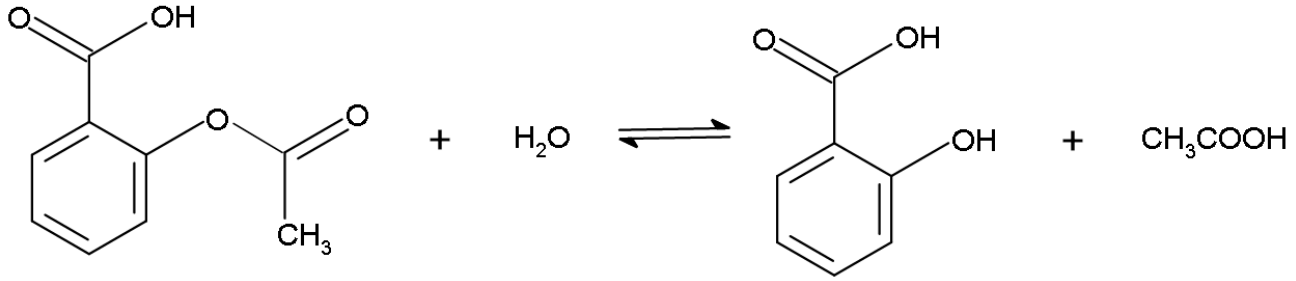
Investigating the Effect of Temperature on the Rate of Hydrolysis of Aspirin

Aim

To investigate the effect of varying the temperature on the rate of hydrolysis of Aspirin using colorimetry.

Background

Aspirin is the trademark for an ester, acetylsalicylic acid, which is a prescription-free painkiller. The active ingredient in Aspirin also prevents infections and damage to blood vessels. The efficiency of any drug depends on its chemical stability. Hydrolysis of the drug can be a major reason for the instability of drug solutions. When Aspirin undergoes hydrolysis, the products are salicylic acid and ethanoic acid.



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Salicylic acid forms violet-blue complexes with Fe^{3+} ions. The intensity of the colour depends on the salicylic acid concentration in the sample.

Curriculum Link

Topic IX Rate of Reaction
Topic XV Analytical Chemistry

Chemicals, Apparatus and Equipment

- Aspirin tablet
- Salicylic acid
- Iron(III) nitrate-9-water
- Concentrated nitric acid
- Ethanol (95%)
- Auto pipettes (1 cm^3, 5 cm^3)
- 25 cm^3 beaker x 8
- 100 cm^3 beaker x 2
- 100.00 cm^3 volumetric flask x 3
- 250.00 cm^3 volumetric flask x 1
- 100 cm^3 reagent bottle
- Mortar and pestle
- Electronic balance
- Colorimeter

Hazards:

Salicylic acid	
Concentrated nitric acid	 
Ethanol	
Iron(III) nitrate-9-water	 

Safety precautions:

- Wear safety glasses and chemical-resistant gloves
- Carry out the addition of concentrated nitric acid in the fume cupboard

Procedure

Part I: Preparation of a calibration curve

1. Dissolve 0.100g of salicylic acid in a mixture of 10 cm^3 ethanol and 10 cm^3 of deionised water. Transfer the solution to a 100.00 cm^3 volumetric flask. Add deionised water so that the final volume of solution is 100.00 cm^3.
2. Transfer 10 cm^3 of the solution prepared in Step 1 and dilute it to 100.00 cm^3 with 1:1 mixture of 95% ethanol and water in a 100.00 cm^3 volumetric flask. The resultant solution is Solution A.
3. Dissolve 4.00 g of $Fe(NO_3)_3 \bullet 9H_2O$ in 50 cm^3 deionised water. Transfer the solution to a 100.00 cm^3 volumetric flask. Add 4 cm^3 concentrated nitric acid. Add deionised water so that the final volume of solution is 100.00 cm^3. The resultant solution is Solution B.
4. Prepare solutions in 25 cm^3 beakers as follows:

	1	2	3	4	5	6	7	8
Solution A (cm^3)	0	0.50	1.00	1.50	2.00	2.50	3.00	3.50
Solution B (cm^3)	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50
Deionised water (cm^3)	4.00	3.50	3.00	2.50	2.00	1.50	1.00	0.50
Concentration of salicylic acid (mg/dm^3)	0	12.50	25.00	37.50	50.00	62.50	75.00	87.50
Absorbance								

5. Measure the absorbance of solutions using colorimeter (green light of wavelength = 533 nm).
6. Prepare a calibration curve.

Part II: Hydrolysis of Aspirin tablet

1. Weigh one tablet of Aspirin. Grind it into powder using mortar and pestle, and dissolve it in 10 cm^3 of 1:1 mixture of ethanol and water.
2. Filter the solution into a 250.00 cm^3 volumetric flask, rinse the filter paper with 10 cm^3 of 1:1 mixture of 95 % ethanol and water. Add deionized water so that the final volume of solution is 250.00 cm^3.
3. Prepare a blank solution of 4.00 cm^3 of deionized water and 0.50 cm^3 of Solution B.
4. Prepare a solution of 4.00 cm^3 of Aspirin solution and 0.50 cm^3 of Solution B.
5. Record the absorbance of the Aspirin sample.
6. Repeat the measurement of the absorbance of the Aspirin solution after 15 minutes, 30 minutes, and 45 minutes.

7. Repeat the experiment of Aspirin hydrolysis (Steps 1-6 above), but this time keep the 100 cm^3 reagent bottle with Aspirin solution in a water bath at elevated temperature (e.g. 60 ^oC).

Results

At ambient temperature

Time / minute	Absorbance
0	
15	
30	
45	

At 60^oC

Time / minute	Absorbance
0	
15	
30	
45	

Questions

1. Compare the results obtained at ambient temperature and at elevated temperature, and discuss the differences.

2. How should aspirin be stored in order to maintain its effects?

Reference:

The experiment “Comparison of Aspirin Hydrolysis at Ambient and Elevated Temperature” under the project “Hands-on approach to analytical chemisty for vocational schools II: AnalChemVoc II” led by Natasa Gros of University of Ljubljana.