Physics > Big idea PEM: Electricity and magnetism > Topic PEM1: Simple circuits

Key concept (age 11-14)
PEM1.4: Static electricity

What's the big idea?

A big idea in physics is electricity and magnetism. The familiar everyday world we live in is largely a consequence of the properties and behaviour of electric charge. Matter is held together by electrostatic forces, and these influence chemical changes. Electricity and magnetism initially seem distinct phenomena but are later found to be closely interrelated. Understanding electricity and magnetism helps us to develop our technology and find applications that can transform our everyday lives.

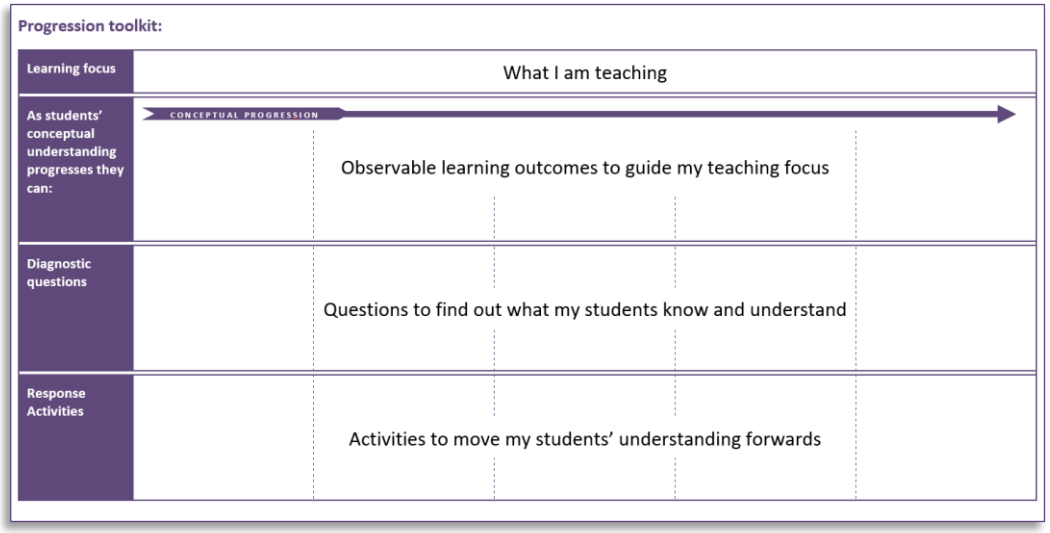
How does this key concept develop understanding of the big idea?

This key concept develops the big idea by building on students' experiences of static electricity to provide the foundations for understanding of electrostatic forces that explain the movement of electric charges in a circuit, and which, in chemistry, form the basis for atomic structure and bonding.

The conceptual progression starts by checking understanding of what is an electrostatic force. It then develops the concept of positive and negative charges by describing the forces they exert on each other in order to enable understanding of how objects gain positive or negative charge by the transfer of electrons.

How can you use the progression toolkit to support student learning?

Use diagnostic questions to identify quickly where your students are in their conceptual progression. Then decide how to best focus and sequence your teaching. Use further diagnostic questions and response activities to move student understanding forwards.



Progression toolkit: Static electricity

Learning focus	Charged objects attract or repel other objects at a distance; they gain charge by the transfer of electrons as the result of rubbing.				
As students' conceptual understanding progresses they can:	CONCEPTUAL PROGRESSION				
	Identify when an electrostatic force is acting in familiar situations.	Describe how objects with a positive or negative charge attract or repel other charged objects.	Describe how friction can rub *only* negative electric charges off one object onto another to charge them both.	Describe how atoms contain equal numbers of positive electric charges and negative electric charges (electrons), and that these normally cancel out so there is no charge.	Explain how an object gains an overall charge in terms of the imbalance between positive and negative charges.
Diagnostic questions	Electrostatic force?	Attract or repel?	Making static electricity	Positive or negative?	
Response Activities	Electrostatic circus	Charged strips	Charging model		
			Charging a balloon		

What's the science story?

When a cloth is used to charge (by rubbing) two objects made of the same material, they repel each other. However, two charged objects made of different materials may attract each other. There are two types of charge, which we call positive and negative. Two objects with the same type of charge repel each other; two with different types of charge attract.

If a charged object touches another object, they can share the charge. If a small amount of charge is shared with a large object, the charge can become so spread out that it is not noticeable. So a charged object can discharge (lose its charge) if it is connected to Earth (e.g., by a wire, or through a person's body). It can also discharge by gradually sharing its charge with its surroundings, including the air.

What does the research say?

In thinking about electrostatics, students need a rudimentary understanding of the structure of an atom: with a fixed positively charged middle (ion) with relatively free negative electric charges on the outside, called electrons. According to Shen and Linn (2011), and Başer and Geban, (2007) the more common misunderstandings students have are:

- They may use the term 'negative' to refer to a neutral material (a negative medical test mean there is *nothing* wrong).
- Some think a charged object contains only one type of charge, rather than an imbalance of opposite charges.
- Many hold the idea that both positive and negative charges transfer between solid materials.
- Many also think that 'friction is the cause of static electricity' and rubbing creates the electric charges.

Strawson (2011) also notes that students often confuse electrostatic effects with magnetism.

Developing students' understanding of the movement and conservation of charge can be challenging, partly because the understanding comes from links with other topics. In particular research recommends that the understanding of the particle model of matter is secure before introducing atomic structure. Using dynamic models to help students visualise what is happening to the negative charge helps students progress in their thinking (Shen and Linn, 2011).

The progression toolkit for static electricity uses a constructive approach to teaching about positive and negative charge, which is very similar to that outlined by Strawson (2011). It links students' own experiences of static electricity to examples in the lab that illustrate its key properties. Students are introduced to the concept of positive and negative charges and learn to describe their properties by investigating the forces between positively and negatively charged strips of plastic. When they can describe the properties of the different charges, they can use their definitions to help to explain, in increasing detail, the ways in which objects gain charge. Comparing their explanations to a model allows students plenty of opportunity to reflect on and to improve their understanding of static electricity.

Guidance notes

It is suggested that static electricity is taught *after* electric current and voltage in simple circuits. Students have experience of electric circuits from their earlier studies, so this is a good starting point for 11-14 year olds. Static electricity builds on the idea that charge is flowing around a circuit. It describes the observable properties of charged objects in terms of sub-atomic charged particles.

At this stage students may not have a good understanding of atomic structure (Chemistry topic CPS5: Periodic table). For this reason it is sufficient to talk about positive electric charges and negative electric charges. Naming the negative electric charges in solids as 'electrons' would give consistency to the development of ideas in later topics, for example in atomic structure and bonding.

References

Başer, M. and Geban, Ő. (2007). Effect of instruction based on conceptual change activities on students' understanding of static electricity concepts. Research in Science and Technological Education. Jul 2007, Vol. 25 Issue 2, p243-267.

Shen, J. and Linn, M.C. (2011). *A Technology-Enhanced Unit of Modelling Static Electricity: Integrating scientific explanations and everyday observations.* International Journal of Science Education. Aug 2011, Vol. 33 Issue 12, p1597-1623.

Strawson, R. (2011) 'Electricity and magnetism'. In Sang, D. (Ed), *Teaching secondary physics* (pp 151-202). London: Hodder Education.