

AP CHEMISTRY SUMMER 2022

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AP Chemistry Summer Assignment

June 2022

Instructor: Dr. Laurence Geyer

Future AP Chemistry Student,

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 is a multitude of tremendous chemistry resources available via the Internet. With the ready access to hundreds of websites either in your home or at the local library, I am confident that you will have sufficient resources to prepare adequately for the fall semester. There are few old chemistry textbooks which can be picked up for your reference. The reference text book as part of AP course is "Chemistry" by Zumdhal and Zumdhal. The book **MUST** be obtained (Room 227) by the end of current school year.

For those students who have already taken a high school chemistry course, much of the material in the summer packet will be familiar to you. For those students who will be taking AP Chemistry as your first high school chemistry course, the problems will help you build a **foundation** in chemistry and insure all students are on a relatively even plane. It will be important for everyone to come to class **the first day** prepared. While I review, extensive remediation is not an option as we work towards our goal of being 100% prepared for the AP Exam in **early May 2023**. There will be a test covering the basic concepts included in the summer packet during the **first week** of school. You can expect a quiz in naming compounds, identifying ions the first day of school.

You may contact me by **email: (lgeyer@bergenfield.org)** this summer. I will do my best to answer your questions **ASAP**.

I hope you are looking forward to an **exciting year** of chemistry. You are all certainly **fine** students, and with **plenty** of motivation and hard work you should find AP Chemistry a successful and rewarding experience.

Finally, I recommend that you spread out the summer assignment. Please do not try to complete it all in the final week of the summer. Chemistry takes time to **process** and **grasp** at a level necessary for success in AP Chemistry. Remember, AP Chemistry is **equivalent to two General Chemistry** courses 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** and **enjoy** the chemistry.

Completed work must be submitted by July 15 (first 50 questions) and August 25 (questions 51 to 95). E-mail the assignments to the e-mail address provided above. Late work will not be accepted. Let me know if there are any problems in submitting the assignment on time. A list of books prescribed by the College Board has been provided for your reference. You do not need all the books to complete the assignment. Any basic chemistry text-book can help you find the information needed to complete the summer assignment.

USE SIGNIFICANT DIGITS in problems.

1. Write the **most common guidelines** to determine significant figures (digits) with an example?
2. Use **factor labeling** method to convert the following:
 - a. 200 meters = ____ miles.
 - b. 650 in = ____ meters
 - c. 4 years= ____ seconds.
 - d. 200 liters = ____ ml
3. Classify each of the following as units of mass, volume, length, density, energy, or pressure.
 - a. Kg
 - b. Liter
 - c. m^3
 - d. mm
 - e. kg/m^3
 - f. Joule
 - g. atm
 - h. cal.
 - i. torr
 - j. g/mL
4. Most laboratory experiments are performed at room temperature at 65°C . Express this temperature in:
 - a. $^\circ\text{F}$
 - b. K
5. A cylinder rod formed from silicon is 46.0 cm long and has a mass of 3.00 kg. The density

of silicon is 2.33 g/cm^3 . What is the diameter of the cylinder? (the volume of cylinder is given by $\pi r^2 h$, where r is the radius and h is the length)

