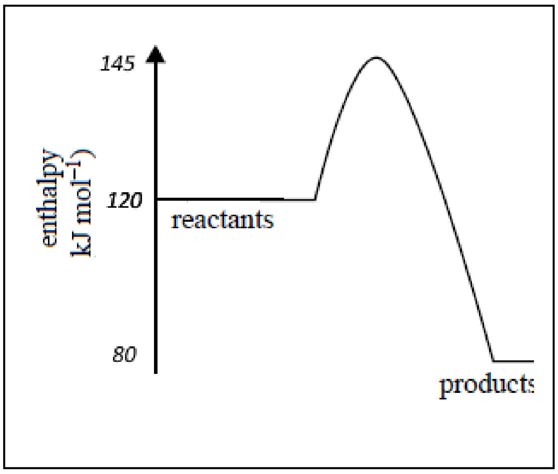
Revision Unit 3 VCE Chemistry 2018

Thermochemical equations, electrolysis, equilibrium and rates of reaction.



1) Consider the energy profile diagram of the reaction a(g) + b(g) → c(g), shown on the right.
   a) Indicate on the diagram the:
      - ΔH
      - Activation energy for the forward reaction a(g) + b(g) → c(g)
      - Activation energy for the reverse reaction c(g) → a(g) + b(g)
      -
   b) Which of the two reactions listed below a(g) + b(g) → c(g) or c(g) → a(g) + b(g) has the fastest rate of reaction at room temperature? Explain why.
   c) When one mole each of a and b react what amount of energy(in kJ) is :
      - required in the process of bond breaking
      - released in the process of bond formation -
   d) The combustion of 0.156 grams of hexane (86.2 g/mol) takes place according to the equation $2C_6H_{14}(g) + 19O_2(g) \rightarrow 12\ CO_2(g) + 14H_2O(g)$ ΔH = - 8316 kJ mol^{-1} in a bomb calorimeter containing 100 mL of water at 25.0°C.

      Calculate the final temperature of the water assuming no energy is lost to the surroundings.

2) Given the following thermochemical equations

- $1/2N_2(g) + 3/2H_2(g) \rightarrow NH_3(g)$; ΔH = -46.1kJ
- $C(s) + 2H2(g) \rightarrow CH4(g)$; ΔH = -74.7kJ
- $C(s) + 1/2H2(g) + 1/2\ N2(g) \rightarrow HCN(g)$; ΔH = +135.2kJ

a) Find the ΔH for the reaction:

$CH_4(g) + NH_3(g) \rightleftarrows HCN(g) + 3H_2(g)$

b) This reaction took place in a bomb calorimeter, where 16.00 grams of CH_4 was placed in a 2.00 litre vessels with 28.05 grams of ammonia and allowed to reach equilibrium at a temperature of 20.0°C . A total of 83.5 kJ of energy was absorbed from the surroundings.

Assuming no heat was lost from the system calculate, at equilibrium, the:

⇨ Mol of CH_4 and the $[CH_4]$

⇨ Mol of NH_3 and the $[NH_3]$

⇨ Mol of HCN and the [HCN]

⇨ Mol of H_2 and the $[H_2]$

c) Calculate the k_c value for the reaction $CH_4(g) + NH_3(g) \rightleftarrows HCN(g) + 3H_2(g)$ at the given temperature in b) above.

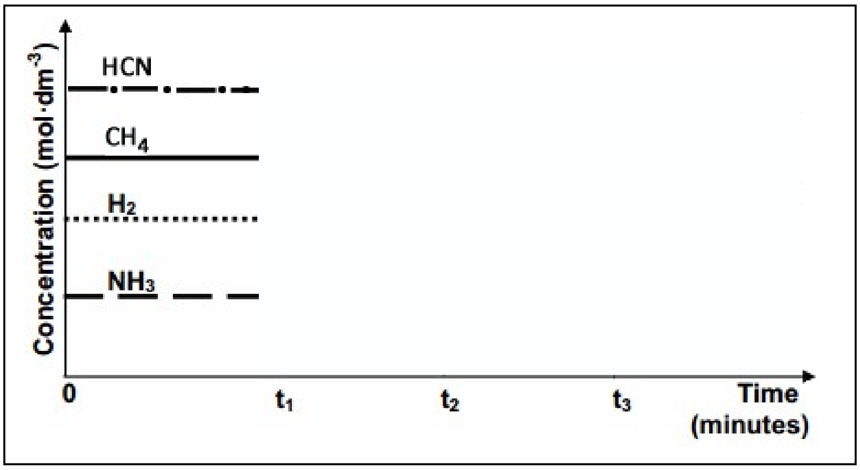
d) Calculate the theoretical yield of HCN in mol.

