Some redox titration problems involving manganate(VII)

Background skills

1. How many moles of manganate(VII) ions, MnO_4^-, are in the following solutions?

   a) $1000cm^3$ of 1M potassium manganate(VII), $KMnO_4$.

   b) $25.0\ cm^3$ of 1M $KMnO_4$.

   c) $25.0\ cm^3$ of 0.020M $KMnO_4$.

   d) $36.5\ cm^3$ of 0.012M $KMnO_4$.

Element	A_r
H	1.00
N	14.0
O	16.0
S	32.1
K	39.1
Mn	54.9
Fe	55.8

2. Calculate the relative formula masses of the following substances using A_r values from the table on the right.

   a) MnO_4^- ion

   b) $KMnO_4$

3. What are the concentrations of MnO_4^- ions in the following solutions?

   a) 1 mole of $KMnO_4$ dissolved in $1000\ cm^3$ of water.

   b) 0.05 moles of $KMnO_4^-$ ions dissolved in $25cm^3$ water.

   c) 39.5g of $KMnO_4$ dissolved in $250cm^3$ water.

   d) 0.253g of $KMnO_4$ dissolved in $25.3\ cm^3$ water.

4. a) Combine the following two half-reaction equations to give a balanced redox equation:

   $MnO_4^- + 8H^+ + 5e^- \rightarrow Mn^{2+} + 4H_2O$ and $Fe^{2+} \rightarrow Fe^{3+} + e^-$

   b) How many moles of Fe^{2+} ions are oxidised by 1 mole of MnO_4^- ions?

Titration problems

5. $25.0cm^3$ of an acidified solution containing Fe^{2+} ions was titrated against potassium manganate(VII) solution. $20.0cm^3$ of 0.050M potassium manganate(VII) was needed.

   Calculate the concentration of Fe^{2+} ions in the acidified solution.

6. A $25.0cm^3$ aliquot of a solution containing Fe^{2+} ions and Fe^{3+} ions was acidified and titrated against potassium manganate(VII) solution. $15.0cm^3$ of 0.020M potassium manganate(VII) was needed. A second $25.0cm^3$ aliquot was reduced using zinc (i.e. the Fe^{3+} ions in the solution were reduced to Fe^{2+} ions), then titrated. This time, $19.0cm^3$ of the 0.020M potassium manganate(VII) was needed. Calculate the concentrations of:

   a) Fe^{2+} ions in the solution b) Fe^{3+} ions in the solution

7. *Kilzemall* (a new fertiliser) contains ammonium iron(II) sulphate, $FeSO_4.(NH_4)_2SO_4.6H_2O$ as a source of iron. A 6.50g sample of *Kilzemall* is made up to $250cm^3$ with dilute sulphuric acid. $25cm^3$ of this solution reacted with $23.5cm^3$ of 0.010M potassium manganate(VII). Calculate:

   a) The concentration of Fe^{2+} ions in the $25cm^3$ aliquot.

   b) The number of moles of Fe^{2+} in the original 6.50g sample of *Kilzemall*.

   c) If it contains more than 10.00% of iron by mass, *Kilzemall* will kill 'em all. Will it?

