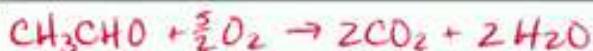


4 • Chemical Equations and Stoichiometry

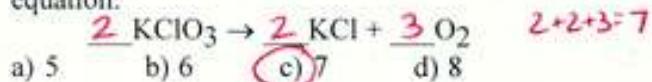
1. Balance the following equation:
 $\underline{2} \text{NH}_3 + \underline{?} \text{O}_2 \rightarrow \underline{2} \text{NO}_2 + \underline{3} \text{H}_2\text{O}$
 BALANCE H's FIRST
 The balanced equation shows that 1.00 mole of NH₃ requires ____ mole(s) of O₂.
 a) 0.57 c) 1.33 b) 1.25 d) 1.75
 $2: \frac{7}{2} \approx 1: \frac{7}{4} = 1.75$

2. Write a balanced equation for the combustion of acetaldehyde, CH₃CHO.



When properly balanced, the equation indicates that ____ mole(s) of O₂ are required for each mole of CH₃CHO.
 a) 1 c) 2.5 b) 2 d) 3
 $1: \frac{5}{2}$

3. Balance the following equation with the **BALANCE O'S FIRST** SMALLEST WHOLE NUMBER COEFFICIENTS possible. Select the number that is the sum of the coefficients in the balanced equation:



- a) 5 b) 6 c) 7 d) 8

4. Write a balanced equation for the combustion of propane, C₃H₈.



When properly balanced, the equation indicates that 5 moles of O₂ are required for each mole of C₃H₈.

- a) 3 b) 3.5 c) 5 d) 8



5. What is the total mass of products formed when 16 grams of CH₄ is burned with excess oxygen?

- a) 80 g c) 36 g b) 44 g d) 32 g
 $1 \text{ mol CH}_4 = 16 \text{ g}$

$$\begin{aligned} 1 \text{ mol CO}_2 &= 44.0 \text{ g} \\ 2 \text{ mol H}_2\text{O} &= \underline{\underline{36.0 \text{ g}}} \\ &80.0 \text{ g} \end{aligned}$$

PRACTICE TEST

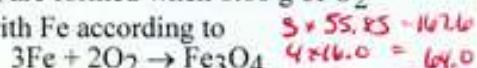
6. Calculate the mass of hydrogen formed when 25 g of aluminum reacts with excess hydrochloric acid.



- a) 0.41 g c) 1.2 g
 b) 0.92 g d) 2.8 g

$$\begin{aligned} 25 \text{ g Al} &\times \frac{1 \text{ mol Al}}{27 \text{ g Al}} \times \frac{3 \text{ mol H}_2}{1 \text{ mol Al}} \times \frac{2 \text{ g H}_2}{1 \text{ mol H}_2} = \text{A LITTLE} \\ &\text{LESS THAN} \\ &3.0 \end{aligned}$$

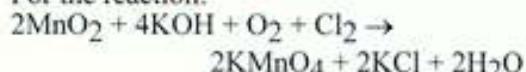
7. How many grams of the mixed oxide, Fe₃O₄, are formed when 6.00 g of O₂ react with Fe according to



- a) 43.4 c) 174 b) 86.8 d) 21.7

$$\begin{aligned} 6.00 \text{ g O}_2 &\times \frac{1 \text{ mol O}_2}{32.0 \text{ g O}_2} \times \frac{1 \text{ mol Fe}_3\text{O}_4}{2 \text{ mol O}_2} \times \frac{231.6 \text{ g Fe}_3\text{O}_4}{1 \text{ mol Fe}_3\text{O}_4} = \\ &\text{ESTIMATE: } (6)(230) \approx (1)(230) \\ &(32)(2) \end{aligned}$$

8. For the reaction:



there is 100. g of each reactant available. Which reagent is the limiting reagent?

[Molar Masses: MnO₂=86.9; KOH=56.1; O₂=32.0; Cl₂=70.9] **Tell me 4**

- a) MnO₂ c) O₂
 b) KOH d) Cl₂
- $$\begin{aligned} \text{MnO}_2 &\frac{100 \text{ g}}{86.9 \text{ g}} \times \frac{1 \text{ mol}}{1 \text{ mol MnO}_2} \times \frac{3 \text{ mol H}_2\text{O}}{2 \text{ mol MnO}_2} = 1.15 \text{ mol H}_2\text{O} \\ \text{KOH} &\frac{100 \text{ g}}{56.1 \text{ g}} \times \frac{1 \text{ mol}}{1 \text{ mol KOH}} \times \frac{2 \text{ mol H}_2\text{O}}{4 \text{ mol KOH}} = 0.891 \text{ mol H}_2\text{O} \\ \text{O}_2 &\frac{100 \text{ g}}{32.0 \text{ g}} \times \frac{1 \text{ mol}}{1 \text{ mol O}_2} \times \frac{2 \text{ mol H}_2\text{O}}{1 \text{ mol O}_2} = 6.25 \text{ mol H}_2\text{O} \\ \text{Cl}_2 &\frac{100 \text{ g}}{70.9 \text{ g}} \times \frac{1 \text{ mol}}{1 \text{ mol Cl}_2} \times \frac{2 \text{ mol H}_2\text{O}}{1 \text{ mol Cl}_2} = 2.8 \end{aligned}$$

