Revision 6 – secondary cells, equilibrium, rates

1) An alkaline nickel cadmium battery is shown on the right.
When discharging the overall cell reaction is given below.

$Cd(s) + 2NiO(OH)(s) + 2H_2O(l) \rightarrow Cd(OH)_2(s) + 2Ni(OH)_2(s)$

a) Give the balanced chemical equation of the half reaction that occurs at the:

- Anode
- Cathode

b) The cell is recharged using a recharger that is 80.0% efficient. A current of 1.11 amps is applied for 2.560 hours.

i) Give the polarity and the balanced chemical equation to the half reaction occurring at the:

- anode
- cathode

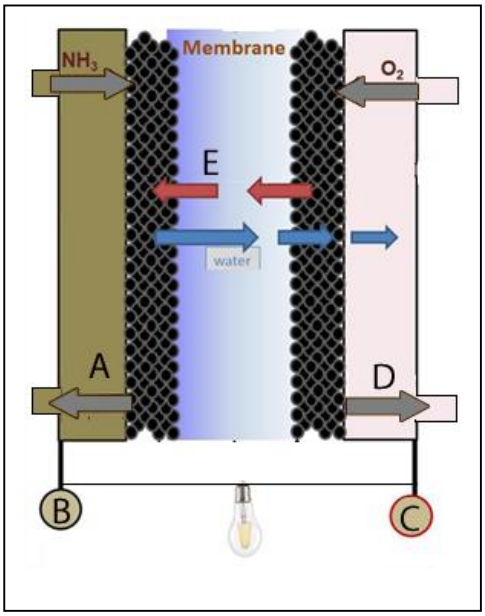
c) What is the change in mass of the cathode after recharging?

2) An ammonia fuel cell is shown on the right. Ammonia is cheaper to store and transport than hydrogen. This fuel cell uses a hydroxide exchange membrane.
The overall cell reaction is given below.

$4NH_3(l) + 3O_2(g) \rightarrow 2N_2(g) + 6H_2O(g)$ $\Delta H = -1290$ kJ/mol

a) Give the balanced equations to the half reactions occurring at the:
anode
cathode

b) Give one advantage of using ammonia over ethanol as the fuel.



c) Identify the following.

i. Polarity of electrode B

ii. Polarity of electrode C

iii. Exhaust gas A

iv. Exhaust gas D

v. Ions labelled E

d) What volume, in litres, of N_2 gas is theoretically formed at S.L.C. if the fuel cell provides a steady 12.00 amps of electrical current over a period of 24.00 hours?

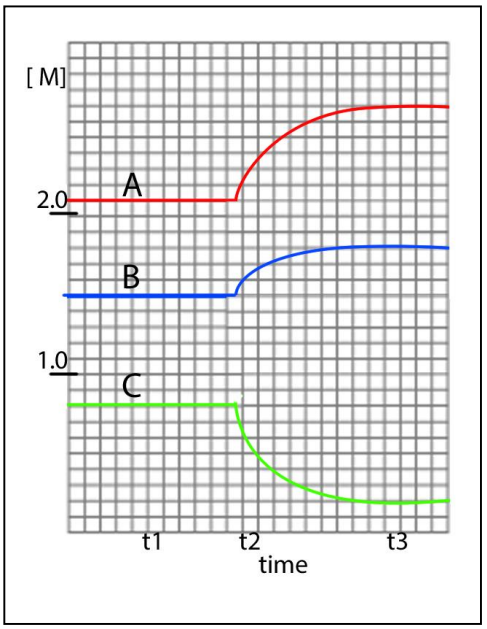
e) If the fuel cell is 80.00% efficient in converting chemical energy into electrical energy what amount of ammonia , in grams, is required to deliver 0.5000 MJ of electrical energy?

f) If the amount of ammonia, calculated in e) above, is placed in a 30.0 L container at 30.00 ^oC what is the pressure, in kPa, exerted by the gas on the walls of the container?

g) An external, 90.0 L, pressurised container of ammonia constantly feeds the fuel cell that is 80.0% efficient. Ammonia is kept in the cylinder at a pressure of 612.3 kPa and a temperature of 25.0 ^oC. Calculate the length, in hours, of operation of the fuel cell if it delivers a constant current of 12.0 amps?

3) Consider the concentration versus time graph shown on the right of a reaction taking place in a closed vessel. At time t_2 the vessel is heated.

a) Give a possible balanced equation to the reaction taking place and indicate whether it is exothermic or endothermic.



b) Consider the reaction forming C. Describe how the yield and the rates of the forward and backward reactions change as a result of a temperature increase. Explain.

c) Calculate the value of the equation quotient at t_1 using your answer to question a) above.

d) Explain how the equilibrium constant changes from t_1 to t_3.