

MOLECULAR FORMULAS

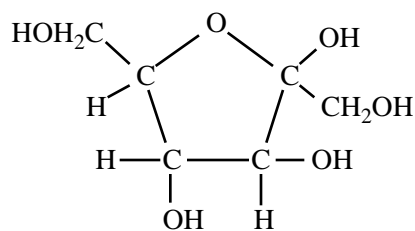
1. (7 points) Fructose is a simple sugar.

a) Molecular formula of fructose

C _____ H _____ O _____

b) Molar mass _____ g/mol

c) *Empirical* formula _____



Structure of fructose

2. (3 points) Nicotine, a poisonous compound found in tobacco leaves, is 74.0% C, 8.65% H, and the remainder N. What is the *molecular* formula of nicotine?

a) $C_5H_5N_2$

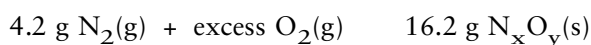
a) C_5H_7N

b) C_7H_5N

c) $C_{10}H_{14}N_2$

d) $C_{14}H_{10}N_2$

3. (3 points) Nitrogen and oxygen can form a series of oxides. If 4.2 g of nitrogen combine with excess oxygen to give 16.2 g of an oxide, which oxide is obtained?



What is the formula of N_xO_y ?

a) N_2O

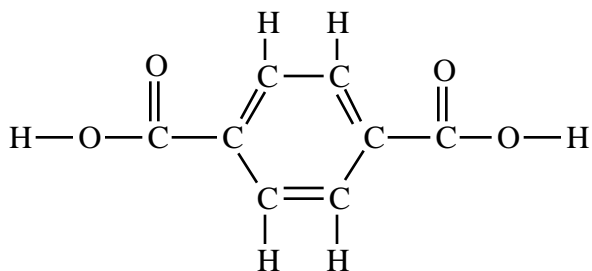
b) NO

c) NO_2

d) N_2O_5



4. (16 points) Terephthalic acid is the basis of synthetic fibers such as Kevlar.



The *molecular* formula of terephthalic acid is _____ and its molar mass is _____

a) What is the weight percent carbon in the molecule?

b) If you have 14.5 g of terephthalic acid, what quantity (in moles) of the compound do you have?

c) How many molecules are contained in 14.5 g of terephthalic acid?

d) How many C atoms are there in 14.5 g of terephthalic acid?

CHEMICAL EQUATIONS AND STOICHIOMETRY

1. (8 points) Balancing equations for the following reactions:

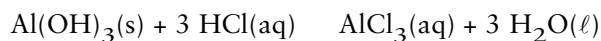
(a) the thermite reaction



(b) the combustion of pentane



2. (14 points) Several brands of antacid tablets use aluminum hydroxide to neutralize excess stomach acid (which is HCl).



What is the name of the compound $\text{Al}(\text{OH})_3$? _____

Suppose you mix 1.5 mol of $\text{Al}(\text{OH})_3$ with excess HCl and you obtain 78 g of AlCl_3 .

- a) What mass of $\text{Al}(\text{OH})_3$ was used in the reaction? _____ g
- b) What quantity HCl (moles) was consumed by the $\text{Al}(\text{OH})_3$? _____ mol
- c) What is the percent yield of AlCl_3 ? [Molar mass $\text{AlCl}_3 = 133.5 \text{ g/mol}$]
- i. 100%
 - ii. 78%
 - iii. 54%
 - iv. 39%
- d) What is the theoretical yield of H_2O ?
- i. 18 g
 - ii. 27 g
 - iii. 54 g
 - iv. 81 g

e) Some over-the-counter antacids contain aluminum hydroxide, whereas others contain CaCO_3 :

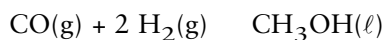


If a tablet contains 750 mg of $\text{Al}(\text{OH})_3$, and another contains 750 mg of CaCO_3 (molar mass = 100.0 g/mol) which consumes the greater mass of HCl?

a) $\text{Al}(\text{OH})_3$ tablet

b) CaCO_3 tablet

3. (5 points) Methanol, CH_3OH , is a clean-burning, easily handled fuel. It can be made by the direct reaction of CO and H_2 (obtained from heating coal with steam).



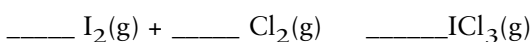
Starting with a mixture of 12.0 g of H_2 and 74.5 g of CO , which is the *limiting reactant*?

- a) H_2 b) CO

What is the theoretical yield of methanol?

- a) 42.6 g CH_3OH
 b) 85.1 g CH_3OH
 c) 95.3 g CH_3OH
 d) 170.4 g CH_3OH
 e) 190.6 g CH_3OH
4. (7 points) Chlorine and iodine are mixed in a reaction flask. The mixture is represented here with I atoms as squares (\square) and Cl atoms as circles (\bullet).

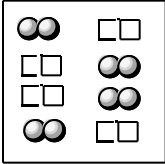
Balance the equation for the reaction:



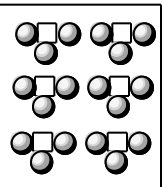
What is the limiting reactant in the original mixture, I_2 or Cl_2 ?

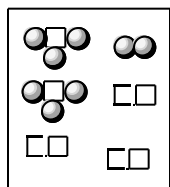
Which product mixture (a-e) represents the flask after the reaction is completed?

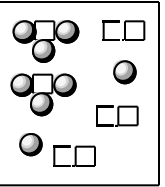
Original Reaction Mixture

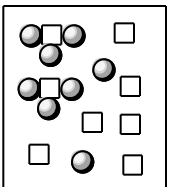


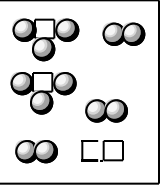
Possible Product Mixtures

a) 

b) 

c) 

d) 

e) 

GROUP QUESTION (9 points)Group members: _____

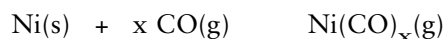
Nickel is an important metal, not least because it is used in the U.S. in the 5 cent piece. One quarter of the world's nickel comes from Canada where it is mined, often in the form of its sulfide. To purify the nickel, the sulfide is heated in air to give nickel(II) oxide and sulfur dioxide.



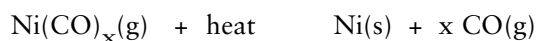
The nickel(II) oxide is then reduced with hydrogen gas to impure metal.



The impure nickel metal is then reacted with CO at about 50 °C, which converts it to a compound containing Ni and CO, Ni(CO)_x.



The compound Ni(CO)_x(g) is unstable at higher temperature, however, and decomposes to pure Ni and CO when heated to 230 °C.



1. If you have 550 g of NiS, what mass of nickel metal can theoretically be obtained?

2. To decide on the formula of Ni(CO)_x(g), suppose you heat 1.560 g of the compound and obtain 0.536 g of Ni metal. What is the value of x? That is, what is the *empirical* formula of Ni(CO)_x?

3. What environmental problems do you suppose could arise from the process described above for obtaining nickel ?