CheMagic Demonstration Notes©

Electrolysis & Chemical Cells

Materials

350-mL clear plastic cup; 9 volt battery (**not lithium**); ~10d iron finishing nail; ~10d galvanized finishing nail; Styrofoam cup; ~50-mL glass wide mouth bottle; 1.5 volt dry cell; multimeter

Chemicals

potassium iodide; spray starch; sodium chloride; DI water

Abstract

Electrolysis

Demonstrate the starch test for elemental iodine (Iodine Test demonstration q.v.). Add 1 g of potassium iodide to a plastic cup which is 2/3 full of water. Spray some laundry starch into the cup and stir. There is no color – Hmm or Duh depending on your chemical sophistication. Drop a cheap 9 volt battery (zinc-carbon) into the cup. Violet color streaming from the anode shows formation of iodine by electrolysis. **Do not drop lithium batteries into water!**

Chemical Cells

Set the multimeter for the lowest voltage range that includes about 2 volts. Use the multimeter to demonstrate the polarity and voltage of the 1.5 volt dry cell by reading the multimeter with positive-positive/negative-negative connections. Reverse the connections to positive-negative/negative-positive. On a digital multimeter, the voltage readings will be + and - respectively. This will set the positive/negative standard for using the multimeter to determine the polarity of the electrodes on the zinc-iron nail cell.

Construct an electrode holder by cutting the bottom out of a Styrofoam coffee cup. Push both nail electrodes through the cut out cup bottom being careful not to short the circuit by allowing the nails to come into contact. The nails should protrude to a length slightly shorter than the wide mouth bottle height. The wide mouth bottle opening must be smaller than the Styrofoam cup cut out bottom. Fill the wide mouth bottle with water and add about 5 g of sodium chloride. Stir and insert the electrodes into the sodium chloride solution by placing the Styrofoam electrode holder on the bottle opening.

Repeat the above multimeter measurements to determine the voltage and polarity of the zinc-iron cell.

Obligatory but Very Important Note

Please check the demonstration video for details on the above abstract. Are there possible hazards and risks in these demonstrations? Yes, absolutely. Dropping a 9 volt battery into water could allow water to breach the battery container with uncertain results. Also, a wet battery could present a disposal hazard. The battery should probably be dried before disposal. With a nine volt battery there is always a potential problem of accidental shorting of the terminals with a conductor (e.g. coins in a pocket). We have not experienced specific problems in our use of the demonstration, but potential problems are there. This video demonstration manual is distributed to chemists and chemistry teachers, and the assumption is made that professionals using

the manual are knowledgeable about materials, chemicals, demonstration procedure, and demonstration risks. If there is any doubt about risk, then please show your students the video rather than doing the demonstration.

Demonstration Note

By way of reminder, the electrode chemistry in this electrolysis is:

$2\ I^- \rightarrow I_2 + 2\ e^-$ (anode reaction)

$2\ H_2O + 2\ e^- \rightarrow H_2 + 2\ OH^-$ (cathode reaction)

Doris and Ken Kolb (Illinois Central College and Bradley University respectively) have described the nifty and popular 2 pencil/9 volt battery electrolysis apparatus [Kolb, Kenneth E.; Kolb, Doris K., *J.Chem.Educ.*, **63**, 517(1986)]. Inevitably, two guys from a neighboring university (Illinois State University) would find the ultimate lazy person's approach to their hard work.

Although the nail cell is not set up as a simple textbook two metal couple, the cell is most likely "seeing" some combination of the following processes:

$Zn \rightarrow Zn^{2+} + 2\ e^-$ (anode reaction)

$2\ H_2O \rightarrow 4\ H^+ + O_2 + 4\ e^-$ (anode reaction)

$Fe^{3+} + 3\ e^- \rightarrow Fe$ (cathode reaction)

$2\ H_2O + 2\ e^- \rightarrow H_2 + 2\ OH^-$ (cathode reaction)
