Expected Quantity of Product Problems Answer Key

1. $2MnI_2(s) + 13F_2(g) \rightarrow 2MnF_3(s) + 4IF_5(\ell)$

$$1.24\,g\ MnI_2 \times \frac{mol}{308.74\,g} MnI_2 \times \frac{2\,mol\ MnF_3}{2\,mol\,MnI_2} \times 111.94 \frac{g}{mol} MnF_3 = 0.450\,g\ MnF_3(s)$$

$$25.0\,g\ F_2 \times \frac{mol}{38.00\,g} F_2 \times \frac{2\,mol\ MnF_3}{13\,mol\,F_2} \times 111.94 \frac{g}{mol} MnF_3 = 11.3\,g\,MnF_3(s)$$

$MnI_2(s)$ is the limiting reactant, and the expected mass of manganese(III) fluoride is 0.450g.

2. $3Cu(s) + 8HNO_3(aq) \rightarrow 3Cu(NO_3)_2(aq) + 2NO(g) + 4H_2O(\ell)$

$$57.4\,g\ Cu \times \frac{mol}{63.55\,g} Cu \times \frac{2\,mol\ NO}{3\,mol\ Cu} \times 30.01 \frac{g}{mol} NO = 18.1\,g\,NO(g)$$

$$165\,g\ HNO_3 \times \frac{mol}{63.02\,g} HNO_3 \times \frac{2\,mol\ NO}{8\,mol\ HNO_3} \times 30.01 \frac{g}{mol} NO = 19.6\,g\ NO(g)$$

Copper is the limiting reactant, and the expected mass of NO(g) is 18.1g.

3. $2H_2O_2(\ell) \rightarrow 2H_2O(\ell) + O_2(g)$

$$10.0\,g\,H_2O_2 \times \frac{mol}{34.02\,g} H_2O_2 \times \frac{2\,mol\ H_2O}{2\,mol\ H_2O_2} \times 18.02 \frac{g}{mol} H_2O = 5.30\,g\,H_2O\,(\ell)$$

The expected mass of water is 5.30 g.

4. $4NH_3(g) + 7O_2(g) \rightarrow 4NO_2(g) + 6H_2O(g)$

$$1.30 \times 10^3\,g\,NH_3 \times \frac{mol}{17.04\,g} \times \frac{4\,mol\ NO_2}{4\,mol\ NH_3} \times 46.01 \frac{g}{mol} NO_2 = 3.51 \times 10^3\,g = 3.51\,kg\,NO_2(g)$$

$$4.21 \times 10^3\,g\ O_2 \times \frac{mol}{32.00\,g} O_2 \times \frac{4\,mol\ NO_2}{7\,mol\ O_2} \times 46.01 \frac{g}{mol} NO_2 = 3.46 \times 10^3\,g = 3.46\,kg\ NO_2(g)$$

The expected mass of nitrogen dioxide is 3.46 kg. Oxygen gas is limiting.

5. $Fe_2(SO_4)_3(s) + 6NaOH(aq) \rightarrow 2Fe(OH)_3\,(aq) + 3Na_2SO_4(aq)$

$$10.0\,g\,Fe_2(SO_4)_3 \times \frac{mol}{399.91\,g} Fe_2(SO_4)_3 \times \frac{2\,mol\ Fe(OH)_3}{1\,mol\,Fe_2(SO_4)_3} \times 106.88 \frac{g}{mol} Fe(OH)_3 = 5.35\,g\ Fe(OH)_3(aq)$$

$$10.0\,g\,NaOH \times \frac{mol}{40.0\,g} NaOH \times \frac{2\,mol\ Fe(OH)_3}{6\,mol\,NaOH} \times 106.88 \frac{g}{mol} Fe(OH)_3 = 8.91\,g\,Fe(OH)_3(aq)$$

The expected mass of iron(III) hydroxide is 5.35g. Iron(III) sulfate is limiting.