

AP Chemistry Summer Assignments 2020-2021

Congratulations on your course selection of AP Chemistry! My goal for every student enrolled in the class is to pass the AP exam. This class will no doubt require much of your time and focus, since the workload and difficulty associated with the class will be incredibly different than that of sophomore year chemistry. To that end I will do my job to the best of my ability and I ask that you do the same in dedicating yourself to the subject. We want to hit the ground running with this course and cover the basics over the summer, since there is never enough time.

If you have yet to join our Discord server, please send me an email (rsato@upatoday.com) so that I can send you an invite. I'll be posting news and other info about the class and you can also ask your chemistry related questions within the server.

** These assignments are due the first day of school in hard copy, and are worth x points. This will have a significant impact on your 1st marking period grade, so be sure not to leave it all to the last minute. **

1. Read chapters 1-5. While I am not going to require you to handwrite notes for these chapters, I do still recommend that you do so. Handwriting notes is slower and more tedious than typing, but it makes you process and summarize information in a way that makes sense to you. You will be required to take handwritten notes when class starts.
2. Complete the summer assignment questions (found below) on a separate sheet of binder paper. I am very well aware that you can look up complete answers to these questions and would like to remind you that you don't get to do that for any test/quiz in the class, including the AP exam.
3. Be prepared for a multiple choice test covering these topic within the first 2 weeks of class (subject to change)

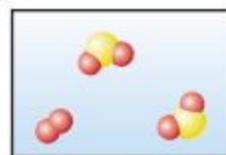
I'm excited to be teaching AP chemistry and am looking forward to an outstanding year with you!

-Mr. Sato

Summer Assignment Questions

Chapter 1 Introduction: Matter and Measurement

Covers basic chemistry terminology that will be used continuously throughout the year. Familiarize yourself with SI units and prefixes used in the metric system. Significant figures and dimensional analysis are two very important concepts that are used all the time and a lot of students struggle with it.



- Does the following diagram represent a chemical or physical change? Explain how you know by comparing the differences between chemical and physical change.
- You are hiking in the mountains and find a shiny gold nugget. It might be the element gold, or it might be "fool's gold," which is a nickname for iron pyrite, FeS_2 . What kind of experiments could be done to determine if the shiny nugget is really gold?
- Three beakers contain clear, colorless liquids. One beaker contains pure water, another contains salt water, and another contains sugar water. How can you tell which beaker is which? (No tasting allowed!)
- (a) The diameter of Earth at the equator is 7926.381 mi. Round this number to three significant figures, and express it in scientific notation. (b) The circumference of Earth through the poles is 40,008 km. Round this number to four significant figures, and express it in standard exponential notation.
- Carry out the following operations, and express the answer with the appropriate number of significant figures.
 - $320.5 - (6104.5/2.3)$
 - $[(285.3 \times 10^5) - (1.200 \times 10^3)] \times 2.8954$
 - $(0.0045 \times 20,000.0) + (2813 \times 12)$
 - $863 \times [1255 - (3.45 \times 108)]$
- Gold is alloyed (mixed) with other metals to increase its hardness in making jewelry. (a) Consider a piece of gold jewelry that weighs 9.85 g and has a volume of 0.675 cm^3 . The jewelry contains only gold and silver, which have densities of 19.3 g/cm^3 and 10.5 g/cm^3 , respectively. If the total volume of the jewelry is the sum of the volumes of the gold and silver that it contains, calculate the percentage of gold (by mass) in the jewelry. (b) The relative amount of gold in an alloy is commonly expressed in units of carats. Pure gold is 24 carat, and the percentage of gold in an alloy that is 50% gold is 12 carat. State the purity of the gold jewelry in carats.

Chapter 2 Atoms, Molecules, and Ions

Covers basic structure of the atoms and discusses the formation of molecules and ions. The more in depth content will require you to have a firm grasp on atomic structure to understand specific trends and phenomena. Chemical nomenclature will also start to become relevant as questions may only have the name of the specific compound. The days of confusing P for Potassium should be long gone.

- Write the chemical formula for the following compound. Is the compound ionic or molecular? Name the compound.



8. (a) Which two of the following are isotopes of the same element: ${}_{16}^{31}\text{X}$, ${}_{15}^{31}\text{X}$, ${}_{16}^{32}\text{X}$? (b) What is the identity of the element whose isotopes you have selected?

9. Fill in the gaps in the following table, assuming each column represents a neutral atom.

Symbol	${}^{65}\text{Zn}$				
Protons		38			92
Neutrons		58	49		
Electrons			38	36	
Mass no.				81	235

10. Rubidium has two naturally occurring isotopes, rubidium-85 (atomic mass = 84.9118 amu; abundance = 72.15%) and rubidium-87 (atomic mass = 86.9092 amu; abundance = 27.85%). Calculate the atomic weight of rubidium.

