

Challenge Problem dealing with electrochemistry....

Note: Knowledge of Star Trek not required for this problem, however, it might add to the “engagement” for those who are fans.

You are a crewmember on the Star Ship, Voyager. While trying to return to the Alpha Quadrant, you encounter a planet with an interesting life-form – a plant that produces electricity! You are part of an “away-team” (exploration team) sent to the planet surface by Captain Janeway. After bringing a few plants back to Voyager, you conduct a few experiments:

1. A scan of the plant’s physiology shows that the electricity is produced by a redox reaction involving oxalic acid/carbon dioxide and hydrogen peroxide/oxygen gas under acidic conditions. What is a possible balanced redox equation involving these compounds? Which compound is the oxidizing agent and which compound is the reducing agent?

Comments to the instructor: Students may have to do a little hunting to find the appropriate half-reactions and potentials to be used in the second part of the problem.

2. Using a table of standard reduction potentials, what is the E°_{cell} for the redox process you proposed in question 1?

Comments to the instructor: You should assign this problem along with or right after problem 1.

3. What is the G°_{cell} ? Is the process spontaneous or non-spontaneous? You figure that in order to produce electricity, the plant’s redox process should be spontaneous. If your calculations show the process to be non-spontaneous, how would you modify your reaction to make it spontaneous?

Comments to the instructor: You may modify this problem easily to involve the Nernst Equation.

4. Lieutenant Torres wants to build a battery using the process used by the plant. Please diagram the electrochemical cell to be built. Hint: Use a platinum electrode to make contact with the solution where necessary.

Comments to the instructor: You may give the students the hint about the platinum electrode at your discretion.