Chapter 14
Electrode potentials and fuel cells

Print out and complete this worksheet to generate a summary for Chapter 14.

1 Write ionic equations for the following reactions:

a $Mg(s) + ZnCl_2(aq) \rightarrow MgCl_2(aq) + Zn(s)$

.....

.....

b $2LiOH(aq) + H_2SO_4(aq) \rightarrow Li_2SO_4(aq) + 2H_2O(l)$

.....

.....

c $Ca(NO_3)_2(aq) + Na_2CO_3(aq) \rightarrow CaCO_3(s) + 2NaNO_3(aq)$

.....

.....

d $Zn(s) + 2HCl(aq) \rightarrow ZnCl_2(aq) + H_2(g)$

.....

.....

e $CuO(s) + 2HNO_3(aq) \rightarrow Cu(NO_3)_2(aq) + H_2O(l)$

.....

.....

2 Give the oxidation number of the element in bold in each of the following.

a $\mathbf{O}_2$ ....

b $\mathbf{Al}(OH)_3$ ....

c $Ba\mathbf{Cr}O_4$ ....

d $Na_2\mathbf{S}O_4$ ....

e $Ca(\mathbf{N}O_3)_2$ ....

f $Na_2\mathbf{O}_2$ ....

g $Na_2\mathbf{Zn}(OH)_4$ ....

h $Na_2\mathbf{Cr}_2O_7$ ....

i $Mg\mathbf{H}_2$ ....

j $K\mathbf{Cl}O_4$ ....

3 Explain what is meant by:

a oxidation

.....

Chapter 14 Electrode potentials and fuel cells

b reduction

c an oxidising agent

d a reducing agent

4 Write a balanced half-equation, including electrons, for each of the following:

a $Mg(s) \rightarrow Mg^{2+}(aq)$

b $Br^-(aq) \rightarrow Br_2(l)$

c $Cr^{2+}(aq) \rightarrow Cr^{3+}(aq)$

d $MnO_4^-(aq) + H^+(aq) \rightarrow Mn^{2+}(aq) + H_2O(l)$

e $ClO_3^-(aq) + H^+(aq) \rightarrow Cl^-(aq) + H_2O(l)$

f $SO_2(g) + H_2O(l) \rightarrow SO_4^{2-}(aq) + H^+(aq)$

5 Use your answers to Question 4 to construct an overall balanced equation for each of the reactions between:

a $Mg(s)$ and $Br_2(l)$

Balanced equation:

b $Cr^{2+}(aq)$ and $MnO_4^-(aq) + H^+(aq)$

Balanced equation:

Chapter 14 Electrode potentials and fuel cells

c $SO_2(g) + H_2O(l)$ and $MnO_4^-(aq) + H^+(aq)$

Balanced equation:

6 Draw a fully labelled diagram to illustrate the measurement of the standard electrode potential of:

$Fe^{3+}(aq) + e^- \rightarrow Fe^{2+}(aq)$

7 Use the electrode potentials in the table to determine the voltage produced by the three cells that follow.

Reaction	$E^\ominus$/V
$Zn^{2+}(aq) + 2e^- \rightleftharpoons Zn(s)$	−0.76
$Co^{2+}(aq) + 2e^- \rightleftharpoons Co(s)$	−0.28
$Sn^{4+}(aq) + 2e^- \rightleftharpoons Sn^{2+}(aq)$	+0.15
$I_2(aq) + 2e^- \rightleftharpoons 2I^-(aq)$	+0.54
$Fe^{3+}(aq) + e^- \rightleftharpoons Fe^{2+}(aq)$	+0.77
$Br_2(aq) + 2e^- \rightleftharpoons 2Br^-(aq)$	+1.09
$Cr_2O_7^{2-}(aq) + 14H^+(aq) + 6e^- \rightleftharpoons 2Cr^{3+}(aq) + 7H_2O(l)$	+1.33
$Cl_2(aq) + 2e^- \rightleftharpoons 2Cl^-(aq)$	+1.36

a $Zn(s)/Zn^{2+}(aq)$ and $Co(s)/Co^{2+}(aq)$

Chapter 14 Electrode potentials and fuel cells

b $Zn(s)/Zn^{2+}(aq)$ and $I_2(aq)/I^-(aq)$

c $Co(s)/Co^{2+}(aq)$ and $Fe^{3+}(aq)/Fe^{2+}(aq)$

8 Use the electrode potential data from Question 7 to determine whether each of the following reactions is feasible:

a $Cl_2(aq) + Sn^{2+}(aq) \rightarrow Cl^-(aq) + Sn^{4+}(aq)$

b $Br_2(aq) \rightarrow Cl^-(aq) \rightarrow Br^-(aq) \rightarrow Cl_2(g)$

c $Cr_2O_7^{2-}(aq) + H^+(aq) + Br^-(aq) \rightarrow Cr^{3+}(aq) + Br_2(aq) + H_2O(l)$

9 For specialist use, a cell using lithium and fluorine has been proposed. The cell operates at temperatures of around 500°C using molten electrolytes. It gives a voltage of 5.26 V.

Use the data in the table to calculate the voltage produced under standard conditions.

Reaction	$E^\ominus$/V
$Li^+(aq) + e^- \rightleftharpoons Li(s)$	–3.03
$F_2(g) + 2e^- \rightleftharpoons 2F^-(aq)$	+2.87

Chapter 14 Electrode potentials and fuel cells

10 Give *two* advantages and *two* problems associated with the use of a fuel cell based on hydrogen as a source of electrical power in a vehicle.