Colorimetric analysis of paracetamol

Student worksheet

Health and safety note

Wear eye protection. 5 mol dm^{-3} hydrochloric acid is irritant.

Principle

Paracetamol reduces iron(III) ions to iron(II) ions. One mole of paracetamol reduces 1 mole of iron(III) ions. The reaction may be used to analyse paracetamol colorimetrically. The iron(II) ions formed react with potassium hexacyanoferrate(III) solution to make Prussian blue, an intense blue coloured complex. By measuring the intensity of the blue solution the concentration of paracetamol may be determined.

Equipment and materials

- Spectrometer (a solution of the complex displays maximum absorption at about 700 nm) or colorimeter with suitable filter (red)
- 250 cm^3 beaker
- 1 dm^3 volumetric flask
- 50 cm^3 burette x 2
- 50 cm^3 volumetric flask x 7
- 1 cm^3 graduated pipette and filler
- 5 cm^3 graduated pipette
- Mortar and pestle
- Paracetamol − Harmful
- 5 mol dm^{-3} hydrochloric acid − Irritant
- 0.002 mol dm^{-3} potassium hexacyanoferrate(III) solution
- 0.02 mol dm^{-3} iron(III) chloride solution
- Deionised water

Note: the same volumetric flask may be used, but must be washed thoroughly before re-use.

Method: Preparing standard solutions and obtaining a calibration graph

1. Weigh 0.100 g paracetamol into a beaker and dissolve in deionised water. Transfer quantitatively to a 1 dm^3 volumetric flask and make up to volume with deionised water.
2. Dilute this solution to make a 0.01 g dm^{-3} stock solution of paracetamol by diluting 25 cm^3 to 250 cm^3.
3. Set up two burettes, one containing the 0.01 g dm^{-3} (10 mg dm^{-3}) stock solution of paracetamol and the other containing deionised water. Use them to measure the following volumes into six 50 cm^3 volumetric flasks, labelled A-F:

	A	B	C	D	E	F
Vol. of 0.01 g dm^{-3} stock solution / cm^3	10	8	6	4	2	1
Vol. of deionised water / cm^3	0	2	4	6	8	9

4. To each flask, add 2 cm^3 of 0.02 mol dm^{-3} iron(III) chloride solution and 4 cm^3 of 0.002 mol dm^{-3} potassium hexacyanoferrate(III) solution. Leave for 10 minutes and then add 1 cm^3 of 5 mol dm^{-3} hydrochloric acid. Make up to the mark with deionised water.

	A	B	C	D	E	F
Concentration of paracetamol / mg dm^{-3}	2.0	1.6	1.2	0.8	0.4	0.2

5. After 20 minutes measure the absorbance at 700 nm. For a colorimeter, use a red filter.
6. Plot a graph of absorbance against concentration of paracetamol. This is the calibration graph.

Method: Analysing paracetamol tablets

1. Make a note of the mass of paracetamol the manufacturer states is in each tablet. This is given on the packaging.
2. Crush one or two tablets in a mortar and pestle.
3. Weigh accurately about 0.1 g of the powdered tablet into a 250 cm^3 beaker and dissolve in deionised water.
4. Transfer the solution quantitatively (if necessary, through a fluted filter paper to remove insoluble material from the tablet) into a 1 dm^3 volumetric solution. Make up to volume with deionised water.
5. Pipette 25 cm^3 of this solution into a 250 cm^3 volumetric flask and make up to volume with deionised water.
6. Measure 10 cm^3 of this solution into a 50 cm^3 volumetric flask. Add 2 cm^3 of 0.02 mol dm^{-3} iron(III) chloride solution and 4 cm^3 of 0.002 mol dm^{-3} potassium hexacyanoferrate(III) solution. Leave for 10 minutes and then add 1 cm^3 of 5 mol dm^{-3} hydrochloric acid. Make up to the mark with deionised water.
7. After 20 minutes measure the absorbance at 700 nm. For a colorimeter, use a red filter.
8. Use the calibration graph to determine the concentration of paracetamol in the solution and use this to work out the mass of paracetamol in the tablet.