Galvanic cells - revision

1. Consider the following overall redox equations
   a. $Pb(s) + 2Fe^{3+}(aq) \rightarrow Pb^{2+}(aq) + 2Fe^{2+}(aq)$

   Oxidant _____

   Reductant _____

   Oxidation reaction _____

   Reduction reaction _____

   Material anode is made from _____

   Material cathode is made from _____

   Write the reactions taking place in each half cell and label the following

   - Anode
   - Cathode
   - Direction of electron flow
   - Direction of negative ion flow.

   b. $Fe(s) + 2Fe^{3+}(aq) \rightarrow 3Fe^{2+}(aq)$

   Oxidant _____

   Reductant _____

   Oxidation reaction _____

   Reduction reaction _____

   Material anode is made from _____

   Material cathode is made from _____

   Write the reactions taking place in each half cell and label the following

   - Anode
   - Cathode
   - Direction of electron flow
   - Direction of negative ion flow.

   c. $6Fe^{2+}(aq + Cr_2O_7^{2-}(aq) + 14H^+(aq) \rightarrow 3Cr^{3+}(aq) + 7H_2O(l) + 6Fe^{3+}(aq)$

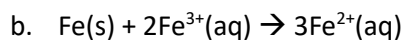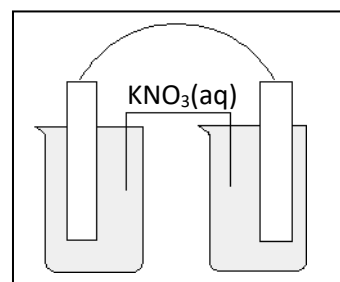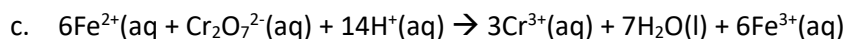   The balanced overall equation, shown above, takes place in an acidic environment in a galvanic cell with the design shown on the right.

   Oxidant _____

   Reductant _____
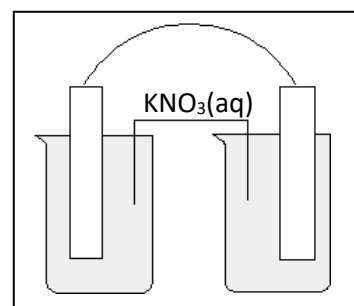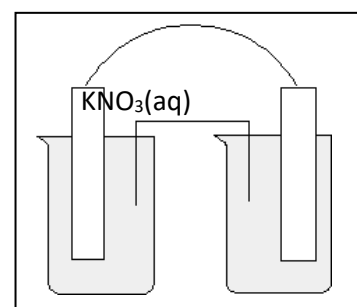
   Oxidation reaction _____

   Reduction reaction _____

   Material anode is made from   _____

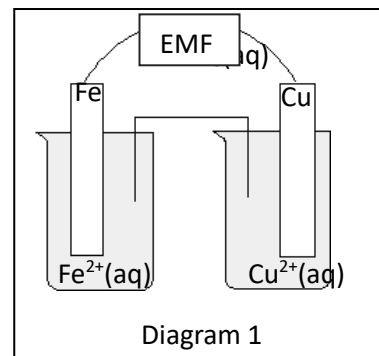   Material cathode is made from _____

   Write the reactions taking place in each half cell and label the following

   - Anode
   - Cathode
   - Direction of electron flow

2. Consider the galvanic cell shown on the right.
   a. Calculate the theoretical voltage if all electrolytes are at 1 M and 25 °C

   _____

   _____

   _____

Diagram 1

   b. When the two half cells are connected no observable reaction takes place. Offer an explanation for this observation.
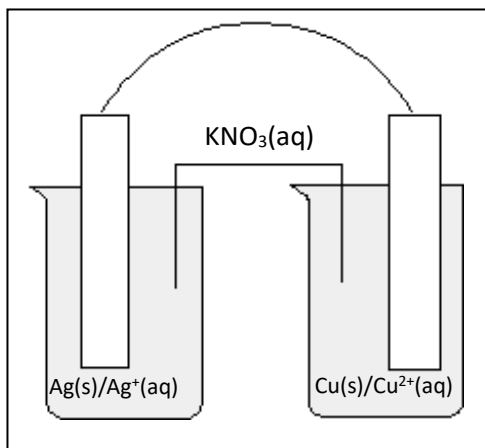
   _____

   _____

   _____

   c. **Explain** the possible outcomes when the following changes to the galvanic cell in diagram 1 are made.
      i.   The copper electrode is replaced with a zinc electrode.

   _____

   _____

   _____

      ii.   The iron electrode is replaced with a carbon (graphite) electrode.

   _____

   _____

   _____

      iii.   The KNO_3 present in the salt bridge is replaced with a solution of $Mg(NO_3)_2$.

   _____

   _____

   _____

3. On the next page is a range of labelled galvanic cells. Complete the questions for each cell.

Diagram 1

KNO₃(aq)

$Ag(s)/Ag^+(aq)$ $Cu(s)/Cu^{2+}(aq)$

Show the following on the diagram.
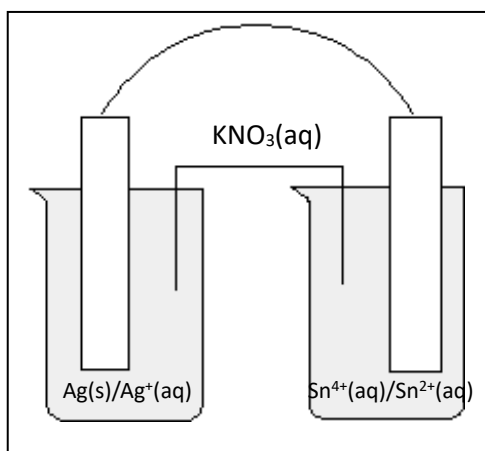
Anode (-)
Cathode (+)
Electron flow.
Anion flow.
Oxidation half equation_____
Reduction half equation_____

Overall equation _____

What material is the anode made from? _____

What material is the cathode made from? _____

Diagram 2

KNO₃(aq)

$Ag(s)/Ag^+(aq)$ $Sn^{4+}(aq)/Sn^{2+}(aq)$

Show the following on the diagram.

