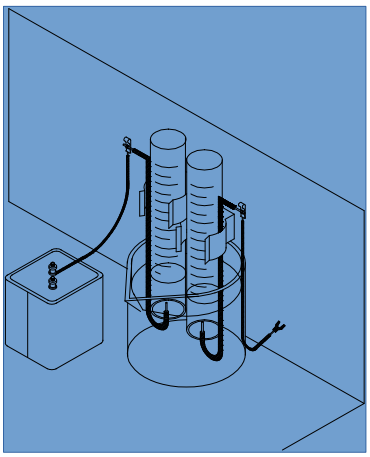
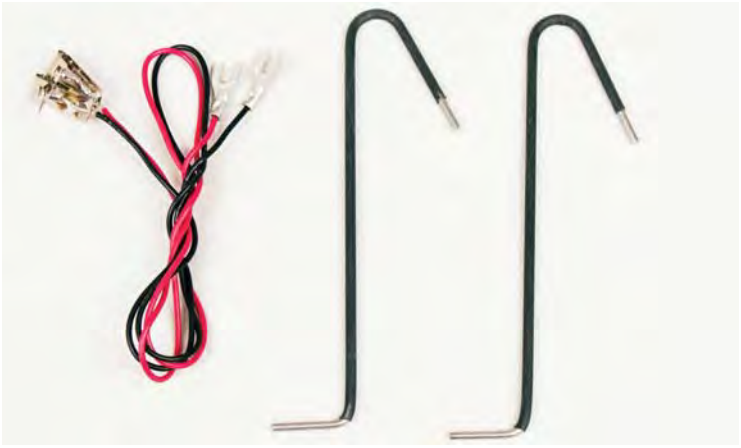
16240 Electrolysis Electrodes





Purpose:
To provide a pair of stainless steel electrodes that are suitable for the decomposition of water.

Required Accessories:
Safety Goggles and/or Plexiglas Shield, Pegboard Stand with Clips, one or two 6 volt batteries or similar DC source, 250 ml (or larger) Pyrex™ beaker, two 10 ml plastic graduated cylinders OR two test tubes and one graduated cylinder, wood splints, matches, sodium carbonate.

Optional Accessories:
Ignition Tube, Tesla Coil or ignition transformer

Background:
Water is a pure substance that cannot be separated into its constituent parts by heating, distilling or freezing. Pure water is also not a very good conductor of electricity. The decomposition of water using electricity dates from around 1800, and makes use of two electrodes held at different potentials in water that has been made slightly conductive. Pure water does not dissociate into ions very readily, but the addition of a suitable material can change this and serve to catalyze the reactions. In process, the (H)+ ions will be repelled by the (+) electrode (anode) and attracted to the (-) electrode (cathode) where an electron will be added to the structure to electrically neutralize the ion. When two atoms have formed, the H2 molecule results, and then several gather together to form a bubble which rises toward the surface. In a container of water, an immersed test tube is inverted over each electrode, to collect the gas sample by the downward displacement of water from the tube. If a graduated cylinder is used instead of the test tube, the volume of the gas can be read directly by lifting the graduate until the water levels inside and outside match. In this way, the pressure at which the gas sample is measured is the same as that of the atmosphere, which can be independently measured. By a related mechanism, the (OH)- ions in the water migrate towards the anode, give up the electron that has made the structure an ion, and O2 is collected and measured. The external power supply serves as an “electron pump”, receiving electrons at the anode and moving them to the cathode to complete the cycle. The material added to improve the conductivity does not become a part of the final reactions, but only serves as a catalyst by becoming temporarily involved.

The Experiment:

Fill a 250 ml, or larger, beaker more than half way with water, add approximately 3 g of sodium carbonate and stir until it is dissolved. Immerse two 10 ml graduates in this water so they fill, then invert and lift them, mounting them on the pegboard stand with the mouth of each just below the water surface. Force the upper stem of an electrode between the graduate and the clamp. The exposed tip of the electrode must be just below the mouth of the graduate. The graduates start out full of water. **Connect the Fahnstock clips to the electrodes** and the spade lugs to one or two 6 volt batteries (in series) or to a similar DC power source. Observe the evolution of the gases over time. When one of the graduates in nearly full, disconnect one of the leads, and read and record the volume of each graduate by adjusting the water level as described before.

Carefully remove the graduates, one at a time, and test each gas with a glowing and then a burning splint. Be sure to remove the graduates from the water in a way that will not lose the gases that are to be tested. Oxygen should rekindle the glowing splint, and a flaming splint should ignite the hydrogen with a sharp "bark."

Divide the volume of the hydrogen by the volume of the oxygen, and compare this ratio with that obtained by others in the class, perhaps others who had used different amounts of sodium carbonate to catalyze the reaction.

Repeat the experiment, this time collecting both gases together in one container, and then carefully igniting the mixture of gases. A thick wall ignition tube can be used for this part of the experiment. Be sure that the two electrodes do not touch each other or no gas will be produced. It is instructive to use an ignition transformer or a Tesla coil to ignite this gas mixture, while the tube is still over water in the collection position, by causing a spark to jump between the two electrodes.

Alternatives:
Test tubes can be used in place of the inverted graduates for collecting and measuring the gases. In this case, a grease pencil or rubber band must be used to mark the water level in each. A graduated cylinder is then used to measure the volume by pouring water into the tube and up to the mark before emptying this water into the graduated cylinder.

Time Allocation:
To prepare this product for an experimental trial should take less than ten minutes. Actual experiments will vary with needs of students and the method of instruction, but are easily concluded within one class period.

Feedback:
If you have a question, a comment, or a suggestion that would improve this product, you may call our toll free number.