Electrochemical cells- revision

An experimental electrochemical cell, known as a carbon-air cell, uses stored, pressurised CO_2 gas as a fuel to store and generate electrical energy. A simplified diagram of the setup during recharge and discharge is shown below. This unit combines a solid oxide fuel cell (SOFC) and an electrolytic cell.

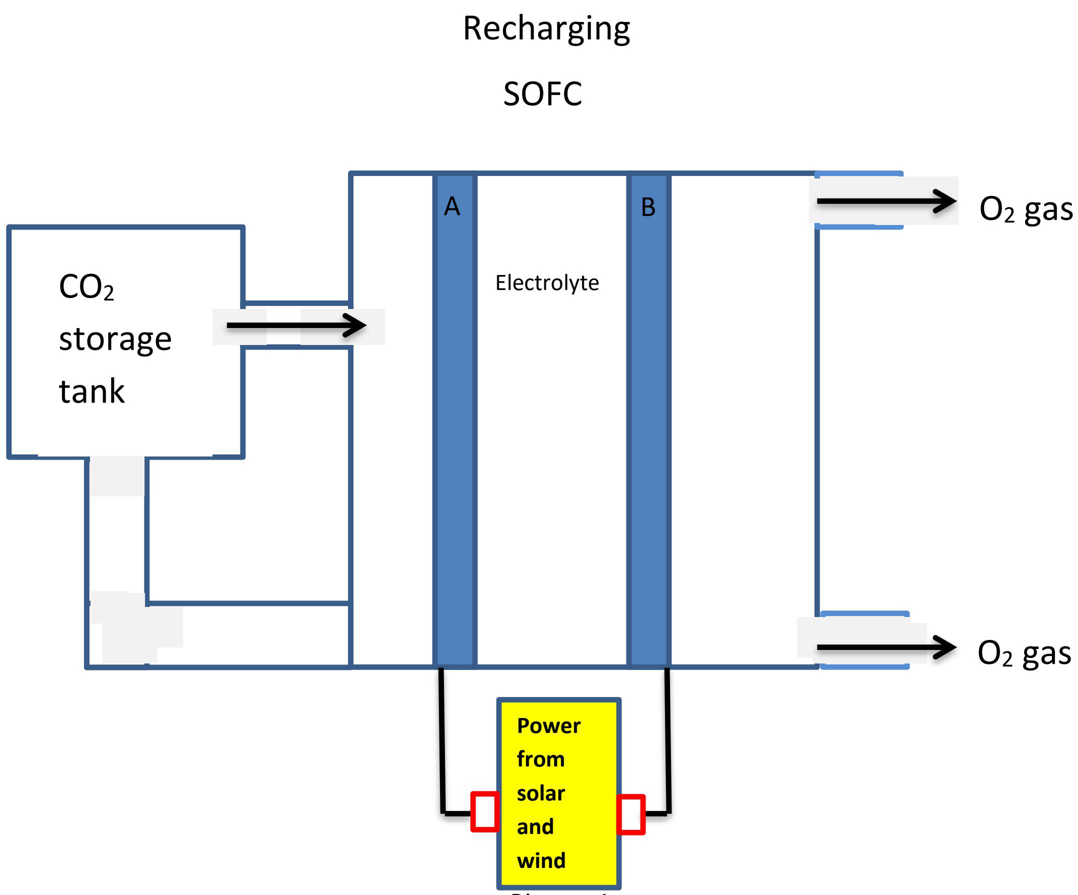

Diagram 1

1) Write a balanced half equation, states not required, for the reaction taking place at electrode :
   "A" ______________________________
   "B" ______________________________
2) Identify the polarity of electrode "A" and give a reason as to why it is the anode or the cathode.
3) In which direction are electrons flowing through the cell shown above?
4) What ions flow though the electrolyte and in what direction?
5) Circle the type of electrochemical cell represented by the diagram above. Justify your selection.
   a. Primary cell
   b. Secondary cell
   c. Fuel cell
   d. Electrolytic cell.

