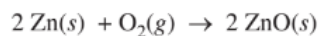


1. Metal-air cells are a relatively new type of portable energy source consisting of a metal anode, an alkaline electrolyte paste that contains water, and a porous cathode membrane that lets in oxygen from the air. A schematic of the cell is shown above. Reduction potentials for the cathode and three possible metal anodes are given in the table below.

Half Reaction	E at pH 11 and 298 K (V)
$\text{O}_2(g) + 2 \text{H}_2\text{O}(l) + 4 e^- \rightarrow 4 \text{OH}^-(aq)$	+0.34
$\text{ZnO}(s) + \text{H}_2\text{O}(l) + 2 e^- \rightarrow \text{Zn}(s) + 2 \text{OH}^-(aq)$	-1.31
$\text{Na}_2\text{O}(s) + \text{H}_2\text{O}(l) + 2 e^- \rightarrow 2 \text{Na}(s) + 2 \text{OH}^-(aq)$	-1.60
$\text{CaO}(s) + \text{H}_2\text{O}(l) + 2 e^- \rightarrow \text{Ca}(s) + 2 \text{OH}^-(aq)$	-2.78

- (a) Early forms of metal-air cells used zinc as the anode. Zinc oxide is produced as the cell operates according to the overall equation below.



- (i) Using the data in the table above, calculate the cell potential for the zinc-air cell.
- (ii) The electrolyte paste contains OH^- ions. On the diagram of the cell above, draw an arrow to indicate the direction of migration of OH^- ions through the electrolyte as the cell operates.

(b) A fresh zinc-air cell is weighed on an analytical balance before being placed in a hearing aid for use.

- (i) As the cell operates, does the mass of the cell increase, decrease, or remain the same?
- (ii) Justify your answer to part (b)(i) in terms of the equation for the overall cell reaction.

Part b

(c) The zinc-air cell is taken to the top of a mountain where the air pressure is lower.

- (i) Will the cell potential be higher, lower, or the same as the cell potential at the lower elevation?
- (ii) Justify your answer to part (c)(i) based on the equation for the overall cell reaction and the information above.

Part c

- (d) Metal-air cells need to be lightweight for many applications. In order to transfer more electrons with a smaller mass, Na and Ca are investigated as potential anodes. A 1.0 g anode of which of these metals would transfer more electrons, assuming that the anode is totally consumed during the lifetime of a cell? Justify your answer with calculations.

Part d

- (e) The only common oxide of zinc has the formula ZnO.
- Write the electron configuration for a Zn atom in the ground state.
 - From which sublevel are electrons removed when a Zn atom in the ground state is oxidized?

Part e