Science@School | Book 3E

Springs and magnets

Teacher's Guide

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1 Teacher's sheet: comprehension

See **pages 4 and 5** of *Springs and magnets*

Answers

1. **The spring should be drawn in between the metal bar and the left-hand battery.**
2. **A piece of wire made into a coil.**
3. **An elastic band.**
4. **A paperclip and a bulldog clip.**
5. **(i) It changes shape; (ii) It springs back to the shape it started with.**
6. **To hold the door shut when you close it.**
7. **It pushes against the batteries. (It also conducts electricity but the children may not know about electrical conduction at this stage.)**

Complementary work

Show the children an open-coil spring, such as the one in a stapler or in a mattress. Show them a closed-coil spring, such as in a spring balance. Ask the children how the shape of the spring changes when it is in use and what it does to go back to its resting shape.

Teaching notes

There are two kinds of coiled spring. They are the open-coil spring and the closed-coil spring. In the open-coil spring the wire coils have spaces between them. The open-coil spring is squashed when it is in use and lengthens to go back to its starting shape. The closed-coil spring is stretched when it is in use and shortens when it goes back to its starting shape.

Open-coil springs are designed for squashing. A bed spring, for example, has an open coil.

A closed-coil spring has wire coils with no space between them. They are designed for stretching. The spring in a spring balance is an example of a closed-coil spring. Some camp beds and garden chairs have closed-coil springs which stretch to give support.

The children may ask why a bed spring is cone shaped. The reason for this is that a spring which has a wide diameter is more squashy than one with a small diameter. In the cone-shaped bed spring the wide part of the coil squashes easily to make the mattress soft, but the narrow part squashes less easily and keeps the body from the hard base of the bed frame.

1

Teacher's sheet: activity

Based on **pages 4 and 5** of *Springs and magnets*

Introducing the activity

(a) Use this activity after the children have read pages 4 and 5 in the pupil book. Tell the children that they are going to look for springs around the school, or you can issue the sheet for homework (see note (i)).

Using the sheet

(b) Give out the sheet, let the children fill in their names and form, then go through task 1.

(c) Let the children try task 1.

(d) Go through tasks 2 and 3, then let the children try them.

Completing the activity

(e) Let the children compare their results.

Conclusion

Springs are used in many different places. They may be used to pull or push on an object, or their stretchiness may have another use, such as helping things to be weighed, as in a spring balance. They may also allow a wire to be stored in a small space yet still be stretched, such as in the cable from a telephone or on a head set attached to a music system. A spring may also be squashed to provide comfort as in the case of springs in mattresses.

Teaching notes

(i) If the children use the sheet for homework, tell them not to dismantle anything, such as a torch, to look for springs unless an adult helps them and reassembles the item correctly.

Teacher's sheet: comprehension

See **pages 6 and 7** of *Springs and magnets*

Answers

1. **(i) The spring is longer, there are wider gaps between the coils; (ii) The spring would go back to its original length and shape.**
2. **A chair.**
3. **(i) It is stretched; (ii) It pulls the door handle back up.**
4. **To push.**
5. **A set of toothed wheels.**
6. **Wind it up.**

Complementary work

The children could hang a closed-coil spring from a support and add a scale pan or yoghurt pot to the lower end. They could then add weights and see how the spring stretched. They should find that the spring stretches in a regular way as more and more weights are added.

More able children may be able to find out that when the weight doubles the extension (not the total length) is also doubled.

Teaching notes

In this unit, the idea that springs push and pull is introduced. In earlier school work the children should have studied pushes and pulls and may even have heard of the word force.

You could now link the ideas together and say that when pushing forces are applied to the ends of a spring, the spring exerts pushing forces in the opposite direction. If the pushing forces on the ends are stronger than the forces exerted by the spring, the coils in the spring are pressed together. If the pushing forces of the spring can match those pushing on its ends, the spring will not be squashed flat. This is what happens in springs in furniture. If the springs were squashed flat, people sitting on a chair or sofa would feel the springs pressed against the furniture frame.

When considering a closed-coil spring that is stretched, you could say that when pulling forces are applied to the ends of the spring, the spring exerts pulling forces in the opposite direction. If the pulling forces on the ends of the spring are stronger than the forces exerted by the spring, the coils can be pulled far apart.

It is important to note that when a spring has been pulled to a certain length it loses its elasticity and will no longer return to its original length when the pulling force is removed from its ends.

Springs return to their normal length when the forces pulling or pushing on them are removed. This happens because the force they exert has nothing to oppose it so the spring springs back into shape.

