Task

To prepare an aqueous solution of copper sulphate and examine the relationship between voltage and current when current passes through it.

Equipment

Plug-in board	06033.00	1
On/off switch	39139.00	1
Trough, grooved	34568.01	1
Copper electrode, 76 x 40 mm	45212.00	2
Connecting cable, 25 cm, red	07313.01	2
Connecting cable, 25 cm, blue	07313.04	2
Connecting cable, 50 cm, red	07314.01	2
Connecting cable, 50 cm, blue	07314.04	2
Crocodile clips, bare, 2 from 10	07274.03	(1)
Multi-range meter	07028.01	2
Power supply, 0...12 V-,6 V~, 12 V~	13505.93	1
Spoon with spatula end	38833.00	1
Water, distilled, 5 l	31246.81	1
Copper-II sulphate, cryst, 250 g	30126.25	1
Emery paper, medium, 1 sheet from 5	01605.02	(1)
Cloth or absorbent paper		

Danger!

Copper sulphate solutions are harmful to health. Do not swallow them!

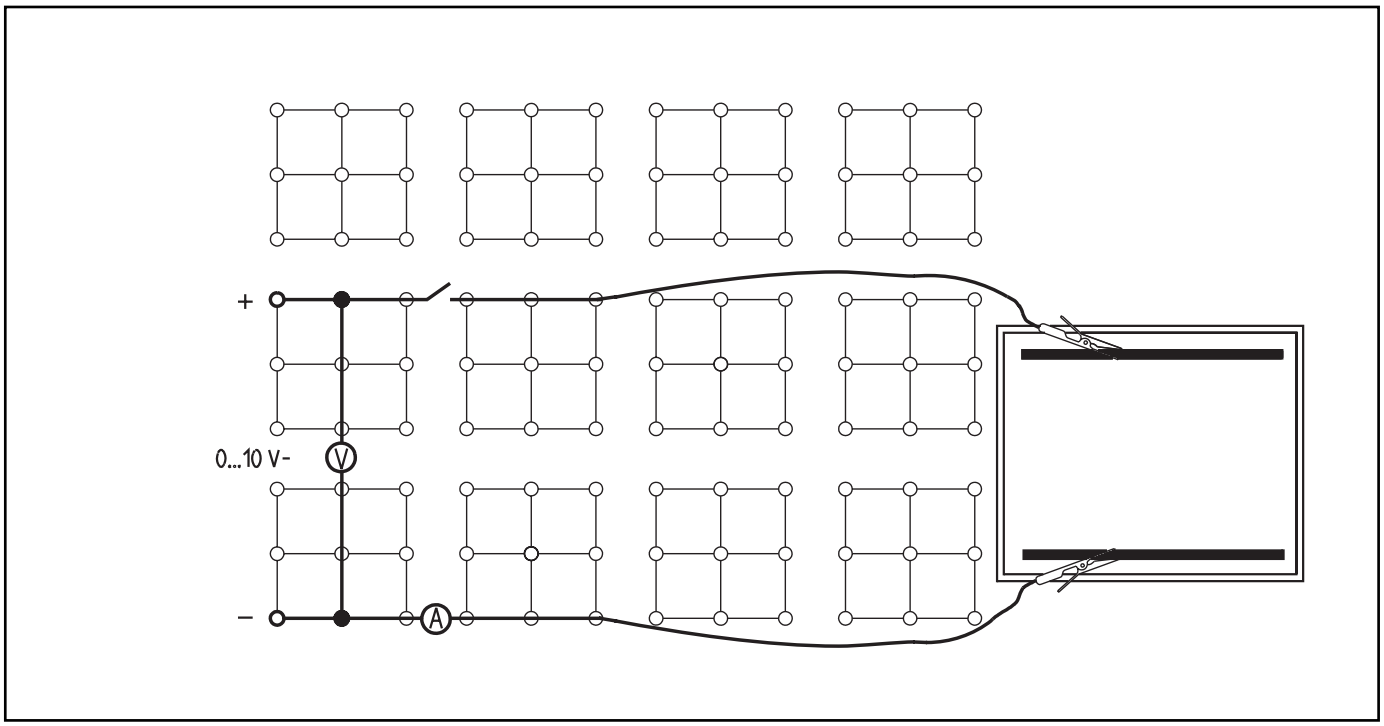
Set-Up and Procedure

— Set up the experiment as shown in Fig.1, with the switch first open. If necessary, thoroughly clean the trough and the copper electrodes, then plug the electrodes into the trough at the maximum distance from each other and use the crocodile clips to connect them to the (short) connecting cables.
— Half-fill the trough with distilled water; add a half-spoonful of copper sulphate and stir the water until the salt is completely dissolved.
— Select the 10 V- and 300 mA- measurement ranges, close the switch.
— Set the power supply to 0 V and switch it on.
— Increase the voltage in steps of 2 V; measure the current strength at each step and note the measured value in Table 1.
— Now set the voltage to 4 V, open the switch and roughly halve the distance of the electrodes from each other.
— Close the switch, measure the current strength and note the measured value.
— Finally, open the switch, bring the electrodes back to their original positions, and then sprinkle a little more copper sulphate into the solution and stir until it is all dissolved. Close the switch, measure the current strength (again at 4 V) and note the measured value.
— Set the power supply to 0 V and switch it off.
— Dry the electrodes and properly dispose of the aqueous solution; clean the trough and wash your hands with soap and water.

Waste disposal

Collect copper sulphate solutions in an appropriately labelled container.

