Briarcliff High School
AP Chemistry

Name: _____

AP Chemistry Summer Assignment

Overview

Students are to complete the following problem set prior to the first day of class for the coming school year. This packet will be collected by your teacher and included as an assignment for the 1st quarter.

This assignment is designed to help you review content from Regents chemistry and to also prepare you for the difficulty of AP Chemistry. It is imperative that you answer ALL questions on the assignment, even if you aren't sure that your answer is 100% correct. We will have time during the first few days to review this assignment, but you MUST have attempted the work beforehand.

For all questions on this packet, answer each question in the space provided. For problems with calculations, be sure to show all work, include units, round answers to the correct number of significant figures where appropriate, and place a box around your final answer.

To answer the questions that follow, read Chapter 1 sections 1.1-1.6 and refer to Sample Exercises 1.1-1.13 for guidance.

1. Classify the following as a pure substance or a mixture. If a pure substance, indicate whether it is an element or compound. If a mixture, indicate whether it is homogeneous or heterogeneous.

   a. Rice pudding _____
   b. Seawater _____
   c. Magnesium _____
   d. Gasoline _____
   e. Air _____
   f. Tomato juice _____
   g. Iodine crystals _____
   h. Sand _____
   i. Blood _____
   j. White gold _____
   k. Quartz _____

2. A solid white substance A is heated strongly in the absence of air. It decomposes to a new white solid B and a gas C. The gas has the same properties as the gas formed when carbon is burned in oxygen. Based on these observations, can we determine whether the A, B, and C are elements or compounds? Explain your conclusions for each substance.

   _____
   _____
   _____
   _____
   _____
   _____
   _____

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3. State the law of definite proportions. How did this law help to confirm the existence of atoms?

4. A molecular compound has the formula C_2H_6O. What exactly does this formula tell us about the compound? What doesn't it tell us?

5. In the process of attempting to characterize a substance, a chemist makes the following observations: The substance is a silvery white, lustrous metal. It melts at 649°C and boils at 1105°C. Its density at room temperature is 1.738 g/mL. The substance burns in air, producing an intense white light. It reacts with chlorine to give a brittle white solid. The substance can be pounded into thin sheets or drawn into wires. It is a good conductor of electricity. In the table below divide these characteristics into chemical or physical properties.

Chemical Properties	Physical Properties

6. Label each of the following as either intensive or extensive properties.
   a. Malleability _____
   b. Mass _____
   c. Density _____
   d. Reactivity with chlorine _____
   e. Temperature _____
   f. Melting point _____
   g. Volume _____
   h. Thermal conductivity _____
   i. Length _____

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7. Label each of the following as either a chemical or physical change.
   a. Corrosion of aluminum metal _____
   b. Melting of ice _____
   c. Pulverizing an aspirin _____
   d. Digesting a candy bar _____
   e. Explosion of nitroglycerin _____
   f. A match burning _____
   g. Salt dissolving in water _____

8. Write a numbered procedure for the separation a mixture of sugar, sand, and iron filings. Include what materials to use and a brief explanation of your reasoning for each step.

_____
_____
_____
_____
_____
_____
_____

9. A mixture of ethanol and water is the product of a chemical reaction.
   a. Draw and label the apparatus for the separation of the by distillation.

   b. The boiling points of ethanol and water are 78.37 ºC and 100.00 ºC respectively. What would be an appropriate temperature to which the mixture should be heated for distillation? Explain your choice.

_____
_____
_____

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c. What substance is collected in the receiving flask? This substance is called the distillate. How could you further purify the distillate if necessary?

_____

_____

_____

10. Two buckets of water are sitting at room temperature. The buckets are placed near a fire for ten minutes and they absorb the exact same amount of heat. At the end of this time the water in one bucket is at a higher temperature than the water in the other. How is this possible?

