AP Chemistry Summer Assignment 2024

The purpose of this summer assignment is to review the nomenclature and problem solving skills you learned in Honors Chemistry so that we can begin the year with AP labs and topics. You can plan on spending approximately 10 hours to complete this summer assignment. It is due the first day you return to class in person or online. It is worth 15 points. You will receive late credit if it is late. Even though it may be easier for you to do this assignment now, I suggest you set the assignment aside until August so that this review process prepares you for the AP chemistry course.

After school is out in June you should organize your notes and prepare a review sheet or file, if you have not already done so. This sheet or file should include at a minimum; the conversion factors, a periodic table, a list of polyatomic ions, a list of the diatomic molecules, a list of common acids and bases with names and formulas (know the strong acids and bases), the processes used in composition stoichiometry calculations, and the equations associated with solutions, acids and bases. If you were in my class you should have a complete set of notes from class and if you have not already done so you may want to print out the online notes provided. I will be archiving the work in July so you may not have access to it. Prepare this review sheet or file while the information is still fresh. Then relax in July.

Begin the AP Chemistry summer assignment in early August. I suggest an hour a day. Since an answer key will be provided, the work you do to solve the problems will be far more important than the answer. Continue to use dimensional analysis and report your answers in correct significant figures and units. You may either type or pint your answers. There will be a **test based on the summer assignment** within the first two two weeks of school.

You will need to know the name, symbols, valence electrons, charges, and location on the periodic table of a list of elements. You will be asked to take a **periodic table quiz** within the first two weeks of school. It is important that you memorize these elements in the periodic table because they will appear frequently throughout the course and you will not have time to search for the elements. The elements you need to know are; all the elements in the s block and the p block, all the transition metals in the 4^{th} period and Mo, W, Pd, Pt, Ag, Au, Cd and Hg.

Upon return to class you will need **1 composition notebook** for formal lab reports. You will also need a **notebook or a ring binder** to organize the notes you will receive throughout the course and **pen, pencils**.

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Directions Show your work for each problem. To receive full credit for problems on the AP exam you have to show your work in a manner that the reader will understand. Therefore use dimensional analysis where appropriate. If the problem is equation based, write the equation, substitute appropriate values for variables and calculate your answer. Use units and significant figures in all your work. You will need to convert names to formulas, and write the equations for each reaction associated with a problem. You may type your work and answers. If you write your work and answers on separate paper, write your name on the paper and upload a picture of it. Include the problem number and letter associated with your work and answer for each question or problem. Write legibly.
<u>If I can not read it I will not grade it.</u>

1. An element consists of 1.40 % of an isotope with a mass of 203.973 amu, 24.10 % of an isotope with a mass of 205.9745 amu, 22.10 % of an isotope with a mass of 206.9757 amu and 52.40 % of an isotope with a mass of 207.9766 amu. What is the average atomic mass of this element?

2. The element rhenium has two naturally occurring isotopes, ^{185}Re and ^{187}Re, with an average atomic mass of 186.207 amu. Rhenium is 62.60 % ^{187}Re with an atomic mass of 186.956 amu. What is the atomic mass of ^{185}Re?

3. Ascorbic acid, Vitamin C ($C_6H_8O_6$), is an essential vitamin. It can not be stored in the body. A typical vitamin C tablet contains 500.0 mg of ascorbic acid. **a.** How many moles of ascorbic acid are 500.0 mg? **b.** How many molecules of ascorbic acid does this represent. **c.** How many carbon atoms are there in 500.0 mg of ascorbic acid?

4. Aspartame ($C_{14}H_{18}N_2O_5$) is an artificial sweetener that tastes 160 times sweeter than sugar when dissolved in water. It is marketed as Nutra-Sweet. **a.** How many moles of aspartame are there in 10.0 g of the compound? **b.** How many molecules does this represent? **c.**How many hydrogen atoms are there in 10.0 g of aspartame?

5. What is the percent composition by mass of acrylic acid ($C_3H_4O_2$)? Acrylic acid is the monomer from which acrylic plastics are made.

6. What is the empirical formula of a compound that contains by mass; 56.79 % carbon, 6.56 % hydrogen, 28.37 % oxygen and 8.28 % nitrogen?

7. An organic compound contains 49.31 % C and 43.79 % oxygen by mass with the remainder as hydrogen. The molar mass of this compound is 146.1 g/mol. **a.** What is the empirical formula of this compound? **b.** What is the molecular formula of this compound?

8. Iron (III) oxide reacts with aluminum to form iron metal and aluminum oxide. **a.** What mass of each reactant is required to form 15.0 g of iron? **b.** What is the maximum mass of aluminum that could be produced?

