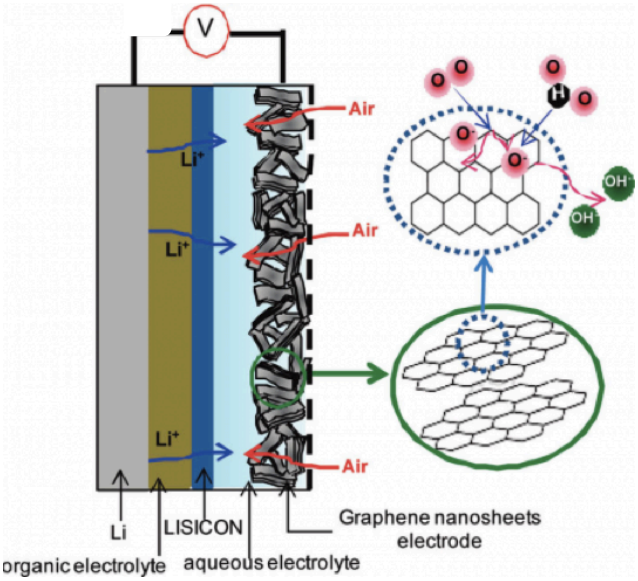
1. (9 pt) Metal air batteries have been proposed as a lightweight and easily maintained auxiliary battery to extend the range of electric cars beyond the 100 miles or so that most of them currently can do. A diagram of a Li-air battery is shown below:

   The battery operates through the reaction of Li metal and O_2 from the air mediated by a graphene electrode shown (note that the OH^- on the far right of the diagram is a product!). The graphene (ring structures) is not directly involved in the reaction.

   a. Label the **anode and the cathode** of the battery. (2 pt)

   b. Calculate a reasonable cell potential for the battery using relevant equations and values from your $E°_{red}$ table. (5 pt)

   c. Show the direction of electron flow in the system on the diagram. (2 pt)



2. (17pts) Several years ago, for dramatic effect, I decided to augment my presentation on redox chemistry by dropping my wedding ring (made of gold (Au)) in a solution of HNO_3, convinced that it wouldn't react. Unfortunately the gold in the ring is not pure and the ring immediately started to tarnish (oxidize) from the reaction of the Cu and Ag (in the Au) with the HNO_3! Luckily I was able to produce the Cu and Ag again by rubbing the ring with some Al foil.

   a. What kind of forces would you expect hold my wedding ring together? (3 pt)

   b. What general class of compounds is the "impure" gold mixed with silver and copper. (2 pt)

   c. Show clearly why I did **NOT** expect a **favorable (spontaneous)** redox reaction between gold and the HNO_3. (4 pt)

d. Using calculations and/or equations, explain why the Cu and Ag in the ring reacted with the HNO_3. (4 pt)

e. Explain how the tarnished products in the ring above could be "brought back" to Cu or Ag (just pick one to demonstrate) using aluminum foil. Show the appropriate reactions and/or calculations. (4 pt)

3. Provide a valid $E°_{ox}$:

a. _____ A valid $E°_{ox}$ for Mn^{2+}