ELECTROLYSIS

EXPERIMENT PROCEDURE

- **Generating hydrogen by electrolysis and measuring the volume of hydrogen *V*.**
- **Measuring the electrical work *W* needed to generate the hydrogen at a constant voltage U_0.**
- **Calculating the Faraday constant *F*.**

OBJECTIVE

Determine the Faraday constant.

SUMMARY

The Faraday constant is determined by measuring the quantities of hydrogen and oxygen generated by the electrolysis of water and the electric charge that is transported during the process.

REQUIRED APPARATUS

Quantity	Description	Number
1	Hofmann's Voltameter	**1002899**
1	Power and Energy Meter with Interface (230 V, 50/60 Hz)	**1003132 or**
	Power and Energy Meter with Interface (115 V, 50/60 Hz)	**1003131**
1	DC Power Supply 0 – 20 V, 0 – 5 A (230 V, 50/60 Hz)	**1003312 or**
	DC Power Supply 0 – 20 V, 0 – 5 A (115 V, 50/60 Hz)	**1003311**
1	Set of 15 Experiment Leads, 75 cm 1 mm²	**1002840**

Aditionally required
Sulphuric Acid, 1 mol/l

BASIC PRINCIPLES

Electrolysis is the breakdown of a chemical compound by the action of an electric current. When this occurs, the process of electrical conduction is accompanied by a release of material, and the quantity of material released, *n* is proportional to the transported charge *Q*. The proportionality constant is called the Faraday constant *F* and it is a universal constant of nature.

For a fuller and more accurate description of the proportionality relationship between the charge Q and the molar quantity n of material that is released, one must also take into account the valence number z of the ions that are released. Thus

(1) $$Q = F \cdot n \cdot z$$

In this manner, the Faraday Constant can be determined by measuring the charge Q and the molar quantity n for an electrolytic process, provided the valence number is known.

In the experiment, water is electrolysed to generate a specific quantity of hydrogen and oxygen. To determine the charge Q that is transported, the electrical work

(2) $$W = Q \cdot U_0$$

that is performed at constant voltage U_0 to achieve electrolysis is measured.

The molar quantity n_H of hydrogen ions that is released at room temperature T and external pressure p is determined from the measured volume V_{H2} of the gas. However, one must take into account the fact that the hydrogen is collected in molecular form, and for each hydrogen molecule collected, two hydrogen ions have been released. Thus, from the equation of state for an ideal gas we have:

(3) $$n_H = 2 \cdot \frac{p \cdot V_{H2}}{R \cdot T}$$

$R = 8.314 \frac{\mathrm{J}}{\mathrm{mol \cdot K}}$: the universal gas constant.

EVALUATION

The valence number of hydrogen ions is $z_H = 1$. Therefore, from Equations 1, 2 and 3, we obtain the following equation for determining the Faraday constant:

$$F = \frac{W}{U_0} \cdot \frac{R \cdot T}{2 \cdot p \cdot V_{H2} \cdot n_H} = \frac{W}{U_0} \cdot \frac{R \cdot T}{2 \cdot p \cdot V_{H2}}$$

For comparison, we can also measure the volume of oxygen that is collected, V_{O2}. It is only half of the hydrogen volume, because each water molecule that is electrolysed releases two hydrogen ions and one oxygen ion. However, the valence number for oxygen ions is $z_O = 2$.

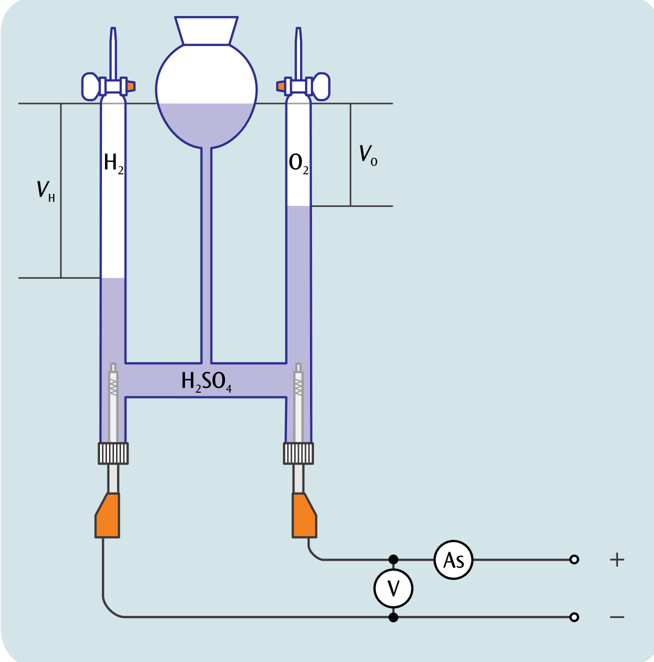

Fig. 1: Schematic diagram