

# Reactions that go both ways

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

Use the sample scores to check your reasoning. Your own colour scores will differ by a point or two, but tubes 2, 3 and 6 should be darker than the control and tubes 4 and 5 paler. Link each change to the shift in equilibrium and the energy sign.

**Level:** Chemistry grades 9-10 (GCSE · IGCSE · O Level · Class 9-10) · **Curriculum:** HS-PS1-6

## Question 1 Adding reactants

$\text{Fe}^{3+}(\text{aq}) + \text{SCN}^{-}(\text{aq}) \rightleftharpoons [\text{Fe}(\text{SCN})]^{2+}(\text{aq})$ . Extra  $\text{Fe}^{3+}$  (tube 2) or extra  $\text{SCN}^{-}$  (tube 3) raises the reactant concentration, so the equilibrium shifts right to use some up, making more red ion and raising the score from 5 to 8 and 7. **Shift right.**

## Question 2 Effect of sodium hydroxide

1.  $\text{Fe}^{3+} + 3\text{OH}^{-} \rightarrow \text{Fe}(\text{OH})_3(\text{s})$ . 2. Removing  $\text{Fe}^{3+}$  shifts the equilibrium left to replace it, so the red ion breaks down and the colour score falls from 5 to 2. **Shift left.**

## Question 3 Temperature effect

Warming (tube 5) gives a paler solution, so the equilibrium shifts left; cooling (tube 6) gives a darker one, so it shifts right. Heating favours the endothermic direction, so the reverse reaction is endothermic and the forward reaction is exothermic:  $\Delta H$  is negative. **Forward reaction exothermic;  $\Delta H$  negative.**

## Question 4 Role of the control

Tube 1 is the standard for comparison, so any difference can be linked to the change made. All tubes are scored together under the same light because the equilibrium changes slowly and the colour looks different in different lighting. **A control is the reference colour.**

## Question 5 A dynamic system

Both reactions continue at the same rate, so the particles keep forming and breaking  $[\text{Fe}(\text{SCN})]^{2+}$  and the net amounts stay constant. This is dynamic equilibrium, not a stopped reaction. **Forward rate equals reverse rate.**

## Question 6 Limits of the method

Judging colour by eye is subjective, so two students may give different scores. A colorimeter measures the absorbance of light and gives a number that depends on the concentration of

the red ion. **Use a colorimeter.**

### Question 7 Prediction and conclusion

Adding solid potassium thiocyanate raises the concentration of  $\text{SCN}^-$ , so the colour becomes darker red (a shift to the right). Conclusion: adding reactants or cooling shifts this equilibrium right; removing a reactant or heating shifts it left, which agrees with Le Chatelier's principle. **Darker red.**