

**(Optional) Experiment for the H<sub>2</sub>O Car –  
Experimentally determining the efficiency of an electrolytic cell.**

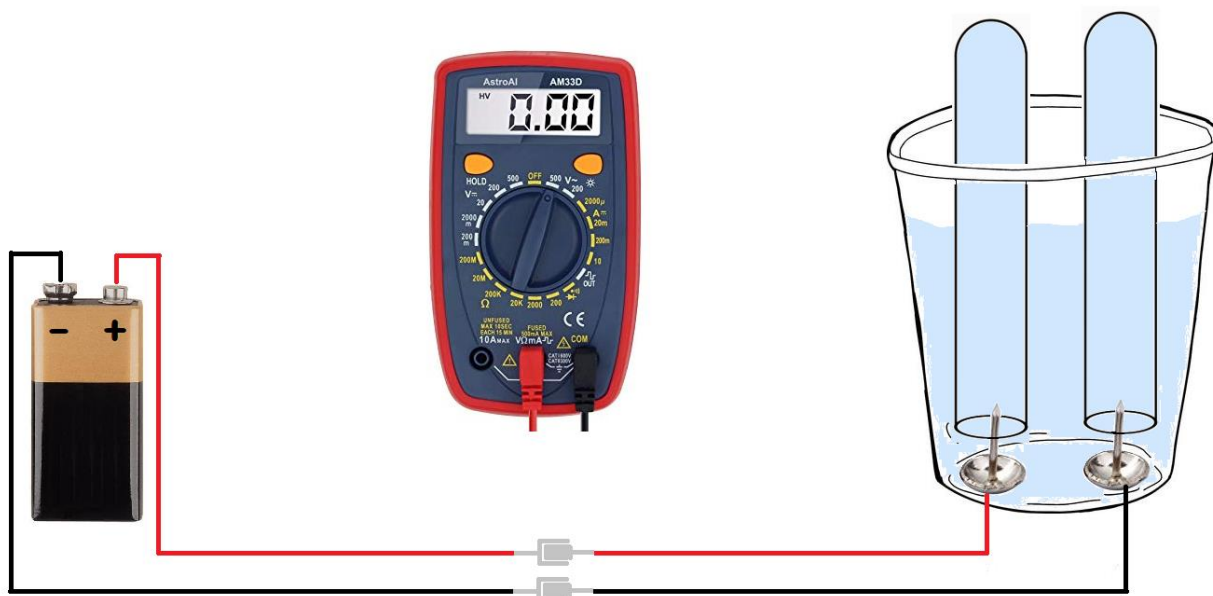
As part of your investigation into the feasibility of the H<sub>2</sub>O Car, you are tasked with experimentally investigating a water splitting system. Water can in fact be separated into its constituent elements hydrogen and oxygen by a process called *electrolysis*. Electrolysis is the process of using electrical current to drive a *thermodynamically unfavourable* chemical reaction. The reaction with which you are concerned is below:



For hydrogen to be used as a fuel, the reverse reaction (*i.e.* combustion of hydrogen) must be performed.



The question remains: how efficient is this process in practise? Your task is to construct a battery powered electrolyzer and determine its efficiency in order to provide experimental evidence for your argument regarding the viability of The H<sub>2</sub>-O Car. An example apparatus is shown in Figure 1.



**Figure 1.** An example electrolysis apparatus.

In the above apparatus, the electrolytic water splitting is being driven by a battery connected to two terminals which are submerged in water. The gases which are produced at those terminals will be

collected in the inverted graduated test tubes which begin completely filled by water which will gradually be displaced by gas. The volume of hydrogen and oxygen produced can be read directly from the gradations on the test tubes. In order for the electrolysis to proceed, the water must contain an electrolyte (typically  $\text{Na}_2\text{CO}_3$  or  $\text{MgSO}_4$ ).

**In order to determine the efficiency of the cell, you will need to record:**

- The volume of hydrogen produced over the duration of your electrolysis.
- The total time for which the electrolysis was active.
- The power (watts) being drawn by the cell, which can be calculated from the current and voltage of the cell.

*To measure the voltage of the cell:*

Using a voltmeter or multi-meter, the voltage is measured ***across the circuit***. Therefore, by touching one lead to the metal joint of the red wire, and one lead to the metal joint of the black wire you can measure the voltage.

*To measure the current of the cell:*

Using an ammeter or multi-meter, the current is measured ***along the circuit***. Therefore, you must separate the metal connectors on the red wire and bridge them with the leads of the multimeter to measure the current of the cell.

**Questions to be answered:**

1. From which electrode (anode or cathode) is hydrogen produced?
2. What is the efficiency of hydrogen production for the electrolytic cell that you built? Show your calculations and explain their basis.
3. What happened to the energy that did not go into producing hydrogen?
4. Could the efficiency of this cell be improved? If so, how?