Discharging

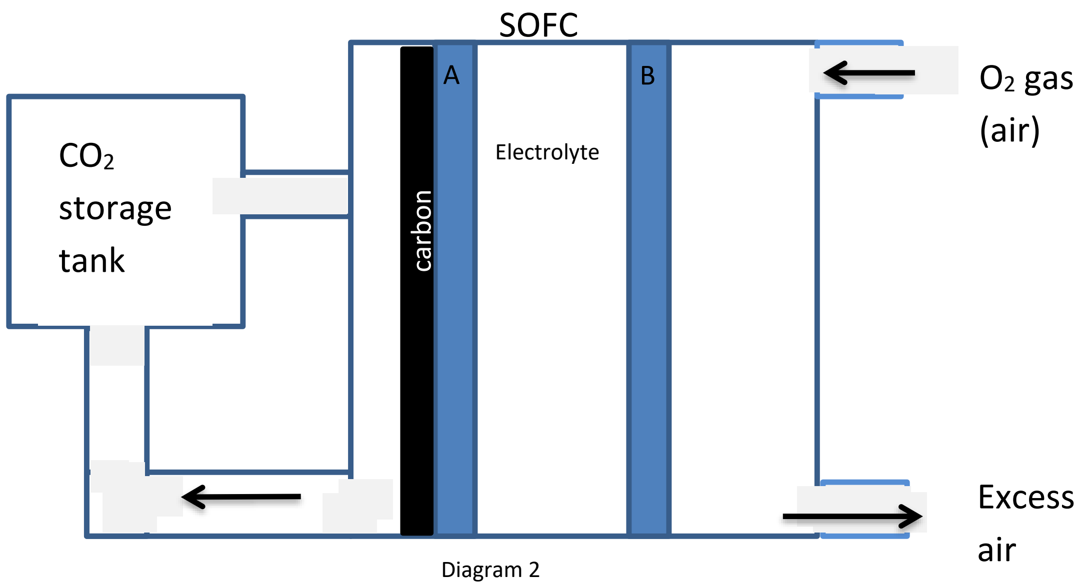

Diagram 2

6) Does this energy system deliver renewable energy? Explain.

7) Write a balanced half equation, states not required, for the reaction taking place at electrode :
   "A" ________________________________
   "B" ________________________________

8) Identify the polarity of electrode "A" and give a reason as to why it is the anode or the cathode.

9) In which direction are electrons flowing through the cell shown above?

10) What ions flow though the electrolyte and in what direction?

11) Circle the type of electrochemical cell represented by the diagram above. Justify your selection.

    a. Primary cell
    b. Secondary cell
    c. Fuel cell
    d. Electrolytic

12) What changes occur to electrodes A and B during:
    - discharge

    - recharge

13) In a typical carbon-air cell 3.00 grams of carbon is deposited during the recharge cycle and is used during the discharge phase.
a. Calculate the time, in hours, that the cell can operate for to produce a current of 0.50 A. Assume the cell is 100% efficient. Express your answer to the right number of significant figures.

b. What mass of carbon should be deposited if the cell is 83.0% efficient to produce a current of 0.500 A for 24.6 hours?

14) The storage tank of another carbon-air cell has a capacity of 46.0 litres and stores gas at 120°C and 300 kPa pressure.
a. Calculate the maximum mol of CO_2 gas that can be stored in the tank under these conditions.

b. Calculate the electrical energy, in kilojoules, generated by the cell during a 24.0 hour period running at 2.75 volts, assuming 100% efficiency. Energy (J) = Voltage(V) X Charge(C)

c. For this particular type of cell the mass of the gas that can be stored is not important, rather it is the volume that is the critical factor. It is suggested that the cell be slightly modified to use hydrogen to replace CO_2. Argue for or against this proposal. Use calculations of energy density (kilojoules/litre) and environmental considerations to justify your decision.