AP Chemistry Summer Work

Before the 1st day of class:

1. Work the following problems on separate sheets of paper-Show all of your work and circle your final answer. All of these problems may be done with a Periodic Table and a calculator.

2. The problems are due the first day of class and will count as your first grade.

3. Begin reading Chapters 1 & 2 in Zumdahl (text). We will not cover these chapters in class, but you are responsible for this material (most should be familiar to you). We will begin with Chapter 3 (Stoichiometry).

4. The first test will cover Chapters 1 & 2. This will include fundamental SI units, basic units of measurements, accuracy & precision, significant figures, unit conversion (dimensional analysis), temperature conversions, classification of matter, and writing names & formulas of compounds.

5. Approximately 50% of the first test will consist of writing names & formulas. You will need to know both monatomic & polyatomic ions. The charge of many of the monatomic ions can be found from the periodic table: elements in the 1st column are 1^+, the second column 2^+; similarly, those in the 2nd to last column are 1^-, the 3rd to last column, 2^-, etc. The transition elements are variable, but you can often work backwards from the compound to determine which particular species is being used.

Have a great summer!
Peace, Love, Chemistry

Dr. K

1a. There are 365 days per year, 24 hours per day, 12 months per year, and 60 minutes per hour. Use these data to determine how many minutes are in a month.

1b. Now use the following data to calculate the number of minutes in a month: 24 hours per day. 60 minutes per hour, 7 days per week, and 4 weeks per month.

1c. Why are these answers different? Which (if any) is more correct? Why?

2. You go to a convenience store to buy candy and find the owner to be rather odd. He allows you to buy pieces in multiples of four, and to buy four, you need $0.23. He only allows you to do this by using 3 pennies and 2 dimes. You have a bunch of pennies and dimes, and instead of counting them, you decide to weigh them. You have 636.3 g of pennies and each penny weighs 3.03 g. Each dime weighs 2.29 g. Each piece of candy weighs 10.23 g.

a. How many pennies do you have?
b. How many dimes do you need to buy as much candy as possible?
c. How much should all of these dimes weigh?
d. How many pieces of candy could you buy (number of dimes from part b)?
e. How much would this candy weigh?
f. How many pieces of candy could you buy with twice as many dimes?

3. When a marble is dropped into a beaker of water, it sinks to the bottom. Which of the following is the best explanation? Justify your choice and for choices you did not pick, explain what is wrong about them.

a. The surface area of the marble is not large enough to be held up by the surface tension of the water.
b. The mass of the marble is greater than that of the water.
c. The marble weighs more than an equivalent volume of the water.
d. The force from dropping the marble breaks the surface tension of the water.
e. The marble has greater mass and volume than the water.

4. You have two beakers, one filled to the 100 ml mark with sugar (the sugar has a mass of 180.0g) and the other filled to the 100 ml mark with water (the water has a mass of 100.0g). You pour all the sugar and all the water together in a bigger beaker and stir until the sugar is completely dissolved. Which of the following is true about the mass of the solution? Explain.
a. It is much greater than 280.0 g
b. It is somewhat greater than 280.0 g
c. It is exactly 280.0g

5. You may have noticed that when water boils, you can see bubbles that rise to the surface of the water. What is inside this water?

6. What data would you need to estimate the money you would spend on gasoline to drive your car from New York to Chicago? Provide estimates of values and a sample calculation.

7. Define and explain the difference between the following terms:

a. law and theory
b. theory and experiment
c. qualitative and quantitative
d. hypothesis and theory

8. is the scientific method suitable for solving problems only in the sciences? Explain.

9. Which of the following statements (hypotheses) could be tested by quantitative measurement?
a. Ty Cobb was a better hitter than Pete Rose
b. Ivory soap is 99% pure.
c. Rolaids consumes 47 times its weight in excess stomach acid.

10. A student performed an analysis of a sample for its calcium content and got the following results:
14.92%, 14.91%, 14.88%, 14.91%. The actual amount of calcium in the sample is 15.70%. What conclusion can you draw about the accuracy and precision of these results.

