Voltage Quest 2008 (maximum voltage)

Students will attempt to build an electrochemical cell that produces a voltage. You will also need to be able to answer basic questions on electrochemistry, write half-reactions, and calculate theoretical voltages in order to decide which of two solutions will be selected for testing.

Students must provide their own equipment, voltmeters, and electrodes. The solutions, the chart of redox potentials, and a small table of equations and constants will be provided at the site.

Requirements

The competition will proceed as follows. Your group (up to four people) must bring to the competition an already assembled set of materials that you will use as your battery, MINUS ALL LIQUID COMPONENTS. You will be provided with liquid solutions (with specified concentration in molarity units) to use at the competition. Do not bring your own solutions. When you arrive, your battery device must be DRY for judges to check it.

Students will then use electrochemical calculations using combinations of half cell reactions to calculate which solutions will produce the maximum cell potentials (the solutions may not be at standard cell conditions). The half cell reactions involved will be determined by the available solutions at the site.

After team collaboration, students may then request 100 ml each of two solutions of their choosing. Students only get one shot in doing this, so it is vital that they complete accurate calculations. If solutions are spilled, they will not be replaced. The cell must be designed to operate on not more than 100 ml for each of two solutions.

Your group must bring safety goggles, aprons or lab coats and a scientific calculator to use in the competition. A 10 point deduction for each item missing and that has to be borrowed. Total deduction for lack of all equipment is 30 points. If missing safety equipment and calculator cannot be borrowed, then a team must forfeit their place in the competition.

- You will have 20 minutes to perform whatever calculations deemed necessary in order to select your desired two solutions.
- Teams will then request (in writing on a piece of paper) 100 ml each of two solutions.
- The solutions will then be dispensed to the team in two beakers.
- When a judge is available to witness the voltage, the team will carefully pour their solutions into their electrochemical cell (using a funnel if needed…. which you will provide).
- While the teams are waiting their turn for a judge, they will label a cell diagram and answer 10 multiple choice questions on basic electrochemistry. The teams should know some basic facts about common batteries.

Your battery must be designed with two contacts sticking out that are easily accessible for voltage testing, without getting the volt meter contacts wet. Your battery also needs to be constructed in a way that judges can easily see inside AND open the device. No parts of the battery device may be sealed. Devices that produce any gas (rendering them potentially explosive) or are too hot to touch with bare hands will be disqualified.

Materials Allowed (may be cut into or used in any size, configuration, and shape)
(ONLY materials on this list are permitted to be incorporated into the battery device. Your group may use other tools and materials in assembly, but they may not be incorporated into the device in any way):
Galvanized Nails
Iron Nails
Copper Nails

White or brown paper towels
Filter paper
Plastic soda, milk, soft drink, and water bottles and caps
Baby food jars
Milk cartons
Juice boxes
Paper bags
Plastic bags (including Ziploc)
Strips of zinc, copper, steel, magnesium, lead or aluminum foil or sheet metal
Copper wire (any gauge)
Rosin core solder
Plastic or glass eyedroppers and bulbs
Cotton balls
Duct tape
Hot glue
Alligator clips (stainless steel)
Dialysis tubing
Drying tubes
Cotton string or rope (any thickness)
Voltmeter
Beakers or other containers suitable for up to 100 ml liquid (no voltaic cells may be assembled from porous cups). Any number of containers may be used, but a team will only receive 100 ml each of two solutions.

Aqueous solutions that may be available at the site include: sodium nitrate, copper II nitrate, zinc nitrate, aluminum nitrate, lead nitrate, magnesium nitrate.

Teams should anticipate and make provision for an independent volt meter to be attached to their cell to verify the results.

Students will be asked to label a diagram of a galvanic cell that has been designated by two electrodes with the corresponding salt solutions to be used. The students must label all parts and solutions with their traditional names, indicating the cathode, anode, and etc. Student must also be able to write the net ionic equation of what is happening on the sample electrochemical cell diagram.

A 20 point multiple choice test on electrochemistry must be answered

The following criteria will be used to judge the competitors:

- Point will be assigned in order of maximum to minimum voltage: 30 pts to the team getting the maximum voltage. 29 points to the team getting the next highest voltage, etc, etc.

- Correct setup: 30 pts for a working cell that indicates any positive voltage. If you need to reverse connections to achieve a positive voltage, your team will get a 5 point deduction. Teams are not allowed to move any part of their galvanic cell while the reading is being taken, since the cell voltage will fluctuate.

- Correctly labeled diagram: 14 pts (two points off for every missing/incorrect element requested)

- Multiple choice test: 20 pts (each question is two points each)

A perfect raw score would be 94 points.