The conductivity of aqeous solutions of electrolytes

(Item No.: P1396900)

Curricular Relevance

Area of Expertise: Physics → **Education Level:** Age 14-16 → **Topic:** Electricity → **Subtopic:** Current and its effect → **Experiment:** The conductivity of aqeous solutions of electrolytes

Difficulty	Preparation Time	Execution Time	Recommended Group Size
Intermediate	10 Minutes	10 Minutes	2 Students

Additional Requirements:

Experiment Variations:

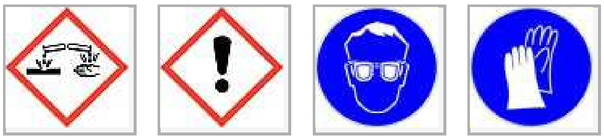
Keywords:

Principle and equipment

Principle

It is to be demonstrated that aqueous solutions of electrolytes conduct electric current.

Safety Precautions



Wear eye protection and gloves!

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S: 26-36/ 39-45

Dilute sulphuric acid and sodium hydroxide solutions are highly corrosive to skin, eyes and mucous membranes. Aerosols irritate the respiratory organs.

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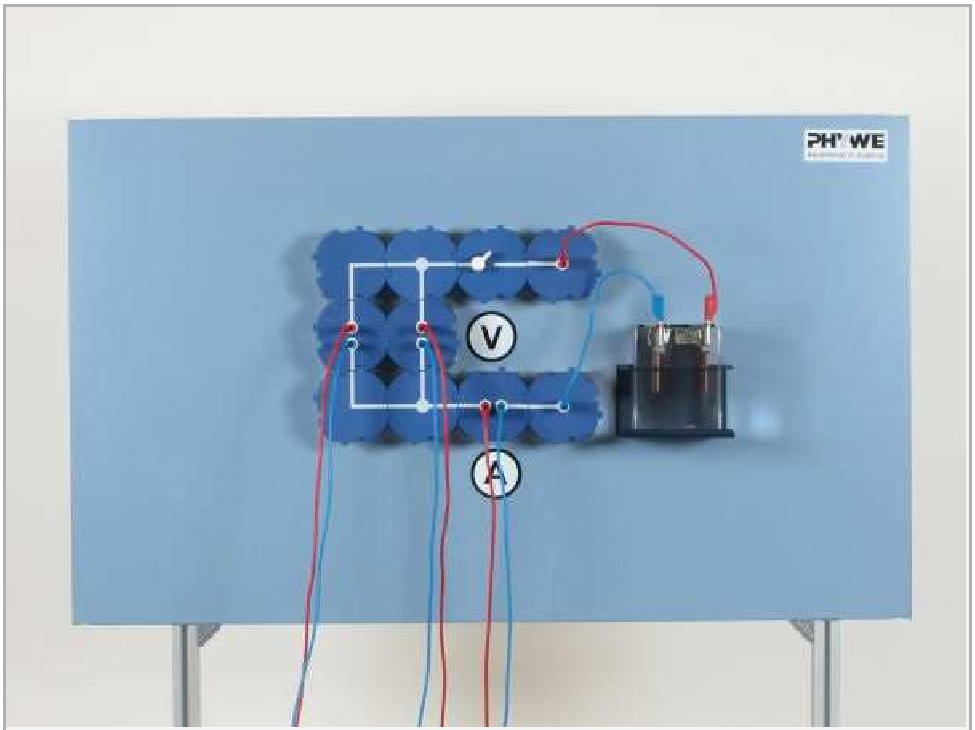

Experimental set-up

Equipment

Position No.	Material	Order No.	Quantity
1	Multimeter ADM2, demo., analogue	13820-01	2
2	PHYWE power supply, universal DC: 0...18 V, 0...5 A / AC: 2/4/6/8/10/12/15 V, 5 A	13500-93	1
3	Demo Physics board with stand	02150-00	1
4	Switch on/off, module DB	09402-01	1
5	Connector interrupted, module DB	09401-04	3
6	Junction, module DB	09401-10	2
7	Support plate w. holder,module DB	09471-00	1
8	Glass tank, 100x50x120 mm	06620-10	1
9	Electr.symbols f.demo-board,12pcs	02154-03	1
10	Connector, angled, module DB	09401-02	2
11	Connector, T-shaped, module DB	09401-03	2
12	Plate electrode holder	06618-00	2
13	Sodium hydroxide sol.,10%, 1000ml	31630-70	1
14	Sulphuric acid, 10%, tech.gr., 1000 ml	31828-70	1
15	Emery paper, medium, 5 sheets	01605-02	1
16	Connecting cord, 32 A, 1000 mm, red	07363-01	3
17	Connecting cord, 32 A, 1000 mm, blue	07363-04	3
18	Connecting cord, 32 A, 250 mm, red	07360-01	1
19	Connecting cord, 32 A, 250 mm, blue	07360-04	1
20	Copper electrode, 76 mm x 40 mm	45212-00	2
21	Spoon,w.spatula end,18 cm,plastic	38833-00	1
Additional material:			
	Common salt (table salt)		
	Distilled water		
	Tap water		
	Absorbent cloth or paper towels		

Set-up and procedure

- Set up the experiment as shown in Fig. 1; position the carefully cleaned electrodes in the clean glass trough so that they are relatively wide apart and reach down almost to the bottom of the trough
- Half-fill the glass trough with distilled water; select the 1 0 V- and 1 mA- measurement ranges
- With the switch open, turn on the power supply and set it to aproximately 5 V direct voltage
- Close the switch, measure the current and enter the measured value in Table 1 under Part 1
- Open the switch, empty the glass trough, then carefully dry it and the electrodes
- Pour so much salt in the glass trough that both electrodes dip into an approx. 5 cm thick layer of salt
- Close the switch, note the current displayed for this part of the experiment in Table 1.