9. Ammonia (NH_3) reacts with oxygen to form nitrogen monoxide and water. All the materials involved in this reaction are gasses. 0.100 moles of each of the reactants are initially introduced to a 5.0 liter reaction vessel. **a.** What would be the quantity of each gas in the container upon completion of the reaction? **b.** What would be the partial pressure of each gases on the reaction vessel upon reaction completion if the temperature of the system is 105 ^oC? **c.** What is the total pressure of all the gases on the reaction vessel at 105 ^oC?

10. What mass of each product is produced when 1.0 Kg of calcium phosphate is combined with 1.0 Kg of concentrated sulfuric acid. (concentrated sulfuric acid solution is 98 % sulfuric acid by mass)

11. Aspirin ($C_9H_8O_4$) is produced by reacting salicylic acid ($C_7H_6O_3$) with acetic anhydride ($C_4H_6O_3$) according to the balanced reaction … $C_7H_6O_3 + C_4H_6O_3 \rightarrow C_9H_8O_4 + HC_2H_3O_2$
a. What mass of acetic anhydride is needed to react completely with 1.00 x 10^2 grams of salicylic acid? **b.** What is the maximum mass of aspirin that could be produced? **c.**In another experiment a student reacted 1.50 g of salicylic acid with 2.00 g of acetic anhydride. The yield was 1.50 g aspirin. What is the percent yield of this reaction?

12. A 752 g sample of iron ore is heated with excess carbon to form pure iron and carbon dioxide. The ore contains iron (III) oxide and other impurities. 453 g of pure iron are obtained from this sample. **a.** What is the mass percent of iron (III) oxide in the ore? Assume that iron(III) oxide is the only source of iron in the ore and the reaction is 100 % efficient. **b.** What is the volume of carbon dioxide at 25 ^oC and 95.0 KPa produced in this reaction.

13. What is the molarity of a solution that is prepared by dissolving 5.623 g of sodium bicarbonate in enough water to make a 250.0 ml solution?

14. What is the molarity of a solution that is prepared by dissolving 184.6 mg of potassium dichromate in enough water to make a 500.0 ml solution?

15. What is the concentration of each ion in a solution that is prepared by dissolving 5.00 g of ammonium chloride in enough water to make a 500.0 ml solution.

16. What is the concentration of each ion in the solution when 1.00 g of potassium phosphate is dissolved in enough water to make a 250.0 ml solution?

17. Which of the following solutions of strong electrolytes would result in the lowest freezing point; 100.0 ml of 0.100 M sodium hydroxide, 50.0 ml of 0.200 molar barium chloride or 75.0 ml of 0.150 molar sodium phosphate?
18. To what volume does 10.0 g of silver nitrate need to be diluted to prepare a 0.25 M solution of silver nitrate?

19. A solution is prepared by dissolving 10.8 g of ammonium sulfate in enough water to make 100.0 ml of stock solution. A 10.0 ml sample of this stock solution is added to 50.0 ml of water. What are the concentrations of ammonium and sulfate ions in this final solution?

20. Which of the following compounds are likely to be soluble in water; aluminum nitrate, magnesium chloride, rubidium sulfate, nickel (II) hydroxide, lead (II) sulfide, magnesium hydroxide and/or iron (IIi) phosphate?

21. Write the formulas of the reactants for each combination. Then write the balanced, ionic and net ionic equations for each combination of reactants that results in the formation of a product. If no product is formed write "no reaction". **a.** phosphate and potassium nitrate, **b.** ammonium sulfate and barium nitrate, **c.** Iron (II) sulfate and potassium chloride, **d.** calcium chloride and sodium sulfate, **e.** potassium sulfide and nickel0 (II) nitrate, **f.** sodium hydroxide and nitric acid, **g. l**ead (II) nitrate and sodium chloride, **h.** copper (II) chloride and sodium hydroxide.

22. What mass of sodium chromate is required to precipitate all the silver ions in 75.0 ml of 0.100 M silver nitrate.

23. What is the mass of the product produced when 50.0 ml of 0.200 M aluminum nitrate is added 200.0 ml of 0.100 M potassium hydroxide.

24. a. How many grams of product can be prepared by the reaction of 100.0 ml of 0.20 M silver nitrate with 100.0 ml of 0.15 M calcium chloride? **b.** What is the concentration of each ion that remains in solution?

25. 75.0 ml of 0.250 M hydrochloric acid is added to 225 ml of 0.0550 M barium hydroxide. **a.** How much product is formed? **b.** What is the concentration of each ion that remains in solution?

