Measuring an equilibrium constant

In this experiment you will be using your microscale titration apparatus to determine the equilibrium constant for the reaction between silver(I) and iron(II) ions:

$Ag^+(aq) + Fe^{2+}(aq) \rightarrow Ag(s) + Fe^{3+}(aq)$

Instructions

1. Using a 2 cm^3 pipette transfer 2 cm^3 each of the 0.10 mol dm^{-3} silver nitrate solution and 0.10 mol dm^{-3} iron(II) sulphate solution to the flask and stopper it so that it is air-tight. Shake the flask and leave undisturbed overnight.
2. Set up the microscale titration apparatus (see 'Apparatus and techniques for microscale chemistry' handout).
3. Fill the apparatus with potassium thiocyanate solution (see 'Element Solutions' handout).
4. Using a 1 cm^3 pipette, transfer 1 cm^3 of the solution to a 10 cm^3 beaker, trying not to disturb the silver precipitate.
5. Using the microscale titration apparatus titrate with potassium thiocyanate solution. A permanent red colour marks the end-point.
6. Repeat the titration and calculate the average of your titres.

Calculations

1. The purpose of this experiment is to calculate the equilibrium constant K_c in the expression:

$$K_c = \frac{[Fe^{3+}(aq)]_{eq}}{[Ag^+(aq)]_{eq}[Fe^{2+}(aq)]_{eq}}$$

2. First, work out the initial concentrations of both Ag^+ (aq) and Fe^{2+}(aq) in the reaction vessel.
3. Write the equation for the titration reaction and then use it to calculate $[Ag^+]_{eq}$ from your titration results.
4. Since the initial concentrations of both Ag(I) and Fe(II) are equal, it follows that their concentrations at equilibrium are also equal. Therefore you also know $[Fe^{2+}]_{eq}$.
5. Before you can calculate K_c you need to know the concentration of iron(III) at equilibrium, $[Fe^{3+}(aq)]_{eq}$. This is equal to the initial concentration of Fe^{2+}(aq) minus the concentration of Fe^{2+}(aq) at equilibrium. Hence calculate K_c.

Health & Safety

Students must wear eye protection.

Iron(II) sulfate, 0.1 mol dm^{-3}, $FeSO_4.7H_2O$ (aq) and Potassium thiocyanate solution 0.020 mol dm^{-3} are of low hazard.

Sulfuric acid, 0.5 mol dm^{-3} H_2SO_4(aq) is of low hazard (if accurately made up. It becomes irritant at 0.51 mol dm^{-3})

Silver nitrate solution 0.10 mol dm^{-3} is IRRITANT.

Credits

Health & safety checked May 2018

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