6. How many **significant figures** are in each of the following?
- a. 1.9200 mm
 - b. 0.0301001 kJ
 - c. 6.022×10^{23} atoms
 - g. 460.000 L
 - e. 0.000036 cm^3
 - f. 10000
 - g. 1.001
 - h. 0.001345
 - i. 0.0101
 - J. 3.02×10^4
 - k. 3.21×10^{-2}
7. Record the following in correct **scientific notation**:
- a. 4050,000,000 cal
 - b. 0.000123 mol
 - c. 0.00345 \AA
 - d. 700,000,000 atoms
8. Calculate the following to the **correct number** of significant figures.
- a. $1.270 \text{ g} / 5.296 \text{ cm}^3$
 - b. $12.235 \text{ g} / 1.010 \text{ L}$
 - c. $12 \text{ g} + 0.38 \text{ g}$
 - d. $170\text{g} + 2.785 \text{ g}$
 - e. 2.1×3.2102
 - f. 200.1×120
 - g. $17.6 + 2.838 + 2.3 + 200$
9. Give the **chemical symbols** for the following elements:
- a. Carbon
 - b. sulfur
 - c. Titanium
 - d. Nitrogen
 - e. Helium
 - f. Krypton
 - g. Fluorine
 - h. Scandium
 - i. Arsenic
 - J. Potassium
 - K. Sodium
 - l. chloride
 - m. Iron
 - n. Zinc
10. Write **the latin** names for each of the elements symbols:
- a. Na
 - b. Au
 - c. Ag
 - d. Sn
 - e. Fe
 - f. Hg
 - g. K
 - h. Pb
11. A solid white substance A is heated strongly in the absence of air. It decomposes to form a new white substance B and a gas C. The gas has exactly the same properties as the product obtained when carbon is burned in an excess of oxygen. Based on these observations, can we determine whether solids A and B and the gas C are elements or compounds? Explain your conclusions for each substance.
12. Label each of the following as either a **physical process** or a **chemical process**.
- a. Corrosion of aluminum metal.
 - b. Melting of ice.
 - c. Pulverizing an aspirin.
 - d. Digesting a candy bar.
 - e. Explosion of nitroglycerin.
 - f. Milk turning sour.
 - g. Burning of paper.
 - h. Forming of frost on a cold night.

- i. Bleaching of hair with hydrogen peroxide.
 - j. A copper wire is hammered flat.
13. You may notice when water boils, you can see bubbles that rise to the surface of the water.
- a. What is inside these bubbles?
 - b. Is the boiling of water a chemical or physical change? Explain
14. Dalton assumed that all atoms of the same element were identical in all their properties. Explain why this assumption is not valid.
15. Why do we call $\text{Ba}(\text{NO}_3)_2$ barium nitrate, but we call $\text{Fe}(\text{NO}_3)_2$ iron(II) nitrate?
16. Calculate the mass of O_2 produced if 3.450 g potassium chlorate is completely decomposed by heating in presence of a catalyst (manganese dioxide).
17. Write the formula of the following compounds?
- a. Calcium sulfate.
 - b. Ammonium Phosphate
 - c. Lithium Nitrite
 - d. potassium perchlorate.
 - e. Barium Oxide
 - f. Zinc sulfide.
 - g. Sodium perbromate
 - l. Calcium Iodide
 - J. Aluminum Carbonate.
18. Convert **6.75 atm** to: (Using **factor-labeling** method)
- a. torr
 - b. kPa
 - c. mmHg
19. Define the words: **atomic number, atomic mass, mass number, molecular formula, structural formula, empirical formula, isotopes, cation, anion, metalloid, and allotrope.**
20. Determine **number of protons and neutrons** in each of the following.
- a. $^{39}_{19}\text{K}$
 - b. $^{23}_{11}\text{Na}$.
 - c. $^{208}_{82}\text{Pb}$
 - d. $^{33}_{15}\text{P}$
21. White gold is an alloy that typically contains 45.0% by mass gold and the remainder is platinum. If **154 g** of gold are available, how many grams of platinum are required to combine with the gold to form this alloy?
22. What is the empirical formula of a compound that contains 53.73% Fe and 46.27% of S ?
23. Determine the number of molecules present in 4.56 mol of nitrogen (N_2).
24. List the following as diatomic molecule, molecular compound, ionic compound, Atomic element.
- a. F_2
 - b. Cl_2
 - c. C
 - d. NaCl
 - e. KF
 - f. CO_2
 - g. H_2
 - h. Ag
 - i. Rust (Fe_2O_3)
 - j. MgO
 - k. O_2
 - l. I_2
 - m. CO
 - n. K_2CO_3

25. State the contribution of the following chemist in one line.

a. Democritus b. Mendeleev c. Henry Becquerel d. Roentgen e. J.J Thompson

f. Faraday g. Chadwick h. Millikan i. Proust j. Cavendish k. Madam Curie

26. What is the difference between a. Chlorine and Chloride? b. Sodium atom and sodium ion.

27. How many grams of methane (CH₄) are present in 5.6 moles of methane gas? (USE factor labeling method)

28. Calculate the **mass in grams** of each of the following:

a. 6.02×10^{23} atoms of Mg.

b. 3.01×10^{23} formula units of CaCl₂.

c. 12.4×10^{15} atoms of neon.