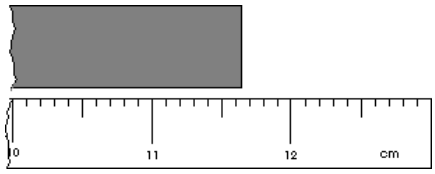
_____

_____

_____

_____

11. What is the length of the object and how many significant figures are allowed for this reading?



12. Perform the following calculations. Report answers with the correct significant figures and units.

a. 4.50×10^{-9} m ÷ 6.0×10^{5} s _____

b. 340 J x 26.0 s _____

c. 230 mol x 0.006560 K _____

d. 35.000 g – 23.73 g _____

e. 456 m x 6.02 m ÷ 200.00 min _____

f. 615 kg – 44.00 kg + 289.7 kg _____

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13. Perform the following conversions using dimensional analysis (factor label method) and record your answer to the correct number of significant figures:
    a. 0.105 in to mm

    b. 3.99 dollars/lb to dollars/kg

    c. 1.35×10^5 nm to pm

    d. 4.45 μL to mL

    e. 22.50 gal/min to L/s

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To answer the questions that follow, read Chapter 2 sections 2.1-2.9 and refer to Sample Exercises 2.1-2.15 for guidance.

14. Hydrogen sulfide is composed of two elements: hydrogen and sulfur. In an experiment, 6.500 g of hydrogen sulfide is fully decomposed into its elements.
    a. If 0.384 g of hydrogen is obtained in this experiment, how many grams of sulfur must be obtained?

    b. What fundamental law does this experiment demonstrate?

    _____
    _____

    c. How is this law explained by Dalton's atomic theory?

    _____
    _____
    _____
    _____

15. A chemist finds that 30.82 g of nitrogen will react with 17.60 g, 35.20 g, 70.40 g, or 88.0g ofoxygen to form four different compounds.
    a. Calculate the mass of oxygen per gram of nitrogen in each compound.

    b. How do the numbers in part a. support Dalton's atomic theory?

    _____
    _____
    _____
    _____

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16. How many protons, neutrons, and electrons are in the following atoms:

c. ^{28}S

d. ^{60}Ni

e. ^{85}Rb

f. ^{128}Xe

g. ^{195}Pt

h. ^{238}U

17. Why is Rutherford's nuclear model of the atom more consistent with the results of his α-particle scattering experiment than Thomson's "plum pudding" model?

_____

_____

_____

18. The element lead (Pb) consists of four naturally occurring isotopes with masses 203.97302, 205.97444, 206.97587 and 207.97663 amu. The relative abundances of these four isotopes are 1.4, 24.1, 22.1, and 52.4%, respectively. From these data, calculate the average atomic mass of lead.

19. Only two isotopes of copper occur naturally, ^{63}Cu (mass = 62.9296 amu; abundance 69.17%)and ^{65}Cu (mass = 64.9278 amu; abundance 30.83%). Calculate the atomic weight (average atomic mass) of copper.

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20. Write the empirical formula corresponding to each of the following molecular formulas:

a. Al_2Br_6

b. C_8H_{20}

c. $C_4H_8O_2$

d. P_4O_{10}

e. $C_6H_4Cl_2$

f. $B_3N_3H_6$

21. Gallium (Ga) consists of two naturally occurring isotopes with masses of 68.926 and 70.925 amu.
    a. How many protons and neutrons are in the nucleus of each isotope?

    b. Write the complete atomic symbol for each, showing the atomic number and mass number.

    c. The average atomic mass of Ga is 69.72 amu. Calculate the abundance of each isotope.

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22. Provide the systematic name for each compound.

a. Na_2CO_3 _____
b. NaOH _____
c. $MgBr_2$ _____
d. P_4S_5 _____
e. KCl _____
f. $FeCl_2$ _____
g. $FeCl_3$ _____
h. HF(aq) _____
i. $HgBr_2$ _____
j. $Zn(OH)_2$ _____
k. O_2 _____
l. $Cu(IO_4)_2$ _____
m. CsSCN _____
n. $BeSO_4$ _____
o. CrF_2 _____
p. SeF_6 _____
q. $HClO_3$(aq) _____
r. Al_2S_3 _____
s. PbO _____
t. HNO_3(aq) _____
u. HNO(aq) _____
v. Hg_2S _____
w. Li_3PO_4 _____
x. Si_2Br_6 _____
y. SCl_4 _____
z. TiI_4 _____
aa. Co_3N_2 _____
bb. Mg_3P_2 _____
cc. B_2Si _____
dd. $Ga(NO_2)_3$ _____
ee. Ag_2SO_3 _____
ff. NF_3 _____
gg. $Al(CN)_3$ _____
hh. H_2S(g) _____
ii. H_2S(aq) _____
jj. H_2SO_4(aq) _____
kk. $Na_2S_2O_3$ _____
ll. $Be(C_2H_3O_2)_2$ _____

