

CHEM V20 Worksheet

Chapter 8

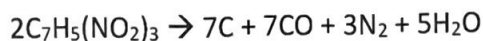
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Mol-Mol Conversions

1. Benzene, C_6H_6 , is a known carcinogen that burns in air according to the following equation:



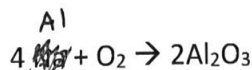
- a) What is the mol ratio of O_2 to C_6H_6 ? $O_2 : C_6H_6$ 15:2
- b) How many mols of O_2 are required to react with 1.3 mol of C_6H_6 ?
- c) How mols of H_2O can be produced with 53.3 mol of C_6H_6 ?
- 53.3 mol $C_6H_6 \times \frac{5 H_2O}{2 C_6H_6} = 133.25$ mol H_2O
2. The balanced equation for the decomposition of TNT, $C_7H_5(NO_2)_3$, is



- a) What is the mol ratio of C and CO? 7:7 = C:CO
- b) How many mols of H_2O would form if 2.32 mol of $C_7H_5(NO_2)_3$ reacts?
- c) How many mols of $C_7H_5(NO_2)_3$ are required to produce 0.0424 mol of CO?
- ~~0.0424 mol CO~~ $0.0424 \text{ mol CO} \times \frac{2 C_7H_5(NO_2)_3}{7 CO} = 0.0121$ mol $C_7H_5(NO_2)_3$

Mass-Mass Conversions

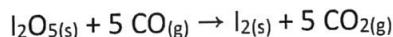
3. When active metals such as sodium are exposed to air, they quickly form a coating of metal oxide. The balanced equation for the reaction of sodium metal with oxygen gas is:



Suppose a sheet of pure aluminum gains 0.0900 g of mass when exposed to air. Assume that this gain can be attributed to its reaction with oxygen. What mass of O_2 reacted with the Al?

$$0.0900 \text{ g Al} \times \frac{1 \text{ mol}}{26.98 \text{ g}} \times \frac{3 O_2}{4 Al} \times \frac{32.00 \text{ g}}{1 \text{ mol}} = 0.801 \text{ g } O_2$$

4. Diiodine pentoxide is used in respirators to remove carbon monoxide from air:



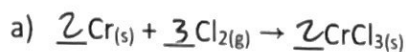
- a) What mass of carbon monoxide could be removed from air by a respirator that contains 50.0 g of diiodine pentoxide?

$$50.0 \text{ g } I_2O_5 \times \frac{1 \text{ mol}}{333.81 \text{ g}} \times \frac{5 CO}{1 I_2O_5} \times \frac{28.01 \text{ g}}{1 \text{ mol}} = \boxed{20.98 \text{ g CO}}$$

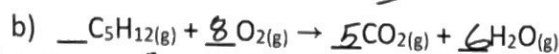
b) What mass of I₂ would remain in the respirator?

5. For each of the following unbalanced equations, balance the equation and then determine how many grams of the second reactant would be required to react completely with 0.600 g of the first reactant.

$$0.6 \text{ g Cr} \times \frac{1 \text{ mol}}{52.00 \text{ g}} = 0.01154 \text{ mol Cr}$$



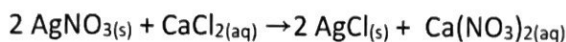
$$0.01154 \text{ mol Cr} \times \frac{3 \text{ Cl}_2}{2 \text{ Cr}} = 0.0173 \text{ mol Cl}_2$$



$$0.6 \text{ g C}_5\text{H}_{12} \times \frac{1 \text{ mol}}{72.15 \text{ g}} \times \frac{8 \text{ O}_2}{1 \text{ C}_5\text{H}_{12}} \times \frac{32.00 \text{ g}}{1 \text{ mol}} = 2.15 \text{ g O}_2$$

$$0.0173 \text{ mol Cl}_2 \times \frac{70.90 \text{ g}}{1 \text{ mol}} = 1.23 \text{ g Cl}_2$$

6. When silver nitrate is added to an aqueous solution of calcium chloride, a precipitation reaction occurs that removes the chloride ions from solution.



