Experiment 33: Electrochemistry and Organic Molecules
(The notebook rubric will not be followed for this experiment. Please follow the notebook directions listed in this experiment. The points for each section are listed; there is a total of 60 points available.)

Purpose
There are two separate, mini experiments for Experiment 33.
The Electrochemistry mini experiment will require a voltaic cell to be constructed and the voltage of the cell to be measured.
The Organic Molecules mini experiment will require the building of 5 molecular models, with questions based on the models.

Background
Electrochemistry: The voltaic cell uses a spontaneous oxidation reduction (redox) reaction. Each component of a voltaic cell has a purpose, and these components are: anode, cathode, wire, salt bridge, and strong electrolyte solutions. When identifying the oxidation and reduction reactions for the two elements involved, the element with the more positive reduction potential is reduced at the cathode.

One voltaic cell will be constructed using a zinc electrode in its zinc ion solution as one half of the voltaic cell. The other half of the voltaic cell will be a graphite electrode in a hydrochloric acid solution. The graphite electrode is not part of the chemistry; it is simply a surface at which electrons are transferred.

Chemicals
Electrodes: Graphite, Zinc
Electrolyte Solutions: (each 0.1 M) HCl, $Zn(NO_3)_2$
Saturated solution of NaCl for the salt bridge

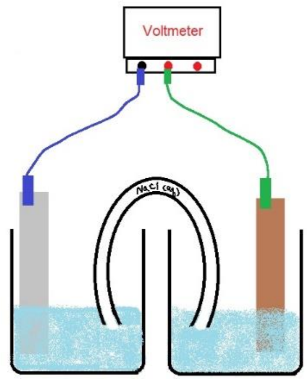
Equipment
Beakers (150 mL), two, to use for half reactions
Electrical wires (2) with alligator clips
Graduated cylinder
Voltmeter (1)
Tubing and cotton ball for the salt bridge
Beakers, medium size for obtaining solutions

Experimental Procedure
Construction of the Voltaic Cell

1) Obtain two beakers (150 mL), two wires, one voltmeter, one piece of tubing, one cotton balls, one graphite electrode, and one Zn electrode. Obtain approximately 100 mL each of the electrolyte solutions: $Zn(NO_3)_2$, HCl.

2) Build the following voltaic cell by following the setup shown below:
   Zn electrode in the $Zn(NO_3)_{2(aq)}$ and the graphite electrode in the $HCl_{(aq)}$

   Record your observation and measured voltage. Calculate the expected voltage of the cell using standard state reduction voltages.



For Your Notebook
1. Draw your voltaic cell and label all of the components. **(6 points)**
2. Make a list of the components, and briefly write what each component if for. **(6 points)**
3. Write the half reactions. One half reaction will be oxidation and the other half reaction will be reduction. Show the electrons in each half reaction. **(2 points each)**
4. Write the whole redox reaction. Make sure it is balanced. **(5 points)**
5. Calculate the expected voltage of the cell. **(5 points)**
6. State the measured voltage and compare it to the expected voltage. **(4 points)**
7. Optional: do the extra credit calculation described below.

Extra Credit Calculation
For the voltaic cell, use your measured voltage to calculate the ΔG for that cell. The equation that relates ΔG to the voltage of the cell is:

$\Delta G = - nFE_{cell}$

n = the number of moles of electrons transferred in the balanced redox reaction. The value of n will be a whole number (1, 2, 3, 4 etc…).

F is Faraday's constant 96,485. J / (v·mole), E_{cell} is the measured voltage.

This calculation is worth 5 points of extra credit for Experiment 33.

Organic Molecules

The IUPAC system of naming is used for this experiment. The following information is needed to build your models, to identify the bonds within the molecules, and to draw the structures.

Table 1: Base Part of Name (the Number of Carbons in the Main Chain)

Number of C Atoms	Base Part of Name		Number of C Atoms	Base Part of Name
1	meth		6	hex
2	eth		7	hept
3	prop		8	oct
4	but		9	non
5	pent		10	dec

Table 2: Ending Part of Name (Bonding)

Type of Bonding in between C Atoms	Ending Part of Name
All single bonds	ane
At least one double bond	ene
At least one triple bond	yne

If the molecule is a ring, use "cyclo" in the name.
If there are branches in the molecule, each branch will need an address number.
If there is a double or triple bond in the molecule, it will need an address number (use the lower address number of the two carbons involved with the double or triple bond).

Table 3: Electron Domain Geometry and Hybridization

Number of Electron Domains around the 'Central' Atom	Electron Domain Geometry	Ideal (Predicted) Bond Angle	Hybridization
2	Linear	180°	sp
3	Trigonal Planar	120°	sp^2
4	Tetrahedral	109.5°	sp^3

Molecules to Build: Build a molecule for each of the following, and provide your answers in your notebook:

1) Ethane:
Show the instructor your model (1 point)
Molecular formula (1 point)
Expanded structural formula (1 point)
Condensed structural formula (1 point)
Which orbitals are overlapping to make the C=C bond? (answer for both the sigma and pi overlaps) (2 points)

2) 1-Propene:
Show the instructor your model (1 point)
Molecular formula (1 point)
Expanded structural formula (1 point)
Condensed structural formula (1 point)
What is the hybridization of each carbon atom? (2 points)

3) 2-Butyne:
Show the instructor your model (1 point)
Molecular formula (1 point)
Expanded structural formula (1 point)
Condensed structural formula (1 point)
Which orbitals are overlapping to make the triple bond? (answer for both the sigma and pi overlaps) (2 points)

4) Cyclobutane:
Show the instructor your model (1 points)
Molecular formula (1 point)
Expanded structural formula (1 point)
Condensed structural formula (1 point)
Which orbitals are overlapping to make the C-H bonds? (2 points)

5) 1-Ethyl Cyclopentane
Show the instructor your model (1 point)
Molecular formula (1 point)
Expanded structural formula (1 point)
Condensed structural formula (1 point)
What is the hybridization for each carbon atom in the ring? (2 points)