INTOCHEMISTRY

Stoichiometry Practice Problems

ANSWER KEY

Solutions include units and setups.

Use: H 1.01; C 12.01; N 14.01; O 16.00; Ca 40.08; Fe 55.85 g/mol. Avogadro's number = 6.022×10^{23} mol^{-1}.

1. Balance the equation by writing the smallest whole-number coefficients: ___ H_2 + ___ O_2 → ___ H_2O

   Solution: 2 H_2 + 1 O_2 → 2 H_2O. Coefficients: 2, 1, 2. Hydrogen and oxygen atoms are conserved.

2. How many moles of H_2 are required to react completely with 4.00 mol O_2? Use the equation in Question 1.

   Solution: 4.00 mol O_2 × (2 mol H_2 / 1 mol O_2) = 8.00 mol H_2.

3. CH_4 + 2 O_2 → CO_2 + 2 H_2O. How many moles of CO_2 form from 2.50 mol CH_4 (excess O_2)?

   Solution: 2.50 mol CH_4 × (1 mol CO_2 / 1 mol CH_4) = 2.50 mol CO_2.

4. 4 Fe + 3 O_2 → 2 Fe_2O_3. How many moles of Fe_2O_3 form from 3.00 mol O_2 (excess Fe)?

   Solution: 3.00 mol O_2 × (2 mol Fe_2O_3 / 3 mol O_2) = 2.00 mol Fe_2O_3.

5. N_2 + 3 H_2 → 2 NH_3. How many moles of NH_3 form from 7.50 mol H_2 (excess N_2)?

   Solution: 7.50 mol H_2 × (2 mol NH_3 / 3 mol H_2) = 5.00 mol NH_3.

6. 2 H_2 + O_2 → 2 H_2O. What mass of water forms from 5.00 g H_2 (excess O_2)?

   Solution: M(H_2) = 2.02 g/mol; M(H_2O) = 18.02 g/mol. 5.00 g H_2 × (1 mol / 2.02 g) × (2 mol H_2O / 2 mol H_2) × (18.02 g/mol) = 44.6 g H_2O.

7. $CH_4 + 2\ O_2 \rightarrow CO_2 + 2\ H_2O$. What mass of CO_2 forms from 8.00 g CH_4 (excess O_2)?

Solution: $M(CH_4) = 16.05$ g/mol; $M(CO_2) = 44.01$ g/mol. 8.00 g CH_4 × (1 mol / 16.05 g) × (1 mol CO_2 / 1 mol CH_4) × (44.01 g/mol) = 21.9 g CO_2.

8. $CaCO_3 \rightarrow CaO + CO_2$. What mass of CaO forms from 12.5 g $CaCO_3$?

Solution: $M(CaCO_3) = 100.09$ g/mol; $M(CaO) = 56.08$ g/mol. 12.5 g × (1 mol / 100.09 g) × (1 mol CaO / 1 mol $CaCO_3$) × (56.08 g/mol) = 7.00 g CaO.

9. $2\ H_2 + O_2 \rightarrow 2\ H_2O$. A mixture starts with 3.00 mol H_2 and 2.00 mol O_2. Identify the limiting reactant, find moles of H_2O made, and moles of excess reactant remaining.

Solution: 3.00 mol H_2 needs 1.50 mol O_2. H_2 is limiting; 3.00 mol H_2O form; 2.00 − 1.50 = 0.500 mol O_2 remains.

10. $N_2 + 3\ H_2 \rightarrow 2\ NH_3$. A mixture starts with 2.00 mol N_2 and 5.00 mol H_2. Identify the limiting reactant and calculate moles of NH_3 formed.

Solution: 2.00 mol N_2 requires 6.00 mol H_2, but only 5.00 is available. H_2 limits. 5.00 × (2/3) = 3.33 mol NH_3.

11. The theoretical yield of CO_2 is 8.00 g. An experiment recovers 6.40 g. Calculate percent yield.

Solution: (6.40 g / 8.00 g) × 100% = 80.0%.

12. How many moles of water molecules are present in 1.80×10^{24} molecules of H_2O?

Solution: (1.80×10^{24} molecules) ÷ (6.022×10^{23} molecules/mol) = 2.99 mol H_2O.