Galvanic cells from a series of concentration, their potentials and how to calculate them (Item No.: P7401400)

Curricular Relevance

Area of Expertise: Chemie

Education Level: Klasse 10-13

Topic: Physikalische Chemie

Subtopic: Elektrochemie - Potenziale, Leitfähigkeit, Elektrolyse

Experiment: Aufbau von Konzentrationsketten a Kaliumchloridlösungen Silber/Silberchloridelek uden

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

Additional Requirements:

- Filter paper strips

Experiment Variations:

Keywords:

galvanic cells, calculation of potential

Information for teachers

Introduction

Principle

Concentration series with potassium chloride solutions and silver/silver chloride electrodes confirm the result of the previous experiment (3.1) in which silver nitrate solutions were used. Should silver nitrate not be available to the students because of cost, then the Nernst equation (see 3.1) can be introduced using the procedure given here. Experience has shown that the measured values which can be obtained are not quite as reproducible as those obtained with silver nitrate solutions, but they are nevertheless sufficiently good for school experiments.

Note

The silver/silver chloride electrodes give the best results when they have been stored in 0.1 molar potassium chloride solution for some days.

Educational objectives

The students will learn how to measure the potential between two half cells which are the same. Furthermore, the students will learn how to use the "Nernst equation". The term "Concentration series" is also introduced.

Preparation of the solutions:

Potassium chloride solution (1 mol/l): Add 37.3 g of potassium chloride to 250 ml distilled water. Stir well and fill up to 500 ml with distilled water.

Potassium chloride solution (0,1 mol/l): Add 50 ml of Potassium chloride solution (1 mol/l) to 450 ml of distilled water.

Potassium chloride solution (0,01 mol/l): Add 50 ml of Potassium chloride solution (0,1 mol/l) to 450 ml of distilled water.

Potassium chloride solution (0,001 mol/l): Add 50 ml of Potassium chloride solution (0,01 mol/l) to 450 ml of distilled water.

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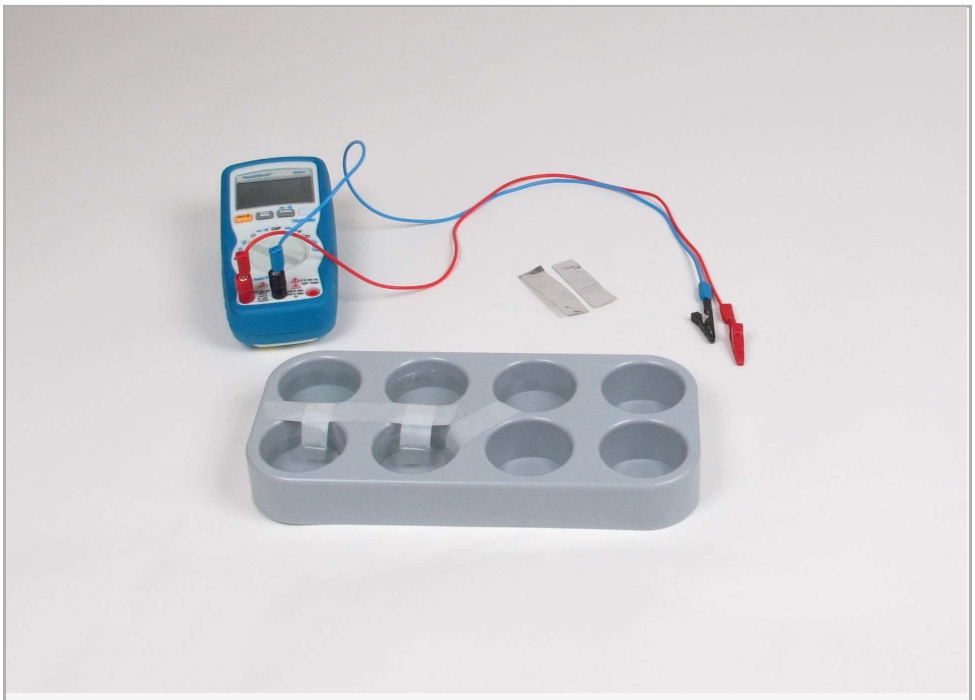

Fig. 1: Experimental set-up

Equipment

Position No.	Material	Order No.	Quantity
1	Digital multimeter 2005	07129-00	1
2	Connecting cord, 2 mm-plug, 5A, 500 mm, red	07356-01	1
3	Connecting cord, 2 mm-plug, 5A, 500 mm, blue	07356-04	1
4	Reducing plug 4mm/2mm socket, 2	11620-27	1
5	Alligator clip, insulated, 2 mm socket, 2 pcs.	07275-00	1
6	Block with 8 holes, d = 40 mm	37682-00	1
7	Silver foil, 150 x150 x 0.1 mm, 25 g	31839-04	1
8	Glass beaker DURAN®, tall, 50 ml	36001-00	5
9	Bottle,wide neck,plastic,50ml	33912-00	1
Additionally needed:			
	Potassium chloride solution in the concentrations 1,0.1,0.01, 0.001 mol/l		
	Filter paper strips		

Safety information

Potassium chloride solutions of concentration c = 1.0 mol/l act as irritants. Protect eyes and skin. Avoid contact of the chemical with eyes and skin. Wear protective gloves and protective glasses!