Teacher’s sheet: activity

Based on **pages 6 and 7** of *Springs and magnets*

Introducing the activity

(a) If you haven’t done the complementary work in Unit 1, you may like to show the children the springs in a stapler and a spring balance. Point out that the spring in the stapler has coils which have spaces between them so that when the stapler is full it pushes on the staples to keep them in place. Also point out that the spring balance has no spaces between its coils and it is designed to stretch when the spring balance is in use.

Tell the children that they are going to look more closely at the forces which occur when a spring has changed its shape. Remind the children that forces can be represented as arrows.

Using the sheet

(b) Give out the sheet, let the children fill in their names and form, then go through tasks 1 and 2.

(c) Let the children try tasks 1 and 2.

(d) Go through task 3, then let the children try it (see note (i)).

(e) Go through tasks 4 and 5, then let the children try them.

(f) Go through tasks 6 and 7, then let the children try them.

(g) Go through task 8, then let the children try it.

(h) Go through tasks 9 and 10 with the children, then let them try them.

Completing the activity

(i) Let the children compare their answers.

Conclusion

When the ends of an open-coil spring are pressed, the spring becomes shorter. A pushing force from the spring can be felt in the hands. In the diagram, black arrows at the ends of the spring should point towards the ends of the spring. Blue arrows in the spring, or on top of it, should point outwards from the centre of the spring towards the ends.

When the ends of a closed-coil spring are pulled, the spring becomes longer. A pulling force from the spring can be felt in the hands. In the diagram, black arrows at the ends of the spring should point away from the ends of the spring. Blue arrows in the spring, or on top of it, should point from the ends of the spring towards the centre.

Teaching notes

(i) The children cannot physically keep pressing on the spring and draw it at the same time. They must either remember what the spring looked like, or ask a friend to press on the spring while they draw it.

3 Teacher's sheet: comprehension

See **pages 8 and 9** of *Springs and magnets*

Answers

1. **The end of the ruler goes up and down.**
2. **(i) The sheet bends down in the middle; (ii) The sheet straightens again.**
3. **Leaf springs.**
4. **Cars, trucks, trains, carriages.**
5. **Steel.**
6. **To give a smoother ride. To make it less bumpy for the passengers. To make the ride more comfortable.**

Complementary work

The children can use secondary sources to find out about the use of leaf springs in horse-drawn carriages and early cars, railway carriages and the type of springs used in the suspension of modern cars.

Teaching notes

You may like to use this unit with Unit 4 'Springy materials' in *3C Properties of materials* in this series. Together, they provide the children with a comprehensive view of springiness.

In the two previous units the work has explored the appearance and behaviour of coiled springs. In this unit, the concept of springiness is taken further, to show that some materials have a natural springiness and do not have to be bent into a coil to be of some use. However, shape is still important as the children will find out in the activity. Here the children discover that once a flat shape is built up into a thick bar it loses much of its springiness.

While flat springs play an important part in transport, you may like to point out that a bow and a crossbow are examples of flat springs that were once used as weapons.

3 Teacher’s sheet: activity

Based on **pages 8 and 9** of *Springs and magnets*

Introducing the activity

(a) You may like to use this activity either before or after the children study pages 8 and 9 in the pupil book. If the children have done the activity in the introduction to this unit on page 10 of this *Teacher’s Guide*, you may like to remind them of it.

Tell the children that they are going to see how the thickness of spring affects its springiness, but instead of firing objects into the air, they are going to make an object move up and down under the spring (see note (i)).

Using the sheet

(b) Give out the sheet and let the children fill in their names and form, go through task 1, then let the children it (see note (ii)).

(c) Go through task 2, then let the children try it (see note (iii)).

(d) Go through tasks 3 and 4, then let the children try them (see note (iv)).

(e) Let the children try task 5, then let the children try it.

(f) Go through tasks 6 and 7, then let the children try them (see note (v)).

(g) Go through tasks 8 and 9, then let the children try them.

Completing the activity

(h) Let the children report on their findings.

(i) Let the children draw a conclusion from their work.

Conclusion

When a single piece of card is bent and released it springs up and down a little and raises the object a little way on the string.

When three pieces of card are bent and released they spring more strongly and make the object rise higher. When 12 pieces of card are bent and released they hardly move and the object only rises a little way.

The springiness of a flat spring depends on its thickness. The springiness of a flat spring increases with its thickness up to a point then decreases again as the spring becomes thicker.

Teaching notes

(i) This allows the activity to be more manageable by keeping the moving object generally beneath the table.