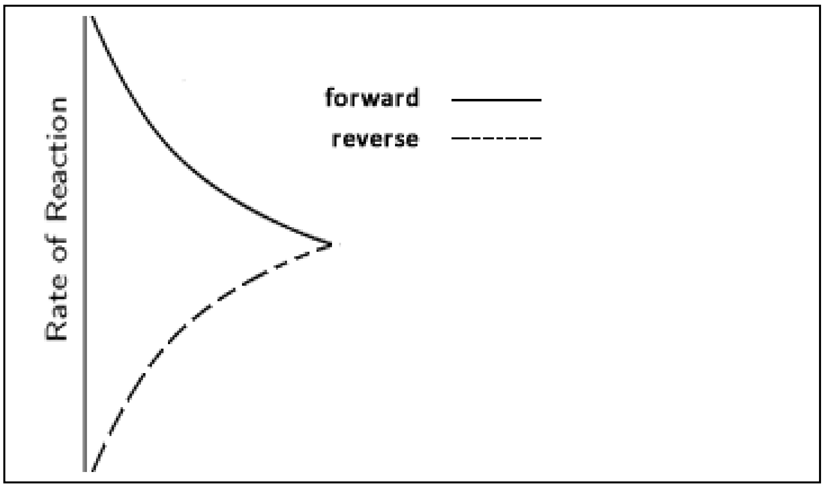
e) Calculate the actual yield of HCN in mol.

f) Calculate the percentage yield for this reaction at equilibrium

g) The temperature of the equilibrium established in d) above was changed. The graph below shows the concentrations for the different species at equilibrium. Sketch how the concentration of each species as well as the rate of the forward and reverse reactions change over time when at:

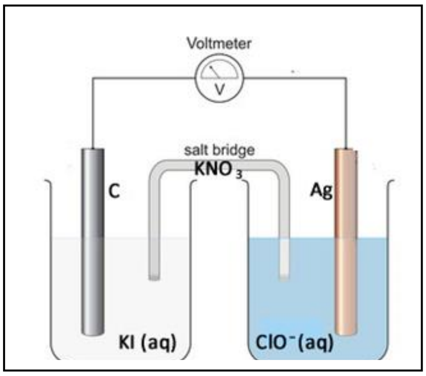
- T_1 extra NH_3 is added to the system and equilibrium is established before T_2
- T_2 the volume of the vessel is doubled and equilibrium is established before T_3
- T_3 neon gas is added to the system and the pressure inside the vessel is doubled