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Introduction

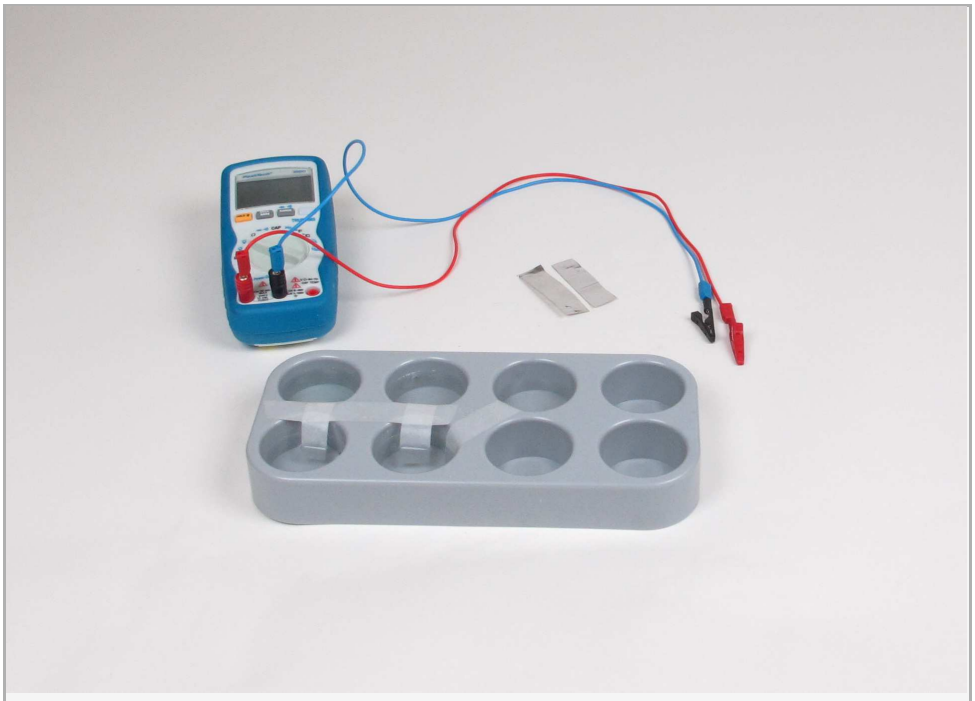
Application and task

Application

Electrical voltages are not only measurable between different metals in solutions of their salts, but also between half-cells which are the same except for containing different concentrations of the salt solution. Such couples of the same half-cells with different salt concentrations are called “concentration series”. The voltages measurable from such concentration series are subject to a conformity to natural law which is expressed mathematically by the so-called “Nernst equation”. Concentration series with potassium chloride solutions and silver/silver chloride electrodes confirm the result of the previous experiment in which silver nitrate solutions were used.

Task

A potassium chloride solution concentration series is to be prepared and the voltages measured. Two silver/silver chloride electrodes are to be used as electrodes.



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Set-up and procedure

Distribute the potassium chloride solutions in the measuring cells as shown in Fig. 1. Start with the greatest dilution in cell 1 (c = 0.001 mol/l), and finally fill 1 molar solution in both of the measuring cells 4 and 5. Conductively connect all 5 filled measuring cells as shown in Fig. 1, using keys made from filter paper strips but not wetted with potassium nitrate solution. Instead of this, allow the solutions in the connected measuring cells to ascend up from the immersed strip ends until they meet at the middle of the strips. If necessary, additionally put a couple of drops of 1 molar potassium chloride solution on the lengthwise strip, to ensure it is completely wetted.

Connect the blue connecting cord to the earthed socket of the measuring instrument (using a reducing plug) and the red connecting cord to the voltage socket (positive input).

Fit crocodile clips on the free ends of these connecting cords, and use these to each grasp a silver/silver chloride electrode above the gray coating of chloride.

Now dip the electrode which is connected to the earthed socket of the measuring instrument (blue connecting cord) in the solution of greatest dilution (measuring cell 1), and the electrode connected to the voltage socket in the solution of next greatest dilution (measuring cell 2) and measure the voltage.

Repeat this procedure to measure the voltages between the measuring cells 2 and 3, 3 and 4, 4 and 5. Note the measured values. Finally measure the voltages between the cells 1 and 3, 1 and 4, and 2 and 4.

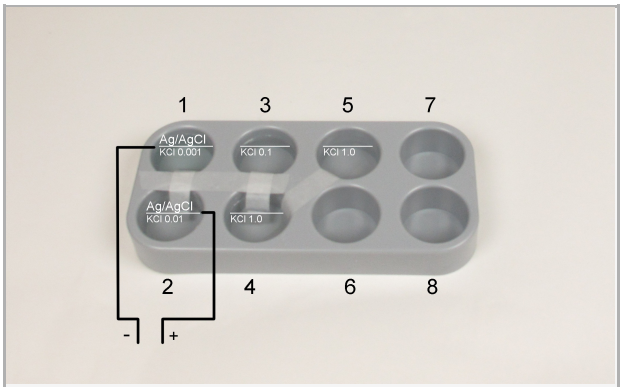

Fig. 2

Report: Galvanic cells from a series of concentration, their potentials and how to calculate them

Results - Question 1

Note down your observation and measurement values.

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Evaluation - Question 1

Why is there no voltage measured between the cells 4 and 5?

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Evaluation - Question 2

In this experiment, we used potassium chloride solutions instead of potassium nitrate, why? And what consequences does that might have for the experiment?

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