

## Easy equilibrium

### Education in Chemistry

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[rsc.li/EiC417ec](http://rsc.li/EiC417ec)

## Technicians notes

### Kit

- 50 cm<sup>3</sup> measuring cylinder
- Five boiling tubes and rack
- Two 250 or 500 cm<sup>3</sup> beakers for use as water baths
- Cobalt(II) chloride hexahydrate, 2 g (toxic, dangerous for the environment) (CLEAPSS Hazcard 25)
- Concentrated hydrochloric acid, 100 cm<sup>3</sup> (corrosive) (CLEAPSS Hazcard 47A)
- Crushed ice (approx. 200 cm<sup>3</sup>) and a kettle

Optional extra: two large buckets or washing up bowls half filled with water, two large plastic beakers (250 or 500 cm<sup>3</sup>) and a much smaller plastic beaker (50 or 100 cm<sup>3</sup>).

### Safety and disposal

Cobalt(II) chloride may cause an allergic skin reaction, asthma symptoms or breathing difficulties if inhaled. It is suspected of causing genetic defects, may cause cancer by inhalation, may damage fertility, and is very toxic to aquatic life with long lasting effects. Avoid contact with skin and wash your hands after use. To avoid raising dust, weigh the solid on a balance in a fume cupboard that is not switched on and has the sash partially pulled down.

Concentrated hydrochloric acid causes severe skin burns and eye damage. It may cause respiratory irritation. Wear splash-proof goggles.

Do not allow small volumes of solution to dry out – clean glassware immediately and wipe up spills with a damp cloth. All chemicals can be washed down the sink with plenty of water.

### Preparation

Prepare an approximately 0.4 M solution of cobalt chloride by dissolving the powder in 20 cm<sup>3</sup> of deionised water, then top it up to 50 cm<sup>3</sup> with concentrated hydrochloric acid. It should be violet. Adding more acid will make it appear more blue, adding more water will make it more pink – adjust the solution until you have an intermediate violet and divide the solution equally among the five boiling tubes. The central tube will be a control for comparison.

Immediately before the demonstration, prepare a beaker of ice water and another of boiled water.

### In front of the class

#### Effect of concentration on equilibrium

Add the acid dropwise to one of the boiling tubes. Initially, the additional chloride ions will increase the frequency of collisions on the left side, leading to the solution appearing more blue. You can show the opposite effect by adding water to another tube.

#### Effect of temperature on equilibrium

As the forward reaction is endothermic, adding heat to the system by placing a tube in hot water will shift the position of equilibrium right to the endothermic side, resulting in the solution appearing more blue. Add one of the two remaining tubes to the ice bath to see the reverse effect.

### Tips

Performing the demonstration in front of a white background can help students to see the colours more easily. Larger containers, such as measuring cylinders or beakers, can be used with a scaled-up version of this demonstration to help larger groups see the effect.

For more spectacular demonstrations, take a look at the *Exhibition Chemistry archive on the Education in Chemistry website*: <https://eic.rsc.org/exhibition-chemistry>