Reaction of Phenolphthalein in Sodium hydroxide Solution
Student Handout

Objective

- To investigate the relationship between the concentration of sodium hydroxide solution and the rate of decolourisation of phenolphthalein in alkaline medium using colorimetry.

Chemicals (per group)

Deionised water
100 cm^3

0.25 M sodium hydroxide solution 

20 cm^3

0.5 M sodium hydroxide solution 

20 cm^3

1.0 M sodium hydroxide solution 

20 cm^3

0.01% phenolphthalein solution 

10 cm^3

10-mL measuring pipette
x 1
50-mL beaker
x 4
Data-logger
x 1
Colorimeter Sensor and replacement cuvettes
x 1
Notebook computer with USB interface and Data-logging software x 1
500-mL beaker
x 1
Washing bottle
x 1
Stopwatch
x 1

Curriculum link

- Topic IX Rate of Reaction
- Topic XIII Industrial Chemistry

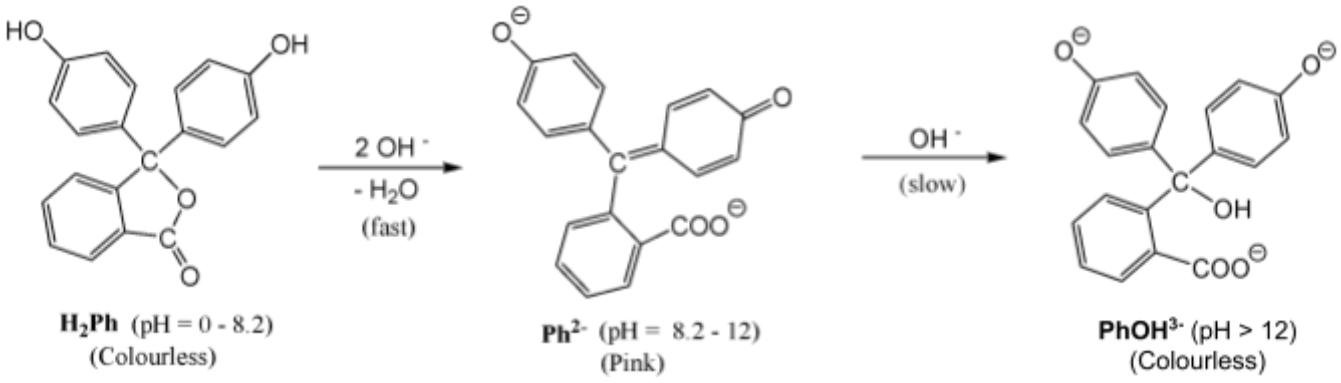
Safety precautions

- Wear safety glasses and disposable protective gloves.
- The solutions used are basic and harmful to skin and eyes. In case of spills, rinse the affect area with plenty of water for about 3 minutes.
- Do not dispose of chemicals by pouring down the drain, use the waste container provided.

Outline

Phenolphthalein is a common indicator used in the determination of end point in an acid-alkaline titration. When an acid is titrated with an alkaline, the solution changes from colourless to pink. If excess base is present in the solution mixture, the pink coloration fades gradually. This is due to the reaction between the dianion of phenolphthalein (Ph^{2-}) and hydroxide ion to form a colourless complex ($PhOH^{3-}$). The rate of such reaction is sufficiently slow to be measured by colorimetry.

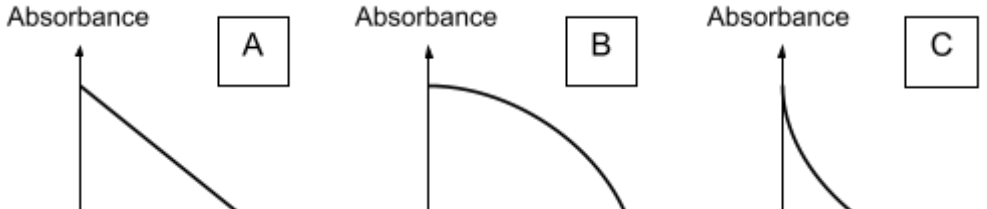
The structures and reaction of phenolphthalein in alkaline solution are shown below:



In this experiment, sodium hydroxide solutions of different concentrations will be used to investigate how the rate of decolourisation changes with the concentration of sodium hydroxide solution.

Question

Which of the followings is the most probable graph you might expect for the light absorbance as the reaction progresses over time?



