Redox reactions - revision Lesson 7c

1) A galvanic cell can be constructed that uses the following two half-reactions

$Cl_2(g) + 2e^- \rightleftharpoons 2Cl^-(aq)$ $E^\circ = +1.36$

$2HOCl(aq) + 2H^+(aq) + 2e^- \rightleftharpoons Cl_2(g) + 2H_2O(l)$ $E^\circ = +1.64$

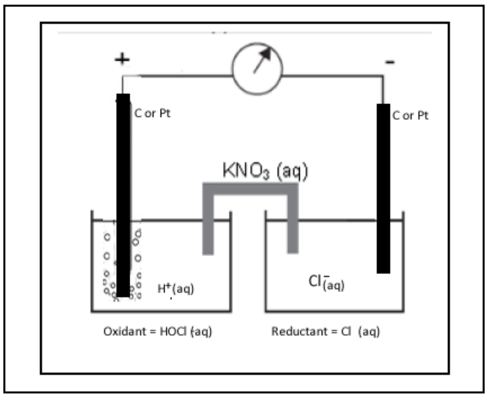
a) Complete the diagram, shown on the right, of this galvanic cell. Indicate:

i. appropriate electrodes

ii. the ions in solution in each half cell

iii. the oxidant

iv. the reductant



b) As the cell discharges what happens to the pH of each half cell? Explain

Since the following reaction takes place at the anode $2Cl^-(aq) \rightleftharpoons Cl_2(g) + 2e^-$ no change in pH takes place

At the cathode however the reaction $2HOCl(aq) + 2H^+(aq) + 2e^- \rightleftharpoons Cl_2(g) + 2H_2O(l)$ takes place and hence the H^+ is used up. The pH rises.

c) Bubbles are seen forming at the negative electrode. Identify this substance and give a reason for your choice.

Cl_2 gas The following reaction takes place $2Cl^-(aq) \rightleftharpoons Cl_2(g) + 2e^-$

2) A student was given strips of two metals, nickel and silver and a solution of copper sulphate. The student placed one of the metals in the copper sulphate solution and left the room. Upon returning he noticed that copper metal had deposited on the metal which had almost dissolved.

a) What was the likely metal placed in the solution? Explain

$Ag^+ + e^- \rightarrow Ag$
$Hg_2^{2+} + 2e^- \rightarrow Hg_2$
$Fe^{3+} + e^- \rightarrow Fe^{2+}$
$I_2 + 2e^- \rightarrow 2I^-$
$Cu^{2+} + 2e^- \rightarrow Cu$
$Hg_2Cl_2 + 2e^- \rightarrow 2Hg + 2Cl^-$
$AgCl + e^- \rightarrow Ag + Cl^-$
$Cu^{2+} + e^- \rightarrow Cu^+$
$Sn^{4+} + 2e^- \rightarrow Sn^{2+}$
$2H^+ + 2e^- \rightarrow H_{2(g)}$
$Pb^{2+} + 2e^- \rightarrow Pb$
$Sn^{2+} + 2e^- \rightarrow Sn$
$Ni^{2+} + 2e^- \rightarrow Ni$

Ni. A spontaneous reaction will occur between the strongest oxidant ($Cu^{2+}(aq)$) and the strongest reductant Ni(s)

b) The student observed that no more copper is been deposited even though there is still metal present in the solution. What ions are present in the solution? *Since no more copper is being deposited even though Ni metal is still present this indicates that there is no more Cu^{2+} ions left hence Ni^{2+} only are present in solution.*

c) Which of the following metals, lead or iron, can be used to precipitate these ions, identified in b) above, out of solution? Explain

According to the E^o table above Fe is the only metal that will react spontaneously with $Ni^{2+}(aq)$

d) Explain what you would expect to observe and write the oxidation and reduction half equations when:

i. Calcium metal is added to a 0.1 M $Mn(NO_3)_2$ solution.

A spontaneous reaction will occur to produce H_2 gas while the Ca dissolves. H_2O is a stronger oxidant than $Mn^{2+}(aq)$

Oxidation = $Ca(s) \Rightarrow Ca^{2+}(aq) + 2e$

Reduction = $2H_2O(l) + 2e \Rightarrow 2OH^{-}(aq) + H_2(g)$

$Zn^{2+}(aq)$	+	$2e^-$	$\rightleftharpoons$	$Zn(s)$
$2H_2O(l)$	+	$2e^-$	$\rightleftharpoons$	$2OH^-(aq) + H_2(g)$
$Mn^{2+}(aq)$	+	$2e^-$	$\rightleftharpoons$	$Mn(s)$
$Al^{3+}(aq)$	+	$3e^-$	$\rightleftharpoons$	$Al(s)$
$Mg^{2+}(aq)$	+	$2e^-$	$\rightleftharpoons$	$Mg(s)$
$Na^+(aq)$	+	e^-	$\rightleftharpoons$	$Na(s)$
$Ca^{2+}(aq)$	+	$2e^-$	$\rightleftharpoons$	$Ca(s)$
$Sr^{2+}(aq)$	+	$2e^-$	$\rightleftharpoons$	$Sr(s)$
$K^+(aq)$	+	e^-	$\rightleftharpoons$	$K(s)$
$Li^+(aq)$	+	e^-	$\rightleftharpoons$	$Li(s)$

ii. Zinc metal is added to a 0.1 M HCl solution

A spontaneous reaction will occur to produce H_2 gas while the Zn dissolves. $H^+(aq)$ is the strongest oxidant present

Oxidation = $Zn(s) \Rightarrow Zn^{2+}(aq) + 2e$

Reduction = $2H^+(aq) + 2e \Rightarrow H_2(g)$

$2H^+(aq)$	+	$2e^-$	$\rightleftharpoons$	$H_2(g)$
$Pb^{2+}(aq)$	+	$2e^-$	$\rightleftharpoons$	$Pb(s)$
$Sn^{2+}(aq)$	+	$2e^-$	$\rightleftharpoons$	$Sn(s)$
$Ni^{2+}(aq)$	+	$2e^-$	$\rightleftharpoons$	$Ni(s)$
$Co^{2+}(aq)$	+	$2e^-$	$\rightleftharpoons$	$Co(s)$
$Cd^{2+}(aq)$	+	$2e^-$	$\rightleftharpoons$	$Cd(s)$
$Fe^{2+}(aq)$	+	$2e^-$	$\rightleftharpoons$	$Fe(s)$
$Cr^{3+}(aq)$	+	$3e^-$	$\rightleftharpoons$	$Cr(s)$
$Zn^{2+}(aq)$	+	$2e^-$	$\rightleftharpoons$	$Zn(s)$
$2H_2O(l)$	+	$2e^-$	$\rightleftharpoons$	$2OH^-(aq) + H_2(g)$