in parenthesis – solid, liquid, gas, aqueous solution *****

i. ___CO (g) + ___O_2 (g) → __CO_2 (g)

ii. ___N_2O_5 (g) + ___H_2O (l) → ___HNO_3 (aq)

iii. ___C_3H_8 (g) + ___O_2 (g) → ___CO_2 (g) + ___H_2O (g)

iv. ___$AgNO_3$ (aq) + ___K_2SO_4 (aq) → ___Ag_2SO_4 (s) + ___KNO_3 (aq)

v. ___$(NH_4)_2Cr_2O_7$ (s) → ___Cr_2O_3 (s) + ___N_2 (g) + ___H_2O (l)

vi. ___C_2H_6 (g) + ___O_2 (g) → ___CO_2 (g) + ___H_2O (g)

vii. ___Al (s) + ___Fe_2O_3 (s) → ___Al_2O_3 (s) + ___Fe (l)

14. **Writing Chemical Reactions**

a. For each of the following, write the chemical reaction that corresponds to the descriptions provided. Be sure to include the state of matter with each reactant and product. Be wary of diatomic elements and your oxidation charges! Try to balance the reactions as well, but if you don't, no worries!

i. When solid potassium chlorate is heated, it decomposes to produce solid potassium chloride and oxygen gas.

ii. Solid zinc metal reacts with an aqueous solution sulfuric acid to produce an aqueous solution of zinc sulfate and hydrogen gas.

iii. When liquid phosphorous trichloride is added to liquid water, it reacts to form an aqueous solution of phosphoric acid and hydrochloric acid.

iv. When hydrogen sulfide gas is passed over solid iron (III) hydroxide, the result of the reaction produces solid iron (III) sulfide and water vapor.

15. **Net Ionic Reactions**

a. Write out the net ionic reaction for the following examples. Remember, net ionic reactions only report the ions that react, leaving out spectator ions (ions that remain aqueous throughout the entire reaction).

i. $Pb(NO_3)_2\ (aq) + 2KI\ (aq) \rightarrow PbI_2\ (s) + 2KNO_3\ (aq)$

ii. $NaHCO_3\ (s) + HCl\ (aq) \rightarrow CO_2\ (g) + H_2O\ (l) + NaCl\ (aq)$

iii. When solutions of silver (I) nitrate and sodium bromide are mixed, the result produces solid silver (I) bromide and a solution of sodium nitrate.

Section 7: Stoichiometry

16. **Mole to Mole Stoichiometry**

a. Consider the following reaction: $5\ KNO_2 + 2\ KMnO_4 + 3\ H_2SO_4 \rightarrow 5\ KNO_3 + 2\ MnSO_4 + K_2SO4 + 3\ H_2O$

i. How many moles of KNO_3 are produced when 0.506 moles of $KMnO_4$ are consumed?

ii. Determine the number of moles of Potassium Sulfate produced when 0.658 moles of sulfuric acid are consumed.

17. **Mole to Gram Stoichiometry**

a. Consider the following reaction: $4\ NH_3 + 5\ O_2 \rightarrow 4\ NO + 6\ H_2O$

i. How many grams of NO (molar mass = 30.006 g/mol) are produced from the reaction when 2.50 moles of O_2 gas is consumed?

ii. How many grams of water (molar mass = 18.015 g/mol) are produced from the reaction when 1.856 moles of ammonia are consumed?

18. **Gram to Gram Stoichiometry**

a. Consider the following reaction: $C_6H_{12}O_6 \rightarrow 2C_2H_5OH + 2CO_2$

i. Determine the number of grams of CO_2 (molar mass = 44.009 g/mol) produced when 4.50 grams of $C_6H_{12}O_6$ (molar mass = 180.156 g/mol) is consumed.

ii. Determine the number of grams of glucose consumed (molar mass = 180.156 g/mol) when 15.89 grams of ethanol (molar mass = 46.069 g/mol) is produced.

19. **Limiting Reactants**

a. Use the balanced reaction to answer the following questions: $2BF3 + 3H2 \rightarrow 2B + 6HF$

If 0.10 mol of BF3 is reacted with 0.25 mol H2, which reactant is the limiting reactant?
What is the maximum amount (in Liters) of HF gas that can be produced from these amounts?

20. **Percent Error and Percent Yield**

a. Research and write out the formulas for percent error and percent yield.

b. Consider the following reaction: $Al(OH)_3\ (s) + 3HCl\ (aq) \rightarrow AlCl_3\ (aq) + 3H_2O\ (l)$

If you begin with 50.3 grams of $Al(OH)_3$ (molar mass = 78.003 g/mol) and you experimentally produce 39.5 grams of $AlCl_3$ (molar mass = 133.332 g/mol), determine the percent error and percent yield of the process.