(ii) Depending on the ability and attitude of the children you may prefer to prepare the strips before the activity.

(iii) A lasso-type loop should be prepared at the end of the string so it can easily fit over the end of the cardboard and be easily transferred to other groups of cardboard strips in the activity. The small object could be a small plastic or wooden block.

(iv) You may like to demonstrate this.

(v) The strips should be stuck together using two pieces of sticky tape.

4 Teacher's sheet: comprehension

See **pages 10 and 11** of *Springs and magnets*

Answers

1. **The elastic band should be shown vibrating.**
2. **A twanging sound.**
3. **A violin, guitar, piano.**
4. **A drum.**
5. **(i) Africa; (ii) Metal leaf springs or thin pieces of steel.**
6. **(i) The sound will go higher; (ii) The sound will go lower.**

Complementary work

The children can use secondary sources to find out how many strings are found on the piano, harp, guitar, banjo, ukelele, violin, viola, double bass and sitar.

Teaching notes

This unit introduces some concepts which the children will find useful later in their science course in different contexts.

The rapid to and fro movement of a string or drum skin is called a vibration. This causes particles in the air to vibrate too. The vibration passes through the air as a sound wave and when it enters the ear it causes the ear drum to vibrate. This is connected, through tiny bones in the ears (which act as levers to strengthen the vibration), to nerves which carry messages about the sound to the brain.

From earlier work, or from general knowledge, the children may be familiar with sounds like 'ping' referred to as a high sound, while sounds like 'pong' are called low sounds. These terms actually refer to low-pitched sounds and high-pitched sounds. A sound is made by a vibrating object. The speed of vibration is called its frequency. An object which vibrates with a low frequency makes a low-pitched sound. An object which vibrates with a high frequency makes a high-pitched sound.

Teacher's sheet: activity

Based on **pages 10 and 11** of *Springs and magnets*

Introducing the activity

(a) Use this activity either straight after the introduction to the unit on page 10 of this *Teacher's Guide*, or after the children have studied pages 10 and 11 in the pupil book (see note (i)).

Take the children into the hall. Remove the front of the piano and let them see the piano wires. Play a few notes and tell them that the sounds are due to the springiness of the wires. Tell the children that they are going to look at an instrument which has fewer wires but still makes a wide range of sounds.

Using the sheet

(b) Give out the sheet and let the children fill in their names and form, go through task 1, then let the children try it.

(c) Go through task 2, then let the children try it (see note (ii)).

(d) Go through tasks 3, 4 and 5, then let the children try them (see note (iii)).

(e) Go through tasks 6 and 7, then let the children try them (see note (iv)).

(f) Go through task 8, then let the children try it (see note (v)).

(g) Go through task 9, then let the children try it (see note (vi)).

Completing the activity

(h) Let the children compare their results.

Conclusion

The guitar has six strings. The strings have different thicknesses. The top string is the thickest and the bottom string is the thinnest. The top string has a lower sound than the one next to it. The difference is due to the difference in thickness of the strings.

The string sounds higher when a finger is pressed on it. As the finger moves down the fret board the sound gets higher.

Teaching notes

(i) Some children may need help with the idea of comparing. You may have to help secure this skill by letting them compare a pencil and a pen first.

(ii) Show the children how a guitar is held. The top string is the thickest and the bottom string is the thinnest.

(iii) The children may need reminding that some sounds are high, or high-pitched, sounds and others are low, or low-pitched, sounds.

(iv) Some children may need it made clear that the third string down is being investigated in this task.

(v) Show the children that the string is pressed on the arm of the guitar, which has metal strips across it. This part of the guitar is called the fret board and the metal strips are frets.

(vi) Tell the children that they should place their finger at several places on the string and pluck each time. Tell them they should see if the sound is related to the position of the finger.

5 Teacher's sheet: comprehension

See **pages 12 and 13** of *Springs and magnets*

Answers

1. **The car moves up the ramp, the elastic band bends up the ramp.**
2. **A catapult.**
3. **It is twisted.**
4. **Jump up and down on it.**
5. **The sheet pushes back as it tries to straighten.**
6. **(i) The more you stretch the elastic band, the more it pulls back; (ii) It tries to go back to its starting shape.**

Complementary work

(a) The children could use the equipment from activity 5 to investigate how the thickness of an elastic band affects its strength.

(b) The children could use secondary sources to find out about the use of throwing machines in history.

