KINETICS

RELATIVE REACTION RATES

Dr. Mioy T. Huynh | Yale University

Chemistry 165b | Spring 2019

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INTRODUCTION

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- Chemical kinetics: study of rates of reactions
- The reaction rate is a measure of the speed of a chemical reaction

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These are the relative reaction rates!

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This is how you can derive them.

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Consider the following unbalanced chemical equation:

$$PH_3\ (g) \rightarrow P_4\ (g) + H_2\ (g)$$

If, over a specific time period, 0.0081 mol PH_3 (g) are consumed in a 1.59 L container each second of the reaction, what is the rate of formation of P_4 (g)?

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Now we can solve for the rate of formation of P_4:

$$\frac{\Delta[\mathrm{P_4}]}{\Delta t} = -\frac{1}{4}\frac{\Delta[\mathrm{PH_3}]}{\Delta t} = -\frac{1}{4} \cdot \left[-0.0050_{94} \frac{\mathrm{M}}{\mathrm{s}}\right] = 0.0013 \frac{\mathrm{M}}{\mathrm{s}}$$

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Consider the following unbalanced chemical equation:

$$A + B \rightarrow C + D$$

After 25 seconds, you measure the rate of formation of C to be 2.97×10^{-6} M/s and the rate of formation of D to be 9.70×10^{-7} M/s. Based on this kinetic data, what is the mole-mole ratio between the two products: C and D?

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a A + *b* B → *c* C + *d* D

From this balanced equation, we can express the relative reaction rates as:

$$-\frac{1}{a}\frac{\Delta[\mathrm{A}]}{\Delta t} = -\frac{1}{b}\frac{\Delta[\mathrm{B}]}{\Delta t} = \frac{1}{c}\frac{\Delta[\mathrm{C}]}{\Delta t} = \frac{1}{d}\frac{\Delta[\mathrm{D}]}{\Delta t}$$

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After 25 seconds, you measure the rate of formation of C to be 2.97×10^{-6} M/s and the rate of formation of D to be 9.70×10^{-7} M/s. Based on this kinetic data, what is the mole-mole ratio between the two products: C and D?

— answer —

First, balance the chemical equation as:

a A + *b* B → *c* C + *d* D

From this balanced equation, we can express the relative reaction rates as:

$$-\frac{1}{a}\frac{\Delta[\mathrm{A}]}{\Delta t} = -\frac{1}{b}\frac{\Delta[\mathrm{B}]}{\Delta t} = \frac{1}{c}\frac{\Delta[\mathrm{C}]}{\Delta t} = \frac{1}{d}\frac{\Delta[\mathrm{D}]}{\Delta t}$$

We are interested in the latter two terms, which deal with the two products formed:

$$\frac{1}{c}\frac{\Delta[\mathrm{C}]}{\Delta t} = \frac{1}{d}\frac{\Delta[\mathrm{D}]}{\Delta t}$$

PRACTICE PROBLEM 2

Consider the following unbalanced chemical equation:

A + B → C + D

After 25 seconds, you measure the rate of formation of C to be 2.97×10^{-6} M/s and the rate of formation of D to be 9.70×10^{-7} M/s. Based on this kinetic data, what is the mole-mole ratio between the two products: C and D?

— answer —

First, balance the chemical equation as:

a A + *b* B → *c* C + *d* D

From this balanced equation, we can express the relative reaction rates as:

$$-\frac{1}{a}\frac{\Delta[\mathrm{A}]}{\Delta t} = -\frac{1}{b}\frac{\Delta[\mathrm{B}]}{\Delta t} = \frac{1}{c}\frac{\Delta[\mathrm{C}]}{\Delta t} = \frac{1}{d}\frac{\Delta[\mathrm{D}]}{\Delta t}$$

We are interested in the latter two terms, which deal with the two products formed:

$$\frac{1}{c}\frac{\Delta[\mathrm{C}]}{\Delta t} = \frac{1}{d}\frac{\Delta[\mathrm{D}]}{\Delta t}$$

We can rearrange this expression to find the mole-mole ratio between C and D, which is *c*/*d*:

$$\frac{c}{d} = \frac{\frac{\Delta[\mathrm{C}]}{\Delta t}}{\frac{\Delta[\mathrm{D}]}{\Delta t}} = \frac{2.97\times10^{-6}\,\frac{\mathrm{M}}{\mathrm{s}}}{9.70\times10^{-7}\,\frac{\mathrm{M}}{\mathrm{s}}} = 3.06 \approx 3$$