11. How many significant figures are in each of the following?
a. 12
b. 1098
c. 2001
d. 2.001×10^3
e. 0.0000101
f. 1.01×10^{-5}
g. 1000.
h. 22.04030

12. How many significant figures are in each of the following?
a. 100
b. 1.0×10^2
c. 1.00×10^3
d. 100.
e. 0.0048
f. 0.00480

13. Round each of the following numbers to three significant figures, and write the answer in standard exponential notation.
a. 312.54
b. 0.00031254
c. 31, 254, 000
d. 0.31254
e. 31.254×10^{-3}

14. Use exponential notation to express the number 480 to:
a. one significant figure
b. two significant figures
c. three significant figures

d. four significant figures

15. Perform the following mathematical operations and express each result to the correct number of significant figures.
a. 97.381 + 4.2502 + 0.99195
b. 171.5 + 72.915 – 8.23
c. 1.00914 + 0.87104 + 1.2012
d. 21.901 – 13.21 – 4.0215

16. Perform the following mathematical operations and express each result to the correct number of significant figures.

a. 4.184 x 100.62 x (25.27 – 24.16)
b. 8.925-8.904/8.925 x 100

17. Perform each of the following conversions:
a. 8.43 cm to millimeters
b. 2.41 x 10^2 cm to meters
c.. 294.5 nm to centimeters
d. 1.445 x 10^4 m to kilometers
e. 235.3 m to millimeters
f. 903.3 nm to micrometers

18. Congratulations! You and your spouse are the proud parents of a new baby, born while you are studying in a country that uses the metric system. The nurse has informed you that the baby weighs 3.91 kg and measures 51.4 cm. Convert your baby's weight to pounds and ounces and her length to inches (rounded to the nearest quarter inch).

19. Perform the following unit conversions.
a. 908 oz. to kilograms
b. 12.8 L to gallons
c. 125 mL to gallons
d. 2.89 gallons to milliliters
e. 4.48 lb to grams
f. 550 mL to quarts

20. A person has a temperature of 102.5°F. What is this temperature on the Celcius scale? On the Kelvin scale?

21. If the temperature in a room is 74°F, what is this temperature on the Celcius scale? On the Kelvin scale?

22. Helium boils at about 4K. What is this temperature on the Fahrenheit scale? On the Celcius scale?

23. A thermometer gives a reading of 96.1 °F +/- 0.2°F. What is the temperature in °C? What is the uncertainty?

24. A rectangular block has dimensions 2.9 cm x 3.5 cm x 10.0 cm. The mass of the block is 615.0 g. What are the volume and density of the block?

25. Diamonds are measured in carats and 1 carat = 0.200 g. The density of diamond is 3.51 g/cm^3. What is the volume of a 5.0 carat diamond?

26. The volume of a diamond is found to be 2.8 mL. What is the mass of the diamond in carats?

27. In each of the following pairs, which has the greater mass?
a. 1.0 kg of feathers or 1.0 kg of lead?
b. 1.0 mL of mercury or 1.0 mL of water?
c. 193 mL of water or 1.00 mL of gold?
d. 75 mL of copper or 1.0 L of benzene?

28. In each of the following pairs, which has the greater volume?
a. 1.0 kg of feathers or 1.0 kg of lead?
b. 100 g of gold or 100 g of water?
c. 1.0 L of copper or 1.0 L of mercury?

29. A mole of helium gas contains 6.02 x 10^{23} helium atoms. How many helium atoms are there in a millimole of helium? In a kilimole?

30. The contents of one 40 lb bag of topsoil will cover 10 square feet of ground to a depth of 1.0 inch. How many bags are needed to cover a plot which measures 200m by 300m to a depth of 4.0 cm?

31. Convert the following Celsius temperatures to Kelvin and Fahrenheit degrees:
a. the boiling point of ethyl alcohol: 78.1
b. a cold wintery day: -25
c. the lowest possible temperature: -273
d. the melting point of sodium chloride: 801

32. Two spherical objects have the same mass. One floats on water, the other sinks. Which object has the greater diameter? Explain your answer.