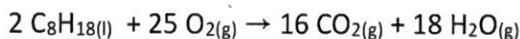
a) If a solution contains 10.0 g CaCl₂, what mass of AgNO₃ should be added to remove all of the chloride ions from solution?

$$10.0 \text{ g CaCl}_2 \times \frac{1 \text{ mol}}{110.98 \text{ g}} \times \frac{2 \text{ AgNO}_3}{1 \text{ CaCl}_2} \times \frac{164.07 \text{ g}}{1 \text{ mol}} = 30.6 \text{ g AgNO}_3$$

b) When enough AgNO₃ is added so that all 10.0 g of CaCl₂ react, what mass of the AgCl precipitate should form?

$$10.0 \text{ g CaCl}_2 \times \frac{1 \text{ mol}}{110.98 \text{ g}} \times \frac{2 \text{ AgCl}}{1 \text{ CaCl}_2} \times \frac{143.32 \text{ g}}{1 \text{ mol}} = 25.83 \text{ g AgCl}$$

7. The balanced equation for the combustion of octane is:

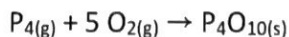


What mass of oxygen is needed to react with 2.42 Kg of oxygen?

$$2.42 \text{ kg}$$

Limiting Reactants

8. The balanced equation for the reaction of phosphorus and oxygen gas to form tetraphosphorus decoxide is:



What is the limiting reactant when each of the following sets of quantities of reactants is mixed?

$$0.50 \text{ mol P}_4 \times \frac{1 \text{ P}_4\text{O}_{10}}{1 \text{ P}_4} = 0.5 \text{ LR}$$

a) 0.50 mol P₄ and 5.0 mol O₂

$$5.0 \text{ mol O}_2 \times \frac{1 \text{ P}_4\text{O}_{10}}{5 \text{ O}_2} = 1.0$$

b) 0.20 mol P₄ and 1.0 mol O₂

$$0.2 \text{ P}_4 \times \frac{1 \text{ P}_4\text{O}_{10}}{1 \text{ P}_4} = 0.2$$

c) 0.25 mol P₄ and 0.75 mol O₂

$$1.0 \text{ O}_2 \times \frac{1 \text{ P}_4\text{O}_{10}}{5 \text{ O}_2} = 0.2 \text{ LR}$$

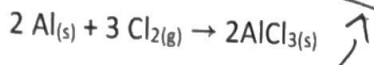
9. The balanced equation for the reaction of aluminum metal and chlorine gas is

$$0.75 \text{ O}_2 \times \frac{1 \text{ P}_4\text{O}_{10}}{5 \text{ O}_2} = 0.15$$

LR

$$a) 0.40g Al \times \frac{1 \text{ mol}}{26.98g} \times \frac{2 AlCl_3}{2 Al} = 0.0148$$

$$0.60g Cl_2 \times \frac{1 \text{ mol}}{70.90g} \times \frac{2 AlCl_3}{3 Cl_2} = 0.0056$$



LR

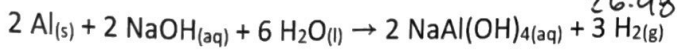
Assume that 0.40 g of Al is mixed with 0.60 g of Cl₂.

- a) What is the limiting reactant?
- b) What is the maximum amount of AlCl₃, in grams, that can be produced?

$$0.60g Cl_2 \times \frac{1 \text{ mol}}{70.90g} \times \frac{2 AlCl_3}{3 Cl_2} \times \frac{133.3g}{1 \text{ mol}} = 0.752g AlCl_3$$

10. Certain drain cleaners are a mixture of sodium hydroxide and powdered aluminum. When dissolved in water, the sodium hydroxide reacts with the aluminum and the water to produce hydrogen gas.

$$2.48g Al \times \frac{1 \text{ mol}}{26.98g} = 0.0916 \text{ mol} \times \frac{3 H_2}{2 Al} = 0.1374$$



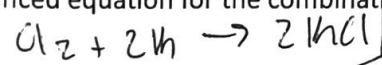
The sodium hydroxide helps dissolve grease, and the hydrogen gas provides a mixing and scrubbing action. What mass of hydrogen gas would be formed from a reaction of 2.48g Al and 4.75g NaOH in water?

