CLEAN ENERGY INSTITUTE
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Aluminum Air Battery Student Worksheet

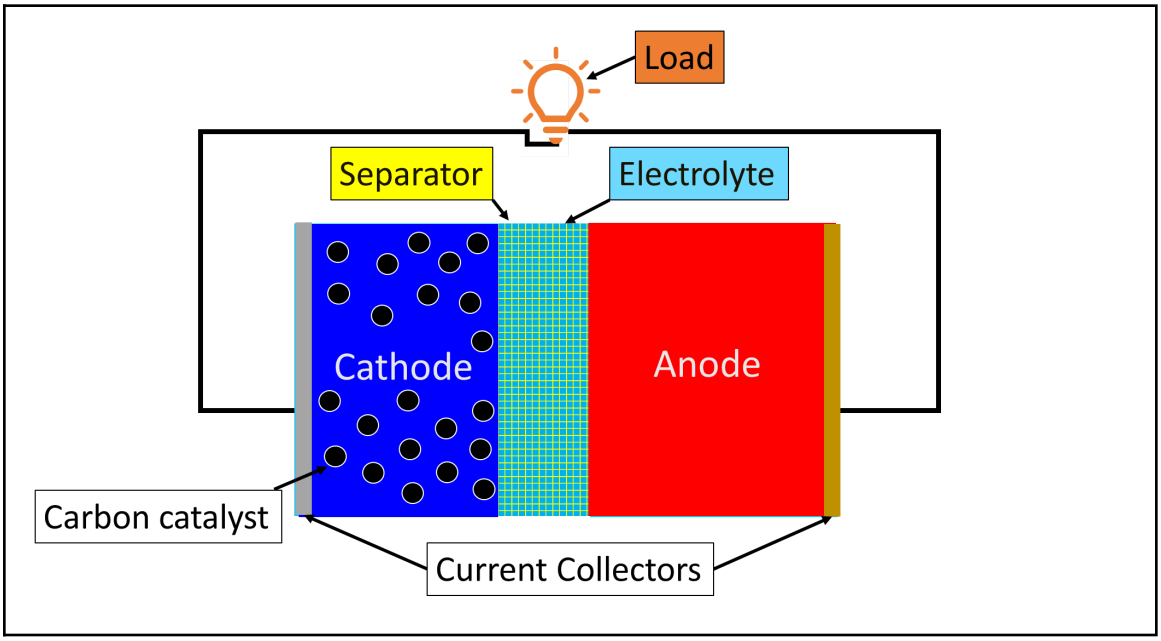
I. Introduction:

1. Balance the following half-reactions

Half-reaction (1): $?Al + ?OH^- \rightarrow ?Al(OH)_3 + ?e^- - 2.31$ V.
Half-reaction (2): $?O_2 + ?H_2O + ?e^- \rightarrow ?OH^- + 0.40$ V.
Full-reaction: $?Al + ?O_2 + ?H_2O \rightarrow ?Al(OH)_3 + ???$ V.

2. Which half-reaction is oxidation and which half-reaction is reduction? Based on your answer, what are the cathode and anode materials in an Aluminum-air battery?

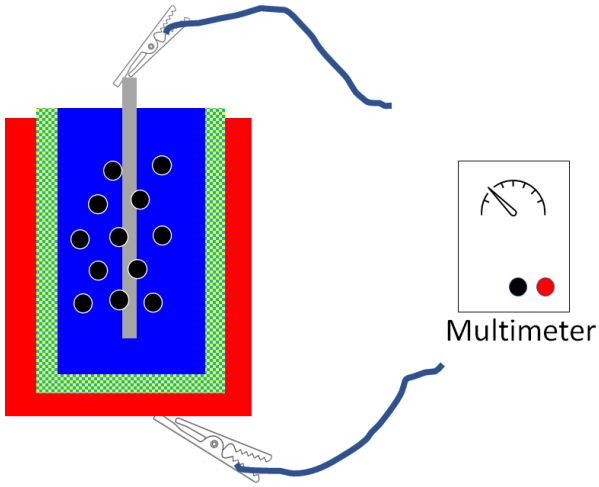
3. Below is a diagram of an Aluminum-air battery cell powering up a lightbulb. Draw the direction of the electron flow in the circuit and the direction of the positive/negative ionic flow in the cell.



II. Experiment:

4. You are given a piece of aluminum foil, a piece of paper towel, a piece of copper, a handful of charcoal powder, a cup of salt water, and the air in the atmosphere as building materials for your battery. Each of these materials corresponds to a battery cell component, i.e cathode, anode, separator, electrolyte, cathode reaction layer, and current collector. Could you guess which one is which? Use your multimeter to measure the voltage and current of each component. What numbers do you get?

5. Based on your judgement from the last question, build an Aluminum-air battery yourself following the diagram below!



6. The standard electronics convention is to connect the positive probe (red) to the positive side of the circuit and the negative probe (black) to the negative side of the circuit. Use your multimeter to measure and write down the current and voltage of your Aluminum-air battery. Are your numbers negative or positive? Why? (Hint: consider the direction of current in your battery.) Compare your measured voltage to the voltage of the balanced full reaction in step 1. Is your measured voltage higher or lower than expected? Why?

7. Connect your Aluminum-air battery to the LED. Does the LED light up? If your LED does not light up, could you list down some reasons why that is the case?

8. Work with your classmates to connect your aluminum air batteries with more wires and alligator clips. How should you connect the batteries to achieve higher voltages/currents? Make a scientific judgement on what the current and voltage your battery chain is most likely to display and write it down. Then measure the voltage and current with the multimeter. Are your guesses close to the measurements?

9. Try different battery chains until you are able to light up the LED. Can you figure out the minimum current/voltage required to light up the LED?

III. Discussion:

10. In October 2013, a Tesla Model S electric vehicle caught fire on the highway after metal debris pierced through the battery module. Now that you are familiar with the different components in a battery, can you tell which component must have been punctured for the fire to occur?

11. Thanks to the firewall design that divided the Lithium-ion battery modules into 16 sections, the fire was contained to a region in the front of the car and no one was injured. Following the incident, the official Tesla blog wrote, “Had a conventional gasoline car encountered the same object on the highway, the result could have been far worse.” Do you agree with the Tesla statement? Why or why not?