33. Many times errors are expressed in terms of percentage. The percentage error is the absolute value of the difference of the true value and the experimental value, divided by the true value, and multiplied by 100. Calculate the percent error for the following measurements:

a. the density of an aluminum block determined in an experiment was 2.64 g/cm^3. (True value is 2.70 g/cm^3).

b. The experimental determination of iron in iron ore is 16.48%. (True value is 16.12%).

34. A diamond contains 5.0 x 10^{21} atoms of carbon. How many moles of carbon and how many grams of carbon are in this diamond?

35. Calculate the molar mass of the following substances:
a. NH_3
b. N_2H_4
c. $(NH_4)_2Cr_2O_7$
d. P_4O_6
e. $Ca_3(PO_4)_2$
f. Na_2HPO_4

36. How many grams of compound are present in 5.00 mol of each of the compounds in Q. 35?

37. How many grams of nitrogen are present in 5.00 mol of each of the compounds in Q. 35a-c?

38. How many grams of phosphorus are present in 5.00 mol of each of the compounds in A. 35d-f?

39. How many atoms of nitrogen are present in 1.00 gram of each of the compounds in Q. 35a-c?

40. How many moles are represented by each of these samples?
a. 100 molecules (exactly) of H_2O?
b. 100 g of H_2O
c. 150 molecules (exactly) of H_2O

41. How many moles are represented by each of these samples?
a. 150.0 g of Fe_2O_3
b. 10.0 mg NO_2
c. 1.5×10^{16} molecules of BF_3

42. How many atoms of nitrogen are present in 5.00 g of each of the following?
a. glycine, C_2H_5O2N
b. magnesium nitride
c. calcium nitrate
d. dinitrogen tetroxide

43. Aspartame is an artificial sweetener that is 160 times sweeter than sucrose (table sugar) when dissolved in water. It is marketed as Nutra-Sweet. The molecular formula of aspartame is $C_{14}H_{18}N_2O_5$.

a. Calculate the molar mass of aspartame
b. How many moles of molecules are present in 10.0g of aspartame?
c. Calculate the mass in grams of 1.56 mol aspartame
d. How many molecules are in 5.0 mg aspartame?
e. How many atoms of nitrogen are in 1.2 g aspartame?
f. What is the mass in grams of 1.0×10^9 molecules of aspartame?
g. What is the mass in grams of one molecule of aspartame?

44. Humulone, $C_{21}H_{30}O_5$, is one of the flavor components that gives a bitter taste to the hops used in making malt.

a. Calculate the molar mass of humulone
b. How many moles of $C_{21}H_{30}O_5$ molecules are in 275 mg of humulone?
c. What is the mass of 0.600 mol of humulone?
d. How many atoms of hydrogen are in 1.00 pg of humulone?
f. What is the mass in grams of 1.0×10^9 molecules of humulone?
g. What is the mass in grams of one molecule of humulone?

45. Calculate the percent composition by mass of the following compounds that are important starting materials for synthetic polymers:
a. $C_3H_4O_2$ (acrylic acid, from which acrylic plastics are made).
b. $C_4H_6O_2$ (methyl acrylate, from which Plexiglass is made).

46. Vitamin B_{12}, cyanocobalamin, is essential for human nutrition. It is concentrated in animal tissue but not in higher plants. Although nutritional requirements for the vitamin are quite low, people who abstain completely from animal products may develop a deficiency anemia. Cyanocobalamin is the form used in vitamin supplements. It contains 4.34% cobalt by mass. Calculate the molar mass of cyanocobalamin, assuming that there is one atom of cobalt in every molecule of cyanocobalamin.

47. Fungal laccase, a blue protein found in wood-rotting fungi, is 0.390% Cu by mass. If a fungal laccase molecule contains 4 copper atoms, what is the molar mass of fungal laccase?

