# *Magnetism and electrostatics* Teaching and learning plan

## Learning intentions

Students will be able to:

* use contact and non-contact forces to describe interactions between objects
* identify when science is used to ask questions and make predictions
* follow instructions to identify investigable questions about familiar contexts and predict likely outcomes from investigations
* discuss ways to conduct investigations and safely use equipment to make and record observations
* use tables and simple column graphs to organise their data and identify patterns in data
* suggest explanations for observations and compare their findings with their predictions
* suggest reasons why their methods were fair or not
* complete simple reports to communicate their methods and findings.

## Suggested timeframe

The time needed to complete the *Magnetism and electrostatics* CLE will depend on the depth of the prior knowledge of students, the time to perform the investigation ‘What can magnets attract?’, the activity stations ‘Exploring properties of magnets’ and the ‘Electrostatic force’ investigation and also the time to participate in the pre- and post-investigation activities. Allow 8–9 hours.

[**Planning ahead and equipment list**](http://assist.asta.edu.au/sites/assist.asta.edu.au/files/Planning%20ahead%20and%20equipment%20list_yr_Magnetism.docx)

## Safety considerations

When you and your class are completing your Risk Assessment, consider the following safety points and add any other relevant ones to the list.

* Ensure students have no allergies to materials used in the investigations.
* Remind students not to place small objects, such as magnets and paper clips, into their mouths.
* Magnets can cause damage to the screens of computers, mobile phones and tablets. Remind students not to put magnets close to these screens.
* Students should not use the nib end of the pen when rubbing the casing on the fabric or on their hair.
* Instruct students about safe practices with electricity as some may confuse static electricity with electric current.

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## Introduction

This CLE focuses on the non-contact forces of magnets and electrostatics, and links to the year 4 Australian Curriculum: Science.

### Equipment needed

* Computer/projector to show video clips

### What to do

1. Show students video ‘Home made magnetic slime’YouTube (0:41 min) <https://youtu.be/dDD67ydGEac>
2. Instruct students to form groups of 3 or 4. Give them 3 minutes to brainstorm and write down as many ideas as they can, that might explain what they saw in the video.
3. Instruct groups to decide how likely their various ideas are to be correct. (They could sort in priority order or write yes (likely) or no (unlikely) next to each idea.)
4. Instruct the groups to discuss their ideas and then record and submit any questions (or hypotheses) to the teacher. The teacher answers each question. For example:

* Is there a magnet? Yes
* Is the slime alive? No
* Is there a string? No
* Is there a magnet in the slime? No

1. Ask the groups to develop a possible explanation for the slime moving, based on the information they have. Each group of students shares its best idea with the class.
2. Inform the students that the silver bars are magnets and that the slime mixture includes a special powder that is attracted to magnets. The class can brainstorm ideas for what they think the powder could be made of and what materials are attracted to magnets.

(If magnets are not available in the school, ask students to bring some from home. Discuss where magnets could be found at home e.g. fridge magnets, some toys etc.)

## Core

### Investigation 1 – What can magnets attract?

This investigation aims to demonstrate that not all metals are attracted to magnets, mainly iron and steel. It is best done in small groups (2–3 students). Students should not be given access to the magnet until the second part of the investigation, when they test the accuracy of their predictions.

### Equipment needed

Per group:

* [Magnet investigation worksheet](http://assist.asta.edu.au/sites/assist.asta.edu.au/files/Magnet%20investigation%20worksheet_yr4_Magnetism%20and%20electrostatics.docx)
* a magnet
* a dozen objects made of assorted materials e.g.
* plastics
* wood
* metals – aluminium foil, nails, pins, old keys, jar lids, cutlery, soft drink cans, paper clips, spoon, coins, pipe cleaners, etc.
* any other materials suggested by students from the initial discussion.

### What to do

1. Remind students of the predictions they made in the last lesson, and tell them that they will be predicting and testing different materials to see if they are attracted to a magnet. They will use the Magnet investigation worksheet to record their predictions and findings.
2. Students work in small groups (preferably of 3 or 4 students) to do the following tasks.
3. Sort the objects into those that they predict will be attracted to a magnet and those that they predict will not. (Consider allowing students to add 1 or 2 objects of their own choice to test.)
4. Record on their worksheet the objects, their predictions and why they made the prediction for each object.
5. Collect a magnet and use it to test each object.
6. Complete the final column ‘Is it magnetic?’ on the Magnet investigation worksheet for each object.
7. Ask students to use the question prompts on page 2 of the worksheet to review their original thinking, based on their observations. Ask students the following questions:

* Were any results of your investigation unexpected?
* What are you thinking now about what materials magnets attract?
* Do you have any new ideas? Compare your ideas with someone else.
* What questions do you have?
* What other materials would you like to try? What do you think will happen? Why?

