***Chemistry***

**4: Stoichiometry of Chemical Reactions**

**4.4: Reaction Yields**

61. What is the limiting reactant in a reaction that produces sodium chloride from 8 g of sodium and 8 g of diatomic chlorine?

Solution

Write the balanced chemical equation and determine the number of moles of each reactant available.

The reaction is: 





The stoichiometric ratio is 2 mol Na: 1 mol Cl2; since the reactants are provided in a 0.3:0.1 or 3:1 ratio, Na is present in excess and Cl2 is the limiting reactant.

63. A student isolated 25 g of a compound following a procedure that would theoretically yield 81 g. What was his percent yield?



65. Freon-12, CCl2F2, is prepared from CCl4 by reaction with HF. The other product of this reaction is HCl. Outline the steps needed to determine the percent yield of a reaction that produces 12.5 g of CCl2F2 from 32.9 g of CCl4. Freon-12 has been banned and is no longer used as a refrigerant because it catalyzes the decomposition of ozone and has a very long lifetime in the atmosphere. Determine the percent yield.

Solution

Write and balance the equation for the reaction: . Molar masses: CCl4 = 153.82 g/mol; CCl2F2 = 120.89 g/mol. The conversions required are. To find the percent yield, divide the 12.5 g of CCl2F2 by the theoretical mass, and multiply by 100%. For complete conversion,



67. Toluene, C6H5CH3, is oxidized by air under carefully controlled conditions to benzoic acid, C6H5CO2H, which is used to prepare the food preservative sodium benzoate, C6H5CO2Na. What is the percent yield of a reaction that converts 1.000 kg of toluene to 1.21 kg of benzoic acid?



Solution





69. Outline the steps needed to solve the following problem, then do the calculations. Ether, (C2H5)2O, which was originally used as an anesthetic but has been replaced by safer and more effective medications, is prepared by the reaction of ethanol with sulfuric acid.



What is the percent yield of ether if 1.17 L (d = 0.7134 g/mL) is isolated from the reaction of 1.500 L of C2H5OH (d = 0.7894 g/mL)?

Solution

Convert mass of ethanol to moles of ethanol; relate the moles of ethanol to the moles of ether produced using the stoichiometry of the balanced equation. Convert moles of ether to grams; divide the actual grams of ether (determined through the density) by the theoretical mass to determine the percent yield.



m = dV = 0.7134 g mL–1 1170 mL = 834.7 g



m = dV = 0.7894 g mL–1 1500 mL = 1184 g

Mass ether = 1.184



71. Outline the steps needed to determine the limiting reactant when 0.50 g of Cr and 0.75 g of H3PO4 react according to the following chemical equation?



Determine the limiting reactant.

Solution

The conversion needed is . Then compare the amount of Cr to the amount of acid present.



Thus, 0.25 mol H3PO4 is in excess, so Cr is the limiting reactant.

73. Uranium can be isolated from its ores by dissolving it as UO2(NO3)2, then separating it as solid UO2(C2O4) ∙ 3H2O. Addition of 0.4031 g of sodium oxalate, Na2C2O4, to a solution containing 1.481 g of uranyl nitrate, UO2(NO2)2, yields 1.073 g of solid UO2(C2O4) ∙ 3H2O.



Determine the limiting reactant and the percent yield of this reaction.

Solution

Using the balanced equation, determine which reactant quantity produces the smallest theoretical yield. This quantity represents the largest amount of product that can be produced. Then calculate the percent yield. The conversions for reaction 1 using the nitrate as limiting reactant are

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The answer to this calculation should be compared with the answer from reaction 2 that uses sodium oxalate as the limiting reactant and requires the following conversions:



Molar masses: UO2(NO3)2 = 394.04 g/mol

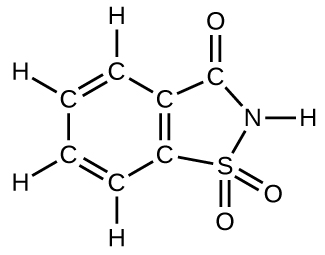
Na2C2O4 = 134.00 g/mol

UO2(C2O4)∙3H2O = 412.09 g/mol

Reaction 1: Reaction 2:Based on the two masses, the smaller mass is the limiting reactant. Thus, Na2C2O4 is the limiting reactant. An amount of UO2(NO3)2 is left unreacted.



75. How many molecules of the sweetener saccharin can be prepared from 30 C atoms, 25 H atoms, 12 O atoms, 8 S atoms, and 14 N atoms?



Solution

Determine the number of atoms of each element in saccharin and then compare these numbers to the numbers of atoms available. The numbers of atoms in saccharin are seven C atoms, five H atoms, three O atoms, one S atom, and one N atom. Compare these to the numbers of atoms available. Divide each of the required number of atoms into the corresponding number of atoms available. These relationships are 30/7 C, 25/5 H, 12/3 O, 8/1 S, and 14/1 N. The smallest value is four for O, so only four molecules can be made.

77. Would you agree to buy 1 trillion (1,000,000,000,000) gold atoms for $5? Explain why or why not. Find the current price of gold at <http://money.cnn.com/data/commodities/> ()

Solution



This amount cannot be weighted by ordinary balances and is worthless.

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