  Note: When dry salt is used, the current is below 1 pA The teacher must decide if the measurement range is to be changed. The knowlege that completely dry salt does not conduct electricity can be impressively imparted by keeping it at the 1 mA measurement range.
- Carefully pour the same distilled water as was used in the first part of the experiment on the salt in the glass trough; change the measurement range stepwise according to the increase in the current and note the last measured current value
- Open the switch, thoroughly clean the glass trough and electrodes; select the 100 mA- measurement range; half-fill the glass trough with tap water and insert the electrodes
- Close the switch and note the current
- With the switch open, replace the tap water by distilled water; select the 1 A- measurement range
- Close the switch, pour a little acid into the water and stir; note the current
- Proceed in the same way with a base, e.g. sodium hydroxide solution

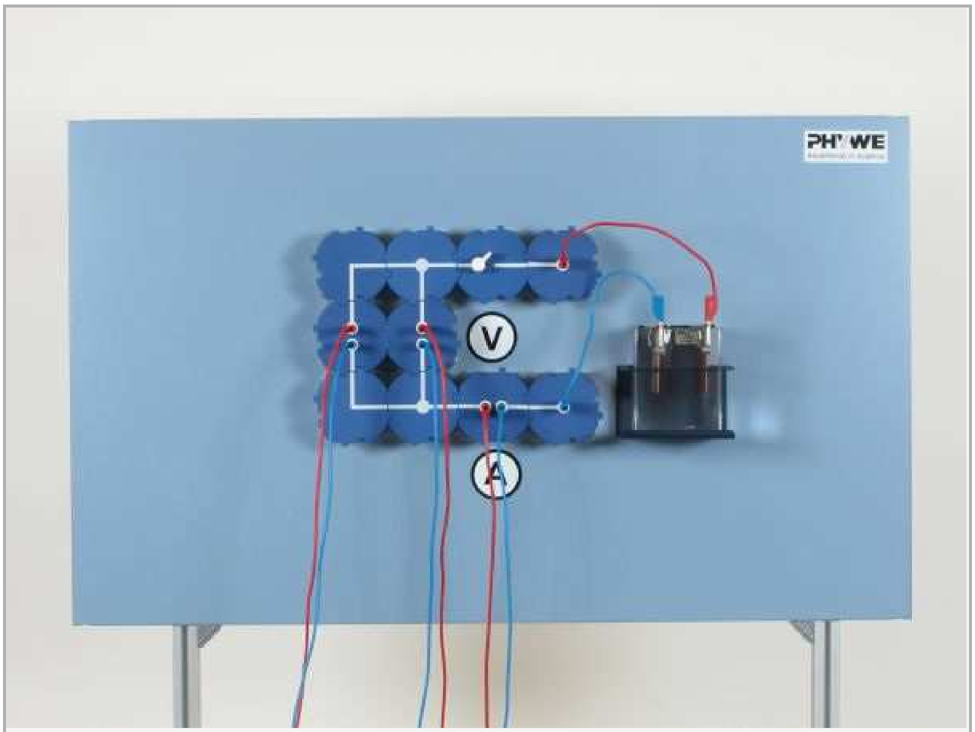

Fig. 1

Observation and evaluation

Observation

Table 1

Expt. Part no.	Contents of the glass trough	Current $\frac{I}{mA}$
1	Distilled water	0.1
2	Common salt	0.0
3	Aqueous salt solution	200
4	Tap water	8
5	Aqueous solution of an acid	210
6	Aqueous solution of a base	205

Evaluation

Distilled water is a bad conductor of electricity.
Salt does not conduct it.
When salt is dissolved in {distilled) water, a current of some hundred mA flows; the aqueous salt solution conducts electricity just as well as the aqueous solutions of the acid and the base.

Tap water conducts electricity better than distilled water. Salts, acids and bases are electrolytes. In their pure form they hardly conduct electricity at all, because they then have hardly any freely mobile ions. When an electrolyte is dissolved in water, it dissociates, i.e. it separates into positive and negative ions. When electrodes are dipped into such a solution of an electrolyte and current is applied across them, the ions migrate to the electrode that has the opposite charge.
On its way from the rain cloud to the consumer, tap water has dissolved electrolytes that were present in the air and earth. In contrast to distilled water, it is a solution with quite a good electrical conductivity. The reason why distilled water is conductive, when only to a very small extent, is that it always contains some ions, although only at a very low concentration. In the second part of the experiment, the following processes occur:

Dissociation: $NaCl_{\rightarrow} \quad Na^{+} + Cl^{-}$.

Na^{+} ions migrate to the cathode, where the following results:

$2Na+ + 2e^{-}{}_{\rightarrow} \quad 2Na$,

$2Na + 2H_2O_{\rightarrow} \quad 2NaOH + H^2\uparrow$,

i.e. atomic sodium splits water molecules to form sodium hydroxide (which again dissociates) and molecular hydrogen (which bubbles out of the solution). Cl^{-} ions migrate to the anode, where chlorine gas is formed, which bubbles out of the solution.

$2Cl^{-} - 2e^{-}{}_{\rightarrow} \quad Cl_2\uparrow$.

Remarks

The values measured for the current are to be only taken as examples. The strength of the current depends in each case not only on the voltage, but also, for example, on the distance between the electrodes and their constitution, as well as on the concentration of the solutions. Acids and bases must be carefully handled, because of their corrosive nature. Inadvertent splashes of them on skin or clothing must be immediately rinsed off with copious water. The electrodes, the electrode holder and the glass trough must be thoroughly cleaned prior to and subsequent to use. Common salt is very hygroscopic. For this reason, it can possibly show a measurable conductivity (*I* = some mA) when it is not stored in a closed container.

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