29. In an experiment, a student gently heated a hydrated copper compound to remove the water of hydration. The following data was recorded:

1. Mass of crucible, cover, and contents before heating 23.4 g.

2. mass of empty crucible and cover 18.82 g.

3. mass of crucible, cover, and contents after heating to constant mass 20.94 g.

Calculate the experimental percent of water in the compound.

30. How do you distinguish?

a. An element from a compound.

b. An element from a mixture.

c. A true solution from a heterogeneous mixture.

d. Distillation from filtration.

e. Chromatography from crystallization

31. An **extensive property** is one that depends on the amount of the sample. Which of the following properties are extensive?

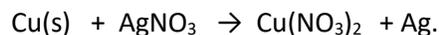
a. volume b. density c. temperature d. energy e. melting point. F. pressure

32. A hydrated compound has an analysis of 18.29% Ca, 32.37% Cl, and 49.34% water. What is its formula?

33. Name the types of **general inorganic reactions** with example of each?

34. Define Acid, base and salt? Give some examples of each.

35. What mass of copper is required to replace silver from 4.00 g of silver nitrate dissolved in water?



36. Write the chemical formulas for the following compounds:

- a. Calcium Carbonate
- b. Ammonium Phosphate
- c. Sodium Chloride
- d. Sodium Oxide
- e. Calcium Sulfate
- f. Sodium Nitrite
- g. Magnesium Acetate
- h. Potassium cyanide
- i. Zinc(II) Nitrate
- j. Iron(III) Phosphate
- k. Nickel (II) Fluoride

37. Define

- a. Law of conservation of mass.
- b. Law of multiple proportion.

38. Strontium consists of four isotopes with masses and their percent abundance of 83.9134 amu (0.5%), 85.9094 amu (9.9%), 86.9089 amu (7.0 %) , and 87.9056 amu (82.6 %). Calculate the atomic mass of Sr?

39. Nitrogen has two isotopes, N-14 and N-15, with atomic masses of 14.00031 amu and 15.001 amu, respectively. What is the percent abundance of N-15?

40. Write the number of protons and electrons?

- a. P₄ molecule b. a PCl₅ molecule c. a P³⁻ Ion d. P⁵⁺ ion.

41. Mercury has an atomic mass of 200.59 amu. Calculate the

- a. Mass of 3.0×10^{10} atoms.
- b. Number of atoms in one nanogram of Mercury.

41. Calculate the molar masses (g/ mol) of

- a. Ammonia (NH₃)
- b. Baking soda (NaHCO₃)
- c. Osmium Metal (Os)

42. Convert the following to moles

- a. 3.86 grams of Carbon dioxide.
- b. 6.0×10^5 g of Hydrazine (N₂ H₄), a rocket propellant.

43. The molecular formula of morphine, a pain-killing narcotic, is C₁₇H₁₉NO₃.

- a. What is the molar mass?
- b. What fraction of atoms in morphine is accounted for by carbon?
- c. Which element contributes least to the molar mass?

44. Complete the list ionic compounds (name or formula)

- a. Cupric Hydroxide
- b. Strontium Chromate
- c. Ammonium Per chlorate
- d. NaHCO_3
- e. $\text{Fe}_2(\text{CO}_3)_3$
- f. Sodium Hydroxide.
- g. Potassium Chloride.

43. The hormone, thyroxine is secreted by the thyroid gland, and has the formula: $\text{C}_{15}\text{H}_{17}\text{NO}_4$. How many milligrams of Iodine can be extracted from 15.0 g of thyroxine?