11. Complete the table by filling in the formula for the ionic compound formed by each pair of cations anions, as shown for the first pair. Provide the name for the ionic compound.

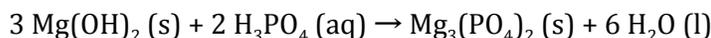
Ion	Na^+	Ca^{2+}	Fe^{2+}	Al^{3+}
O^{2-}	Na_2O sodium oxide			
NO_3^-				
SO_4^{2-}				
CO_3^{2-}				

12. The explosion of an atomic bomb releases many radioactive isotopes, including strontium-90. Considering the location of strontium in the periodic table, suggest a reason for the fact that this isotope is particularly harmful to humans.

Chapter 3 Stoichiometry: Calculations with Chemical Formulas and Equations

Covers basic chemical reactions and how to balance them. Avogadro's number and the mole will be relevant for pretty much any calculations involving chemical reactions. Also includes everyone's favorite chemistry concept of stoichiometry. You should become completely familiar with these types of calculations without the use of the mole map.

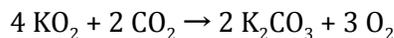
13. (a) What is the difference between adding a subscript 2 to the end of the formula for CO to give CO₂ and adding a coefficient in front of the formula to give 2 CO? (b) Is the following chemical equation, as written, consistent with the law of conservation of mass?



14. Write balanced chemical equations to correspond to each of the following descriptions: (a) When sulfur trioxide gas reacts with water, a solution of sulfuric acid forms. (b) Boron sulfide, B₂S₃ (s), reacts violently with water to form dissolved boric acid, H₃BO₃, and hydrogen sulfide gas. (c) Phosphine, PH₃ (g), combusts in oxygen gas to form water vapor and solid tetraphosphorus decoxide. (d) When solid mercury (II) nitrate is heated, it decomposes to form solid mercury (II) oxide, gaseous nitrogen dioxide, and oxygen. (e) Copper metal reacts with hot concentrated sulfuric acid solution to form aqueous copper (II) sulfate, sulfur dioxide gas, and water.

15. (a) What is the mass, in grams, of 1.223 mol of iron (III) sulfate?
(b) How many moles of ammonium ions are in 6.955 g of ammonium carbonate?
(c) What is the mass, in grams, of 1.50×10^{21} molecules of aspirin, C₉H₈O₄?
(d) What is the molar mass of diazepam if 0.05570 mol has a mass of 15.86 g?
16. Determine the empirical and molecular formulas of each of the following substances:
(a) Ibuprofen, a headache remedy, contains 75.69% C, 8.80% H, and 15.51% O by mass, and has a molar mass of 206 g/mol
(b) Cadaverine, a foul-smelling substance produced by the action of bacteria on meat, contains 58.55% C, 13.81% H, and 27.04% N by mass; its molar mass is 102.2 g/mol.
(c) Epinephrine (adrenaline), a hormone secreted into the bloodstream in times of danger or stress, contains 59.0% C, 7.1% H, 26.2% O, and 7.7% N by mass; its MW is about 180 amu.

17. The reaction between potassium superoxide, KO₂, and CO₂,

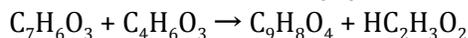


is used as a source of O₂ and absorber of CO₂ in self-contained breathing equipment used by rescue workers. (a) How many moles of O₂ are produced when 0.400 mol of KO₂ reacts in this fashion? (b) How many grams of KO₂ are needed to form 7.50 g of O₂? (c) How many grams of CO₂ are used when 7.50 g of O₂ are produced?

18. When hydrogen sulfide gas is bubbled into a solution of sodium hydroxide, the reaction forms sodium sulfide and water. How many grams of sodium sulfide are formed if 1.25 g of

hydrogen sulfide is bubbled into a solution containing 2.00 g of sodium hydroxide, assuming that the sodium sulfide is made in 92.0% yield?

19. Aspirin ($C_9H_8O_4$) is produced from salicylic acid ($C_7H_6O_3$) and acetic anhydride ($C_4H_6O_3$):



(a) How much salicylic acid is required to produce 1.5×10^2 kg of aspirin, assuming that all of the salicylic acid is converted to aspirin? (b) How much salicylic acid would be required if only 80% of the salicylic acid is converted to aspirin? (c) What is the theoretical yield of aspirin if 185 kg of salicylic acid is allowed to react with 125 kg of acetic anhydride? (d) If the situation described in part (c) produces 182 kg of aspirin, what is the percentage yield?

Chapter 4 Reactions in Aqueous Solution

Covers reactions that occur in aqueous solutions, which make up a good amount of chemistry.

Knowing solubility for common ionic compounds in water is recommended. If I taught you last year, we never covered acids/bases, neutralization reactions, and titration. Redox reactions are new, but should be pretty simple.