1. Tell students that, as they may have observed, not all metals are attracted to magnets.
2. Ask students to refer to their worksheet and highlight or mark the tested objects that are likely to be made of iron/steel, cobalt or nickel.
3. Ask students what they think the magnetic slime in the first video may have had added to it? Show students the video ‘Magnetic Super Putty’ YouTube (4:40 min) <https://youtu.be/tJHM5LCpT4w> to reveal how the magnetic slime was made.

### Expected results and explanations

Only objects made from iron/steel, cobalt or nickel are attracted to magnets. Students should have marked the objects on their worksheet that were attracted to magnets as being made of iron/steel, cobalt or nickel. They should be able to conclude from this that the magnetic slime in the first video would have had some form of iron/steel, cobalt or nickel added to the mixture.

### Investigation 2 – Exploring properties of magnets (Activity stations)

In this investigation students rotate through 5 different exploratory activity stations in groups of 2 or 3. Depending on class size, there could be 2 groups of students (up to 6 students in total) working concurrently at any one station. Optimally, both groups will have access to their own set of equipment, including the instruction sheet. Students should make a record of their observations, discoveries, ideas and questions. Ideas include using a tablet to create a video or annotated photographic record, or making a written entry in a science journal.

The role of the teacher is to circulate through the classroom, facilitating discussion and guiding students through the experiments as needed, using their content knowledge to assist with guiding questions, rather than giving answers.

***Activity station 1 – Make a magnet***

***Activity station 1a – Make a compass***

### Equipment needed

Per group:

* instruction sheets, [Make a magnet](http://assist.asta.edu.au/sites/assist.asta.edu.au/files/Make%20a%20magnet%20worksheet_yr4_Magnetism%20and%20electrostatics.docx) and [Make a compass](http://assist.asta.edu.au/sites/assist.asta.edu.au/files/Make%20a%20compass%20worksheet_yr4_Magnetism%20and%20electrostatics.docx)
* a magnet
* paper clips
* a bowl of water
* a floating disc of cork, or similar material (base of a polystyrene cup or piece of polystyrene foam)
* a straightened paper clip

***Activity station 2 – Attraction and repulsion***

### Equipment needed

Per group:

* instruction sheet, [Attraction and repulsion – magnet cars](http://assist.asta.edu.au/sites/assist.asta.edu.au/files/Attraction%20and%20repulsion%20worksheet_yr4_Magnetism%20and%20electrostatics.docx)
* 2 bar magnets
* 2 plastic toy cars
* tape

***Activity station 3 – Levitating ring magnets***

### Equipment needed

Per group:

* instruction sheet, [Levitating ring magnets](http://assist.asta.edu.au/sites/assist.asta.edu.au/files/Levitating%20ring%20magets%20worksheet_yr4_Magnetism%20and%20electrostatics.docx)
* 3 or more ring magnets
* a pencil

***Activity station 4 – How strong is a magnet?***

### Equipment needed

Per group:

* instruction sheet, [How strong is a magnet?](http://assist.asta.edu.au/sites/assist.asta.edu.au/files/How%20strong%20is%20a%20magnet%20worksheet_yr4_Magnetism%20and%20electrostatics.docx)
* a balance scale
* weights
* tape
* 3 or more magnets
* counters (spacers)

***Activity station 5 – What can magnetic force pass through?***

### Equipment needed

Per group:

* instruction sheet, [What can magnetic force pass through?](http://assist.asta.edu.au/sites/assist.asta.edu.au/files/What%20can%20magnetic%20force%20pass%20through_yr4_Magnetism%20and%20electrostatics.docx)
* a magnet
* a piece of cardboard
* assorted other objects (e.g. paper, the desk, water)
* a paper clip

When the activities have been completed, students discuss the activities and formulate questions that have been raised.

