Electrostatic induction (Item No.: P1433001)

Curricular Relevance

Area of Expertise: Physics
Education Level: Age 14-16
Topic: Electricity
Subtopic: Electric charge, electrostatics
Experiment: Electrostatic induction

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

Additional Requirements:

Experiment Variations:

Keywords:

Introduction

Overview

The charge displacement caused by an electric field in an electric conductor is called electrostatic induction. In this experiment the separation of positive and negative charges in a previously discharged body is observed.

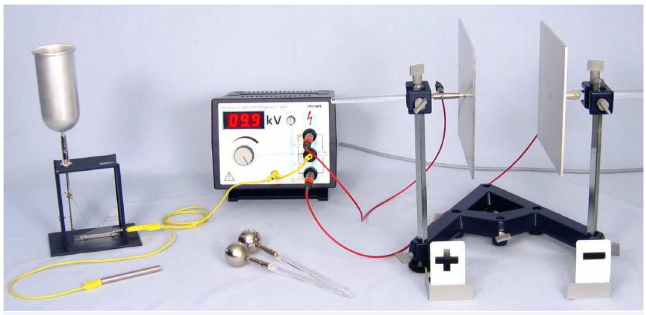


Fig. 1

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.

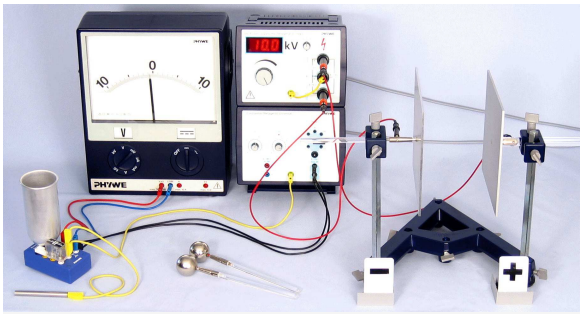
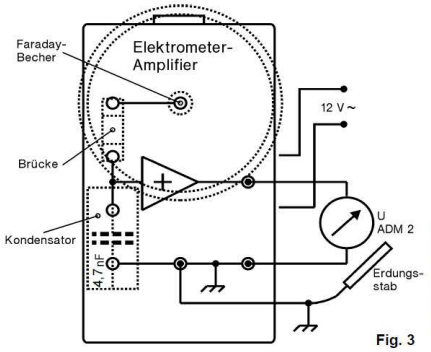


Fig. 2



Legend for Fig. 3
Faraday-Becher = **Faraday pail**
Elektrometer-Amplifier = **Electrometer amplifier**
Brücke = **Jumper (bridge connector)**
Kondensator = **Capacitor**
Erdungsstab = **Grounding rod**

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).

Robert-Bosch-Breite 10
D - 37079 Göttingen
Tel: +49 551 604 - 0
Fax: +49 551 604 - 107
info@phywe.de
www.phywe.com

Equipment

Experiment with electroscope P1433001

Position No.	Material	Order No.	Quantity
1	Support base DEMO	02007-55	1
2	Barrel base expert	02004-55	1
3	Support rod with hole, stainless steel, 10 cm	02036-01	1
4	Right angle clamp expert	02054-55	2
5	Sign holder	02066-00	2
6	Electr.symbols f.demo-board,12pcs	02154-03	1
7	Insulating stem	06021-00	3
8	Faraday pail	06231-00	1
9	Conductor ball, d 40mm	06237-00	2
10	Danger sign - high-voltage -	06543-00	1
11	Electroscope, Kolbe type, Electrometer	07120-00	1
12	High-value resistor, 10 MOhm	07160-00	2
13	Connecting cord,100 mm, green-yellow	07359-15	1
14	Connecting cord, 32 A, 500 mm, green-yellow	07361-15	1
15	Connecting cord, 32 A, 1000 mm, green-yellow	07363-15	1
16	Connecting cord, 30 kV, 1000 mm	07367-00	2
17	PHYWE High voltage supply unit with digital display DC: 0... ± 10 kV, 2 mA	13673-93	1
18	Spacer plates,1 set	06228-01	1
19	Plate capacitor, 283x283 mm	06233-02	2
20	Support rod, stainless steel, l = 250 mm, d = 10 mm	02031-00	2

