ANSWER KEY.

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Limiting & Excess Reactants

Chemistry | ANSWER KEY

Convert each reactant to moles, find the product each one could make, and the smaller amount is limiting. Compare moles, never grams. % yield = actual ÷ theoretical × 100%.

1. $2Al + 3Cl_2 \rightarrow 2AlCl_3$. A reaction starts with 1.50 mol Al and 1.80 mol Cl_2. Which reactant is limiting? How many moles of $AlCl_3$ form?

From Al: 1.50 mol × (2 mol $AlCl_3$ / 2 mol Al) = 1.50 mol $AlCl_3$
From Cl_2: 1.80 mol × (2 mol $AlCl_3$ / 3 mol Cl_2) = 1.20 mol $AlCl_3$
Answer: Cl_2 is limiting, and 1.20 mol $AlCl_3$ forms.

2. $4Fe + 3O_2 \rightarrow 2Fe_2O_3$. 20.0 g of Fe reacts with 10.0 g of O_2. Which reactant is limiting? What mass of Fe_2O_3 forms?

Moles: Fe 20.0 ÷ 55.85 = 0.35810 mol; O_2 10.0 ÷ 32.00 = 0.31250 mol
From Fe: 0.35810 mol × (2/4) = 0.17905 mol Fe_2O_3; from O_2: 0.31250 mol × (2/3) = 0.20833 mol Fe_2O_3
Fe makes less, so Fe is limiting.
Mass: 0.17905 mol × 159.70 g/mol = 28.594 g
Answer: Fe is limiting, and 28.6 g Fe_2O_3 forms.

3. In problem 2, which reactant is in excess, and what mass of it is left over?

O_2 is in excess.
O_2 used: 0.35810 mol Fe × (3 mol O_2 / 4 mol Fe) × 32.00 g/mol = 8.5944 g
Left over: 10.0 g − 8.594 g = 1.4 g O_2

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4. In problem 2, a student collects 25.3 g of Fe_2O_3. What is the percent yield?

25.3 g ÷ 28.594 g × 100% = 88.479%
Answer: 88.5% (less than 100%, which makes sense)

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5. $CH_4 + 2O_2 \rightarrow CO_2 + 2H_2O$. 8.00 g of CH_4 burns in 16.0 g of O_2. Which reactant is limiting? What mass of CO_2 forms?

Moles: CH_4 8.00 ÷ 16.05 = 0.49844 mol; O_2 16.0 ÷ 32.00 = 0.50000 mol
From CH_4: 0.49844 mol CO_2 (1:1); from O_2: 0.50000 × (1/2) = 0.25000 mol CO_2
O_2 makes less, so O_2 is limiting.
Mass: 0.25000 mol × 44.01 g/mol = 11.003 g
Answer: O_2 is limiting, and 11.0 g CO_2 forms.

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6. $2H_2 + O_2 \rightarrow 2H_2O$. A student mixes 5.0 g of H_2 with 30.0 g of O_2 and says H_2 is limiting because it has less mass. Is the student right? Show why.

No. Compare moles. H_2: 5.0 ÷ 2.02 = 2.4752 mol, which makes 2.4752 mol H_2O. O_2: 30.0 ÷ 32.00 = 0.93750 mol, which makes 1.8750 mol H_2O. O_2 makes less product, so O_2 is limiting, even though it has more mass.

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