Teachers may choose to construct and use a reflection scaffold such as the one below to assist student thinking.

|  |  |  |
| --- | --- | --- |
| What we think | Why we think that | What we wonder |
|  |  |  |

### Expected results and explanations

The purpose of the activity stations is for students to notice and develop their ideas and questions. There will be a range of observations, questions and ideas that provide an opportunity for the teacher to develop student understanding of fair testing procedures. Teachers could explain that when scientists are curious about something they plan a very detailed investigation that helps them to find out the answers to their questions. Scientists know that it is important for the investigations they plan to be consistent and fair.

Notice discrepancies in student findings, and/or discuss examples of things you noticed (as students were doing their exploration activities) that might affect their results in an unfair way.

For example, if students added more magnets to the basket on the scale, this would have increased the overall weight of the basket. Question prompts might be:

* Would increased weight in the basket affect the results? How?
* What could be done to make investigation more fair?
* Did students notice anything else that could be improved?

### Explaining magnetic force

### What to do

1. Ask students if they have any questions about magnets. Make a record of these. Tell students that they will be watching an information video about magnets and ask them to watch the video carefully to see if the answer to their question is revealed in the video.
2. Show students the video ‘Bill Nye – Magnetism (edited)’,YouTube(10:22 min) <https://youtu.be/079ROtsEf2k>
3. Discuss the students’ questions after viewing the video. Were their questions answered? Was anything unclear or surprising? Were other questions raised?
4. Students could each create a written or digital page (e.g. PowerPoint slide) to collate as a class answer book/slideshow about magnets. The final page could have a collection of unanswered questions – ‘Magnet mysteries’. Make the finished product available for students to view.
5. The magnets quiz at <https://www.bbc.co.uk/bitesize/topics/znmmn39/articles/zhj9r2p> may also be useful at this point.
6. Ask students to **reflect on what they have observed** in terms of magnetic forces as forces that act from a distance. Tell students that in the next lesson they will be investigating another force that acts from a distance. Ask them to speculate what that might be.

### Investigation 3 – Electrostatic force

The investigations into electrostatic forces give students the opportunity to transfer their conceptual understanding about non-contact forces into a different context and further develop their inquiry skills. This helps them to develop and demonstrate deep understanding about non-contact forces.

### Equipment needed

Per group:

* [Science investigation planner](http://assist.asta.edu.au/sites/assist.asta.edu.au/files/Science%20investigation%20planner_yr4_Magnetism%20and%20electrostatics.docx)
* small paper scraps
* plastic rods (e.g. pen or felt-tipped pen, plastic ruler) (1 per student)
* fabric, fur (clothing, carpet or hair could be used)

#### **Demonstration**

**What to do:**

1. Sprinkle a few small pieces of paper on a table and slowly lower a plastic rod or pen towards them. Observe what happens. (Nothing.)
2. Rub the plastic rod or pen on the carpet or a jumper. (It is recommended that the teacher experiment with different materials prior to the lesson to determine the best materials to use.)
3. Slowly lower the pen towards the small pieces of paper on the table until they jump up onto it. Ask students to **think** about why the paper now seems to be attracted to the pen when it wasn’t before.

#### **Planning the investigation**

**What to do:**

1. Inform students that an electrical charge has been produced (static electricity), and that this is the force that is causing the paper to move.
2. Ask students whether they think a greater force could be produced if the pen was rubbed on the material for a longer period. Remind students of the discussion during the last lesson on fair testing when carrying out investigations.
3. Instruct students to work in teams to devise a fair way of carrying out this investigation to find the answer to the following question ‘Does more rubbing make an electrostatic force stronger?’
4. Have students write up their method as a procedure. Groups could swap their ideas and give reasons for deciding whether the investigations that are devised are fair.
5. Students decide which investigation will be best for all of them to do, and collaboratively devise a way to record their results. The teacher and students should work together to construct how to create and fill in this data collection table.

Scaffolds such as the [Science investigation planner](http://assist.asta.edu.au/sites/assist.asta.edu.au/files/Science%20investigation%20planner_yr4_Magnetism%20and%20electrostatics.docx) provided may help student thinking.

#### **Conducting the investigation**

Have students:

* predict what they think will happen
* carry out the investigation
* record their results on the collaboratively designed table, and graph the data collected
* discuss any patterns they notice in the data
* compare results with predictions, suggesting possible reasons for findings
* draw conclusions from their results, based on the aim of the experiment, (‘Does more rubbing make an electrostatic force stronger?’)