48. Express the composition of each of the following compounds as the mass percents of its elements.

a. formaldehyde, CH_2O
b. glucose, $C_6H_{12}O_6$
c. acetic acid, $HC_2H_3O_2$

49. Give the empirical formula for each of the following compounds.
a. vitamin C, $C_6H_8O_6$
b. benzene, C_6H_6
c. acetylene, C_2H_2
d. phosphorus pentoxide, P_4O_{10}
e. glucose, $C_6H_{12}O_6$
f. acetic acid, $HC_2H_3O_2$

50. Determine the molecular formulas to which the following empirical formulas and molar masses pertain.

a. SNH (188.35 g/mol)
b. $NPCl_2$ (347.64 g/mol)
c. CoC_4O_4 (391.94 g/mol)
d. SN (184.32 g/mol)

51. One of the most commonly used white pigments in paint is a compound of titanium and oxygen

that contains 59.9% Ti by mass. Determine the empirical formula of this compound.

52. The compound adrenaline contains 56.79% C, 6.56% H, 28.37%, and 8.28% N by mass. What is the empirical formula of adrenaline?

53. A compound that contains only nitrogen and oxygen is 30.4 % N by mass; the molar mass of the compound is 92 g/mol. What is the empirical formula of the compound? What is the molecular formula of the compound?

54. Benzene contains only carbon and hydrogen and is 7.74% H by mass; the molar mass of benzene is 78.1 g/mol. Determine the empirical and molecular formulas of benzene.

55. Cumene is a compound containing only carbon and hydrogen that is used in the production of acetone and phenol in the chemical industry. Combustion of 47.6 mg cumene produces some CO2 and 42.8 mg water. The molar mass of cumene is between 115 and 125 g/mol. Determine the empirical and molecular formulas.

56. A compound contains only carbon, hydrogen, and oxygen. Combustion of 10.68 mg of the compound yields 16.01 mg CO2 and 4.37 mg H2O. The molar mass of the compound is 176.1 g/mol. What are the empirical and molecular formulas of the compound?

57. Write a balanced chemical equation that describes each of the following:

a. Iron metal reacts with oxygen to form rust, iron (III) oxide.
b. Calcium metal reacts with water to produce aqueous calcium hydroxide and hydrogen gas.
c. Aqueous barium hydroxide reacts with aqueous sulfuric acid to produce solid barium sulfate and water.

58. Give the balanced equation for each of the following chemical reactions:

a. Glucose ($C_6H_{12}O_6$) reacts with oxygen gas to produce gaseous carbon dioxide and water vapor.
b. Solid iron (III) sulfide reacts with gaseous hydrogen chloride to form solid iron (III) chloride and hydrogen sulfide gas.
c. Carbon disulfide liquid reacts with ammonium gas to produce hydrogen sulfide gas and solid ammonium thiocyanate (NH_4SCN).

59. Balance the following equations:

a. $Cu(s) + AgNO_3(aq) \rightarrow Ag(s) + Cu(NO_3)_2(aq)$
b. $Zn(s) + HCl\ (aq) \rightarrow ZnCl_2(aq) + H_2(g)$
c. $Au_2S_3(s) + H_2(g) \rightarrow Au(s) + H_2S(g)$

60. Balance the following equations:
a. $Ca(OH)_2(aq) + H_3PO_4(aq) \rightarrow H_2O(l) + Ca_3(PO_4)_2(s)$
b. $Al(OH)_3(s) + HCl(aq) \rightarrow AlCl_3(aq) + H_2O(l)$
c. $AgNO_3(aq) + H_2SO_4(aq) \rightarrow Ag_2SO_4(s) + HNO_3(aq)$
61. Balance the following equations representing combustion reactions:

a. $C_{12}H_{22}O_{11}(s) + O_2(g) \rightarrow CO_2(g) + H_2O(g)$
b. $C_6H_6(l) + O_2(g) \rightarrow CO_2(g) + H_2O(g)$
c. $Fe(s) + O_2(g) \rightarrow Fe_2O_3(s)$
d. $C_4H_{10}(g) + O_2(g) \rightarrow CO_2(g) + H_2O(g)$
e. $FeO(s) + O_2(g) \rightarrow Fe_2O_3(s)$