9. How many grams of nitric acid, HNO₃, can be prepared from the reaction of 92.0 g of NO₂ with 36.0 g H₂O? **Tell me both**



- a) 64 c) 84
 b) 76 d) 116

$$\begin{aligned} 92.0 \text{ g NO}_2 &\times \frac{1 \text{ mol NO}_2}{46.0 \text{ g NO}_2} \times \frac{2 \text{ mol HNO}_3}{3 \text{ mol NO}_2} \times \frac{63.0 \text{ g HNO}_3}{1 \text{ mol HNO}_3} \\ &= 84 \text{ g HNO}_3 \end{aligned}$$

$$\begin{aligned} 36.0 \text{ g H}_2\text{O} &\times \frac{1 \text{ mol H}_2\text{O}}{18.0 \text{ g H}_2\text{O}} \times \frac{2 \text{ mol HNO}_3}{1 \text{ mol H}_2\text{O}} \times \frac{63.0 \text{ g HNO}_3}{1 \text{ mol HNO}_3} \\ &= 26.7 \text{ g HNO}_3 \end{aligned}$$

10. The reaction of 25.0 g benzene, C_6H_6 , with excess HNO_3 resulted in 21.4 g $C_6H_5NO_2$. What is the percentage yield?



- a) 100% c) 54.3%
 b) 27.4% d) 85.6%

THEORETICAL:

$$25.0 \text{ g } C_6H_6 \times \frac{1 \text{ mol } C_6H_6}{78.0 \text{ g } C_6H_6} \times \frac{1 \text{ mol } C_6H_5NO_2}{1 \text{ mol } C_6H_6} \times \frac{123 \text{ g } C_6H_5NO_2}{1 \text{ mol } C_6H_5NO_2} = 32.3 \text{ g } C_6H_5NO_2$$

$$\% \quad \frac{21.4}{32.3} \times 100 = 54.3\%$$

11. How many grams of H_2O will be formed when 16.0 g H_2 is allowed to react with 16.0 g O_2 according to $2H_2 + O_2 \rightarrow 2H_2O$

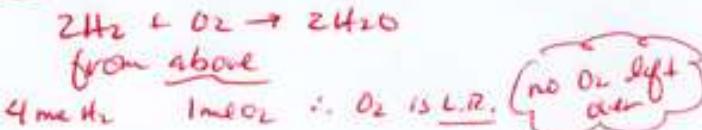
- a) 18.0 g c) 9.00 g
 b) 144 g d) 32.0 g

$$16.0 \text{ g } O_2 \times \frac{1 \text{ mol } O_2}{32.0 \text{ g } O_2} \times \frac{2 \text{ mol } H_2O}{1 \text{ mol } O_2} \times \frac{18.0 \text{ g } H_2O}{1 \text{ mol } H_2O} = 18.0 \text{ g } H_2O$$

Estimate: $\frac{(16)(2)}{(32)} = 1 \times 18$

12. When 8.00 g of H_2 reacts with 32.0 g of O_2 in an explosion, the final gas mixture will contain:

- a) H_2 , H_2O , and O_2 c) O_2 and H_2O only
 b) H_2 and H_2O only d) H_2 and O_2 only



13. 1.056 g of metal carbonate, containing an unknown metal, M, were heated to give the metal oxide and 0.376 g CO_2 .



What is the identity of the metal M?

- a) Mg c) Zn
 b) Cu d) Ba

$$0.376 \text{ g } CO_2 \times \frac{1 \text{ mol } CO_2}{44.0 \text{ g } CO_2} = 0.008545 \text{ mol } CO_2 = \text{mol } MO_3$$

molar mass $= \frac{1.056 \text{ g}}{0.008545 \text{ mol}} = 123.57 \text{ MO}_3$

14. Styrene, the building block of polystyrene, is a hydrocarbon, a compound containing only C and H. A given sample is burned completely and it produces 1.481 g of CO_2 and 0.303 g of H_2O .

Determine the empirical formula of the compound.

- a) CH c) C_2H_3
 b) CH_2 d) C_2H_5

See above right span

14 $1 \text{ mol } CO_2 \approx 1 \text{ mol } C$

$$1.481 \text{ g } CO_2 \times \frac{1 \text{ mol } CO_2}{44.0 \text{ g } CO_2} = 0.03366 \text{ mol } C$$

$$0.303 \text{ g } H_2O \times \frac{1 \text{ mol } H_2O}{18.0 \text{ g } H_2O} \times \frac{2 \text{ mol } H}{1 \text{ mol } H_2O} = 0.3347 \text{ mol } H$$

C : H
 $1 : 1$

Answers:

1.	D	8.	B
2.	C	9.	C
3.	C	10.	C
4.	C	11.	A
5.	A	12.	B
6.	D	13.	B
7.	D	14.	A