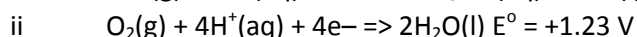
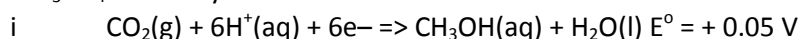


Friday worksheet 3 Fuel cells

1 A  $\text{H}_3\text{PO}_4$  electrolyte fuel cell can be constructed that uses the following two half-reactions.



a) Draw a labelled fuel cell using the template

on the right. Label the:

- anode and cathode
- polarity of the electrode
- direction of electrons
- direction of ions through the electrolyte

b) Identify the oxidant and reductant.

- oxidant

- reductant

c) Which of the following is likely to occur at the

**cathode**? Explain

-  $\text{CH}_3\text{OH}$  is used up

- pH of the surrounding electrolyte decreases

- Water is formed

- Oxygen gas is used up.

d) Ethane is burnt in an alkaline electrolyte fuel cell.

i. Write the balanced reaction occurring at the

- cathode

- anode

ii. Label the remaining products and reactants

iii. Identify the ions travelling through the electrolyte and indicate their direction of travel.

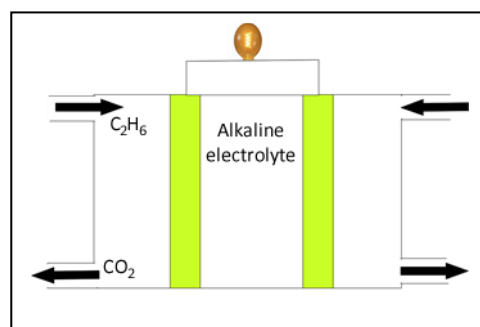
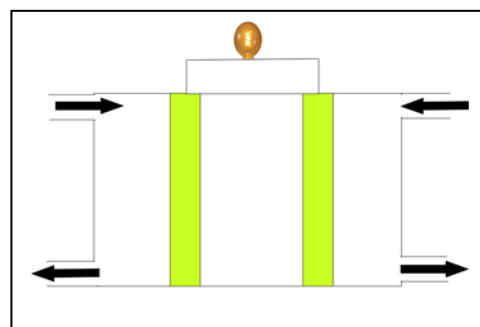
iv. Which of the comments below is/are true about this alkaline fuel cell.

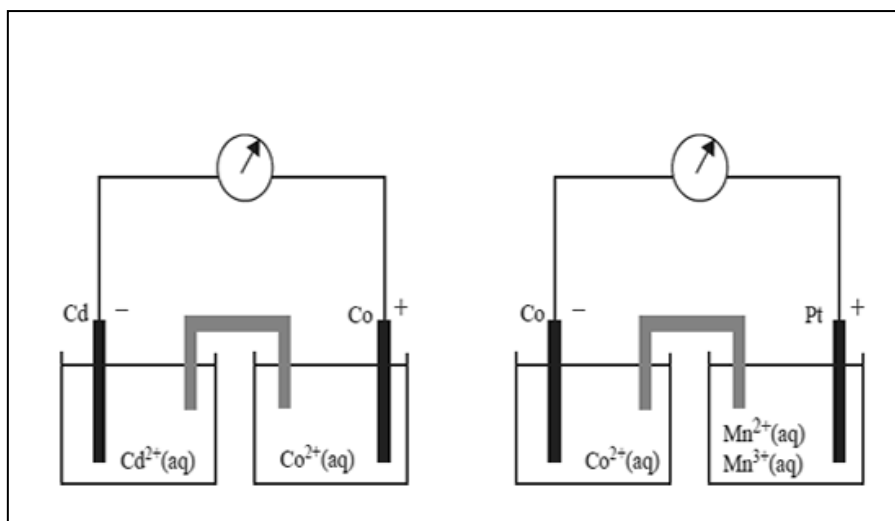
- All the chemical energy supplied is converted into electrical energy.

- The cell can be recharged using electrical energy from a power source.

- The pH of the electrolyte increases as the cell discharges

v. Calculate the energy efficiency of this cell when 20.0 grams of ethane produces 800 kJ of electrical energy at  $25^\circ\text{C}$  and 100 kPa pressure.





2) Consider the half cells shown above. Which one of the following reactions would not be expected to occur spontaneously? Explain

- A.  $\text{Co}^{2+}(\text{aq}) + \text{Cd}(\text{s}) \rightarrow \text{Co}(\text{s}) + \text{Cd}^{2+}(\text{aq})$
- B.  $2\text{Mn}^{3+}(\text{aq}) + \text{Co}(\text{s}) \rightarrow 2\text{Mn}^{2+}(\text{aq}) + \text{Co}^{2+}(\text{aq})$
- C.  $2\text{Mn}^{3+}(\text{aq}) + \text{Cd}(\text{s}) \rightarrow 2\text{Mn}^{2+}(\text{aq}) + \text{Cd}^{2+}(\text{aq})$
- D.  $2\text{Mn}^{2+}(\text{aq}) + \text{Co}^{2+}(\text{aq}) \rightarrow 2\text{Mn}^{3+}(\text{aq}) + \text{Co}(\text{s})$

3) Consider the vanadium ion battery shown below.

a) Give the polarity of each electrode

b) Which vanadium-containing ion will have the highest concentration at the anode after the cell's first recharge and while it is still connected to the power source.

c) Write a balanced overall equation to show why iron would be an unsuitable material to use as electrode B in the vanadium redox cell.

d) Write a balanced overall equation to show if Zn metal is or is not appropriate for use as electrode B. Discuss if heat or electrical energy is the main output for this cell if Zn is used as electrode B.

e) Discuss one major difference between a fuel cell and the vanadium ion battery.

