

The electrical charge quantity (Item No.: P1432801)

Curricular Relevance



Difficulty



Easy

Preparation Time



10 Minutes

Execution Time



20 Minutes

Recommended Group Size



2 Students

Additional Requirements:

Experiment Variations:

- P1432801 with an electroscope
- P1432802 with an electrometer amplifier

Keywords:

Introduction

Overview

Charges can be incrementally increased and also cancelled. This demonstrates that the electrical charge is a unit of quantity. Amounts of positive and negative charge can be added and subtracted like positive and negative numbers.



Fig. 1: Experimental set-up

The experiment can be performed with the electroscope (Fig. 1) or with the electrometer amplifier ADM 2 (Fig. 2). Fig. 3 shows how to connect the electrometer amplifier. The experiment with the electroscope is described here.

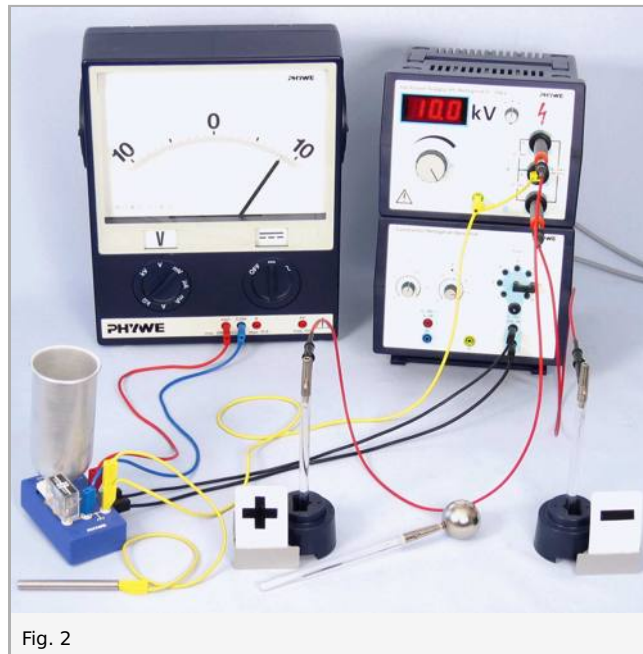


Fig. 2

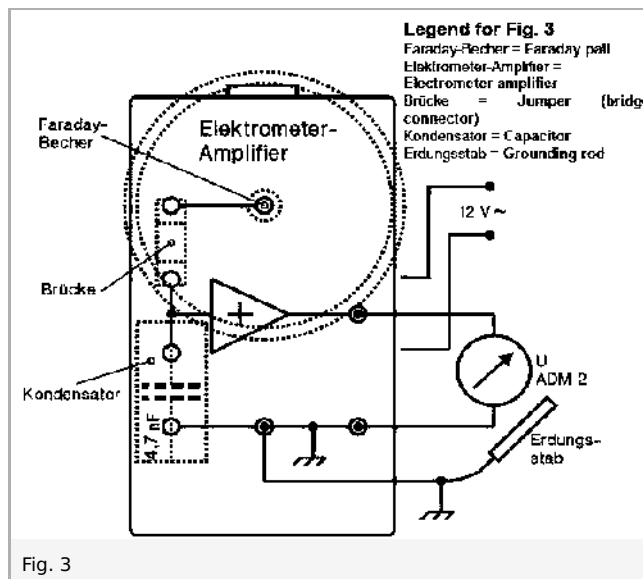


Fig. 3

Safety information



Voltages exceeding 25 V are hazardous if the current is greater than 0,5 mA. In the 2. experimental part, voltages that are **dangerous to touch** are delivered to the long distance cables.

The experiment is only to be operated by a specialist supervisor; never let students perform the experiment.

This experimental set-up delivers high voltages that are dangerous to touch. The set-up does not ensure a sufficient isolation against this high voltage. Therefore, the following advice is **strictly** to be followed!

- Put up a warning sign "high voltage" (e.g. 06543-00) before starting the experiment.
- The experiment is to be set up only when there is absolutely no voltage applied (disconnect power plug completely!); check every part once again before connecting the power supply to the mains.
- Changes in the experimental set-up are only to be made after disconnecting the power plug.
- **Important:** In order to prevent the danger of an electric shock, only perform the experiment with one hand (and the other hand in the trouser pocket).

Equipment

Experiment with electroscope P1432801

Position No.	Material	Order No.	Quantity
1	Barrel base PHYWE	02006-55	3
2	Support rod with hole, stainless steel, 10 cm	02036-01	1
3	Sign holder	02066-00	2
4	Electr.symbols f.demo-board,12pcs	02154-03	1
5	Insulating stem	06021-00	3
6	Faraday pail	06231-00	1
7	Conductor ball, d 40mm	06237-00	1
8	Danger sign - high-voltage -	06543-00	1
9	Electroscope, Kolbe type, Electrometer	07120-00	1
10	High-value resistor, 10 MOhm	07160-00	2
11	Connecting cord,100 mm, green-yellow	07359-15	1
12	Connecting cord, 32 A, 500 mm, green-yellow	07361-15	1
13	Connecting cord, 32 A, 1000 mm, green-yellow	07363-15	1
14	Connecting cord, 30 kV, 1000 mm	07367-00	2
15	PHYWE High voltage supply unit with digital display DC: 0... ± 10 kV, 2 mA	13673-93	1

