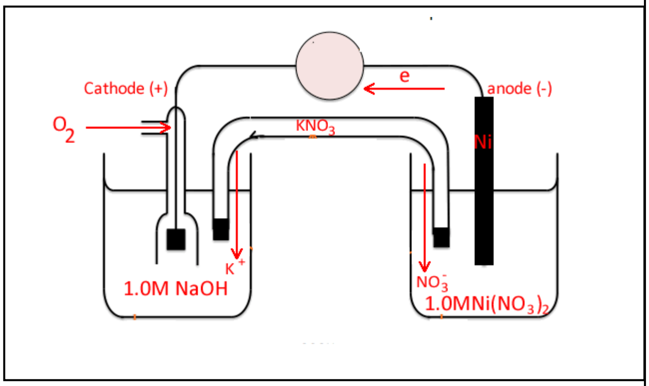
Redox reactions – galvanic cells revision

Lesson 5

1) Below is a diagram showing part of the electrochemical series and an unlabelled galvanic cell.



$O_2(g) + 2H_2O(l) + 4e^- \rightleftharpoons 4OH^-(aq)$	+0.40
$Cu^{2+}(aq) + 2e^- \rightleftharpoons Cu(s)$	+0.34
$Sn^{4+}(aq) + 2e^- \rightleftharpoons Sn^{2+}(aq)$	+0.15
$S(s) + 2H^+(aq) + 2e^- \rightleftharpoons H_2S(g)$	+0.14
$2H^+(aq) + 2e^- \rightleftharpoons H_2(g)$	0.00
$Pb^{2+}(aq) + 2e^- \rightleftharpoons Pb(s)$	−0.13
$Sn^{2+}(aq) + 2e^- \rightleftharpoons Sn(s)$	−0.14
$Ni^{2+}(aq) + 2e^- \rightleftharpoons Ni(s)$	−0.23
$Co^{2+}(aq) + 2e^- \rightleftharpoons Co(s)$	−0.28

a) The E^o values shown above are measured at standard conditions. What are the standard conditions that E^o values for each half cell are measured at? *100 kPa, 25^{o}C and 1.0 M concentrations.*

b) Using the diagram above, construct a galvanic cell that will deliver 0.63V under standard conditions.

Clearly label or give the following

i. The direction of electron flow
ii. The anode and cathode
iii. The polarity of each electrode
iv. The material each electrode is made up of.
v. The substance forming the salt bridge
vi. Direction of anion and cation movement
vii. The oxidant *O_2*
viii. The reductant *Ni(s)*
ix. The oxidation half equation *$Ni(s) \rightarrow Ni^{2+}(aq) + 2e$*
x. The reduction half equation *$O_2(g) + 2H_2O(l) + 4e \rightarrow 4OH^-(aq)$*
xi. Overall equation *$O_2(g) + 2H_2O(l) + 2Ni(s) \rightarrow 4OH^-(aq) + 2Ni^{2+}(aq)$*

c) One of the electrodes starts to corrode as the cell discharges. If 1.1012 mol of electrons flow through the external circuit of the galvanic cells while discharging, what is the mass loss of the electrode given to the right number of significant figures. The data book should be used.

According to the equation below the nickel electrode will corrode to form Ni^{2+} ions.

$O_2(g) + 2H_2O(l) + 2Ni(s) \rightarrow 4OH^-(aq) + 2Ni^{2+}(aq)$

The half equation for the oxidation reaction is $Ni(s) \rightarrow Ni^{2+}(aq) + 2e$

For every 2 mol of electrons one mole of Ni is used up, hence the ratio is 1:2.

If 1.1012 mol of electrons flow through the circuit then 0.5506 mol of Nickel must react.

The mass loss of the Ni electrode is

=> 0.5506 X 58.7 = 32.3 grams (3 sig figs)

2) A galvanic cell consists of one half cell that is made up of an inert graphite electrode in a solution containing 1.0 M Fe^{2+}(aq) and 1.0 M Fe^{3+}(aq) at 25°C.
Which of the following could be used as the second half cell so that the polarity of the electrode in this second half cell is positive? Explain

i. a lead electrode in a solution of 1.0 M Pb^{2+}(aq)

ii. a silver electrode in a solution of 1.0 M Ag^{+}(aq)

iii. A cobalt electrode in a solution of 1.0 M Co^{2+}(aq)

iv. an inert graphite electrode in a solution of 1.0 M Sn^{4+}(aq) and 1.0M Sn^{2+}(aq)

