10.1 Stoichiometry

Greek "Element – Measure"

1. Opening Problem

Your boss needs 465 kilograms of rubber for a project. Your source of rubber is tricycles (3 tires per trike); each tricycle tire has a mass of 2.5 kilograms. How many tricycles will you have to de-tire to meet your boss' request?

$$465\,\cancel{kilos\ rubber} \times \frac{1\,\cancel{tire}}{2.5\,\cancel{kilos\ rubber}} \times \frac{1\,tricycle}{3\,\cancel{tires}} = 62\,tricycles$$

Stoichiometry

Def: Study of quantitative relationships between reactants used and products formed.

Allows us to calculate exactly how much product a chemical reaction makes, or how much reactant is needed.

Demo

Watch this! Steel wool plus a battery.

The balanced reaction: end product is iron (III) oxide:

$$4\ Fe_{(s)} + 3\ O_{2(g)} \longrightarrow 2\ Fe_2O_{3(s)}$$

2. Particle Interpretation

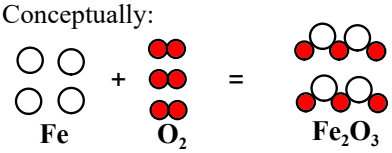
$$4\ Fe_{(s)} + 3\ O_{2(g)} \longrightarrow 2\ Fe_2O_{3(s)}$$

A. How many atoms of iron reacted? = 4

B. How many oxygen molecules (O_2)? = 3

C. How many formula units of iron (III) oxide formed? = 2

Conceptually:



3. Molar Interpretation

$$4\ Fe_{(s)} + 3\ O_{2(g)} \longrightarrow 2\ Fe_2O_{3(s)}$$

A. How many moles of iron reacted? = 4

B. How many moles of oxygen molecules (O_2)? = 3

C. How many moles of iron (III) oxide formed? = 2

4. Massive Interpretation

$$4\ Fe_{(s)} + 3\ O_{2(g)} \longrightarrow 2\ Fe_2O_{3(s)}$$

In terms of mass:

A. Iron = $4\,mol\,Fe \bullet \frac{55.85\,g\,Fe}{1\,mol\,Fe} = 223.4\,g\,Fe$

B. Oxygen = $3\,mol\,O_2 \bullet \frac{32.00\,g\,O_2}{1\,mol\,O_2} = 96.00\,g\,O_2$

C. Iron (III) oxide =

$$2\,mol\,Fe_2O_3 \bullet \frac{159.7\,g\,Fe_2O_3}{1\,mol\,Fe_2O_3} = 319.4\,g\,Fe_2O_3$$

Mole Ratios

Mole Ratio: Way of comparing the amountsof any two substances in a balanced reaction.

Car analogy: compare number of tires to the number of frames.

There are 4 tires per frame in this car, or 1 frame per 4 tires.

Written ratios:

$$\frac{1\ Frame}{4\ Tires} \text{ or: } \frac{4\ Tires}{1\ Frame}$$

5. Mole Ratio Example

Consider the reaction: $2\ K + Br_2 \longrightarrow 2\ KBr$

Depending on what is being calculated, any two ingredients could be compared in a mole ratio.

Make four mole ratios for potassium:

$$\frac{2\ mol\ K}{2\ mol\ KBr} \text{ or: } \frac{2\ mol\ KBr}{2\ mol\ K} \text{ or: } \frac{2\ mol\ K}{1\ mol\ Br_2} \text{ or: } \frac{1\ mol\ Br_2}{2\ mol\ K}$$

Calculation Format

When converting from one molar value to another, use this process:

$$Moles\ Known \bullet \frac{Moles\ Seeking}{Moles\ Known} = Moles\ Seeking$$

Given in Problem | Mole Ratio from Balanced Equation | What You're Looking For

6. Example: Which Ratio to Use?

$$2\ K + Br_2 \longrightarrow 2\ KBr$$

How many moles of Br_2 are needed to generate 156.3 moles of KBr?

Mole Ratio (from balanced equation): $\frac{1\ mol\ Br_2}{2\ mol\ KBr}$

$$156.3\,mol\,KBr \bullet \frac{1\,mol\,Br_2}{2\,mol\,KBr} = 78.15\,mol\,Br_2$$

7. Another Ratio Example

$$2\ K + Br_2 \longrightarrow 2\ KBr$$

How many moles of KBr will be made by reacting 22.4 mol K?

Given: 22.4 mol K. Seeking: mol KBr.

Mole Ratio: $\frac{2\ mol\ KBr}{2\ mol\ K}$

$$22.4\,mol\,K \bullet \frac{2\,mol\,KBr}{2\,mol\,K} = 22.4\,mol\,KBr$$

Homework

10.1 Problems.
Due Next Class