26. A 25.00 ml sample of hydrochloric acid is titrated to the phenolphthalein endpoint with 24.16 ml of 0.106 M sodium hydroxide. What is the molarity of the acid?

27. A 10.0 ml sample of vinegar, an aqueous solution of acetic acid (C_2H_3OH) is titrated with 16.58 ml of 0.5062 M sodium hydroxide to the equivalence point. **a.** What is the molarity of the acetic acid? **b.** If the density of the vinegar is 1.006 g/cm^3 what is the mass percent of acetic acid in the vinegar?

28.A particular balloon is designed by its manufacturer to be inflated to a volume of no more than 2.5 L. If the balloon is filled with 2.0 L of helium at sea level and is released and rises to an altitude where the atmospheric pressure is 500. mm Hg will the balloon burst? Assume the temperature remains constant. Support your answer.

29. A flask that can withstand an internal pressure of 2500 torr, but no more, is filled with a gas at 21.0 ºC to a pressure of 758 torr. At what temperature will this tank burst if it is heated?

30. A bicycle tire is filled with air to a pressure of 100. psi at a temperature of 19 ºC. After riding the bike on asphalt on a hot day the temperature of the tire increases to 58 ºC. The volume of the tire increases by 4.0 %. What is the pressure of the air in the tire?

31. A sealed balloon is filled with 1.00 L of helium at 23 ºC and 1.00 atm. The balloon rises to a point in the atmosphere where the pressure is 220. torr and the temperature is - 31 ºC. What is the change in the volume of the balloon as it ascends from 1.00 atm to a pressure of 220. Torr?

32. Methane (CH_4) is the main component of marsh gas. Heating methane in the presence of sulfur produces carbon disulfide and hydrogen sulfide as the only products. **a.** What is the maximum quantity of each product that is produced when 120. g of methane is reacted with an equal mass of sulfur. **b.** What volume does the methane occupy at 23 ºC and 740. mm Hg?

33. Commercial hydrogen peroxide (H_2O_2) solutions are explosively decomposed by traces of transition metal ions such as manganese or iron. When peroxide decomposes it forms water and oxygen. **a.** What volume of pure oxygen collected at 27 ºC and 746 torr would be generated by the decomposition of 125 g of a 50 % by mass hydrogen peroxide solution. **b.** If the water formed by this reaction condenses what is the volume of the liquid water formed?

34. A mixture of 1.00 g hydrogen and 1.00 g helium is placed in a 1.00 liter container at 27 ºC. What is the partial pressure of each gas in the container and what is the total pressure of the gasses in the container?

35. Small quantities of hydrogen gas can be prepared in the laboratory by placing zinc metal in aqueous hydrochloric acid. Typically the hydrogen gas is bubbled through water for ease of collection and it becomes saturated with water vapor. Suppose 240. ml of hydrogen gas is collected over water at 30. ºC and a barometric pressure of 1.032 atm. (The vapor pressure of water at 30 º is 32 torr) **a.** What is the partial pressure of the hydrogen gas? **b.** How many grams of zinc were reacted to generate this volume of hydrogen? **c.** What is the minimum volume of a 50 % by mass solution of hydrochloric acid required to react with all of the zinc? Assume the density of the hydrochloric acid solution is 1.00 g/ml. **d.** To ensure all the zinc reacts, 25 % more hydrochloric acid is used than the minimum required. What is the concentration of the ions in solution after the reaction is complete?

36. The rate of effusion of a particular gas was measured and found to be 24.0 ml/min. Under the same conditions the rate of effusion of methane (CH_4) gas is 47.8 ml/min. What is the molar mass of the unknown gas?

37. What is the pH of each of the following solutions? **a.** 4.4×10^{-5} M hydrochloric acid, **b.** 3.35×10^{-6} M sodium hydroxide solution, **c.** distilled water, **d.** 3.6×10^{-4} M sulfuric acid solution, and **e.** 2.13×10^{-2} M barium hydroxide solution?

38. What is the pOH of each of the solutions in problem 37?

39. A solution is prepared by adding 50.0 ml of 0.050 M hydrochloric acid to 150.0 ml of 0.10 M nitric acid. What is the concentration of each ion in this solution?

40. 20.0 ml of nitric acid is titrated with 20.65 ml of a 0.115 M sodium hydroxide solution. What is the molarity of the acid?

41. 20.0 ml of a 0.0985 M solution of sodium hydroxide is added to 18.0 ml of a 0.103 M solution of hydrochloric acid. What is the pH of the final solution?