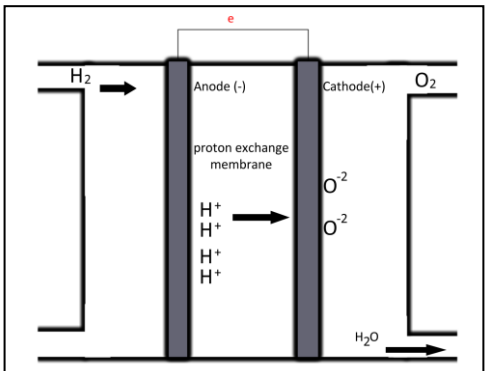
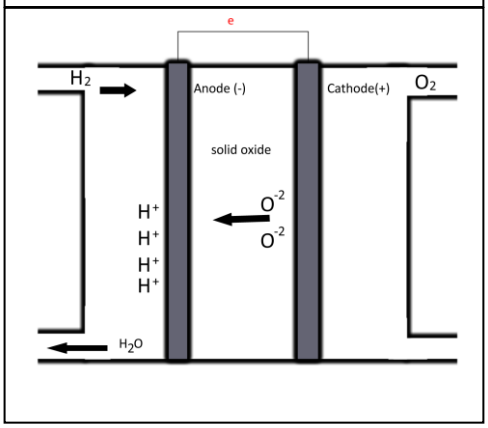
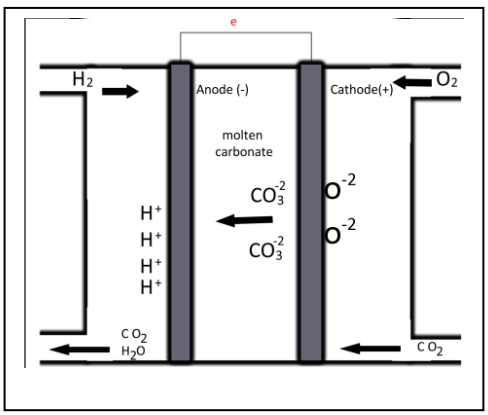
Lesson 12 Fuel cells

1) A hydrogen-oxygen fuel cell, operating at 25 ^{o}C, has gaseous oxygen and hydrogen pumped in at a pressure of 1 atm. This cell is 70.0% efficient in transforming chemical energy into electrical energy. Oxygen is kept in a full cylinder.
   a) Write an overall equation for the redox reaction occurring in the fuel cell.
   $O_2(g) + 2H_2(g) \rightarrow 2H_2O(l)$
   b) What is the volume of the cylinder if one full cylinder of oxygen allows for the evolution of 30.00 MJ of electrical energy?
   Step 1 Find the total amount of heat energy released in order to deliver 30.00 MJ of electrical energy.
   => let x be the total energy released
   => x X 0.700 = 30,000kJ
   => x = 30,000/ 0.700 = 42,860 Kj
   Step 2 find the mol of hydrogen gas that released this amount of energy
   => 42,860 KJ / 282 KJ = 152 mol
   Step 3 Find the mol of oxygen gas.
   => according to the stoichiometry of the overall equation
   => mol of oxygen = ½ X 152 = 76.0 mol of O_2 gas.
   Step 4 find the volume of oxygen gas.
   => since the cell operates at standard conditions the volume is calculated by the formula below
   V =76.0 X 24.8 = 1880 litres.
2) Using the template shown on the right construct a hydrogen –oxygen fuel cell using an:
   - Proton exchange membrane electrolyte
   - Solid oxide electrolyte
   - Molten sodium carbonate electrolyte
   - Alkaline (KOH) electrolyte.
   - Acidic (H_3PO_4) electrolyte
   - Label the:
     Anode and cathode
     ions flow through the electrolyte and their direction
     Products and reactants







Write the balanced equations for the half cell reactions

Proton exchange membrane fuel cells

Anode $H_2 \rightarrow 2H^+ + 2e$

Cathode $O_2 + 4H^+ + 4e \rightarrow 2H_2O$

Acidic electrolyte

Anode $H_2 \rightarrow 2H^+ + 2e$

Cathode $O_2 + 4H^+ + 4e \rightarrow 2H_2O$

Alkaline fuel cell

Anode $H_2 + 2OH^- \rightarrow 2H_2O + 2e$

Cathode $O_2 + 2H_2O + 4e \rightarrow 4OH^-$

Solid oxide

Anode $H_2 + O^{-2} \rightarrow H_2O + 2e$

Cathode $O_2 + 4e \rightarrow 2O^{-2}$

Molten carbonate

Anode $H_2 + CO_3^{-2} \rightarrow H_2O + 2e + CO_2$

Cathode $O_2 + 4e + 2CO_2 \rightarrow 2CO_3^{-2}$

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