Experiment with electrometer amplifier P1433002

Position No.	Material	Order No.	Quantity
1	Support base DEMO	02007-55	1
2	Barrel base expert	02004-55	1
3	Support rod with hole, stainless steel, 10 cm	02036-01	1
4	Right angle clamp expert	02054-00	2
5	Sign holder	02066-00	2
6	Electr.symbols f.demo-board,12pcs	02154-03	1
7	Insulating stem	06021-00	3
8	Faraday pail	06231-00	1
9	Conductor ball, d 40mm	06237-00	2
10	Danger sign - high-voltage -	06543-00	1
11	High-value resistor, 10 MOhm	07160-00	2
12	Connecting cord,100 mm, green-yellow	07359-15	1
13	Connecting cord, 32 A, 500 mm, green-yellow	07361-15	1
14	Connecting cord, 32 A, 1000 mm, green-yellow	07363-15	1
15	Connecting cord, 30 kV, 1000 mm	07367-00	2
16	PHYWE High voltage supply unit with digital display DC: 0... ± 10 kV, 2 mA	13673-93	1
17	Spacer plates,1 set	06228-01	1
18	Plate capacitor, 283x283 mm	06233-02	2
19	Support rod, stainless steel, l = 250 mm, d = 10 mm	02031-00	2
20	Connecting plug white 19 mm pitch	39170-00	1
21	Connecting cord, 500 mm, red	07361-01	1
22	Connecting cord, 500 mm, blue	07361-04	1
23	Connecting cord, 500 mm, black	07361-05	2
24	Power supply, universal	13504-93	1
25	Electrometer amplifier	13621-00	1
26	PHYWE demonstration multimeter ADM 3	13840-00	1
	OHP pen		

Robert-Bosch-Breite 10
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info@phywe.de
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Set-up and Procedure

Set-up and procedure

Set-up

- Connect the center tap of the high voltage supply unit and housing of the electroscope with the grounding connection of the high voltage supply unit, then plug one high value resistor each on the upper (plus pole) and lower (minus pole) connection
- Move the switch of the high voltage supply unit to the middle position
- Connect one capacitor plate with the plus pole, the other with the minus pole

Implementation

Experiment 1

- Apply 10 kV between the capacitor plates
- Discharge the electroscope or electrometer by touching it with the grounding contact so that the pointer is at zero
- Place the conductor balls on the insulated stems and discharge by touching them with the grounding contact
- Hold the balls in such a manner that the center of the ball and the center of the capacitor plates are aligned and make the balls touch
- Separate the balls in the inside of the capacitor and lead them out of the capacitor without touching the plates
- Lead one of the balls into the Faraday pail and release the charge to the electroscope
- Then transfer the charge of the second ball to the electroscope

Experiment 2

Repeat the experiment this time, however, hold the balls parallel to the capacitor plates next to each other

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Results and evaluation

Observation

Experiment 1

If the balls are held perpendicular to the capacitor plates next to each other, then the balls are charged after they are separated. If one of the balls is discharged in the pail of the electroscope, then the pointer moves. When discharging the second ball, the pointer returns to zero on the electroscope. This means that the balls are oppositely charged and the amounts of the charge are the same size.

Experiment 2

If the balls are held parallel to the capacitor plates next to each other, then no charge is detected on them after they are separated.

Evaluation

Experiment 1

The balls are electrically conductible, i.e. they have movable charge carriers. In the parallel-plate capacitor the negative charge carriers are attracted to the positive parallel plate, and the positive charge carriers to the negative parallel plate. If the balls are held perpendicular to the capacitor, then the negative charges flow towards the positive parallel plate and collect on that ball. The negative charge carriers are called electrons. The positive charges are then located on the other ball that is located closer to the negatively charged parallel plate(electron deficiency) If the balls are separated in the capacitor, the charges can no longer flow back and remain maintained on the ball. The amount of the charges is the same size.

Experiment 2

If the balls are held parallel to the capacitor plates the charges also separate. Positive charges are located on one side of the ball, negative charges on the other side. However, no charges flow from one ball to the other. Outside of the capacitor these charges cancel each other out again. The displacement of charges to one electric carrier through forces that other charges exert on is called
electrostatic induction.

Remarks

If the field term is already known it can also be explained that electrostatic induction causes the inside of the carriers to always remain field free.

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