Fig. 1



Measurement Results

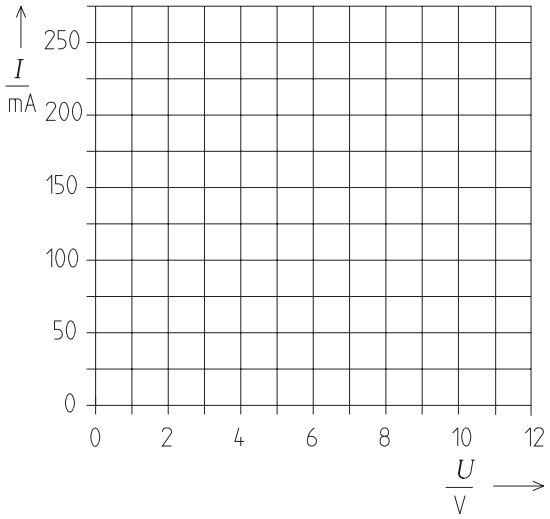
Table 1

U / V	I / mA	R / Ω
2		
4		
6		
8		
10		
4 (with reduced distance between electrodes)		
4 (at higher salt concentration)		

Evaluation

1. Plot a graph of the current intensity I against the voltage applied U (Fig. 2).
2. Welcher Zusammenhang besteht zwischen U und I ? Additionally calculate the quotients U / I and enter the results in the third column of Table 1. What do you find? Answer the question first asked.

Fig. 2



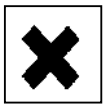
3. Compare the current strengths in line 2 of Table 1 with the current strengths which you measured at the same voltage but under changed conditions (lines 6 and 7 of Table 1). What can be concluded from this comparison with respect to the resistance of aqueous solutions of electrolytes?

4. Consider on what else the resistance of a conducting liquid could be dependent, and summarize the dependences which you have determined or presume!
   The resistance of a conducting liquid is dependent on

(Is Ohm's Law also valid for conduction processes in liquids?)

After the students have recognized that there are also conducting liquids, namely aqueous solutions of electrolytes, the question as to whether Ohm's Law is valid for them is to be answered.
The experimental results affirm that this is so. The students should however be subsequently informed that this is not the case with all solutions of electrolytes.

Notes on Set-Up and Procedure
No measurement should be made until the copper sulphate is completely dissolved, otherwise the value of the resistance will alter during the series of measurements.
Should it begin to become evident in any of the groups that a higher current strength than 300 mA will result at 10 V, then, for example, the last measurement can also be made at 9 V.
The teacher can avoid higher current strengths than 300 mA at 10 V, however, by portioning out appropriate quantities of copper sulphate to the groups.
The proper waste disposal of the aqueous solutions should be organized centrally and be superintended by the teacher.



Danger!
Copper sulphate solutions are harmful to health. Do not swallow them!
Waste disposal
The copper sulphate solutions should be collected in an appropriately labelled container.

Measurement Results
Refer to Table 1

Evaluation
1. Refer to Fig. 2.
2. There is a linear relationship: $I \sim U$
   Refer to column 3 in Table 1.
   U / I = konstant –> $I \sim U$. Ohm's Law is valid.
3. The resistance of conducting liquids depends on the concentration of the solution and on the distance between the electrodes. The higher the concentration of the solution and the shorter the distance between the electrodes, the lower the resistance.
4. The resistance of a conducting liquid is dependent on
   — the substance (for electrolytes),
   — the concentration of the solution,
   — the distance between the electrodes,
   — the size of the immersed areas of the electrodes, and
   — the temperature of the aqueous solution.

Remarks
The students can themselves easily demonstrate that the resistance is also dependent on the sizes of the area of the immersed parts of the electrodes, they need only lift an electrode up and observe the ammeter while doing so.
The values entered in Table 1 are only approximate values, as different series of measured values are given, for example, according to the concentration of the solution.
The results of this experiment and the evaluation suggest a consideration of their analogy to the law of resistance $R = \rho \cdot l / A$ which is valid for metal wires.

Fig. 2

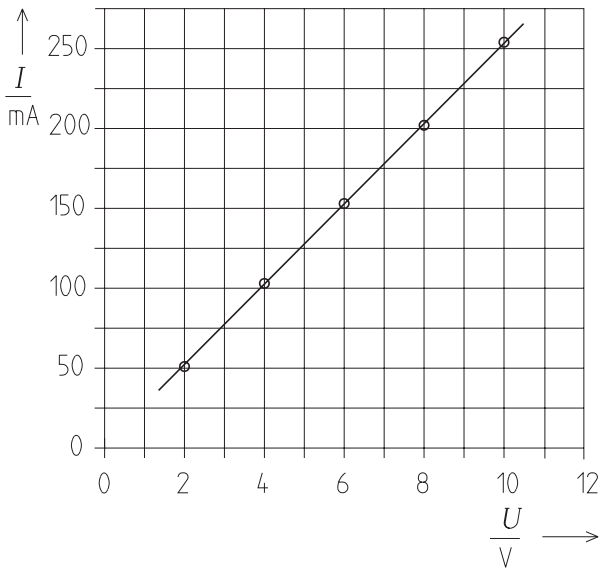


Table 1

U / V	I / mA	R / Ω
2	51	39
4	103	39
6	153	39
8	202	40
10	254	39
4 (with reduced distance between electrodes)	206	19
4 (at higher salt concentration)	125	32

T	EEP 4.2	The relationship between voltage and current intensity in conduction processes in liquids	PHYWE

(Is Ohm's Law also valid for conduction processes in liquids?)

Room for notes