



## Hoffman Electrolysis Apparatus

Model: HEA01

### Description:

Water is decomposed into hydrogen and oxygen gases using electricity. A Hoffman electrolysis apparatus collects the two gases separately and shows the 2 to 1 ratio nicely. If a pH indicator is used the anode becomes yellow and cathode becomes blue. Hydrogen gas can be burned to produce a small pop sound and the oxygen can be used to re-ignite a glowing wooden splint.

### Concept:

When a DC current is passed through an aqueous sodium sulfate solution, water is oxidized at the anode producing  $O_2$  and reduced at the cathode producing  $H_2$ . The solution becomes acidic at the anode and basic at the cathode.

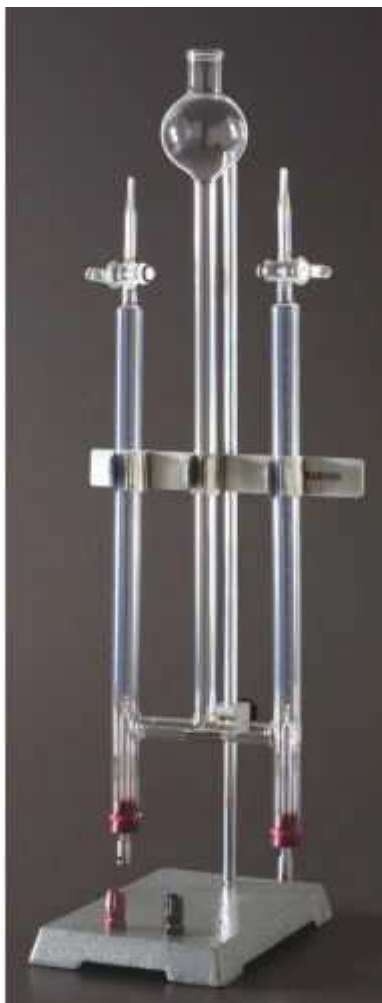
### Materials Included:

- Hoffman electrolysis apparatus
- stand
- 2 platinum electrodes
- 2 test tubes
- electrical tape

### Other Materials (Some Optional):

- adjustable DC power supply or battery with clip leads
- 1 Liter beaker
- 1 Liter of 1 M Sodium Sulfate
- 60 mL of bromothymol blue (optional)
- 10 mL of 1M Hydrochloric acid (optional)
- 10 mL of 1M Sodium hydroxide (optional)
- stirring rod
- Pasteur pipettes
- candle
- matches
- wooden splints

**Safety:** Be careful of explosive hydrogen and oxygen mixtures. It is a good idea to burn the gases off to prevent a dangerous mixture. Sodium Sulfate, Hydrochloric acid, and Sodium Hydroxide will irritate skin. Wear gloves and goggles.



**Figure 1**

**Assembly:**

Begin by placing the base on a sturdy level surface with the red and black terminals on top and in front. Screw the mounting rod into the base by turning clockwise. Insert the lower cup support over the end of the mounting rod so that the cup can cradle the bottom of the central connecting tube. Insert the upper tri-clamp arm over the top of the mounting rod, ensuring that the clamps are facing forward (toward the red and black terminals on the base).

Insert the electrodes into the openings at the bottom of the Hoffman apparatus.

Refer to Figure 1. **Carefully** place the Hoffman tube on the lower cup support, adjusting the height of the support as necessary to allow for a clearance of 2-3" between the base and the platinum electrode terminals. Adjust the height of the tri-clamp assembly so that it will be in position on the center of the glass tubes. When properly positioned, **carefully** press the glass Hoffman tube assembly into the tri-clamp assembly. **Never force the glass, and always handle with extreme care.**

Note: Check the stopcocks for proper lubrication prior to filling the device. Prolonged storage can make a stopcock fail. Petroleum jelly or lanolin is the suggested lubricant.

## Procedure:

If indicator is needed, add the bromothymol blue to the sodium sulfate. It will turn the sodium sulfate solution blue, but you want it to be green. Add drops of NaOH to make more blue and/or HCl to make more yellow until the solution is green. Close the stop cocks on the Hoffman apparatus. Pour the sodium sulfate into the apparatus through the bulb until the bulb is almost full. Open one of the stop cocks and let the solution fill that arm of the apparatus. You may need to add more sodium sulfate solution to make sure that the arm is completely full. Do the same for the other side.

Clip the black lead from the negative terminal of the power supply to the cathode. Clip the red lead from the positive terminal of the power supply to the other electrode (this will be the anode). Bubbles should start to evolve on both electrodes. Adjust the power supply to 6 - 12 volts and 1.5 amperes. You may be able to use higher voltage, but make sure that bubbling is not too vigorous to push bubbles of gas to the middle (filling) arm of the Hoffman Apparatus.

After about 45 minutes you should have about 22 cm of H<sub>2</sub> and 11 cm of O<sub>2</sub>. Turn the power supply off and disconnect the leads. Measure the amount of gas with the ruler. Light the candle and make a match handy. Open the stop cock on the cathode side and collect the H<sub>2</sub> in a test tube. Put your finger over the top of the test tube. Light the match in the candle and then put the match up to the mouth of the test tube. It should make a soft pop. Collect the O<sub>2</sub> gas at the anode in another test tube. Light a splint in the candle and let burn for a few seconds. Blow the splint out and while it is still glowing insert it into the test tube. It should re-ignite the splint.

## Clean-Up:

**Keeping your goggles and gloves on**, make sure the power supply is off and turned down to the lowest settings. **Close both stop cocks.** **Carefully** remove the glass Hoffman tube from the base. Pour the sodium sulfate solution back into the beaker from the bulb until the middle arm of the apparatus is emptied. Empty the other arms through the stopcocks. The sodium sulfate solution with or without indicator can be reused. Pour the contents of the beaker into a bottle. Rinse the apparatus with plenty of water and then distilled water. Remove the electrodes and rinse with distilled water. Let the apparatus and electrodes dry thoroughly. Do not store the electrodes in the Hoffman tube, and leave stop cocks open during storage.

**Note:** Handling this apparatus can be tricky and it takes some practice to set this demo up and the clean it up. Be careful not to break our Hoffman tube. Making the pop and re-igniting the glowing splint is also tricky and requires some practice.

At the anode:  $2 \text{H}_2\text{O} (\text{l}) = \text{O}_2 (\text{g}) + 4 \text{H}^+ (\text{aq}) + 4 \text{e}^-$  (indicator yellow-acid)

At the cathode:  $4 \text{H}_2\text{O} (\text{l}) + 4 \text{e}^- = 2 \text{H}_2 (\text{g}) + 4 \text{OH}^- (\text{aq})$  (indicator blue-base)

