Take Home Exam 10(Pre): Nernst Potential & Energy Density

to be Assigned: the week of Oct 31

Due (as pdf by email) 10/30/2022 (Sunday)

HW 10

10.1

This problem combines the water-splitting problem we addressed in class and materials selection for a solid state battery.

Consider a hypothetical battery where the anode is lithium metal and the cathode is Li_2O. We consider only the discharge problem.

The following chemical reaction drives the battery:

$2Li + \frac{1}{2}O_2 = Li_2O$ The free energy for this exothermic reaction is -599 kJ per mol of Li_2O at room temperature (298 K) (note the negative sign since the right hand side has a lower energy than the sum of the left hand side).

Calculate the value for the Nernst potential (the open circuit voltage).

10.2

A battery is made from *Li metal as the anode* and $LiCoO_2$ as the cathode. Draw the activity diagram for the anode and the cathode during discharge down to half its initial voltage.

10.3

One gallon of gasoline weighs 2.7 kg and packs 121,000 kJ of energy. Starting from elemental equations translate this number into kWh/kg of battery energy density. Assume that the battery weighs the same as one gallon of gasoline.

10.4

The (charge) capacity of the anode is written in units of mAh/g. Write a short paragraph giving the concepts behind the analysis that translates this quantity into the energy density of the for the battery. No equations.

10.5

If the voltage to charge the battery is too high then it precipitates lithium metal at the anode which then reacts with the liquid electrolyte to cause a fire. Why does Lithium metal precipitate at high charging voltage?