44. Determine the **formula weight** (molar mass) for the following:

- a. N_2O_5
- b. CuSO_4
- c. $\text{Ca}(\text{HCO}_3)_2$
- d. $\text{CaSO}_4 \cdot 2 \text{H}_2\text{O}$

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

- a. SO_3
- b. $\text{CH}_3\text{COOCH}_3$
- c. Ammonium Nitrate.

46. Determine the empirical formula of the compounds with the following compositions by mass:

- a. 10. 4 % C, 27. 8% S , 61. 7 % Cl
- b. 21.7 % C, 9.6 % O, and 68.7 % F

47. 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?

48. Vanillin, a flavoring agent, is made up of carbon, hydrogen, and Oxygen atoms. When a sample of Vanillin weighing 2.500 g burns in excess oxygen, 5.79 g of carbon dioxide and 1.18 g of water are obtained. What is the empirical formula of Vanillin?

49. Washing soda is a hydrate of sodium carbonate. Its formula is $\text{Na}_2\text{CO}_3 \cdot x \text{H}_2\text{O}$. A 2.714 g Sample of washing soda is heated until a constant mass of 1.006 g of Na_2CO_3 is reached. What is x?

50. What is the molecular formula of each of the following compounds?

- a. Empirical formula CH_2 , molar mass = 84g/mol.
- b. Empirical formula NH_2Cl , Molar mass = 51.5 g/ Mol

51. Determine the empirical and molecular formula of each of the following substances:

- a. Ibufuren, a headache remedy contains 75.6 % C, 8.80 % H, and 15.5 % O by mass and has a

molar mass about 206 g/mol.

b. Epinephrine(adrenaline) a hormone secreted into the bloodstream in times of danger or stress contains 59% C, 7.1% H, 26.2% O, and 7.7% N by mass, its MW (molecular mass) is about 180 amu.

52. Write balanced chemical equations for the reactions of **sodium** with the following nonmetals to form ionic solids.

- a. Nitrogen b. Oxygen c. Sulfur d. Bromine

53. Write a **balanced equation** for the following:

a. Reaction of boron trifluoride gas with water to give liquid hydrogen fluoride and solid boric acid, H_3BO_3 .

b. Reaction of magnesium Oxide with Iron to form Iron (III) Oxide and Magnesium.

c. The decomposition of dinitrogen Oxide gas to its elements.

d. The reaction of Calcium Carbide solid with water to form calcium hydroxide and acetylene (C_2H_2) gas.

e. The reaction of solid calcium cyan amide ($CaCN_2$) with water to form calcium carbonate and ammonia gas.

f. Ethane, C_2H_6 burns in air (Oxygen).

g. Hydrogen reacts with oxygen to form water.

h. Nitrogen gas reacts with Hydrogen to form ammonia.

j. Hydrogen reacts with Iodine gas to form Hydrogen Iodide.

k. Sodium reacts with Iodine gas to form Sodium Iodide.

l. Sodium Oxide reacts with water to form sodium hydroxide and hydrogen.

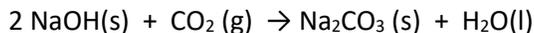
m. Carbon dioxide combines with water to form carbonic acid.

n. Magnesium and nitrogen gas combine to form magnesium nitride.

o. Concentrated Hydrochloric acid reacts with Conc. Sodium hydroxide to form sodium chloride and water.

54. DEFINE limiting reagent, theoretical yield, and actual yield?

55. Sodium hydroxide reacts with carbon dioxide as follows:



Which reagent is the limiting reactant when 1.85 mol of sodium hydroxide and 1.00 mol carbon dioxide are allowed to react? How many moles of sodium carbonate can be produced? How many moles of the excess reactant remain after the completion of the reaction?

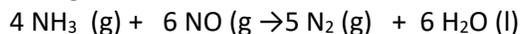
56. When benzene (C_6H_6) reacts with bromine (Br_2) bromobenzene($\text{C}_6\text{H}_5\text{Br}$) is obtained:



a. What is the theoretical yield of bromobenzene in this reaction when 30.0g of benzene reacts with 65.0 g of bromine?

b. If the actual yield of bromobenzene was 56.7 g what was the percentage yield?