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23. Write the formula for each compound.
    a. Sodium phosphide _____
    b. Magnesium nitrate _____
    c. Antimony tribromide _____
    d. Lead(II) sulfite _____
    e. Dichromic acid _____
    f. Calcium phosphate _____
    g. Ammonium sulfate _____
    h. Hexaboron silicide _____
    i. Phosphoric acid _____
    j. Silver cyanide _____
    k. Aluminum sulfide _____
    l. Iodous acid _____
    m. Chlorine dioxide _____
    n. Hydrogen iodide _____
    o. Beryllium chloride _____
    p. Copper(I) arsenide _____
    q. Iron(III) oxide _____
    r. Gallium nitride _____
    s. Iron(II) bromide _____
    t. Vanadium(V) phosphate _____
    u. Calcium hydrogen sufate _____
    v. Copper(I) borate _____
    w. Calcium oxide _____
    x. Iodine pentafluoride _____
    y. Oxalic acid _____
    z. Potassium permanganate _____
    aa. Magnesium acetate _____
    bb. Percarbonic acid _____
    cc. Aluminum sulfate _____
    dd. Dinitrogen trioxide _____
    ee. Copper(I) carbonate _____
    ff. Barium oxide _____
    gg. Ammonium sulfate _____
    hh. Phosphorous triiodide _____
    ii. Silver bromide _____
    jj. Sulfuric acid _____
    kk. Lead(IV) nitrate _____
    ll. Copper(II) bicarbonate _____

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24. Draw all isomers of chloropropane and name them.

25. Name the following organic compounds.
    a. CH_3COOH

    b. C_2H_5OH

    c. C_4H_{10}

    d. $CH_3CHFCH_2CH_2CH_3$

You are also responsible for the following:

- Know the names and symbols of the following elements: 1-56, 78-88, 91-94
  - Make flash cards with the name of the element on one side and the symbol on the other
  - It is not necessary to remember the atomic numbers or weights, however you may find that memorizing this information for at least elements 1-20 will save you time
  - Refer to your textbook for the correct spellings of the elements
- Know the names, formulas, and charges for all the ions listed on the "Golden Sheet of Nomenclature"
  - Make flash cards with the name of the ion on one side and its formula and charge on the other

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To answer the questions that follow, read Chapter 3 sections 3.1-3.7 and refer to Sample Exercises 3.1-3.20 for guidance.

26. Balance the following equations:

a. ____$SO_2(g)$ + ____$O_2(g)$ → ____$SO_3(g)$

b. ____$Li(s)$ + ____$N_2(g)$ → ____$Li_3N(s)$

c. ____$NH_4NO_3(s)$ → ____$N_2(g)$ + ____$O_2(g)$ + ____$H_2O(g)$

d. ____$Ca_3P_2(s)$ + ____$H_2O(l)$ → ____$Ca(OH)_2(aq)$ + ____$PH_3(g)$

e. ____$Al(OH)_3(s)$ + ____$HClO_4(aq)$ → ____$Al(ClO_4)_3(aq)$ + ____$H_2O(l)$

27. Convert these descriptions into balanced equations:

a. When sulfur trioxide gas reacts with water, a solution of sulfuric acid forms.

b. Boron sulfide, $B_2S_3(s)$, reacts violently with water to form dissolved boric acid, H_3BO_3, and hydrogen sulfide gas.

c. Phosphine, $PH_3(g)$, combusts in oxygen gas to form gaseous water 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.