$O_2(g) + 4H^+(aq) + 4e^- \rightleftharpoons 2H_2O(l)$

$Br_2(l) + 2e^- \rightleftharpoons 2Br^-(aq)$

$Ag^+(aq) + e^- \rightleftharpoons Ag(s)$

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

$O_2(g) + 2H^+(aq) + 2e^- \rightleftharpoons H_2O_2(aq)$

$I_2(s) + 2e^- \rightleftharpoons 2I^-(aq)$

$O_2(g) + 2H_2O(l) + 4e^- \rightleftharpoons 4OH^-(aq)$

$Cu^{2+}(aq) + 2e^- \rightleftharpoons Cu(s)$

$Sn^{4+}(aq) + 2e^- \rightleftharpoons Sn^{2+}(aq)$

$S(s) + 2H^+(aq) + 2e^- \rightleftharpoons H_2S(g)$

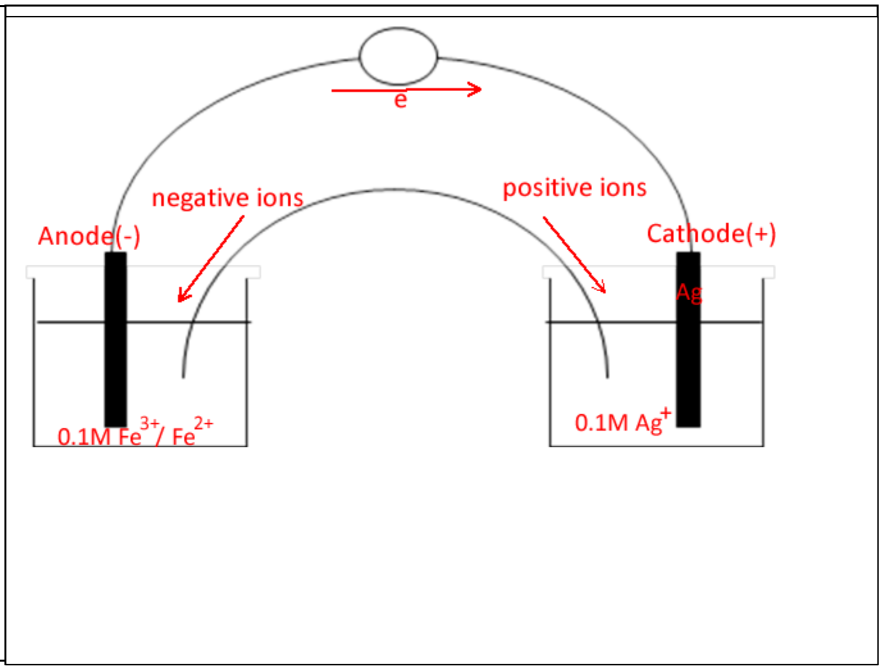
$2H^+(aq) + 2e^- \rightleftharpoons H_2(g)$

$Pb^{2+}(aq) + 2e^- \rightleftharpoons Pb(s)$

$Sn^{2+}(aq) + 2e^- \rightleftharpoons Sn(s)$

$Ni^{2+}(aq) + 2e^- \rightleftharpoons Ni(s)$

$Co^{2+}(aq) + 2e^- \rightleftharpoons Co(s)$



Only two solutions can undergo a spontaneous reaction with the Fe^{3+}/Fe^{2+} *half cell.*
They are pictured above on the diagram of the electrochemical series.
Ag^+*, however, will form an electrode with a positive polarity, since reduction of the* Ag^+ *ion will take place.*

Clearly label or give the following

xii. The direction of electron flow

xiii. The anode and cathode

xiv. The polarity of each electrode

xv. The material each electrode is made up of.

xvi. The substance forming the salt bridge

xvii. Direction of anion and cation movement

xviii. The oxidant Ag^{+}

xix. The reductant Fe^{2+}

xx. The oxidation half equation $Fe^{2+}(aq) \rightarrow Fe^{3+}(aq) + e$

xxi. The reduction half equation $Ag^{+}(aq) + e \rightarrow Ag(s)$

xxii. Overall equation $Fe^{2+}(aq) + Ag^{+}(aq) \rightarrow Ag(s) + Fe^{3+}(aq)$