62. Silicon is produced for the chemical and electronics industries by the following reactions. Give the balanced equation for each reaction:
a. $SiO_2(s) + C(s) \rightarrow Si(s) + CO_2(g)$
b. Silicon tetrachloride is reacted with very pure magnesium, producing silicon and magnesium chloride.
c. $Na_2SiF_5(s) + Na(s) \rightarrow Si(s) + NaF(s)$

63. Over the years, the thermite reaction has been used for welding railroad rails, in incendiary bombs, and to ignite solid fuel rocket motors. The reaction is:
$Fe_2O_3(s) + 2Al(s) \rightarrow 2Fe(l) + Al_2O_3(s)$

What masses of iron (III) oxide and aluminum must be used to produce 15.0 g of iron? What is the maximum mass of aluminum oxide that could be produced?

64. The compound cisplatin, $Pt(NH_3)_2C_{12}$, has been studied extensively as an antitumor agent.
a. Calculate the elemental percent composition by mass of cisplatin.
b. Cisplatin is synthesized as follows: $K_2PtCl_4(aq) + 2NH_3(aq) \rightarrow Pt(NH_3)_2Cl_2(s) + 2KCl(aq)$

What mass of cisplatin can be made from 100.g of K_2PtCl_4 and sufficient NH_3? What mass of KCl is also produced?

65. Asprin ($C_9H_8O_4$) is synthesized by reacting salicylic acid ($C_7H_6O_3$) with acetic anhydride ($C_4H_6O_3$). The balanced equation is: $C_7H_6O_3 + C_4H_6O_3 \rightarrow C_9H_8O_4 + HC_2H_3O_2$

a. What mass of acetic anhydride is needed to completely consume 1.00×10^2 g salicylic acid? water.

66. Consider the reaction: $Mg(s) + I_2(s) \rightarrow MgI_2(s)$

Identify the limiting reagent in each of the reaction mixtures:
a. 100 atoms of Mg and 100 molecules of I_2
b. 150 atoms of Mg and 100 molecules of I_2
c. 200 atoms of Mg and 300 molecules of I_2
d. 0.16 mol Mg and 0.25 mol I_2
e. 0.14 mol Mg and 0.14 mol I_2
f. 0.12 mol Mg and 0.08 mol I_2
g. 6.078 g Mg and 63.46 g I_2
h. 1.00 g Mg and 2.00 g I_2
i. 1.00 g Mg and 20.00 g I_2

67. Hydrogen cyanide is produced industrially from the reaction of gaseous ammonia, oxygen, and

methane: $2NH_3(g) + 3O_2(g) + 2CH_4(g) \rightarrow 2HCN(g) + 6H_2O(g)$

If 5.00×10^3 kg each of NH_3, O_2, and CH_4 are reacted, what mass of HCN and of H_2O will be produced, assuming 100% yield?

68. Consider the following unbalanced reaction: $P_4(s) + F_2(g) \rightarrow PF_3(g)$
How many grams of F_2 are needed to produce 120. g of PF_3 if the reaction has a 78.1% yield?

69. Chloral hydrate ($C_2H_3Cl_3O_2$) is a drug formerly used as a sedative.
a. Calculate the molar mass of chloral hydrate
b. How many moles of $C_2H_3Cl_3O_2$ molecules are in 500.0 g chloral hydrate?
c. What is the mass in grams in 2.0×10^{-2} mol choral hydrate?
d. How many chlorine atoms are in 5.0 g of chloral hydrate?
e. What mass of chloral hydrate would contain 1.0 g Cl?
f. What is the mass of exactly 500 molecules of chloral hydrate?

70. Vitamin A has a molar mass of 286.4 g/mol and a general molecular formula of C_xH_yE, where E is an unknown element. If vitamin A is 83.36% C and 10.56% H by mass, what is the molecular formula of vitamin A?

