

Note: There are 7 questions in this exam (check both sides of the sheet).

Fill in your answer in the blank space provided immediately following each question. Half a point will be subtracted every time you report a numerical result with an incorrect number of significant figures. A copy of the periodic table is attached. Good luck!

1. a. (4) What is the chemical formula of magnesium phosphate?



- b. (4) What is the name of the compound $KClO_4$?

Potassium Perchlorate

- c. (4) How many protons and electrons does the sodium ion have?

Na^+ : 11 protons, 10 electrons

- d. (4) What is the molar mass of $PbCO_3$?

$$\mathbf{207.2+12.01+3*16.00= 267.2}$$

- e. (4) Give the name of the elements with the following atomic symbols:

Hg: Mercury

P: Phosphorus

F: Fluorine

Mn: Manganese

2. Write a balanced equation for each of the following reactions (it is not necessary to indicate the states of each substance):

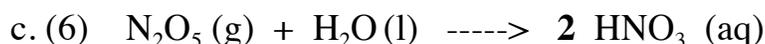
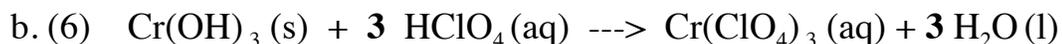
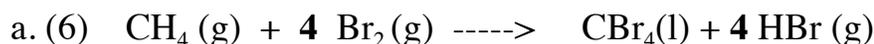
a. (6) Burning butane in oxygen



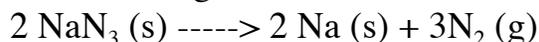
b. (6) Calcium Carbide (CaC_2) reacts with water to form an aqueous solution of calcium hydroxide and acetylene (C_2H_2)



3. Balance the following chemical equations:



4. (10) Automotive air bags inflate when sodium azide rapidly decomposes:



a) (5) How many moles of N_2 are produced by the decomposition of 1.50 moles of NaN_3 ?

$$1.50 \text{ mol NaN}_3 \times (3 \text{ mol N}_2) / (2 \text{ mol NaN}_3) = 2.25 \text{ mol N}_2$$

b) (5) How many grams of NaN_3 are required to form 5.00 g of nitrogen gas?

$$\text{Molar mass NaN}_3 = 22.99 + 3 \times 14.01 = 65.02 \text{ g/mol}$$

$$\text{Molar mass N}_2 = 2 \times 14.01 = 28.02 \text{ g/mol}$$

$$5.00 \text{ g N}_2 / (28.02 \text{ g N}_2 / \text{mol N}_2) \times (2 \text{ mol NaN}_3 / 3 \text{ mol N}_2) \\ \times 65.02 \text{ g NaN}_3 / \text{mol NaN}_3 = 7.73 \text{ g NaN}_3$$

5. (15) Vanillin, the dominant flavoring in vanilla, contains C, H, and O. When 1.050 g of this substance is completely combusted, 2.43 g of CO₂ and 0.500 g of H₂O are produced. What is the empirical formula of vanillin?

$$2.43 \text{ g CO}_2 \times (12.01 \text{ g C} / 44.01 \text{ g CO}_2) = 0.663 \text{ g C}$$

$$0.500 \text{ g H}_2\text{O} \times (2 \times 1.008 \text{ g H} / 18.02 \text{ g H}_2\text{O}) = 0.0559 \text{ g H}$$

$$1.050 - 0.663 - 0.0559 = 0.331 \text{ g O}$$

Convert to moles:

$$0.663 / 12.01 = 0.0552 \text{ mol C}$$

$$0.0559 / 1.008 = 0.0555 \text{ mol H}$$

$$0.331 / 16.00 = 0.0207 \text{ mol O}$$

Divide by the smallest (0.0207):

$$\text{C: } 0.0552 / 0.0207 = 2.66$$

$$\text{H: } 0.0555 / 0.0207 = 2.68$$

$$\text{O: } 0.0207 / 0.0207 = 1$$

To get whole numbers multiply all by 3. Empirical formula:



6. (15) When chlorine gas is bubbled into hot potassium hydroxide solution, it reacts according to the equation:



A reacting mixture contains 6.00 mol of chlorine and 8.00 mol of potassium hydroxide.

a) (5) Find the limiting reactant

$$\text{Cl}_2:\text{KOH} = 6 / 8 > 3/6 \Rightarrow \text{KOH is limiting reactant}$$

b) (5) How many moles of KClO_3 will form and how many moles of excess reactant will remain?

8.00 mol KOH X (1 mol KClO_3 /6 mol KOH) = 1.33 mol KClO_3 will form

8.00 mol KOH X (3 mol Cl_2 /6 mol KOH) = 4.00 mol Cl_2 will react

6.00-4.00 = 2.00 mol Cl_2 will remain

c) (5) How many grams of KOH are needed to form 50.0 Kg of KClO_3 ?

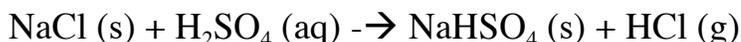
molar mass of KClO_3 = 39.10 + 35.45 + 3*16.00 = 122.55 g/mol

molar mass of KOH: 39.10 + 16.00 + 1.008 = 56.11 g/mol

50.0 Kg KClO_3 X 1000 g/Kg /122.55 (g /mol) = 408 mol KClO_3

**408 mol KClO_3 X (6 mol KOH/1 mol KClO_3) X 56.11 g/mol /(1000 g/Kg)
= 137 Kg KOH**

7. (10) Hydrogen chloride is prepared commercially by the reaction of sodium chloride with concentrated sulfuric acid:



If the percent yield is 81.5%, how many grams of HCl will be obtained by treating 25.0 Kg of NaCl with excess sulfuric acid?

molar masses:

NaCl: 22.99+35.45 = 58.44 g/mol HCl: 35.45+1.008=36.46 g/mol

25.0 Kg X 1000 (g/Kg) / (58.44 g/mol) = 428 mol NaCl

theoretical yield: 428 mol NaCl X (1 mol HCL/1 mol NaCl)X 36.46 g/mol / (1000g/Kg) = 15.6 Kg HCl

actual yield= 15.6 Kg X 81.5% = 12.7 Kg