Name: _____ **Date:** _____ **Period:** _____

Stoichiometry Practice Worksheet

Show all work clearly. Include units and correct significant figures in all final answers.

1. How many grams of oxygen gas are required to completely react with 25.0 grams of hydrogen gas to produce water? The balanced equation is:

$$2H_2 + O_2 \rightarrow 2H_2O$$

2. Consider the reaction:

$$N_2 + 3H_2 \rightarrow 2NH_3$$

If 15.0 grams of nitrogen gas react with excess hydrogen, what mass of ammonia (in grams) is produced?

3. Iron(III) oxide reacts with carbon monoxide to produce iron and carbon dioxide:

$$Fe_2O_3 + 3CO \rightarrow 2Fe + 3CO_2$$

How many moles of carbon monoxide are needed to produce 112 grams of iron?

4. A student reacts 50.0 grams of calcium carbonate ($CaCO_3$) with excess hydrochloric acid:

$$CaCO_3 + 2HCl \rightarrow CaCl_2 + H_2O + CO_2$$

What volume of carbon dioxide gas (at STP) is produced? (At STP, 1 mole of gas occupies 22.4 L.)

5. In the reaction:

$$2\mathrm{Al} + 3\mathrm{Cl}_2 \rightarrow 2\mathrm{AlCl}_3$$

If 10.0 grams of aluminum react with 35.0 grams of chlorine gas, which reactant is limiting? What mass of aluminum chloride is produced?

6. How many molecules of water are produced when 5.00 grams of methane (CH_4) are burned completely in oxygen?

$$CH_4 + 2O_2 \rightarrow CO_2 + 2H_2O$$

7. For the reaction:

$$4NH_3 + 5O_2 \rightarrow 4NO + 6H_2O$$

Calculate the mass of nitrogen monoxide produced when 34.0 grams of ammonia react with 80.0 grams of oxygen. Identify the limiting reactant.

8. A sample of 25.0 grams of sodium hydroxide (NaOH) is neutralized by sulfuric acid (H_2SO_4):

$$2NaOH + H_2SO_4 \rightarrow Na_2SO_4 + 2H_2O$$

What mass of sodium sulfate is produced?

9. In the reaction:

$$Zn + 2HCl \rightarrow ZnCl_2 + H_2$$

If 13.0 grams of zinc react with excess hydrochloric acid, what volume of hydrogen gas (at STP) is produced?

10. Consider the combustion of propane:

$$C_3H_8 + 5O_2 \rightarrow 3CO_2 + 4H_2O$$

If 44.0 grams of propane are burned, how many grams of carbon dioxide are produced? How many grams of oxygen are consumed?

Answer Key

1. **Answer:** 199 g O_2
   Work: Molar mass H_2 = 2.02 g/mol; moles H_2 = 25.0 / 2.02 = 12.38 mol; mole ratio O_2:H_2 = 1:2, so moles O_2 = 6.19 mol; mass O_2 = 6.19 × 32.00 = 198.1 g ≈ 199 g.

2. **Answer:** 18.2 g NH_3
   Work: Molar mass N_2 = 28.02 g/mol; moles N_2 = 15.0 / 28.02 = 0.5353 mol; mole ratio NH_3:N_2 = 2:1, so moles NH_3 = 1.0706 mol; mass NH_3 = 1.0706 × 17.04 = 18.24 g ≈ 18.2 g.

3. **Answer:** 3.01 mol CO
   Work: Molar mass Fe = 55.85 g/mol; moles Fe = 112 / 55.85 = 2.005 mol; mole ratio CO:Fe = 3:2, so moles CO = (3/2) × 2.005 = 3.008 mol ≈ 3.01 mol.

4. **Answer:** 11.2 L CO_2
   Work: Molar mass $CaCO_3$ = 100.09 g/mol; moles $CaCO_3$ = 50.0 / 100.09 = 0.4996 mol; mole ratio CO_2:$CaCO_3$ = 1:1, so moles CO_2 = 0.4996 mol; volume at STP = 0.4996 × 22.4 = 11.19 L ≈ 11.2 L.