#### **Analysing the investigation**

1. Give students the opportunity to compare results with each other and to identify any discrepancies. Tell students the following quote:

*‘The most exciting phrase to hear in science, the one that heralds new discoveries, is not 'Eureka!' (I found it!), but 'That's funny ...'* Isaac Asimov, *US science fiction novelist and scholar (1920–1992).*

Discuss with students what this quote might mean.

1. If the results of the investigations by different groups were different, have students explore possible reasons why.
2. Ask students the following questions.

* Does the discrepancy lead to asking more questions?
* Ask students what they have learned about electrostatic force.

### Expected results and explanations

Increasing the number of rubs between two materials with opposite electrical charges, (one positive and one negative) will build up and increase the electrical charge, and so ‘make the electrostatic force stronger’. Students are expected to notice that a stronger force is created by more rubs, and that the electrically charged object does not need to make direct contact with the paper to move it. The type of materials being rubbed together causes the electrostatic force. The vigorous rubbing simply transfers the electrical charge between the materials. Objects that have opposite charges are attracted to one another (such as clingy socks), objects that have the same charge repel. Some materials end up with net positive charges when they're rubbed and some end up with negative charges. The charge is due to the loss or gain of negatively charged electrons. Some materials also gain more charge than others. Broadly speaking, minerals, wool or fur are positively charged, wood and paper are neutral and plastics are negative. It should be noted that a greater electrostatic charge is likely to be produced when the humidity is low.

#### **Making connections**

Have students watch the following demonstrations of static electricity force, either by demonstration or by watching the following video.

Electrostatic Soap Bubble Science Experiment, YouTube (3:14 min) <https://youtu.be/aySWX55-xX4>

Inform students that they will be learning more about electrons and electrical charges in secondary school physics.

**Conclusion**

A scaffold such as the [How is electrostatic force similar/different to magnetism](http://assist.asta.edu.au/sites/assist.asta.edu.au/files/How%20is%20electromagnetic%20force%20similar%20to%20or%20different%20from%20magnetism%20worksheet_yr4_Magnetism%20and%20electrostatics.docx) worksheet could be used to further probe student thinking.

Support small groups of students to generalise and make connections by saying:

‘Some people say that gravity is a non-contact force. What do you think? Explain your thinking’.

Students who are able to make connections between electrostatic force and magnetism—as both being forces that are able to change the movement of an object without touching, and/or if they can generalise to include gravity—show an excellent understanding of the concept of non-contact forces. The extent to which they are able to compare the two forces and their demonstration of proficiency in inquiry, (such as questioning, planning an investigation and drawing conclusions) will also be useful as measures of student science proficiency of the concept for assessment purposes.

### Assessment opportunities

Investigation 3 provides an opportunity to assess student understanding of the concepts related to non-contact forces.

### In addition, the level of student achievement of the science inquiry skills, *Processing and analysing data and information* and *Evaluating* could be assessed.

### Additional lessons and activities about contact and non-contact forces:

**Contact forces**

* Queensland Studies Authority (QSA) 2013. *The force of friction*, Australian Curriculum Year 4 Science Sample assessment |Teacher guidelines, QSA website, <https://www.qcaa.qld.edu.au/downloads/p_10/ac_sa_sci_yr4_force_of_friction.pdf>
* Academy of Science PrimaryConnections ‘Smooth Moves’ <https://www.primaryconnections.org.au/resources-and-pedagogies/curriculum-units/smooth-moves>

**‘At a distance’ forces**

* ‘Forces without contact’, Victoria Department of Education and Early Childhood Development website <http://www.education.vic.gov.au/school/teachers/teachingresources/discipline/science/continuum/Pages/forcescontact.aspx>
* ‘Magnetism: A Non-Contact Force’, Victoria Department of Education and Early Childhood Development website <http://www.education.vic.gov.au/school/teachers/teachingresources/discipline/science/continuum/Pages/magnetism.aspx#3>
* ‘Electrostatics: A Non-Contact Force’, Victoria Department of Education and Early Childhood Development website <http://www.education.vic.gov.au/school/teachers/teachingresources/discipline/science/continuum/Pages/electrostatics.aspx>