

## Electrical circuits 2: Static electricity

### Components

	NAME	DESCRIPTION	AUDIENCE
	<i>Static electricity</i> teacher guide	This guide describes how to use a series of activities to explore static electricity.	teachers
	<i>Exploring electrostatics</i> procedure sheet	Students respond to questions about a series of activities using common laboratory equipment.	students
	<i>Electrostatics in action</i> worksheet	This two-part worksheet contains a detailed description of the powder-coating process and descriptions of different types of lightning strike. Questions are posed about the role of electrical charge in each.	students

### Purpose

To **Explore** how objects can be repelled or attracted due to the charge they are carrying, and apply knowledge of electrostatics to investigate related applications.

### Outcomes

Students:

- propose reasons why objects carrying charge are repelled or attracted by other objects;
- explore the charge rule and offer suggestions as to why objects sometimes repel and other times attract each other;
- understand that charged particles include electrons and ions that can move, and
- describe common situations and phenomena that depend upon movement of charged particles for their operation.

### Activity summary

ACTIVITY	POSSIBLE STRATEGY
The teacher leads a discussion centred around the worksheet <i>Exploring electrostatics</i> , and directs students to perform activities described on it.	teacher-led discussion
Common activities are used to demonstrate attraction and repulsion.	students perform the activities and respond to questions
Teachers discuss applications of electrostatics and charge movement in general.	whole of class discussion
Students complete the worksheet, <i>Electrostatics in action</i> .	students work on the worksheet individually
Students use their understanding resulting from the previous activity to re-examine the <i>Lightning strikes!</i> video and offer explanations for phenomena shown.	Think, pair, share

## Teacher notes

The seven activities described in the procedure sheet, *Exploring electrostatics*, can be set up simultaneously in a laboratory with students moving between them.

Experiments with rods, fur and cloth are best done in a dry atmosphere. In damp conditions, a conductive layer of moisture and dissolved salts may build up on equipment, which prevents build up of static charge. Portable heaters can help overcome this problem.

The stirrup used in task four can be made from thin coat hanger wire and reused from year to year.

If teachers wish to include quantitative aspects of electrostatics they could get students to perform a procedure that investigates the inverse square law. A description of a procedure using a sensitive, top-loading balance and charged perspex plates can be found in *Exploring physics, Stage 2*, published by the Science Teachers Association of Western Australia (STAWA), Experiment 14.2: The force between electric charges.

## Open-ended method

An alternative method of exploration is to provide groups of students with equipment and instruct them to investigate the effects of charge. Equipment supplied may include rods, fur, silk, pith balls, cotton thread, retort stands and clamps.

Teachers may supplement student activities by using a van der Graaff generator or Wimshurst machine to demonstrate additional electrostatic effects.

Leading questions can be posed by teachers to encourage students to explore effects of charge.

## Using the worksheet

Some of the descriptions in part 2 of the worksheet, *Electrostatics in action*, match scenes from the video *Lightning strikes!*. For example, the first high-speed (black and white) sequence shows what is described in the 'Cloud to ground' part of the worksheet.

Students can be encouraged to interpret what is happening in the other scenes in the video as the same principles apply, but the direction of charge movement and the nature of the initial charge may be different.