Procedure

1. Calibrate the colorimeter.
2. Pipette 5 mL of 0.25 M sodium hydroxide solution into a cuvette.
3. Start a 30 seconds countdown using a timer.
4. Immediate after starting the timer, pipette 1 mL of 0.01% phenolphthalein solution into the cuvette. Close the cuvette with the cap and invert the cuvette 2 – 3 times to mix the solution inside the cuvette.
5. Place the cuvette in the sample compartment of the colorimeter and close the lid.
6. Sharply at 30 seconds countdown ends, start recording the absorbance.
7. Stop recording when the absorbance does not change with time.
8. Measure the slope at 0^{th} second on the graph using the data logger software.
9. Record the slope in table 1.
10. Measure the absorbance (y-axis) at time 0^{th} and 60^{th} second on the graph using the data logger software.
11. Record the absorbance in table 1.
12. Discard the content of the cuvette into a waste container, rinse the cuvette thoroughly with deionised water.
13. Repeat Step 2 to 12 using 0.5 M and 1.0 M sodium hydroxide solution respectively instead of 0.25 M sodium hydroxide solution.

Data analysis

Table 1

Concentration of sodium hydroxide solution	Slope of the Absorbance-time curve at 0^{th} second	Absorbance at 0^{th} second	Absorbance at 60^{th} second
0.25 M			
0.50 M			
1.00 M			

Calculate the Average rate of decolorisation of phenolphthalein in alkaline medium from 0^{th} to 60^{th} second using:

(i) 0.25 M sodium hydroxide solution

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(ii) 0.50 M sodium hydroxide solution

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(iii) 1.00 M sodium hydroxide solution

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Discussion questions

1. Explain the shape of the absorbance-time curve.

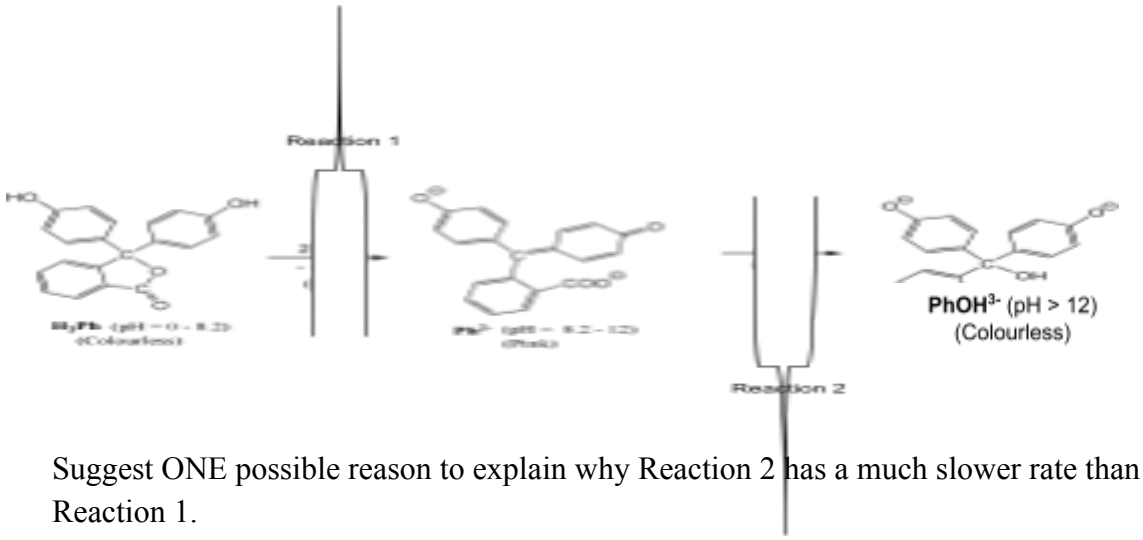
2. Based on the experimental result, state the relationship between the concentration sodium hydroxide solution and the reaction rate.

3. Suggest a possible value of the instantaneous rate of decolorisation of phenolphthalein in alkaline medium at 0^{th} second, using 2.0 M sodium hydroxide solution.

4. Give ONE advantage in using data-logger system to follow the progress of a reaction.

5. Suggest another way to follow the progress of the reaction.

6. Consider the reaction below:



Suggest ONE possible reason to explain why Reaction 2 has a much slower rate than Reaction 1.