Video worksheet -primary, secondary and fuel cells.

1. A secondary, alkaline cell produces 1.5 V, but has a longer shelf life and maintains a constant voltage output during discharge than an acidic, primary cell. Its overall equation is shown below.

$$Zn(s)+2MnO_2(s)\longrightarrow ZnO(s)+Mn_2O_3(s)$$

   a. Identify the oxidant. _____

   b. Identify the reductant. _____

   c. Give the balanced equation, states included, for the reaction taking place at the positive electrode.

   d. As the cell is allowed to discharge for exactly 3.45 minutes it produces a current equivalent to 0.60 mol of electrons. What is the mass change, in grams, at the anode as the battery is discharging? Give your answer to the right number of significant figuress.

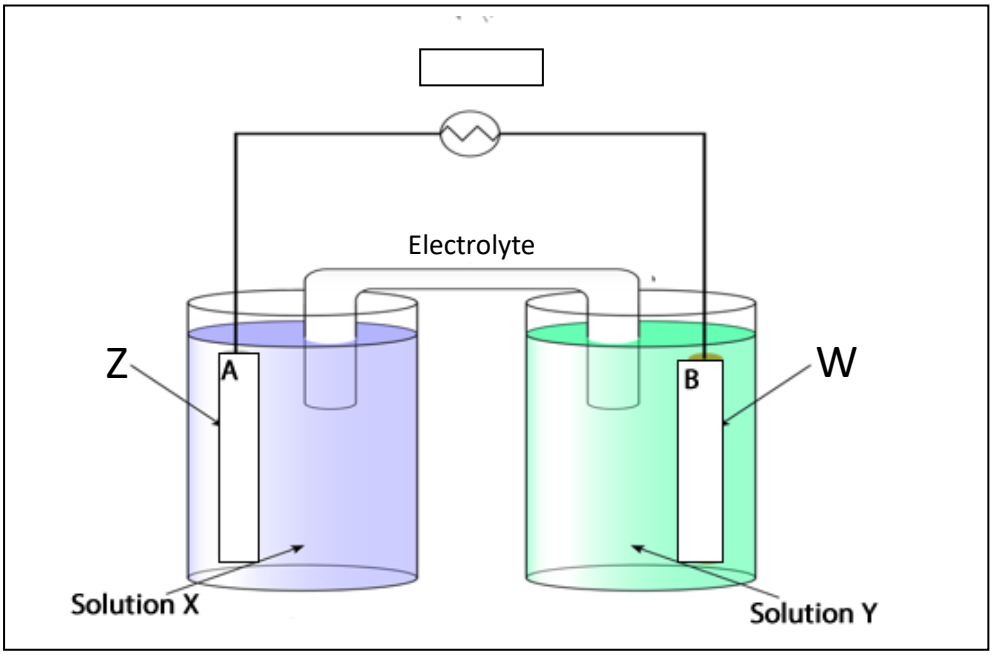
   e. An attempt is made to recharge the battery. Give the balanced, half equation occurring the positive electrode of the battery when the recharger is connected. Included states.

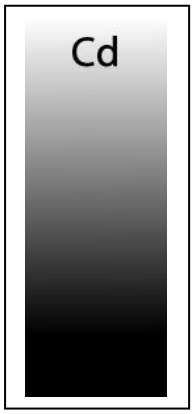
   f. Give one condition of this cell that enables recharging to occur?

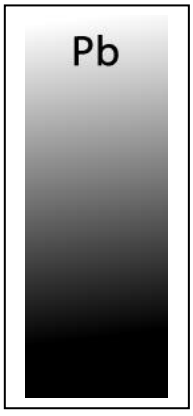
   g. Argue for or against this comment. “Fuel cells and secondary cells can be recharged multiple times”

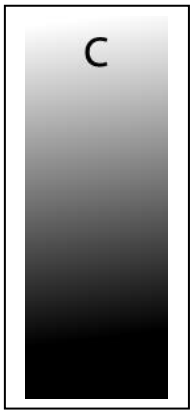
   h. State one disadvantage of using a fuel cell as opposed to a set of secondary cells.

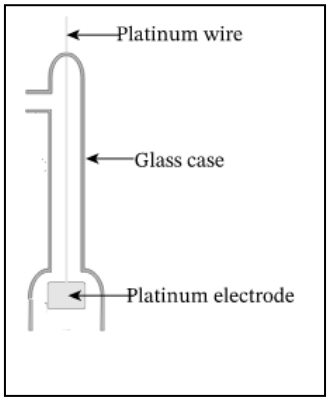
2. A galvanic cell is setup by a student to produce a theoretical output of 1.36 V at standard conditions.
   Construct this galvanic cell using the template shown and select from the electrodes given below.







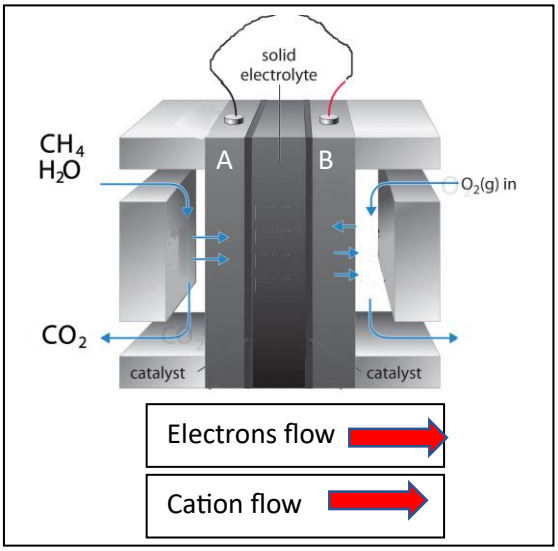




a. In the spaces labelled A and B draw and correctly label the electrodes used in each half cell.
b. Indicate the direction of electron flow by placing an arrow in the box provided.
c. Select an appropriate electrolyte. Justify your selection.
d. Choose appropriate solutions for X and Y, concentration needed.
   Solution X _____ Concentration _____
   Solution Y _____ Concentration _____
e. Give the reactants Z and W Z _____ , W _____
f. Give the half reaction occurring at the:
   - anode
   - cathode

g. How will the cell function change if $Al(NO_3)_3$ is used as the electrolyte for the salt bridge?

3. The PEMFC shown on the right operates on methane gas sourced from biogas.



a. Give the balanced reaction, states not required, occurring at each electrode:

- A _____

- B _____

b. Give the balanced equation, states not included, to the overall reaction taking place in the fuel cell.

c. In the boxes provided in the diagram on the right, label the following:
- direction of electron flow
- direction of cation flow

d. List three differences between the electrodes of this cell and the electrodes of a primary cell.

Fuel cell	Primary cell

e. List one similarity between the electrodes of the fuel cell and the primary cell.

h. An MCFC (molten carbonate fuel cell) operates at 800 °C and can also be used to burn methane. The combustion reaction in the MCFC is exactly the same as the combustion of methane in the PEMFC. Give the reaction taking place, states included, at the negative electrode if methane gas is burnt in an MCFC to produce electricity.

f. Methane gas is also used as a fuel to drive an electric generator, shown on the right. Both the PEMFC and the generator have the same overall reaction taking place. Compare the efficiency of both the fuel cell and the generator in producing electrical energy from a given mass of methane gas. Justify your response.