Stoichiometric Rate Calculations

Mr.Yeung

Stoichiometric rate calculations

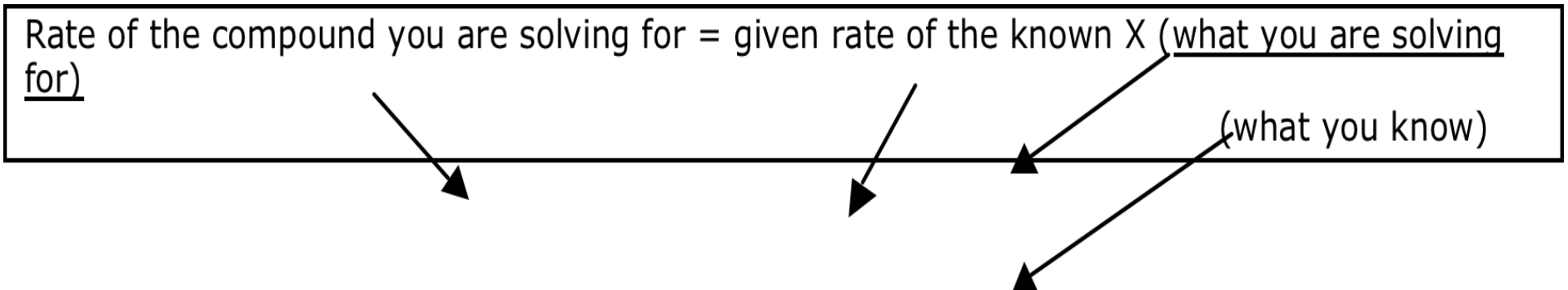
- Aside from the graphical calculation of average and instantaneous rates, rates can be calculated from the molar ratios.
- **Given the reaction: $O_2(g)$ + 2 NO(g) → 2 NO_2 (g)**
- If 2 mols of NO decomposes then 2 mols of NO_2 are formed
- The ratio of NO to NO_2 is 1:1
  NO decomposes at the same rate as NO_2 is formed

Stoichiometric rate calculations

- Aside from the graphical calculation of average and instantaneous rates, rates can be calculated from the molar ratios.
- **Given the reaction: $O_2(g)$ + 2 NO(g) → 2 NO_2 (g)**
- If 1 mol of O_2 decomposes then 2 mols of NO_2 are formed
- The ratio of O_2 to NO_2 is 1:2
- O_2 decomposes ½ of the rate as NO_2 is formed

Stoichiometric rate calculations

- **Given the reaction: $O_2(g)$ + 2 NO(g) → 2 NO_2 (g)**
- If the rate of decomposition of $O_2(g)$ is determined to be 1.5mol/Ls, predict the amount of NO_2 created.
- Since ratio of $O_2(g)$ **to** $NO_{2\,(g)}$ is **1:2, there will be 2x as much of 1.5mol/Ls. Therefore 3.0mol/Ls of** NO_2.
- **Or…**



Example 2

The decomposition of nitrogen dioxide occurs according to the equation below.

$$2\ NO_2 \rightarrow O_2 + 2\ NO$$

If the rate of decomposition of NO_2 is determined to be 0.50 mol/Ls at a certain temperature, predict the rate of creation of both products.

Ratio of NO_2 to O_2 = 2:1

Therefore, the rate of O_2 will be half of the rate of NO_2

or 0.50/2 = 0.25 mol/Ls

Another way of solving is canceling the NO_2 in the form

Rate of the compound you are solving for = given rate of the known X (what you are solving for)

(what you know)

$$\text{rate } O_2 = 0.50 \text{ mol/Ls } NO_2 \left(\frac{1 O_2}{2 NO_2} \right) = 0.25 \text{ mol/Ls } O_2$$

$$\text{rate NO} = 0.50 \text{ mol/Ls } NO_2 \left(\frac{1 NO}{1 NO_2} \right) = 0.50 \text{ mol/Ls NO}$$

Stoichiometric rate calculations

Rate of the wanted = Rate of known X (what you are solving for)
(What you know)

Example 2. For the reaction 2 A + B → 3 C, what is the rate of production of **C** and the rate of disappearance of **B** if A is used up at a rate of 0.60 mol/Ls?

Example 2. For the reaction 2 A + B → 3 C, what is the rate of production of **C** and the rate of disappearance of **B** if A is used up at a rate of 0.60 mol/Ls?

Rate of the compound you are solving for = given rate of the known X (what you are solving for)

(what you know)

$$\text{rate C} = 0.60 \text{ mol/Ls } \cancel{\text{A}} \left(\frac{3 \text{ C}}{2 \cancel{\text{A}}} \right) = 0.90 \text{ mol/Ls C}$$

The "compound" cancels out with denominator

$$\text{rate B} = 0.60 \text{ mol/Ls } \cancel{\text{A}} \left(\frac{1 \text{ B}}{2 \cancel{\text{A}}} \right) = 0.30 \text{ mol/Ls B}$$

Example 3.

If NOCl(g) is decomposing at a rate of 1.1×10^{-8} mol/L/min in the following reaction:

$$2\ NOCl(g) \rightarrow 2\ NO(g) + Cl_2(g)$$

a) What is the rate of formation of NO(g)?

b) What is the rate of formation of $Cl_2(g)$?

So far we know how to…

- Calculate rates
- Calculate average rates
- Calculate instantaneous rates
- Calculate rates from stoichiometric ratios