

## Experiment 6—Effect of concentration changes on equilibrium yields

**Purpose** To investigate the effect of concentration changes on an aqueous equilibrium

### SAFETY

- Wear safety glasses and a laboratory coat for this experiment.
- Sodium fluoride solution is toxic if swallowed. Wear gloves when handling it.
- Silver nitrate solution can stain skin, clothing and bench surfaces.
- Iron(III) nitrate is irritating to the skin and eyes.

**Duration** 35 minutes

### Material

25 mL of  $5 \times 10^{-4}$  M  $\text{Fe}(\text{SCN})^{2+}$  solution, 0.1 M iron (III) nitrate solution, 0.1 M potassium thiocyanate solution, 0.1 M sodium fluoride solution, 0.1 M silver nitrate solution, 6 x semi-micro test-tubes, semi-micro test-tube rack, bench mat, marking pen, dropping pipette, white tile or white sheet of paper, gloves, **safety glasses**

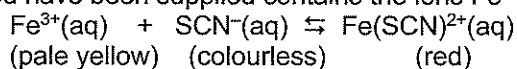
### Procedure

1. Fill each of six semi-micro test-tubes to one-third of its volume with  $\text{Fe}(\text{SCN})^{2+}$  solution. Check that the liquid in each tube has the same intensity of colour when you look down the tube onto a white tile or sheet of paper as a background. If needed, add more solution so that the liquid in each tube is the same colour. Label the tubes A–F.
2. Using test-tube F for the purposes of comparison, perform each of the tests described in the table and record the change that occurs in the colour of the solution when viewed down the test-tube.
3. Complete the table below.

Test-tube	Test	Colour change
A	1 drop of $\text{Fe}(\text{NO}_3)_3(\text{aq})$ added	
B	1 drop of $\text{KSCN}(\text{aq})$ added	
C	1 drop of $\text{NaF}(\text{aq})$ added	
D	1 drop of $\text{AgNO}_3(\text{aq})$ added	
E	volume of water added	
F	None – Control Sample	No change

### Theory

The solution of  $\text{Fe}(\text{SCN})^{2+}$  with which you have been supplied contains the ions  $\text{Fe}^{3+}$ ,  $\text{SCN}^-$  and  $\text{Fe}(\text{SCN})^{2+}$  at equilibrium:



The intense, blood-red colour of the solution is due to the presence of the  $\text{Fe}(\text{SCN})^{2+}$  ion. The colour of the solution in each test-tube, when viewed down the tube, is a measure of the amount of  $\text{Fe}(\text{SCN})^{2+}$  ions present in the tube. By noting how the intensity of this colour changes, it is possible to deduce the effect of each of the tests performed in this experiment on the equilibrium. For instance, if the colour deepens, the amount of  $\text{Fe}(\text{SCN})^{2+}$  ions has increased and the amount of the  $\text{Fe}^{3+}$  and  $\text{SCN}^-$  ions must have simultaneously decreased since they are used to form  $\text{Fe}(\text{SCN})^{2+}$ . *The equilibrium would be described as having a net forward reaction (its position would have 'shifted to the right').*

In tests A to E the amount of  $\text{Fe}^{3+}$  or of  $\text{SCN}^-$  ions present in the solution is initially changed as follows:

- Test A—addition of  $\text{Fe}(\text{NO}_3)_3$  increases the amount of  $\text{Fe}^{3+}$ .
- Test B—addition of  $\text{KSCN}$  increases the amount of  $\text{SCN}^-$ .
- Test C—addition of  $\text{NaF}$  decreases the amount of  $\text{Fe}^{3+}$  because F ions react with  $\text{Fe}^{3+}$  ions to form  $\text{FeF}_6^{3-}(\text{aq})$ .
- Test D—addition of  $\text{AgNO}_3$  decreases the amount of  $\text{SCN}^-$  because  $\text{Ag}^+$  ions react with  $\text{SCN}^-$  ions to form a white precipitate of  $\text{AgSCN}$ .
- Test E—addition of water has no effect.

### Questions

1. Write an expression for the equilibrium constant of the reaction that is the subject of this experiment.

2. Complete the table below. Use an upward arrow to indicate an increase in the concentration of a chemical species and a downward arrow to indicate a decrease in the concentration of a chemical species. Also write a dot-point explanation of the results. Test A has been filled in as an example.

	[Fe <sup>3+</sup> ]	[SCN <sup>-</sup> ]	[Fe(SCN) <sup>2+</sup> ]	Brief explanation
Test A	↑	↓	↑	<ul style="list-style-type: none"> <li>• Adding Fe(NO<sub>3</sub>)<sub>3</sub>(aq) increases [Fe<sup>3+</sup>]</li> <li>• This produces more Fe(SCN)<sup>2+</sup> so [Fe(SCN)<sup>2+</sup>] must increase</li> <li>• SCN<sup>-</sup>(aq) must be used up in the process so [SCN<sup>-</sup>] must decrease.</li> </ul>
Test B				
Test C				
Test D				
Test E				

*(Experiment 34 is questions are continued over the page)*