5. **Answer:** Cl_2 is limiting; 43.8 g $AlCl_3$
   Work: Molar mass Al = 26.98 g/mol; moles Al = 10.0 / 26.98 = 0.3706 mol; molar mass Cl_2 = 70.90 g/mol; moles Cl_2 = 35.0 / 70.90 = 0.4937 mol; mole ratio Al:Cl_2 = 2:3; required Cl_2 for Al = (3/2) × 0.3706 = 0.5559 mol (more than available, so Cl_2 limiting); moles $AlCl_3$ from Cl_2 = (2/3) × 0.4937 = 0.3291 mol; mass $AlCl_3$ = 0.3291 × 133.34 = 43.88 g ≈ 43.8 g.

6. **Answer:** 3.76×10^{23} molecules H_2O
   Work: Molar mass CH_4 = 16.04 g/mol; moles CH_4 = 5.00 / 16.04 = 0.3117 mol; mole ratio H_2O:CH_4 = 2:1, so moles H_2O = 0.6234 mol; molecules = $0.6234 \times 6.022 \times 10^{23} = 3.754 \times 10^{23} \approx 3.76 \times 10^{23}$.

7. **Answer:** O_2 is limiting; 60.0 g NO
   Work: Molar mass NH_3 = 17.03 g/mol; moles NH_3 = 34.0 / 17.03 = 1.997 mol; molar mass O_2 = 32.00 g/mol; moles O_2 = 80.0 / 32.00 = 2.50 mol; mole ratio NH_3:O_2 = 4:5; required O_2 for NH_3 = (5/4) × 1.997 = 2.496 mol (available 2.50 mol, so NH_3 slightly in excess? Check: required NH_3 for O_2 = (4/5) × 2.50 = 2.00 mol, available 1.997 mol, so NH_3 is limiting? Let's recalc: 1.997 mol NH_3 needs (5/4)×1.997 = 2.496 mol O_2, we have 2.50 mol O_2, so O_2 is in excess, NH_3 is limiting. Moles NO = moles NH_3 = 1.997 mol; mass NO = 1.997 × 30.01 = 59.93 g ≈ 60.0 g. (Alternatively, using O_2: 2.50 mol O_2 would produce (4/5)×2.50 = 2.00 mol NO, but NH_3 only gives 1.997 mol, so NH_3 is limiting.)

8. **Answer:** 44.4 g Na_2SO_4
   Work: Molar mass NaOH = 40.00 g/mol; moles NaOH = 25.0 / 40.00 = 0.625 mol; mole ratio Na_2SO_4:NaOH = 1:2, so moles Na_2SO_4 = 0.3125 mol; molar mass Na_2SO_4 = 142.04 g/mol; mass = 0.3125 × 142.04 = 44.39 g ≈ 44.4 g.

9. **Answer:** 4.46 L H_2
   Work: Molar mass Zn = 65.38 g/mol; moles Zn = 13.0 / 65.38 = 0.1988 mol; mole ratio H_2:Zn = 1:1, so moles H_2 = 0.1988 mol; volume at STP = 0.1988 × 22.4 = 4.453 L ≈ 4.46 L.

10. **Answer:** 132 g CO_2; 160 g O_2
    Work: Molar mass C_3H_8 = 44.10 g/mol; moles C_3H_8 = 44.0 / 44.10 = 0.9977 mol; mole ratio CO_2:C_3H_8 = 3:1, so moles CO_2 = 2.993 mol; mass CO_2 = 2.993 × 44.01 = 131.7 g ≈ 132 g. Mole ratio O_2:C_3H_8 = 5:1, so moles O_2 = 4.989 mol; mass O_2 = 4.989 × 32.00 = 159.6 g ≈ 160 g.