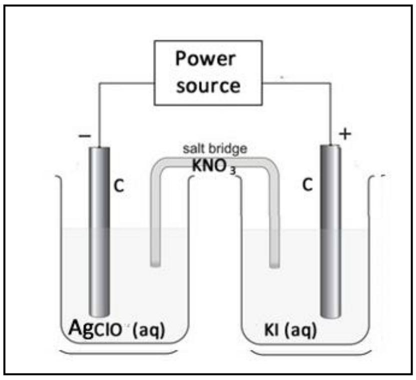


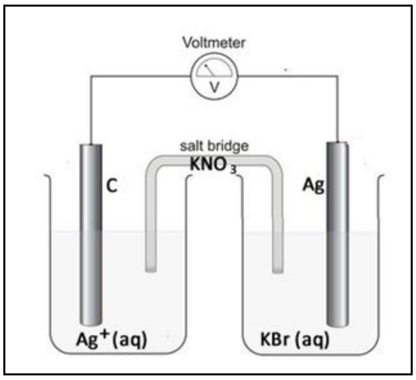


3) Consider the **Standard Reduction Potentials at 25°C (298K) shown below**

$Cr_2O_7^{2-}(aq) + 14H^+(aq) + 6e^- \rightarrow 2Cr^{3+}(aq) + 7H_2O(l)$	+1.33
$O_2 + 4H^+(aq) + 4e^- \rightarrow 2H_2O(l)$	+1.23
$ClO_4^-(aq) + 2H^+(aq) + 2e^- \rightarrow ClO_3^-(aq) + H_2O(l)$	+1.23
$MnO_2(s) + 4H^+(aq) + 2e^- \rightarrow Mn^{2+}(aq) + 2H_2O(l)$	+1.23
$IO_3^-(aq) + 6H^+(aq) + 5e^- \rightarrow I_2(s) + 3H_2O(l)$	+1.20
$Br_2(l) + 2e^- \rightarrow 2Br^-(aq)$	+1.09
$HNO_2(aq) + H^+(aq) + e^- \rightarrow NO(g) + H_2O(l)$	+1.00
$NO_3^-(aq) + 4H^+(aq) + 3e^- \rightarrow NO(g) + 2H_2O(l)$	+0.96
$ClO^-(aq) + H_2O(l) + 2e^- \rightarrow Cl^-(aq) + 2OH^-(aq)$	+0.89
$ClO^-(aq) + 2H^+(aq) + e^- \rightarrow NO_2(g) + H_2O(l)$	+0.80
$Ag^+(aq) + e^- \rightarrow Ag(s)$	+0.80
$Fe^{3+}(aq) + e^- \rightarrow Fe^{2+}(aq)$	+0.77
$BrO^-(aq) + H_2O(l) + 2e^- \rightarrow Br^-(aq) + 2OH^-(aq)$	+0.76
$MnO_4^{2-}(aq) + 2H_2O(l) + 2e^- \rightarrow MnO_2(s) + 4OH^-(aq)$	+0.60
$H_3AsO_4(aq) + 2H^+(aq) + 2e^- \rightarrow H_3AsO_3(aq) + H_2O(l)$	+0.56
$MnO_4^{2-}(aq) + e^- \rightarrow MnO_4^{2-}(aq)$	+0.56
$H_3AsO_4(aq) + 2H^+(aq) + 2e^- \rightarrow H_3AsO_3(aq) + H_2O(l)$	+0.56
$I_2(s) + 2e^- \rightarrow 2I^-(aq)$	+0.54
$2H_2O(l) + 2e^- \rightarrow H_2(g) + 2OH^-(aq)$	-0.83







Indicate on the diagram the:
- direction of electron flow
- direction of cation movement

Identify the

Oxidant -

Reductant -

Write the

- half equation at the negative electrode

- half equation at the positive electrode

Calculate the theoretical voltage.

Indicate on the diagram the:
- direction of electron flow

Identify the

Oxidant -

Reductant -

Write the

- oxidation half equation

- reduction half equation

At which electrode is each half equation taking place.

Will a reaction occur?

Identify the

Oxidant -

Reductant -

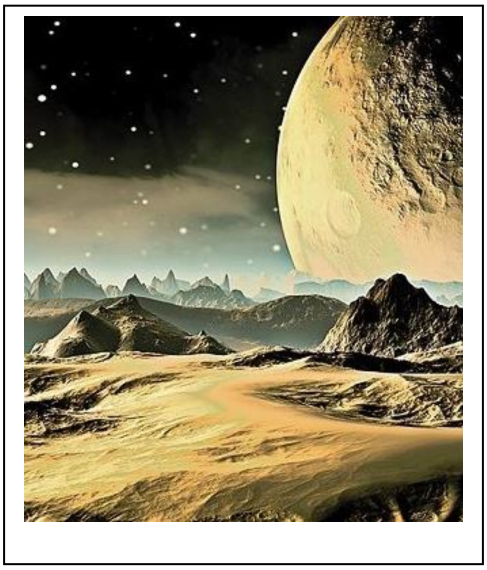
Write the

- half equation at the negative electrode

- half equation at the positive electrode

Calculate the theoretical voltage.

4) On an alien planet a Human colony is established.



The planet is near a star and receives as much solar energy as Earth, however, unlike Earth has no atmosphere but has huge deposits of ice found in the shaded areas of craters. The planet rotates on its axis much like Earth, but has a gravitational pull one tenth that of Earth and has long periods of night and day. The colony has access to a variety of crops including corn and a range of micro-organisms such as yeast.

Using your chemical knowledge suggest plausible solutions for the following. Provide balanced chemical equations to justify all your suggestions and diagrams of any electrochemical cells that are needed.

a) The need for:
   - water for drinking and for the herbarium to sustain plant life.

   - a reliable, inorganic, source of oxygen gas (draw a possible device labelling the terminals and their polarity as well as the chemical reactions taking place at each terminal)

   - a reliable electrical supply in the night provided by fuel cells, with acidic electrolytes, powered by recyclable gases.

   - a renewable, organic, fuel that is carbon neutral to power electric vehicles when travelling in long periods of darkness. Suggest why this fuel is renewable.

   - a low weight fuel to launch vehicles into space that has the highest energy density of all the available fuels produced by the colony. Justify your choice of fuel.