Anode (-)
Cathode (+)
Electron flow.
Anion flow.
Oxidation half equation_____
Reduction half equation_____

Overall equation _____

What material is the anode made from? _____

What material is the cathode made from? _____

Diagram 3

KNO₃(aq)

Cl_2

Pt

$Zn(NO_3)_2(aq)$ $NaCl(aq)$

Show the following on the diagram.
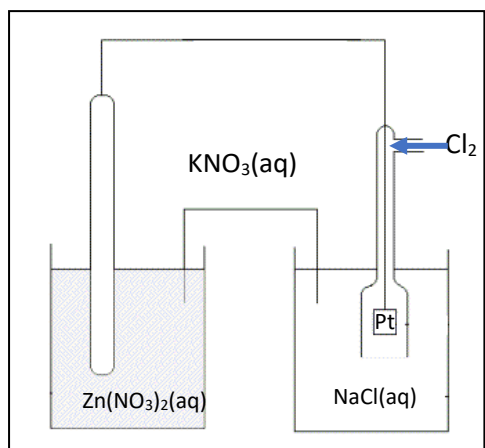
Anode (-)
Cathode (+)
Electron flow.
Anion flow.
Oxidation half equation_____
Reduction half equation_____

Overall equation _____

What material is the anode made from? _____

What material is the cathode made from? _____

Diagram 4

KNO₃(aq)

Au Cu(s)

$AuNO_3(aq)$ $Cu(NO_3)_2(aq)$

Show the following on the diagram.

Anode (-)
Cathode (+)
Electron flow.
Anion flow.
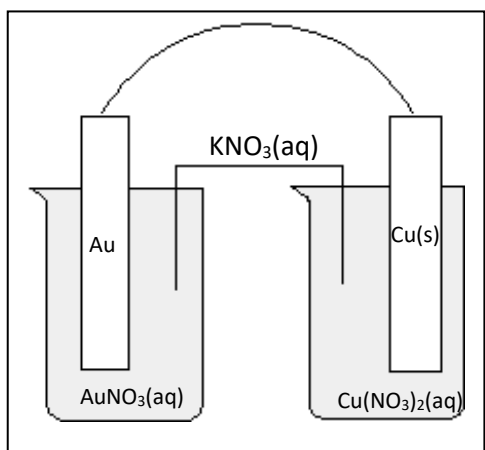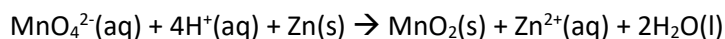Oxidation half equation_____
Reduction half equation_____

Overall equation _____

What material is the anode made from? _____

What material is the cathode made from? _____

3. The following overall redox reaction occurs during the discharge of a primary cell using an acidic electrolyte.

$$MnO_4{}^{2-}(aq) + 4H^+(aq) + Zn(s) \rightarrow MnO_2(s) + Zn^{2+}(aq) + 2H_2O(l)$$

a. Identify the:

i. Oxidant _____

ii. reductant _____

b. Write a balanced ionic equation, states included, for the oxidation reaction.

_____

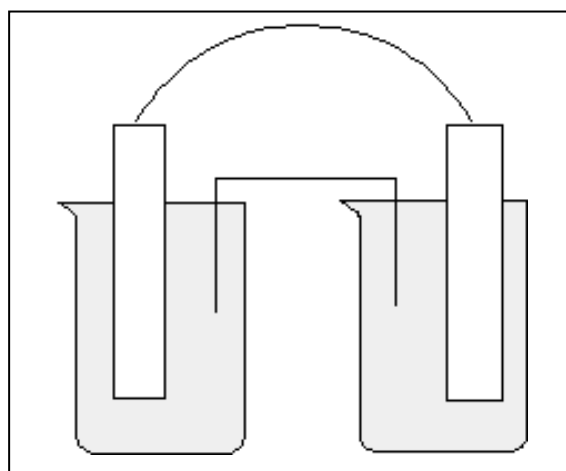c. Write a balanced ionic equation, states included, for the reduction reaction.

_____

d. Write the reactions taking place in each half cell and label the following :

i. Anode

ii. Cathode

iii. Direction of electron flow.

iv. Direction of **cation**, flow

e. Give one possible material which could be used to make the

i. anode

_____

ii. Cathode

_____

f. Is it possible to use MnO_2 as an electrode? Justify your answer.

_____

_____

_____

g. Suggest the possible changes in the mass of each electrode by circling one of the three alternatives given. Offer an explanation to support your choice.

i. anode . *Increase,* *stay the same ,* *decrease*

_____

_____

ii. cathode. *Increase,* *stay the same ,* *decrease*

_____

_____

h. A research scientist suggested that an alkaline electrolyte be used for the same battery to improve the shelf life of the battery. Write the balanced equation, states included, for the overall reaction taking place in the new **alkaline** version.

_____

i. Given that the cell EMF is 1.36 V, in an acidic electrolyte, calculate the standard electrode potential (E^O), in volts, of the half cell MnO_4^- (aq)/MnO_2(s). Place the reaction and its E^0 in the appropriate position in the table below. Two possible locations are highlighted for you.

Reaction	E^o
$2H^+$(aq) + 2e⁻ → $H_2^{(g)}$	0.00
Zn^{2+}(aq) + 2e → Zn(s)	-0.76