Experiment with electrometer amplifier P1432802

Position No.	Material	Order No.	Quantity
1	Barrel base PHYWE	02006-55	3
2	Support rod with hole, stainless steel, 10 cm	02036-01	1
3	Sign holder	02066-00	2
4	Electr.symbols f.demo-board,12pcs	02154-03	1
5	Insulating stem	06021-00	3
6	Faraday pail	06231-00	1
7	Conductor ball, d 40mm	06237-00	1
8	Danger sign - high-voltage -	06543-00	1
9	Electroscope, Kolbe type, Electrometer	07120-00	1
10	High-value resistor, 10 MOhm	07160-00	2
11	Connecting cord,100 mm, green-yellow	07359-15	1
12	Connecting cord, 32 A, 500 mm, green-yellow	07361-15	1
13	Connecting cord, 32 A, 1000 mm, green-yellow	07363-15	1
14	Connecting cord, 30 kV, 1000 mm	07367-00	2
15	PHYWE High voltage supply unit with digital display DC: 0... ± 10 kV, 2 mA	13673-93	1
16	Connecting cord, 500 mm, red	07361-01	1
17	Connecting cord, 500 mm, blue	07361-04	1
18	Connecting cord, 500 mm, black	07361-05	2
19	Power supply, universal	13500-93	1
20	Electrometer amplifier	13621-00	1
21	Multimeter ADM 2, demo, analog	13820-00	1
22	Capacitor G1 4.7 nF	39105-13	1
23	Connecting plug white 19 mm pitch	39170-00	1

Set-up and procedure

- Connect the center tap with the grounding connection at the high voltage supply unit
- Move the switch of the high voltage supply unit to the middle position
- Also connect the electroscopes housing and the support rod with the grounding connection
- Place one insulation stem in each barrel base. Connect one of these with the positive pole and the other with the negative pole
- Place the conductor ball onto the third insulation stem
- Adjust the power supply to 5 kV
- Connect the Faraday pail to the electroscopes with the grounding contact
- Touch a pole with the ball, discharge the ball in the pail, make a note of the position of the pointer (table 1)
- Repeat several times
- Discharge the pail step-by-step with a charge of the opposite sign and charge vice versa, watch the position of the pointer

Results and evaluation

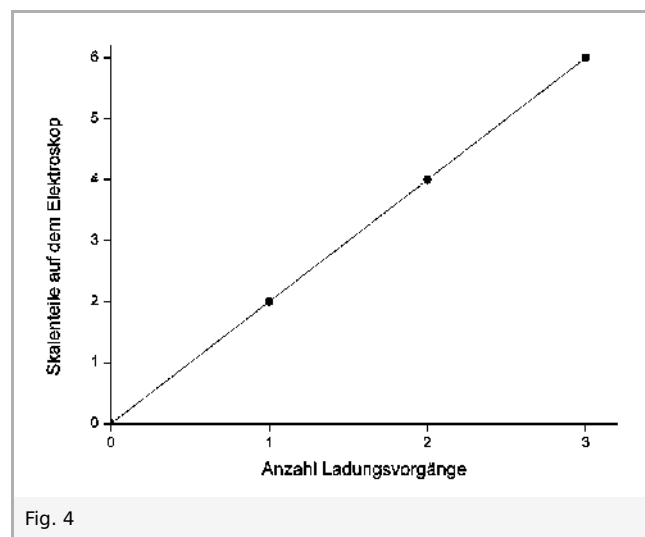
Observation

In the beginning the electroscope does not move. If the ball is held up to one of the contacts and then placed into the pail, the pointer moves. The pointer position increases, if the ball is held again to the same contact and returned to the pail.

Number of charges	0	1	2	3
Pointer position/ scale division	0	2	4	6

If the ball is held up to the other pole and then placed into the pail, the pointer decreases step-by-step back to zero. During this just as many transfers will be needed as with the first experiment to bring the pointer back to zero. If further charge is transferred, then the pointer increases again.

Evaluation



The amount of charge on the ball can be added on the electroscope. The charge is transferred from the ball to the Faraday pail. Multiple charges also have a multiple effect on the movement of the pointer. The movement of the pointer is proportional to the amount of charge.

The charge of one contact is cancelled by the charge of another contact - that corresponds with the deduction of the same charge amount. As a result, positive and negative charges or amounts of charge are distinguished, with which positive and negative numbers are added or subtracted.

Remarks

1. Before the experiment the insulation stems should be cleaned with a towel and methylated spirit, in order to remove existing conducting contaminants.
2. In order to avoid influential effects, the distance between the electroscope and the parts under high voltage should be more than 50 cm (approx. 2 feet).
3. A complete discharging of the ball only occurs in the field-free inside the Faraday pail. When transferring charges from the ball to the pail the ball should touch the pail only if the ball and the metal parts of the insulating stem are completely within the field-free range of the pail. The experiments should be performed quickly in order to avoid losses in charge. Do not touch the pail with your hands during the experiment. Make sure that the grounding is correct (also of the experimenting person).