Stoichiometry: Number of Particles and Volume of Gases Problems

1. \( \text{KClO}_3 \rightarrow \text{KCl} + \text{O}_2 \)

How many molecules of potassium chloride are produced if 2.3 \( \times 10^{23} \) molecules of potassium chlorate decompose?

Know: 2.3 \( \times 10^{23} \) molecules KClO\(_3\)

Want: molecules KCl

\[
\frac{2.3 \times 10^{23} \text{ molecules KClO}_3}{6.022 \times 10^{23} \text{ molecules}} \times \frac{2 \text{ mol KCl}}{2 \text{ mol KClO}_3} = \frac{2.3 \times 10^{23} \text{ mol KCl}}{1 \text{ mol KClO}_3}
\]

2. \( \text{N}_2(g) + 3 \text{H}_2(g) \rightarrow 2 \text{NH}_3(g) \)

How many liters of hydrogen are necessary to react completely with 50.0 L of nitrogen gas in the above reaction at standard temperature and pressure?

Know: 50.0 L N\(_2\)

Want: L H\(_2\)

\[
\frac{50.0 \text{ L N}_2}{\frac{22.4 \text{ L}}{1 \text{ mol N}_2}} \times \frac{3 \text{ mol H}_2}{1 \text{ mol N}_2} = \frac{150 \text{ L H}_2}{1 \text{ mol N}_2}
\]

How many liters of ammonia are produced in the above reaction?

Know: 50.0 L N\(_2\)

Want: L NH\(_3\)

\[
\frac{50.0 \text{ L N}_2}{22.4 \text{ L}} \times \frac{2 \text{ mol NH}_3}{1 \text{ mol N}_2} = \frac{100 \text{ L NH}_3}{1 \text{ mol N}_2}
\]

3. \( \text{AgNO}_3 + \text{BaCl}_2 \rightarrow \text{AgCl} + \text{Ba(NO}_3)_2 \)

How many molecules of silver chloride are produced from 5.0 \( \times 10^{25} \) molecules of silver nitrate reacting with an excess of barium chloride?

Know: 5.0 \( \times 10^{25} \) molecules Ag(NO\(_3\))

Want: molecules AgCl

\[
\frac{5.0 \times 10^{25} \text{ molecules AgNO}_3}{6.022 \times 10^{23} \text{ molecules}} \times \frac{2 \text{ mol AgCl}}{2 \text{ mol AgNO}_3} = \frac{5.0 \times 10^{25} \text{ mol AgCl}}{1 \text{ mol AgNO}_3}
\]

How many molecules of barium chloride are necessary to react with the silver nitrate?

Know: 5.0 \( \times 10^{25} \) molecules Ag(NO\(_3\))

Want: molecules BaCl\(_2\)

\[
\frac{5.0 \times 10^{25} \text{ molecules AgNO}_3}{6.022 \times 10^{23} \text{ molecules}} \times \frac{1 \text{ mol BaCl}_2}{2 \text{ mol AgNO}_3} = \frac{5.0 \times 10^{25} \text{ mol BaCl}_2}{1 \text{ mol AgNO}_3}
\]
4. \(5 \text{C} + 2 \text{SO}_2 \rightarrow \_\text{CS}_2 + 4 \text{CO}\)

How many grams of carbon are needed to react with 7.24x10^{24} molecules of sulfur dioxide (SO₂)?

\[
\text{Know: } 7.24 \times 10^{24} \text{ molecules SO}_2
\]
\[
\text{Wanted: g C}
\]
\[
7.24 \times 10^{24} \text{ molecules SO}_2 \times \frac{1 \text{ mol SO}_2}{6.022 \times 10^{23} \text{ molecules}} \times \frac{5 \text{ mol C}}{2 \text{ mol SO}_2} \times \frac{12.01 \text{ g C}}{1 \text{ mol C}} = 361 \times 10^4 \text{ g C}
\]

How many grams of carbon monoxide (CO) would be produced from a complete reaction with 7.24x10^{24} molecules of sulfur dioxide (SO₂)?

\[
\text{Know: } 7.24 \times 10^{24} \text{ molecules SO}_2
\]
\[
\text{Wanted: g CO}
\]
\[
7.24 \times 10^{24} \text{ molecules SO}_2 \times \frac{1 \text{ mol SO}_2}{6.022 \times 10^{23} \text{ molecules}} \times \frac{4 \text{ mol CO}}{2 \text{ mol SO}_2} \times \frac{28.01 \text{ g CO}}{1 \text{ mol CO}} = 673 \times 10^4 \text{ g CO}
\]

5. \(2 \text{Na}_2\text{O}_2 + 2 \text{H}_2\text{O} \rightarrow \_\text{O}_2 + 4 \text{NaOH}\)

How many grams of NaOH are produced when 3.20 g of O₂ is formed?

\[
\text{Known: } 3.20 \text{ g O}_2
\]
\[
\text{Wanted: g NaOH}
\]
\[
3.20 \text{ g O}_2 \times \frac{1 \text{ mol O}_2}{32.00 \text{ g O}_2} \times \frac{4 \text{ mol NaOH}}{1 \text{ mol O}_2} \times \frac{39.998 \text{ g NaOH}}{1 \text{ mol NaOH}} = 116 \text{ g NaOH}
\]

6. \(_\text{N}_2(g) + 6 \text{Na(s)} \rightarrow 2 \text{Na}_3\text{N(s)}\)

How many grams sodium nitride is produced from 1.0L of nitrogen gas at Standard Temperature and Pressure?

\[
\text{Known: } 1.0 \text{ L N}_2
\]
\[
\text{Wanted: g Na}_3\text{N}
\]
\[
1.0 \text{ L N}_2 \times \frac{1 \text{ mol N}_2}{28.01 \text{ L N}_2} \times \frac{2 \text{ mol Na}_3\text{N}}{2 \text{ mol N}_2} = 7.4 \text{ g Na}_3\text{N}
\]