71. Why do we call $Ba(NO_3)_2$ barium nitrate, but we call $Fe(NO_3)_2$ iron (II) nitrate?

72. Why is calcium dichloride not the correct systematic name for $CaCl_2$?

73. Use Dalton's atomic theory to account for each of the following:
a. the law of conservation of mass
b. the law of definite proportions
c. the law of multiple proportions

74. What is the distinction between atomic number and mass number? Between mass number and atomic mass?

75. Several compounds containing only sulfur(S) and fluorine(F) are known. Three of them have the following composition:
i. 1.188 g of F for every 1.000 g of S
ii. 2.375 g of F for every 1.000 g of S
iii. 3.563 g of F for every 1.000 g of S

76. Give the names of the metals that correspond to the following metals: Sn, Pt, Co, Ni, Mg, Ba, K

77. Give the names of the nonmetals that correspond to the following nonmetals: As, I, Xe, He, C, Si

78. What is the symbol for an ion with 63 protons, 60 electrons, and 88 neutrons?

79. An ion contains 50 protons, 68 neutrons, and 48 electrons? What is its symbol?

80. What is the symbol of an ion with 16 protons, 18 neutrons, and 18 electrons?

81. Classify the following elements as metals or nonmetals: Mg, Ti, Au, Bi, Si, Ge, B, At, Rn, Eu, Am, Br

82. Would you expect each of the following atoms to gain or lose electrons when forming ions? What ion is the most likely in each case?
a. Na
b. Sr
c. Ba
d. I
e. Al
f. S

83. Would you expect each of the following atoms to gain or lose electrons when forming ions? What ion is the most likely in each case?
a. Ra
b. In
c. P
d. Te
e. Br
f. Rb

84. Name each of the following compounds:
a. CsF
b. Li_3N
c. Ag_2S
d. MnO_2
e. TiO_2
f. Sr_3P_2

85. Name each of the following compounds:
a. $KClO_4$
b. $Ca_3(PO_4)_2$
c. $Al_2(SO_4)_3$
d. $Pb(NO_3)_2$

86. Name each of the following compounds:
a. $BaSO_3$
b. $NaNO_3$
c. $KMnO_4$
d. $K_2Cr_2O_7$

87. Name each of the following compounds:
a. NI_3
b. PCl_3
c. SF_2
d. N_2F_4

88. Name each of the following compounds:
a. SO_2
b. ICl_3
c. P_2S_5
d. N_2O_4

89. Name each of the following compounds:
a. CuI
b. CuI_2
c. CoI_2
d. Na_2CO_3
e. $NaHCO_3$
f. S_4N_4
g. SF_6
h. NaOCl
i. $BaCrO_4$
j. NH_4NO_3

90. Name each of the following compounds:
a. $HC_2H_3O_2$
b. NH_4NO_2
c. Co_2S_3
d. ICl
e. $Pb_3(PO_4)_2$
f. KIO_3
g. H_2SO_4
h. Sr_3N_2
i. $Al_2(SO_3)_3$
j. SnO_2
k. Na_2CrO_4
l. HClO

91. Write the formula for each of the following compounds:
a. cesium bromide
b. barium sulfate
c. ammonium chloride
d. chlorine monoxide
e. silicon tetrachloride
f. chlorine trifluoride
g. beryllium oxide
h. magnesium fluoride

92. Write the formula for each of the following compounds:
a. sulfur difluoride
b. sulfur hexafluoride
c. sodium dihydrogen phosphate

d. lithium nitride
e. chromium (III) carbonate
f. tin(II) fluoride
g. ammonium acetate
h. ammonium hydrogen sulfate
i. cobalt (III) nitrate
j. mercury (I) chloride
k. potassium chloride
l. sodium hydride

93. Write the formula for each of the following compounds:
a. sodium oxide
b. sodium peroxide
c. potassium cyanide
d. copper (II) nitrate
e. silicon tetrachloride
f. lead (II) sulfide
g. lead (IV) sulfide
h. copper (I) chloride
i. gallium arsenide
j. cadmium selenide
k. zinc sulfide

94. Write the formula for each of the following compounds:
a. ammonium hydrogen phosphate
b. mercury (I) sulfide
c. silicon dioxide
d. sodium sulfite
e. aluminum hydrogen sulfate
f. nitrogen trichloride
g. hydrobromic acid
h. bromous acid
i. perbromic acid
j. potassium hydrogen sulfide