The effect of a force of electrostatic induction (imagecharge)

Physics > Electricity & Magnetism > Electrostatics & electric field

Difficulty level	Group size	Preparation time	Execution time
easy	-	10 minutes	10 minutes

This content can also be found online at:

http://localhost:1337/c/6426bcb0ab58420002f62876

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Teacher information

Application

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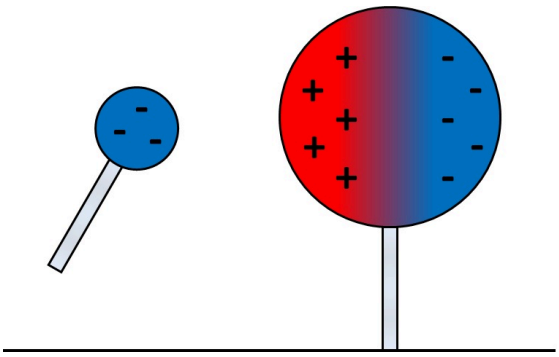

Influence in conductive bodies.

Influences, or electrostatic inductions, are interactions that are caused by electrically charged objects or by electric fields, in which spatial charge shifts or polarisation may occur. These influences are largely dependent on the nature and material of the bodies used (conductors or non-conductors).

It is well known that unlike electrical charges attract each other and like charges repel each other. The phenomenon of the force effect can also occur between charged objects and uncharged conductors. This special type of force effect due to electric charge is to be investigated by the students.

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Other teacher information (1/2)

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Prior knowledge

Students should already have learned about and understood the interaction between positively and negatively charged bodies. They should already know that and why a force effect exists between charged particles.

Principle

For a force effect to occur between electrically charged objects, both objects do not necessarily have to be electrically charged. Metallic objects, for example, are often very good conductors due to their nature and therefore a force effect can also be created by induction to a charged object of other materials.

Other teacher information (2/2)

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Learning objective

The students should realise that electrical attractive forces can also occur between an electrically charged insulator and an uncharged electrical conductor. The forces are of the same kind as with differently charged insulators, but they can only be explained by a displacement of the charges in the electrically neutral conductor.

Tasks

In this experiment, students are asked to investigate the force effect between a rubbed polypropylene rod and an insulated, uncharged metal plate.

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Safety instructions

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The general instructions for safe experimentation in science lessons apply to this experiment.

Notes on set-up and procedure:

The metal plate must be electrically neutral. Therefore, the students should be explicitly informed that the plate must be discharged by touching it with the hand before the experiment and that the plate must not touch the hanging rod. In this experiment, it can also be discussed in the evaluation why the charged rod should hang at right angles to the base of the electroscope if possible (if it were hung in an unfavourable position, it would be pulled towards the electroscope by the effect of an induction). If necessary, it should be pointed out that the force effect on the hanging rod would be the same if the opposite charge to that of the rod existed in the mirror image behind the influence plate (image charge). However, this only applies if the plate used is sufficiently large.

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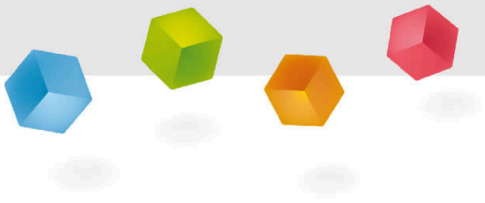

Student information

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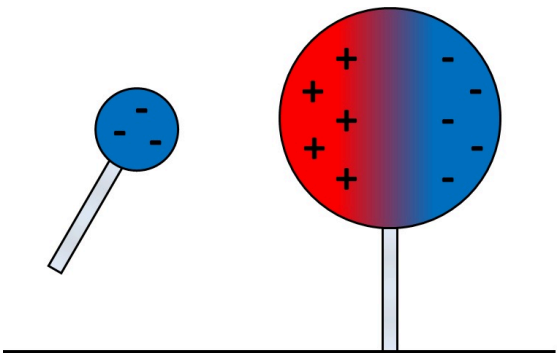
Motivation



Influences in conductive bodies.

As you have already learned, forces can act between electrically charged objects. Until now, the effect of the force was largely dependent on the type of charge, i.e. whether two bodies were equally or unequally charged. As you also know, these forces also apply to objects of different materials (conductors and non-conductors).

But what about charged objects that are brought together with uncharged objects (in this case ladders)?

This phenomenon is to be investigated in this experiment.