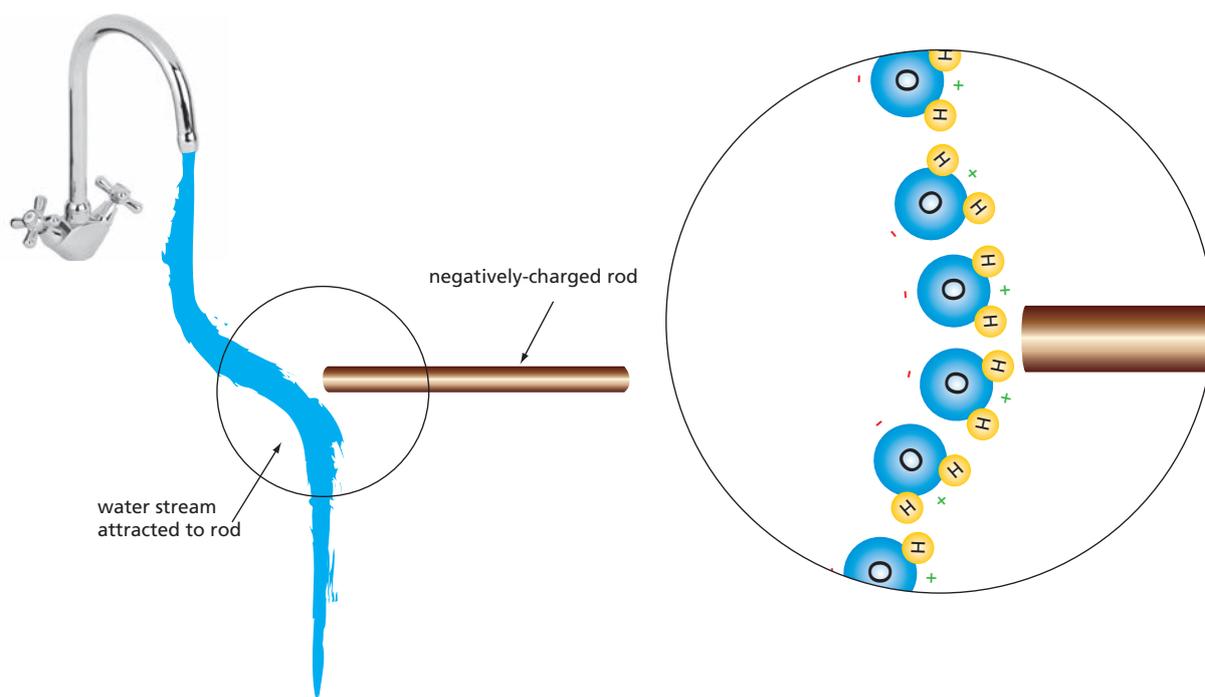
## Electrostatic effects on water

This common demonstration, illustrated below, does not use principles established in earlier activities. Care should be taken not to introduce misconceptions to students.

Water molecules are polar. That is, water molecules have a positive end (hydrogens) and a negative end (oxygen). Electrons are unevenly distributed in water molecules because oxygen is more electronegative than hydrogen.

When a negatively-charged rod is brought close to a water stream, individual water molecules align themselves so the positive (hydrogen) end points towards the rod. Negative and positive charges attract one another and the water stream is bent towards the rod.

To probe understanding, ask students if the same bending effect occurs when a positively-charged rod is brought close to a similar stream of water? Explain your answer in terms of polar molecules and charge.



## More about the origin of charge

The following points may be used to promote discussion with students.

- There is general acceptance in the scientific community that electrostatic charge is dependent on the arrangement of particles in the quantum mechanical atom. Under normal circumstances bodies are neutral, that is, they do not exhibit a charge. However if excess electrons are added to the body it will take on an overall negative charge. Conversely, if electrons are removed it will take on a positive charge.
- Positive charge is due to excess positive charge in the nucleus compared to the number of electrons surrounding it. This charge imbalance can be caused by physically transferring electrons from one body to another. For instance, if a piece of plastic is rubbed with fur it is possible to remove electrons from the fur and deposit them on the plastic. The fur becomes positively-charged and the plastic becomes negatively-charged.
- Insulators are best for storing electrical charge. Electrons tend to accumulate in one place because they do not travel freely along insulators. Because of this, electrostatic charge is concentrated in a limited area.
- Two bodies carrying the same electrostatic charge repel each other. Bodies carrying different electrostatic charges attract each other. A charge difference leads to a difference in electrical potential. For instance if a positively-charged body is near a neutral (uncharged) body then the positively-charged body will be at a higher potential than the uncharged body.
- An electric field occupies the space around a charged body. The field is responsible for attracting or repelling other bodies within its influence.

## Follow up questions

The following questions may be used after the students have completed the worksheet, *Exploring electrostatics*.

- Why is it difficult to charge a metal rod by rubbing it with fur or cloth?
- A student charges a plastic rod by rubbing it with fur. She places the rod near some small pieces of paper and observes some pieces are initially attracted but then jump quickly away. Explain why this occurs.
- The student repeats this experiment on a very humid day but observes that the rod will not become charged, despite rubbing the rod as before. Explain why the rod is difficult to charge.

## Technical requirements

The teachers guide, procedure sheet and worksheet require Adobe Reader (version 5 or later), which is a free download from [www.adobe.com](http://www.adobe.com). The procedure sheet and worksheet are also provided in Microsoft Word format.

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Email: [spice@uwa.edu.au](mailto:spice@uwa.edu.au)  
Phone: (08) 6488 3917

Centre for Learning Technology (M016)  
The University of Western Australia  
35 Stirling Highway  
Crawley WA 6009

## Associated SPICE resources

*Electrical circuits 2: Static electricity* may be used with related SPICE resources to address the broader topic of electricity.

DESCRIPTION	LEARNING PURPOSE
<p><i>Electrical circuits (sequence overview)</i></p> <p>This learning pathway shows how a number of SPICE resources can be combined to teach the topic of electricity.</p>	
<p><i>Electrical circuits 1: Lightning</i></p> <p>Students are engaged in the topic of electricity through observing and exploring lightning.</p>	<b>Engage</b>
<p><i>Electrical circuits 2: Static electricity</i></p> <p>Students explore the effects of charge through a series of laboratory experiments.</p>	<b>Explore 1</b>
<p><i>Electrical circuits 3: Current electricity</i></p> <p>Students construct circuits using simple electrical components.</p>	<b>Explore 2</b>
<p><i>Electrical circuits 4: Circuit rules</i></p> <p>Students use an interactive learning object to record observations and derive rules for circuits.</p>	<b>Explain 1</b>
<p><i>Electrical circuits 5: Measuring electricity</i></p> <p>Six measurements that relate to electricity are explained and related to electrical safety: charge, current, electric potential, resistance, power and energy.</p>	<b>Explain 2</b>
<p><i>Electrical circuits 6: Bioelectricity</i></p> <p>Four fact sheets and a video provide examples of how electricity is used in living organisms, including humans.</p>	<b>Elaborate</b>