2.48g	4.75g	0.2786g
0.0916	0.1188	0.1379 mol

) x $\frac{2.02g}{101}$

11. A 5.0-g sample of greenish-yellow Cl₂ gas is added to a 10.0-g sample of gray potassium metal to form a white solid in a sealed container.

- a) Write a balanced equation for the combination reaction that should occur.



- b) Identify the limiting reactant. $5g Cl_2 \times \frac{1 \text{ mol}}{70.90g} \times \frac{2 KCl}{1 Cl_2} = 0.141 \text{ mol KCl}$
- c) Predict the appearance of the substances left in the reaction container once the reaction is complete.

- d) Calculate the mass of product that should form. $0.141 \text{ mol KCl} \times 74.55g = 10.5g KCl$

- e) What mass of excess reactant should be mixed with the product after the reaction is complete?

$$10g K \times \frac{1 \text{ mol}}{39.10g} \times \frac{2 KCl}{2 K} = 0.256$$

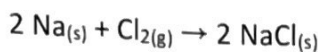
Percent Yield

12. A student was synthesizing aspirin in the laboratory. Using the amount of limiting reactant, she calculated the mass of aspirin that should form as 8.95 g. When she weighed her aspirin product on the balance, its mass was 7.44 g.

- a) What is the actual yield of aspirin? 7.44g
- b) What is the theoretical yield of aspirin? 8.95g
- c) Calculate the percent yield for this synthesis.

$$\frac{7.44}{8.95} \times 100 = 83.13\%$$

13. The combination reaction of sodium metal and chlorine gas to form sodium chloride is represented by the following balanced equation:



$$\frac{11.5g}{1.4285g} = \boxed{59\%}$$

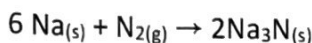
If 5.00 g of sodium metal reacts completely with excess chlorine gas, and 11.5 g NaCl is actually obtained, what is the percent yield of sodium chloride?

$$5.00g \text{ Na} \times \frac{1 \text{ mol}}{22.99} = 0.1088 \text{ mol Na}$$

$$0.1088 \text{ mol} \times \frac{1 \text{ Cl}}{2 \text{ Na}} = 0.0544 \text{ mol Cl}_2$$

$$0.0544 \text{ mol Cl}_2 \times 35.453 \frac{\text{g}}{\text{mol}} = 1.9285 \text{ g Cl}_2$$

14. The combination reaction of sodium metal and nitrogen gas to form sodium nitride is represented by the following balanced equation:



If 0.30 mol of Na is mixed with 0.60 mol of N₂, and 0.092 mol of Na₃N is obtained, what is the percent yield for the reaction?

$$0.3 \text{ mol Na} \times \frac{2 \text{ Na}_3\text{N}}{6 \text{ Na}} = 0.1 \text{ mol Na}_3\text{N}$$

$$\frac{0.092}{0.1} \times 100 = \boxed{92\%}$$

15. The decomposition reaction of calcium carbonate is represented by the following balanced equation:



After a 15.8-g sample of calcium carbonate was heated in an open container to cause decomposition, the mass of the remaining solid was determined to be 8.10g. The student is unsure if the reaction is complete, so the solid could contain unreacted CaCO₃.



$$\frac{A}{T} \times 100 = \% \text{ Yield}$$

15.8g

$$15.8g \text{ CaCO}_3 \times \frac{1 \text{ mol}}{100.09g} = 0.1579 \text{ mol CaCO}_3 \times \frac{1 \text{ CaO}}{1 \text{ CaCO}_3} = 0.1579 \text{ mol CaO} \times \frac{56.08g}{1 \text{ mol}}$$

8.10g

$$\frac{8.10g}{8.86g} \times 100$$

8.86g

$$\boxed{91.42\%}$$

$$= \frac{\boxed{8.86g \text{ CaO}}}{T \text{ amount}}$$