Tasks

In this experiment you will investigate the force effect between a rubbed polypropylene rod and an insulated, uncharged metal plate.

For this purpose, you will work on the following steps:

1. Electrically charge a polypropylene rod.
2. Hang this on an electroscope.
3. Bring an uncharged metal plate closer to the rod.
4. Then bring your finger closer to the staff.
5. Watch what happens!

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Equipment

Position	Material	Item No.	Quantity
1	Electroscope w. metal pointer	13027-01	1
2	Polypropylene rod, l=175mm, d=10 mm	13027-09	2
3	Clip for rods, with cord	13027-16	1
4	Electrostatic influence plate, 30 x 60 mm	13027-12	1

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Additional Equipment

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Position	Equipment	Quantity
1	Dry, rough paper	DIN A4

Set-up

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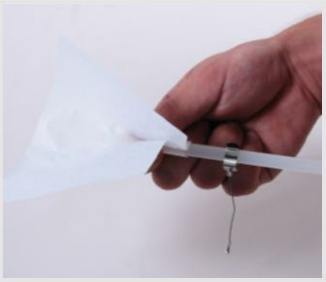
- Put the clip on the middle of one of the sticks.
- Electrically charge one end of the polypropylene rod by rubbing it vigorously with paper.
- Hang the rod on the electroscope without touching it / discharging it. It should hang horizontally and across the base of the electroscope.
- Attach the Influence Plate to one end of the other rod. Make sure that the plate is discharged / neutral. If in doubt, discharge it by touching it with your hand.



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Procedure (1/2)

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Approach the uncharged end of the rod and the charged end of the rod to the induction plate

- Bring the Influence Plate closer to the uncharged end of the hanging rod.
- Then bring the Influence Plate closer to the charged end of the rod.
- Pay close attention to the behaviour of the hanging rod.

Procedure (2/2)

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Approach the uncharged end of the stick and the charged end of the stick with your finger.

- Bring one finger close to the uncharged end of the stick.
- Bring one finger close to the charged end of the stick.
- Again, pay close attention to the behaviour of the hanging stick.

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Report

Task 1

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Approaching the Influence Plate to the Rod

What were your observations during the experiment with the Influence Plate?

- ☐ The influence plate has attracted the uncharged end of the rod.
- ☐ The influence plate has attracted the charged end of the rod.
- ☐ The influence plate has neither attracted nor repelled the uncharged rod end.

Check

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Task 2

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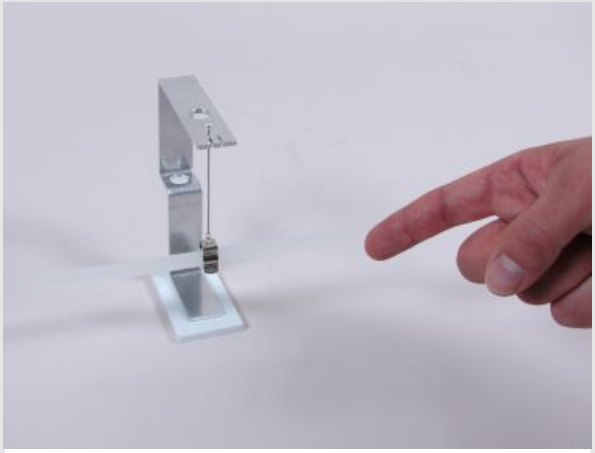

Approach the rod with the fingers

What were your observations during the finger experiment?

- ☐ The fingers neither attracted nor repelled the uncharged end of the rod.
- ☐ The finger has attracted the charged end of the rod.
- ☐ The fingers were attracted to the unloaded end of the stick.

Check

Task 3

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Explain your observations. Drag the words into the correct boxes!

Negative charges in the metal are _____ from the _____ charged polypropylene rod and migrate to the side of the metal plate facing away from the rod. The remaining _____ charges are _____ more strongly by the smaller distance to the rod than the negative charges are repelled. This results in an overall _____ between the rod and the metal plate. When approaching the _____ end of the rod, the effect of charge separation in the metal does not occur, therefore there is no force effect. In the human finger, the _____ effect occurs.
Not needed: _____

inverted
same
uncharged
attraction
attracted
repelled
negative
positive

Check

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Slide	Score / Total
Slide 15: Observation: experiment with plate	0/2
Slide 16: Observation: Experiment with finger	0/2
Slide 17: Explanation	0/8

Total 0 / 12

Solutions Repeat

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