Experiment

38 Permanganate ion and dichromate ion as oxidising agents

Study Guide, for Wed tutorial

Background

The permanganate ion and dichromate ion are commonly used oxidising agents in aqueous solution. In acid solution the permanganate ion (MnO_4), which is deep purple in colour, may be reduced to manganese(ll) ion (Mn^{2+}) which is almost colourless (actually a very pale pink). The equation for the half-reaction is

$Mn0_4$ *(aq)* + $8H^+$*(aq)* + 5e -~ Mn^{2+}*(aq)* + $4H_20$(l)

purple *colourless*

The orange dichromate ion ($Cr_20_7^{2-}$) may be reduced in acid solution to green chromium(lll) ion (Cr^{3+}). The equation for this half-reaction is

$Cr_20_7^2$*(aq)* + $14H^+$(*aq)* + 6e - $2Cr^{3+}$*(aq)* + $7H_2O$(1)

orange *green*

In this experiment some reactions involving the permanganate and dichromate ions will be investigated.

Procedure

#1 Make up a stock solution of acidified potassium permanganate solution by mixing 3 mL of 0.02 mol L^{-1} $KMnO_4$ with 3 mL of 2 mol L^{-1} H_2SO_4.

#2 Place 2 mL of 0.5 mol L^{-1} KI into a test tube. Using a dropper add dropwise about 1 mL of the stock permanganate solution and shake well. If a redox reaction occurs the purple permanganate colour will disappear, or at least be greatly reduced in intensity.

$$MnO_4^- + 8H^+ + 5e^- \longrightarrow Mn^{2+} + 4H_2O$$

$$I_2 + 2e^- \longrightarrow 2I^-$$

Write this in reverse so that it is oxidised

Multiply top equation by 2, and bottom by 5. Add so that they cancel electrons

#4 Repeat instructions #2 and #3 using the KBr and KCl solutions in place of the KI solution.

$$MnO_4^- + 8H^+ + 5e^- \longrightarrow Mn^{2+} + 4H_2O$$

$$Cl_2 + 2e^- \longrightarrow 2Cl^-$$

$$Br_2 + 2e^- \longrightarrow 2Br^-$$

Write these in reverse so that it is oxidised

Multiply top equation by 2, and bottom 2 by 5. Add so that they cancel electrons

#5 Place a small quantity of $FeSO_4.7H_2O$ in a test tube and dissolve in about 2 mL of water. Repeat instruction #2 using the $FeSO_4$ solution in place of the KI solution.

$$MnO_4^- + 8H^+ + 5e^- \longrightarrow Mn^{2+} + 4H_2O$$

$$Fe^{3+} + e^- \longrightarrow Fe^{2+}$$ ← Write this in reverse so that it is oxidised

This is simple, just multiply the second equation by 5 and add to first

#6 Repeat instruction #2 using H_20_2 solution in place of the KI solution.

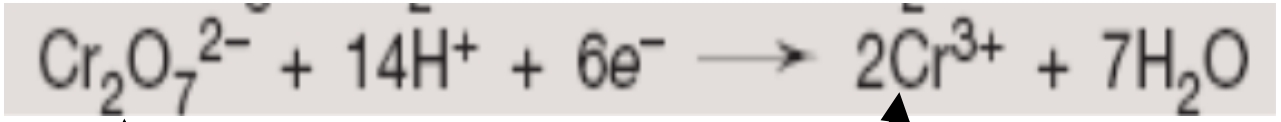
$$MnO_4^- + 8H^+ + 5e^- \longrightarrow Mn^{2+} + 4H_2O$$

$$H_2O_2 - 2e \longrightarrow 2H^+ + O_2$$

NOT ON TABLE ?

Multiply top eq by 2, and second by 5. Add together to cancel electrons

#7 Make up a stock solution of acidified potassium dichromate by mixing 3 mL of 0.05 mol L^{-1} $K_2Cr_2O_7$ with 3 mL of 2 mol L^{-1} H_2SO_4.
#8 Repeat instructions #2 to #6 using about 1 mL of the acidified dichromate solution instead of the acidified permanganate solution.



orange

green

ACTION
Research Redox titrations!

$$Cr_2O_7^{2-} + 14H^+ + 6e^- \longrightarrow 2Cr^{3+} + 7H_2O$$

$$I_2 + 2e^- \longrightarrow 2I^-$$ Reverse this

Then, multiply second by 3 before adding together

Repeat with $Cl_2 + 2e^- \longrightarrow 2Cl^-$

$Br_2 + 2e^- \longrightarrow 2Br^-$

etc etc