Do the chemical properties of a conducting liquid change when current is passing through it?

EEP 4.3

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Task

To conduct electrical current through an aqueous solution of sodium sulphate and observe if this thereby changes chemically.

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	1
Connecting cable, 50 cm, blue	07314.04	1
Crocodile clips, bare, 2 from 10	07274.03	(1)
Multi-range meter	07028.01	1
Power supply, 0...12 V-,6 V~, 12 V~	13505.93	1
Spoon, special steel	38833.00	1
Water, distilled, 5 l	31246.81	1
Sodium sulphate, dried, 5 g reqd	48344.25	1
Emery paper, medium, 1 sheet from 5	01605.02	(1)
Scissors		
Pins		
Cardboard or similar, 76 mm x 40 mm		
Cloth or absorbent paper		

Danger!

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

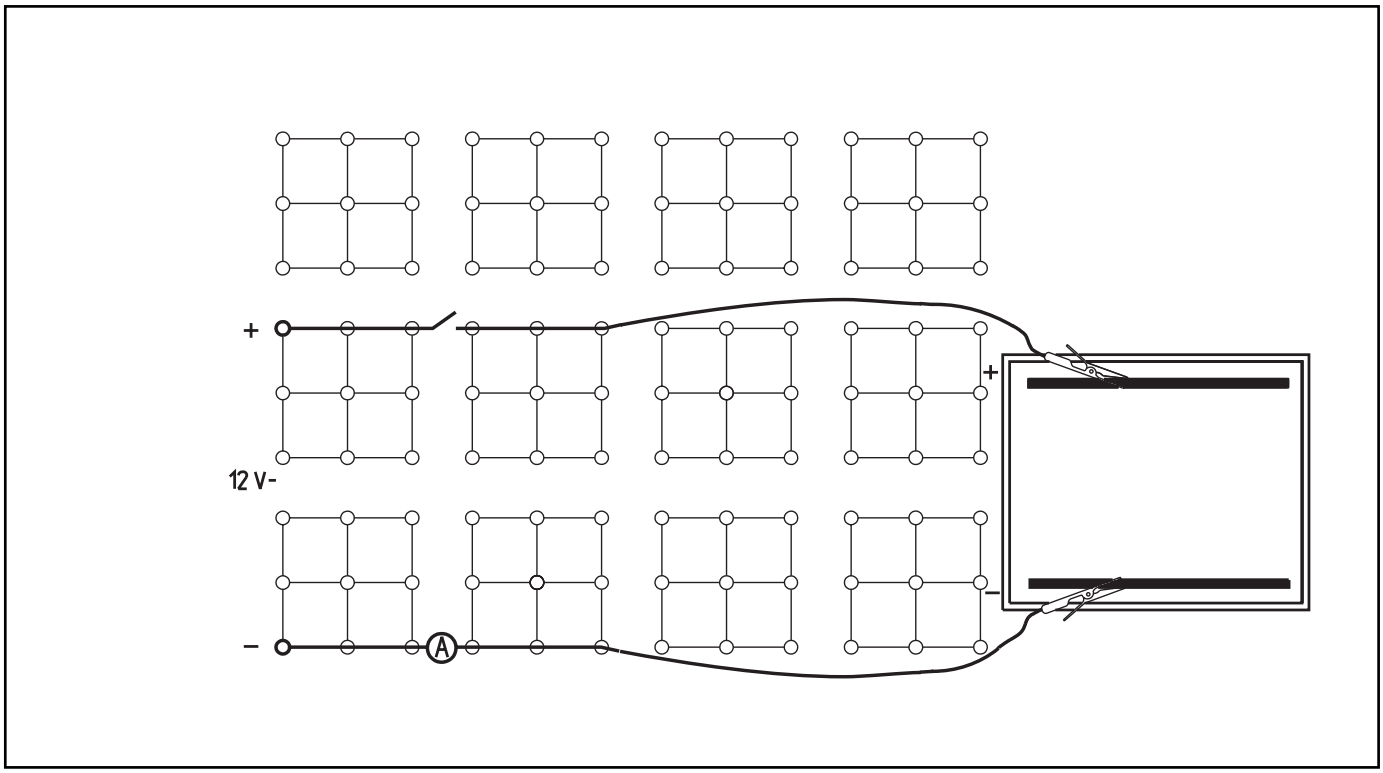
Set-Up and Procedure

— Set up the experiment as shown in Fig.1, with the switch first open. Fill the cleaned trough to about two thirds with distilled water; sprinkle a half-spoonful of sodium sulphate so slowly in the water that no clumps form and stir.
— Cut out pieces of cardboard of the same size as the electrodes, and make holes in them with a pin.
— Insert the carefully cleaned electrodes at the sides and the pieces of perforated cardboard in the middle of the trough.
— Select the 3 A- measurement range.
— Switch on the power supply and adjust it to 12 V-.
— Close the switch and allow current to flow for 2 to 3 minutes; measure the current and observe any processes or changes which occur in the trough.
— Open the switch, set the power supply to 0 V and switch it off.
— Note the measured value for the current and your observations.
— 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



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Observations and Measurement Results
Current strength I = ...

Processes and changes:
a) At the cathode:

b) At the anode:

Evaluation
1. Attempt to explain the processes observed at the cathode, whereby it would be best to use equations for the reactions.

2. Attempt to explain the visible changes in the solution in the area between the anode and the pieces of cardboard.

3. Before electrical current was passed through the aqueous solution, it was composed of water + sodium sulphate. Write down the components present in the solution at the end of the experiment:

   Water + sodium sulphate + ...+.....

(Do the chemical properties of a conducting liquid change when current is passing through it?)

