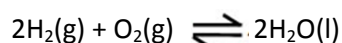


Friday Worksheet

Name:

Fuel cells worksheet 1

- 1) A hydrogen-oxygen fuel cell can operate with an alkaline electrolyte such as potassium hydroxide. The overall reaction is given below



- a) Write the half-equation for the reaction that occurs at the cathode.

The reduction reaction takes place at the cathode.

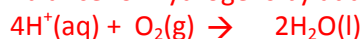
Step 1 since oxygen goes from an oxidation state of 0 to -2 it is reduced. Write the reduction reaction



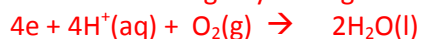
Balance for oxygens by adding H₂O on the right



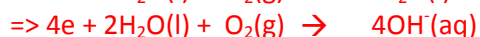
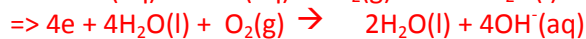
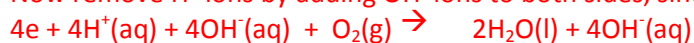
Balance for hydrogens by adding H⁺ on the left



Balance for charge by adding electrons to the most positive side



Now remove H⁺ ions by adding OH⁻ ions to both sides, since it is an alkaline electrolyte.

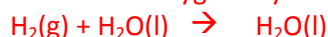


- b) Write the half-equation for the reaction that occurs at the anode.

Step 1 since hydrogen goes from an oxidation state of 0 to +1 it is oxidised. Write the oxidation reaction



Balance for oxygens by adding H₂O on the left



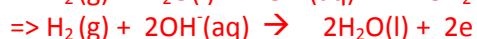
Balance for hydrogens by adding H⁺ on the right



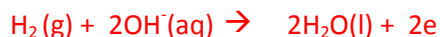
Balance for charge by adding electrons to the most positive side



Now remove H⁺ ions by adding OH⁻ ions to both sides, since it is an alkaline electrolyte.



- c) This hydrogen-oxygen fuel cell uses 1.45×10^{-5} mol of hydrogen gas per second of operation. What is the current produced by this cell?



According to the equation above, for every mol of H_2 gas used 2 mol of electron is produced.

$$\Rightarrow n_e = 2.90 \times 10^{-5}$$

Find the charge produced by this mol of electrons using Faraday's constant

$$\Rightarrow Q = 2.90 \times 10^{-5} \times 96,500 = 2.80 \text{ Coulomb}$$

Find the current

$I = Q \times t$ where Q is charge in Coulomb and t is time in seconds and I is current in amps

$$\text{Current} = 2.80 \times 1 = 2.80 \text{ Amps}$$

- d) What is the maximum voltage predicted for one alkaline hydrogen/oxygen fuel cell under standard conditions?

$$0.40 - - 0.83 = 1.23 \text{ V}$$

$\text{O}_2(\text{g}) + 2\text{H}_2\text{O}(\text{l}) + 4\text{e}^- \rightleftharpoons 4\text{OH}^-(\text{aq})$	+0.40
$\text{Cu}^{2+}(\text{aq}) + 2\text{e}^- \rightleftharpoons \text{Cu}(\text{s})$	+0.34
$\text{Sn}^{4+}(\text{aq}) + 2\text{e}^- \rightleftharpoons \text{Sn}^{2+}(\text{aq})$	+0.15
$\text{S}(\text{s}) + 2\text{H}^+(\text{aq}) + 2\text{e}^- \rightleftharpoons \text{H}_2\text{S}(\text{g})$	+0.14
$2\text{H}^+(\text{aq}) + 2\text{e}^- \rightleftharpoons \text{H}_2(\text{g})$	0.00
$\text{Pb}^{2+}(\text{aq}) + 2\text{e}^- \rightleftharpoons \text{Pb}(\text{s})$	-0.13
$\text{Sn}^{2+}(\text{aq}) + 2\text{e}^- \rightleftharpoons \text{Sn}(\text{s})$	-0.14
$\text{Ni}^{2+}(\text{aq}) + 2\text{e}^- \rightleftharpoons \text{Ni}(\text{s})$	-0.23
$\text{Co}^{2+}(\text{aq}) + 2\text{e}^- \rightleftharpoons \text{Co}(\text{s})$	-0.28
$\text{Fe}^{2+}(\text{aq}) + 2\text{e}^- \rightleftharpoons \text{Fe}(\text{s})$	-0.44
$\text{Zn}^{2+}(\text{aq}) + 2\text{e}^- \rightleftharpoons \text{Zn}(\text{s})$	-0.76
$2\text{H}_2\text{O}(\text{l}) + 2\text{e}^- \rightleftharpoons \text{H}_2(\text{g}) + 2\text{OH}^-(\text{aq})$	-0.83

- 2) Which of the following are advantages of modern fuel cells over conventional methods of electricity generation.
- They generate very little noise.
 - They are a cheap source of electricity.
 - They enable electricity to be generated on site.
 - They have the potential to reduce emissions of carbon dioxide into the atmosphere

i,iii and iv. At the moment fuel cells are very expensive.