06M: Problems Related to the Nernst Potential

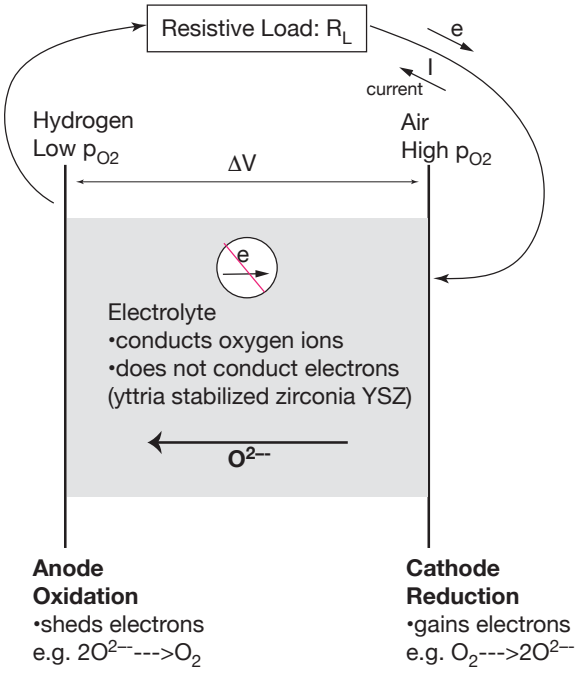
1. Derive the relationship between an eV and kJ mol^{-1}. Write one or two sentences on the circumstances when one or the other is a more intuitive representation of energy.

2.

•The anode, by definition, is the electrode for oxidation and the cathode the electrode for reduction. A schematic for the reaction that leads to the production of electrical energy using the chemical reaction

$$2H_2 + O_2 = 2H_2O \qquad (1)$$

is shown on the right.



•Describe the reactions at the anode and the cathode in terms of the three species,

O_2 , O^{2-} and e (electrons with an intrinsic charge of -1).

•Write down the equilibrium among the species in the reactions in terms of the chemical or electrochemical potentials.

(species with a charge on them are described by the electrochemical potential which is defined as follows

$$\mu_{X^{2+}} = \mu^o_{X^{2+}} + 2FV \qquad (2)$$

where the species X is assumed to have a charge of +2 units. If the species had a charge of -2 then Eq. (2) would be written as

$$\mu_{X^{2-}} = \mu^o_{X^{2-}} - 2FV$$

Here the Faraday constant is equal to $F = |e| N_A$ where $|e|$ is the magnitude of the charge on one electron, and N_A is the Avogadro's number. The remaining term in Eq. (2), $\mu^o_{X^{2+}}$ is the remaining part of the chemical potential.

3. Apply the above equations to derive the expression for the Nernst Potential as follows

$$\Delta V_{OCV} = \frac{RT}{4F} \ln \frac{p^A_{O_2}}{p^C_{O_2}}$$

4. Explain the above equation in words: the parameters, and a physical explanation for the relationship between them in the Nernst Equation.