The students know that metallic conductors do not change chemically when current passes through them. This experiment should bring them to the realization, that the chemical composition of a liquid conductor does change when electrical current passes through it.

Notes on Set-Up and Procedure

To save time, we recommend that the experimental groups are supplied with cleaned troughs and electrodes, as well as with pieces of perforated cardboard. Students are normally very willing to carry out the preliminary work required.

It is also important in this experiment that the teacher centrally organizes and superintends the waste disposal of the aqueous solutions, and also ensures that the necessary safety precautions are maintained during the whole of the experiment.

Danger!

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

Waste disposal

Collect copper sulphate solutions in an appropriately labelled container and re-use them in similar experiments.

Observations and Measurement Results

Current strength I = 1.2 A

Processes and changes:

a) At the cathode: Lively formation of bubbles of gas, which rise up towards the surface of the aqueous solution and go pop.

b) At the anode: Bluish green colouration of the aqueous solution between the anode and the pieces of perforated cardboard; the coloured solution slowly penetrates through the pieces of perforated cardboard.

Evaluation

1. Na_2SO_4 dissociates: $2Na^+ + SO_4^{2-}$; Na^+ ions migrate to the cathode, where each takes up one electron:
   $Na^+ + e^- \longrightarrow Na$;
   Na splits water molecules:
   $2Na + 2H_2O \longrightarrow 2NaOH + H_2\uparrow$;
   the sodium hydroxide dissociates:
   $NaOH \longrightarrow Na^+ + (OH)^-$. The gas bubbles consist of hydrogen.
2. The bluish-green colouration of the solution leads to the conclusion that copper sulphate has been formed by combination of the SO_4 ions with copper atoms from the anode. The $CuSO_4$ is subsequently also dissociated:
   $CuSO_4 \longrightarrow Cu^{2+} + SO_4^{2-}$.
3. The components present in the solution at the end of the experiment are: Water + sodium sulphate + sodium hydroxide + copper sulphate.

Remarks

Electrolysis is the term used to denote the decomposition of chemical compounds by electric current.

Water is decomposed to its components oxygen and hydrogen at the cathode; molecular hydrogen emerges from the solution.

The ammeter used in this experiment serves simply to show that current flows. The current measured is only an approximate value, and is, at the voltage given, predominately dependent on the ionic concentration of the solution.

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Room for notes