Chemical Kinetic Rate

Objective

Using "Borderless Lab 365", to determine the rate constant by using initial rate method

Introduction

- Rate of the chemical reaction is very significant in application and explain the reaction response.
- The most common example is the airbag in vehicle. The airbag is required to be swelled in an extremely short time in order to protect the passengers.
- There are many factors, which affect the rate of reaction such as concentration, temperature, and the presence of catalyst.
- In this experiment, the effect of concentration is focused, and demonstrated by the reaction between bleach and brilliant blue (dye). The bleach is well known on its decolorizing ability, therefore; it can be used to decolor the dye by using different concentration to analyze how concentration affect the rate of reaction.

Theory

1. Rate Law

   The rate of chemical reaction normally depends on the concentration and the order of involved chemical. The formula is expressed as:

   $$rate(s) = k[A]^a[B]^b$$

   k: rate constant

   [A] and [B]: concentration of chemical A and B

   a and *b*: the order of chemical A and B respectively

   By calculating the ratio between two reaction pairs with different concentration, the rate constant can be obtained. It is shown as follow:

   $$\frac{rate_i}{rate_j} = \frac{k[A]_i^a[B]_i^b}{k[A]_j^a[B]_i^b}$$

   i and j: two different reaction pairs

2. Concentration

PPM is one of the units used in concentration, especially in very tiny amount of substance (very diluted). In the mathematical explanation, PPM refers to parts per million (1/1000000). In term of concentration, it can be referred to 1 mg/ 1L (molarity) or 1mg/ 1 kg (molality).

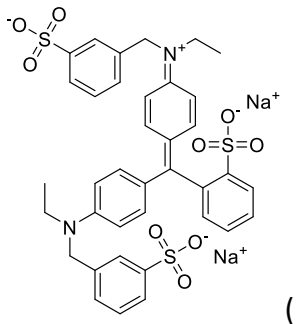
$$Molarity = \frac{ppm \times 0.001}{Molar\ mass}$$

3. Bleach

The major factional compound, which responds for disinfecting and sterilizing, is sodium hypochlorite. In this experiment, sodium hypochlorite acts as oxidizing agent, which oxides the dye to colorless.

4. Brilliant Blue (Dye)

Brilliant Blue is a blue-colored synthetic organic compound. In this experiment, it acts as a reducing agent and indicator, where it is oxidized from blue color to colorless.



(Brilliant Blue)

Apparatus, Chemicals and Reagents

(1) "Borderless Lab 365" Platform

(2) Bleach (0.076 mol/dm^3/5600ppm)

(3) Brilliant Blue (0.000030mol/dm^3/25.0ppm)

Procedure

1. Log in the experiment module “kinetic rate” on the Borderless Lab 365 platform https://stem-ap.polyu.edu.hk/remotelab/

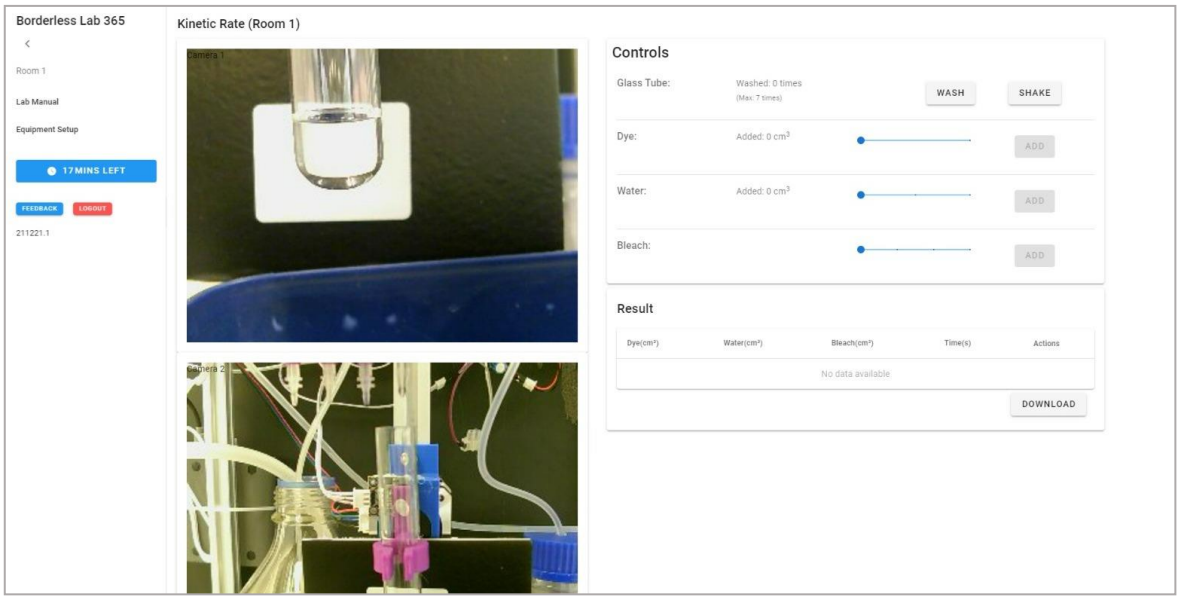


Figure 2. User interface of Kinetic Rate

2. Wash the glass tube by pressing “WASH”. (Note: you can wash the glass tube 7 times only throughout the session.)
3. Complete the table of Data sheet and calculate the concentration of each reaction pair.
4. For dye solution, 4cm^3 can be chosen by clicking the bar and pressing “ADD”; for water, difference volume (0 / 0.5 / 0.75 cm^3) can be chosen by sliding the bar and pressing “ADD”; and difference volume (0 / 0.25 / 0.5 / 1 cm^3) of bleach can be chosen by sliding the bar and pressing “ADD”.
5. Add 4cm^3 of dye.
6. Add the calculated amount of water to dilute the dye.
7. Add the calculated amount of bleach to decolor the dye and the timer will be started.
8. Record the time needed for the color changed from blue to colorless.
9. Press “WASH” to clean the test tube in the machine.
10. Repeat step 5-9 until all the reaction pair measured.
11. Press “LOGOUT” on the left when you completed the experiment.

Data

Reaction pair	Amount of bleach (cm^3)	Conc. of bleach (ppm)	Amount of dye (cm^3)	Conc. of dye (ppm)	Amount of water (cm^3)	Total Volume (cm^3)	Time (s)	Initial rate (ppm/s)
1	0.25		4.0		0.75			
2	0.5		4.0		0.5			
3	1.0		4.0		0			

Remarks: The equation for initial rate of reaction is $\frac{\mathbf{1}}{\boldsymbol{time}}$

Discussion

1. Determine the order of bleach.
2. Given the order of dye is 1.0, determine the total order of reaction.
3. Determining the rate constant (k).
4. Suggest 2 ways to increase the rate of reaction.
5. Suggest 2 possible errors of the experiment.

Reference

Fleming, P. (2020, October 04). 11.7: The method of initial rates. Retrieved February 22, 2021, from https://chem.libretexts.org/Bookshelves/Physical_and_Theoretical_Chemistry_Textbook_Maps/Book:_Physical_Chemistry_(Fleming)/11:_Chemical_Kinetics_I/11.07:_The_Method_of_Initial_Rates