57. One way to remove Nitrogen Oxide (NO) from smokestack emissions is to react it with ammonia:



Fill in the blanks below:

f. 12.3 mol of NO reacts with _____ mol of ammonia.

g. 5.87 mol NO yields _____ mol nitrogen.

58. Chlorine and Fluorine react to form gaseous chlorine trifluoride. You start with 1.75 mol of chlorine and 3.68 mol of fluorine.

a. Write the balanced equation for the reaction.

b. What is the limiting reactant?

59. To prevent a condition called the "bends", deep sea divers breathe a mixture containing, in mole percent, 10.0% O_2 , 10.0% N_2 , and 80.0% He.

a. Calculate the molar mass of this mixture.

b. What is the ratio of the density of this gas to that of pure Oxygen?

60. A 2.0g sample of SX_6 (g) has a volume of 329.5 cm^3 at 1.00 atm and 20°C . Identify the element 'X'. Name the compound.

61. When Hydrogen sulfide gas, H_2S , reacts with oxygen, Sulfur dioxide gas and steam are produced.

a. Write the balanced chemical equation for this reaction.

b. How many liters of sulfur dioxide would be produced from 4.0 l of Oxygen? Assume 100% yield and that all gases are measured at the same temperature and pressure.

62. Hydrogen cyanide, HCN is a poisonous gas. It can be formed by the reaction:



What mass of sodium cyanide is required to make 8.5 L of Hydrogen Cyanide at 22°C and 751 mm Hg?

63. A gaseous mixture contains 5.78 g of methane, 2.15 g of neon, and 6.8 g of sulfur dioxide. What pressure is exerted by the mixture inside a 75.0 L cylinder at 85°C and 751 mm Hg?

64. A sample of Methane gas is at 50°C and 20 atm. Would you expect it to behave more ideally or less ideally if:

- The pressure was reduced to 1 atm.
- The temperature were reduced to - 50°C?

65. Define solubility. Prepare a list of solubility rules for ionic compounds in water. (online resources) (IMPORTANT)

An example: All the chloride, iodide, and bromide are soluble in water except silver, mercury and lead.

66. Name the following: a. CO₂ b. P₄S₁₀ c. NI₃ d. PCl₅ e. CCl₄ f. SF₆ g. CH₄

h. C₂H₆ i. C₃H₈

67. Define **Oxidation and reduction**. Provide at least five examples of oxidation and reduction with chemical reactions. (Example: Rusting of Iron; $4\text{Fe} + 3\text{O}_2 \rightarrow 2\text{Fe}_2\text{O}_3$)

68. Define **Oxidation number**. Find the **Oxidation number** of

- Carbon in CO₂.
- Sulfur in H₂SO₄.
- Phosphorus in PO₄³⁻
- Manganese in MnO₄²⁻

69. Which of the following statements are always true? Never true? Not always true?

- A compound with the molecular formula C₆H₆ has the same simplest formula.
- The mass percent of copper in CuO is less than in Cu₂O.
- The limiting reactant is the one present in the smallest number of grams.
- Since C₃H₆O₃ and C₆H₁₂O₆ reduce to the same formula, they represent the same compound.

70. A bedroom 11 ft × 12 ft × 8.0 ft contains 35.41 kg of air at 25°C. Express the volume of the room in liters, the amount of air in moles (molar mass of air is 29.0 g/mol) and the temperature in Kelvin.

71. A sample of carbon dioxide gas, CO₂ (g), occupies a volume of 5.75 L at 0.890 atm. If the temperature and the number of moles remain constant, calculate the volume when the pressure

- increased to 1.25 atm

b. decrease to 0.350 atm

72. A nitrogen sample at 30°C has a volume of 1.75L. If the pressure and the amount of gas remain unchanged, determine the volume when:

a. The Celsius temperature is doubled

73. An open flask contains 0.200 mol of air. Atmospheric pressure is 745 mmHg and room temperature is 68°F. How many moles are present in the flask when the pressure is 1.10 atm and the temperature is 33°C?