20. Three solutions are mixed together to form a single solution. One contains 0.2 mol $Pb(CH_3COO)_2$, the second contains 0.1 mol Na_2S , and the third contains 0.1 mol $CaCl_2$. (a) Write the net ionic equations for the precipitation reaction or reactions that occur. (b) What are the spectator ions in the solution?
21. As K_2O dissolves in water, the oxide ion reacts with water molecules to form hydroxide ions. Write the molecular and net ionic equations for this reaction. Based on the definitions of acid and base, what ion is the base in this reaction? What is the acid? What is the spectator ion in the reaction?
22. Determine the oxidation number of sulfur in each of the following substances: (a) barium sulfate, $BaSO_4$, (b) sulfurous acid, H_2SO_3 , (c) strontium sulfide, SrS , (d) hydrogen sulfide, H_2S . (e) Based on these compounds what is the range of oxidation numbers seen for sulfur? Is there any relationship between the range of accessible oxidation states and sulfur's position on the periodic table?
23. (a) Use the following reactions to prepare an activity series for the halogens:
- $$Br_2(aq) + 2NaI(aq) \rightarrow 2NaBr(aq) + I_2(aq)$$
- $$Cl_2(aq) + 2NaBr(aq) \rightarrow 2NaCl(aq) + Br_2(aq)$$
- (b) Relate the positions of the halogens in the periodic table with their locations in this activity series. (c) Predict whether a reaction occurs when the following reagents are mixed: $Cl_2(aq)$ and $KI(aq)$; $Br_2(aq)$ and $LiCl(aq)$.
24. (a) Calculate the molarity of a solution made by dissolving 12.5 grams of Na_2CrO_4 in enough water to form exactly 550 mL of solution. (b) How many moles of KBr are present in 150 mL

of a 0.275 M solution? (c) How many milliliters of 6.1 M HCl solution are needed to obtain 0.100 mol of HCl?

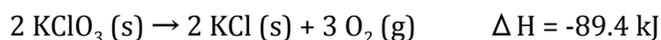
25. An 8.65-g sample of an unknown group 2A metal hydroxide is dissolved in 85.0 mL of water. An acid-base indicator is added and the resulting solution is titrated with 2.50 M HCl (aq) solution. The indicator changes color signaling that the equivalence point has been reached after 56.9 mL of hydrochloric acid solution has been added. (a) What is the molar mass of the metal hydroxide? (b) What is the identity of the metal cation: Ca^{2+} , Sr^{2+} , Ba^{2+} ?

Chapter 5 Thermochemistry

Covers relationships between chemical reactions and energy changes that involve heat. Discusses some basic energy concepts that can also be used within physics. Enthalpy is relevant for many energy calculations in chemistry, and so becoming familiar with its use is key.

26. For the following processes, calculate the change in internal energy of the system and determine whether the process is endothermic or exothermic: (a) A balloon is cooled by removing 0.655 kJ of heat. It shrinks on cooling, and the atmosphere does 382 kJ of work on the balloon. (b) A 100.0-g bar of gold is heated from 25°C to 50°C during which it absorbs 322 J of heat. Assume the volume of the gold bar remains constant. (c) The surroundings do 1.44 kJ of work compressing gas in a perfectly insulated cylinder.

27. At one time, a common means of forming small quantities of oxygen gas in the laboratory was to heat KClO_3 :



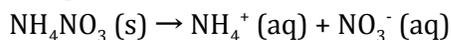
For this reaction, calculate ΔH for the formation of (a) 1.36 mol of O_2 and (b) 10.4 g of KCl. (c) The decomposition of KClO_3 proceeds spontaneously when it is heated. Do you think that the reverse reaction, the formation of KClO_3 from KCl and O_2 , is likely to be feasible under ordinary conditions? Explain your answer.

28. Consider the decomposition of liquid benzene, C_6H_6 (l), to gaseous acetylene, C_2H_2 (g):



(a) What is the enthalpy change for the reverse reaction? (b) What is ΔH for the formation of 1 mol of acetylene? (c) Which is more likely to be thermodynamically favored, the forward reaction or the reverse reaction? (d) If C_6H_6 (g) were consumed instead of C_6H_6 (l), would you expect the magnitude of ΔH to increase, decrease, or stay the same? Explain.

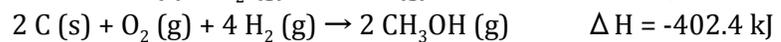
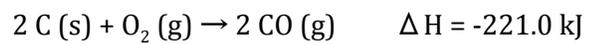
29. (a) When a 4.25-g sample of solid ammonium nitrate dissolves in 60.0 g of water in a coffee-cup calorimeter, the temperature drops from 22.0°C to 16.9°C. Calculate ΔH (in kJ/mol NH_4NO_3) for the solution process



Assume that the specific heat of the solution is the same as that of pure water (4.184 J/g°C).

(b) Is this process endothermic or exothermic?

30. From the enthalpies of reaction



calculate ΔH for the reaction