28. Calculate the percentage by mass of the indicated element in the following compounds:
    a. Hydrogen in ammonium sulfate, $(NH_4)_2SO_4$, a substance used as a nitrogen fertilizer

    b. Oxygen in ascorbic acid, $HC_6H_7O_6$, also known as vitamin C

    c. Carbon in capsaicin, $C_{18}H_{27}NO_3$, the compound that gives the hot taste to peppers

29. Calculate the following quantities:
    a. Mass, in grams, of 1.73 mol CaH_2

    b. Number of moles of NH_2Cl in 76.5 g of this substance

    c. Number of NO_3^- ions in 4.88×10^{-3} mol $Al(NO_3)_3$

    d. What is the mass, in grams, of 7.70×10^{20} molecules of caffeine, $C_8H_{10}N_4O_2$?

30. Determine the empirical and molecular formulas of each of the following substances:
    a. Ibuprofen, a headache remedy that contains 75.60% C, 8.80% H, and 15.51% O by mass; molar mass about 206 g/mol

    b. Epinephrine (adrenaline), a hormone secreted into the bloodstream in times of danger or stress: 59.0% C, 7.1% H, 26.2% O and 7.7% N by mass; MW approx 180 amu.

31. Menthol, the substance we can smell in mentholated cough drops, is composed of C, H, and O. A 0.1005 g sample of menthol is combusted producing 0.2829 g of CO_2 and 0.1159 g of H_2O. What is the empirical formula for menthol? If the compound has a molar mass of 156 g/mol, what is its molecular formula?

32. Nicotine a component of tobacco is composed of C, H, and N. A 5.250 mg sample of nicotine was combusted, producing 14.242 mg of CO_2 and 4.083 mg of H_2O. What is the empirical formula for nicotine? If the substance has a molar mass of 160 ± 5 g/mol, what is its molecular formula?

33. Hydrofluoric acid, HF(aq), cannot be stored in glass bottles because compounds called silicates in the glass are attacked by the HF(aq). Sodium silicate (Na_2SiO_3), for example reacts as follows:

$$Na_2SiO_3(s) + 8HF(aq) \rightarrow H_2SiF_6(aq) + 2NaF(aq) + 3H_2O(l)$$

a. How many moles of HF are needed to react with 0.300 mol of Na_2SiO_3?

b. How many grams of NaF from when 0.500 mol of HF reacts with excess Na_2SiO_3?

c. How many grams of Na_2SiO_3 can react with 0.800 g of HF?

34. Detonation of nitroglycerin proceeds as follows:

$$4C_3H_5N_3O_9(l) \rightarrow 12\ CO_2(g) + 6N_2(g) + O_2(g) + 10H_2O(g)$$

a. If a sample containing 3.00 mL of nitroglycerin (density = 1.592 g/mL) is detonated, how many total moles of gas are produced?

b. If each mole of gas occupies 55 L under the conditions of the explosion, how many liters of gas are produced?

c. How many grams of N_2 are produced in the detonation?

35. A 2.00 g sample of ammonia is mixed with 4.00 g of oxygen:

$$4NH_3(g) + 5O_2(g) \rightarrow 4NO(g) + 6H_2O(g)$$

Which is the limiting reactant and how much excess reactant remains after the reaction has stopped?

36. A 50.6 g sample of $Mg(OH)_2$ is reacted with 45.0 g of HCl to produce $MgCl_2$ and water. What is the theoretical yield of magnesium chloride in grams? What mass of excess reagent remains?

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37. A student performed the following combination reaction in their chemistry lab to form compound X.

$$3H_2 + N_2 \rightarrow 2X$$

The masses of the reactants the student used are shown to the right:

H_2	3.0 g
N_2	5.12 g
X	_____

a. Find the limiting reactant.

b. Find the mass of excess reactant remaining.

c. Find the mass of product formed and record on table.

d. What is the percent by mass of each element in the product?

e. Determine the empirical formula of the product.

f. If a student produced 5.21 g of the product in the lab, what is the percent yield of the experiment?