74. On a warm day, an amusement park balloon is filled with 47.8 g He. The temperature is 33°C and the pressure in the balloon is 2.25 atm. Calculate the volume of the balloon.

75. A drum use to transport crude oil has a volume of 162 L. How many water molecules, as steam, are required to fill the drum at 1.00 atm and 100°C? What volume of liquid water (density of water is 1.0 g/cm³) is required to produce that amount of steam?

76. Calculate the densities of the following gases at 27°C and 763 mmHg

a. Carbon monoxide

b. Chlorine

77. Define strong electrolyte, weak electrolyte, precipitation reactions and solubility?

78. What is an **Activity series** of metal? How does it help us in studying properties of elements?

79. A volatile liquid (one that evaporates) is put into a jar and the Jar is then sealed. Does the mass of the sealed jar and its contents change upon the vaporization of the liquid?

80. Identify each of the following as being most like an **observation, a law, or a theory**.

a. All coastal areas experience two high tides and two low tides each day.

b. The tides in Earth's oceans are caused mainly by the gravitational attraction of the moon.

c. Yesterday, high tide in San Francisco Bay occurred at 2.43 a.m. and 3.07 P.m.

d. Tides are higher at the full moon and ne moon than at other times of the month.

81. Define the terms: Exothermic, endothermic reactions? How much heat is required to raise the temperature of 100 grams of water from 25°C to 82°C?

82. A piece of unknown metal with mass 14.9 g is heated to 100°C and dropped into 75.0 g of water at 20°C. The final temperature of the system is 28 degree Celsius. What is the specific heat of the metal?

83. What is a solute and solvent? Define Molarity, Molality, mole-fraction and Mass percent of a solution?

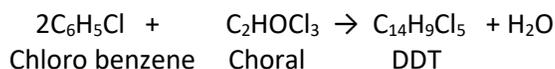
84. Calculate the molarity of a solution that contains 0.0345 mol NH_4Cl in exactly 400 ml of solution?

85. Calculate the molarity of a solution that contains 20.0 grams of sodium hydroxide in 200 ml?

86. How many grams of solute are present in 50.0 ml of 0.360 M sodium chloride?

87. The compound adrenaline contains 56.7 % C, 6.56 % H, 28.37% O and 8.28 % N by mass. What is the empirical formula for adrenaline?

88. DDT, an insecticide harmful to fish, birds, and humans, is produced by the following reaction:



If 1142 g of chlorobenzene is reacted with 485 g of chloral.

- What mass of DDT is formed?
- Which reactant is limiting? Which is in excess?
- What mass of excess reactant is left over?
- If the actual yield of DDT is 200.0 g, what is the percent yield?

89. A 2.25 g sample of scandium metal is reacted with excess hydrochloric acid to produce 0.1502 g hydrogen gas. What is the formula of the scandium chloride produced in the reaction?

90. What volume of 0.100 M HCl solution is needed to make 50.0 mL of 0.025 M KOH?

91. Differentiate between what happens when the following are dissolved in water.

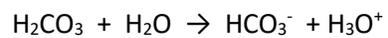
- Polar solute vs non polar solute.
- KF vs CO_2
- RbCl vs AgCl

92. Determine the pH of the following solutions:

- 0.10 M of HCl
- 0.10 M CH_3COOH $K_a = 1.8 \times 10^{-5}$
- 0.010 M NaOH
- 0.010 M NH_3 $K_b = 1.8 \times 10^{-5}$

93. Define Arrhenius and B-L acids and bases. Give an example of each.

94.



Identify the acid, base, Ca and CB in the above reaction.

95. Identify the IMF (H-bonding, Dipole-dipole or LDF) in each of the following compounds in the liquid state:

- a. HF
- b. H₂O
- c. NH₃
- d. C₂H₆
- e. He
- f. SO₂
- g. HCl