

Reactions that go both ways

Chemistry grades 9-10 (GCSE · IGCSE · O Level · Class 9-10) · Lab

Name: _____ Date: _____ Class: _____

The deep red ion $[\text{Fe}(\text{SCN})]^{2+}$ forms when iron(III) and thiocyanate ions meet, and it can change back again. By changing the concentrations and the temperature of one stock solution, you watch the colour move and decide in which direction the equilibrium shifts, and whether the forward reaction takes in or gives out energy.

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Aim

To observe how changes in concentration and temperature move the position of the equilibrium $\text{Fe}^{3+}(\text{aq}) + \text{SCN}^{-}(\text{aq}) \rightleftharpoons [\text{Fe}(\text{SCN})]^{2+}(\text{aq})$, and to explain each change with Le Chatelier's principle.

Equipment

- Six test tubes in a rack and a 100 cm³ beaker
- 0.1 mol/dm³ iron(III) nitrate, 0.1 mol/dm³ potassium thiocyanate and 1 mol/dm³ sodium hydroxide
- Dropping pipettes, distilled water, a 60 °C water bath and an ice bath
- White tile or paper, marker pen and a colour chart scored 0 (colourless) to 10 (deep red)

Safety

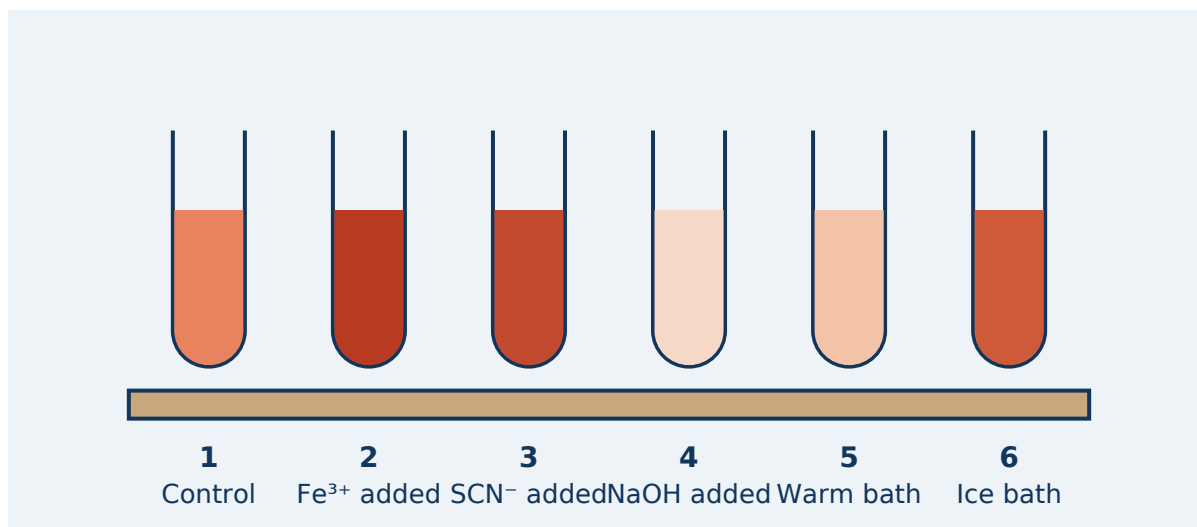
Safety

Wear safety goggles and gloves. Iron(III) nitrate is an irritant and potassium thiocyanate is harmful if swallowed, so keep both away from acids. Sodium hydroxide irritates skin: wash splashes at once. Handle the warm bath with care.

Method

1. Add 1 cm³ of each of the two solutions to 100 cm³ of water in the beaker. This is the stock red solution.
2. Pour 5 cm³ into each of six test tubes and label them 1 to 6. Score the colour of tube 1 against the chart.
3. To tubes 2, 3 and 4 add 10 drops of iron(III) nitrate, potassium thiocyanate and sodium hydroxide respectively. Shake gently.

- Place tube 5 in the warm bath and tube 6 in the ice bath for five minutes.
- View all tubes against the white tile and give each a colour score.



Six tubes of the same red solution after different changes.

Results

Sample colour scores, with tube 1 as the control:

Tube	Change made	Colour score
1	None (control)	5
2	Extra iron(III) nitrate	8
3	Extra potassium thiocyanate	7
4	Sodium hydroxide	2
5	Warm bath (60 °C)	3
6	Ice bath (0 °C)	7

Analysis questions

Question 1 Adding reactants

Write the equilibrium equation. Explain the colour scores of tubes 2 and 3 compared with tube 1.

Question 2 Effect of sodium hydroxide

Sodium hydroxide removes iron(III) ions as a brown solid.

- Write the ionic equation for this change.
- Explain the colour score of tube 4.

Question 3 Temperature effect

Use tubes 5 and 6 to decide whether the forward reaction is exothermic or endothermic. Give the sign of ΔH .

Question 4 Role of the control

Explain why tube 1 is needed and why all tubes are scored at the same time.

Question 5 A dynamic system

The colour of tube 1 does not change once mixed. Explain why this does not mean the reactions have stopped.

Question 6 Limits of the method

Suggest one weakness of scoring colour by eye and an instrument that would improve it.

Question 7 Prediction and conclusion

Predict the effect of adding solid potassium thiocyanate to tube 1 and write the conclusion of the lab.