Teaching notes

The illustrations in picture 3 show the basic steps in the making of a cotton reel dragster. The success will depend on the size and strength of the elastic band, the way the short matchstick grips the cotton reel, the ease with which the long matchstick slides over the surface of the cotton reel and the grip between the cotton reel and the surface it is moving along. Over the years there have been many modifications to this basic design that you may wish your children to use in making their cotton reel dragsters. Here are some examples of modifications that could be made:

- The short matchstick can be stuck in place with sticky paper.
- A wax washer can be made by cutting a one centimetre slice from the end of a household candle. A groove can be cut in one side to hold the long matchstick The washer can then be placed between the long matchstick and the cotton reel. This helps the long matchstick to turn on the cotton reel by reducing friction. The long matchstick may be held in the groove with sticky tape.

  You will need to make the wax washers for the children but they should be able to add the new components. This activity can be linked with studies in *4E Friction* in this series.

If you wish the children to know about energy, you may say that energy is stored in an elastic sheet or band when it is stretched. This energy is called strain energy (or elastic potential energy). When the elastic material is allowed to release this energy it is converted into movement energy as the elastic material springs back to its original shape. Some of this movement energy is transferred to any object in contact with the contracting elastic material.

Teacher's sheet: activity

Based on **pages 12 and 13** of *Springs and magnets*

Introducing the activity

(a) You can use this activity after the children have studied pages 12 and 13 in the pupil book. If you performed the activity in the introduction to this unit on page 11 of this *Teacher's Guide*, you can remind them of the catapult you made. You can also remind them of the car on the ramp in the pupil book and tell the children that they are going to make an investigation about a car catapult.

Using the sheet

(b) Give out the sheet, let the children fill in their names and form. Go through task 1, then let the children try it (see note (i)).

(c) Go through task 2, then let the children try it.

(d) Go through task 3, then let the children try it.

(e) Go through tasks 4 and 5, then let the children try them.

(f) Go through tasks 6 to 8, then let the children try them (see notes (ii) and (iii)).

Completing the activity

(g) Let the children compare their results.

Conclusion

When the elastic band is pulled back a short way and released, the car only travels a short distance. When the elastic band is pulled back a long way and released, the car travels a long distance. The more the elastic band is stretched, the further the car travels when the elastic band is released.

Teaching notes

(i) Screw the hooks into the board for the children so that they are firmly held in place and will not fly out when an elastic band is stretched between them. Eye protection should be worn. If the board is long and the elastic band is weak, you may prefer to keep the board flat. If the board is short and the elastic band is strong, you may like to raise the end of the board, as shown in the diagram, to prevent the car travelling over the end of the board.

(ii) The elastic band should be stretched to different measured distances and the distance travelled by the car should be measured each time the elastic band is released. The table should have two columns headed: 'Stretch of elastic band (cm)' and 'Distance travelled by car (cm)'. The table may have several columns for the distance travelled by the car if the children have decided to repeat their measurements.

(iii) You may like to use ICT to present the results in a table or to make bar graphs.

Teacher's sheet: comprehension

See **pages 14 and 15** of *Springs and magnets*

Answers

1. **The two pieces of metal enclosing the central coil should be shaded.**
2. **Bar, horseshoe, barrel.**
3. **Because they have a magnet in them which sticks to the metal.**
4. **In a loudspeaker.**
5. **(i) On the video tape; (ii) It stores sound and pictures.**
6. **There are small magnets in the rubber door seal that attract the steel in the case of the fridge and holds the door to it.**

Complementary work

If the children do not fully understand the difference between magnetic and non-magnetic materials, let them test a wide range of objects in the classroom with a magnet and record their results in a table.

A magnetic material is one to which a magnet sticks. A non-magnetic material is one to which a magnet does not stick. The children should discover that not all metals are magnetic. Do not let the children bring their magnets near a television or any part of a computer.

Teaching notes

Iron and steel are the most widely used magnetic metals. Nickel and cobalt are two other metals which have magnetic properties. You may also see some magnets, particularly those in the form of a ring, advertised as ceramic magnets. Ceramics are used in the making of some magnets but the children do not need to know about them at this stage, as it conflicts with their possible experience of pottery (a kind of ceramic) being a non-magnetic material.

The children may ask why the magnets are associated with electrical devices such as loudspeakers and motors. In fact, magnetism and electricity are very closely related. A loudspeaker contains a coil of wire which receives pulses of electricity. These turn the coil into a magnet which is pushed and pulled by the metal magnet at the base of the cone. The coil is attached to the paper cone. This means that when it is pushed and pulled, it also makes the paper cone vibrate, and this is what produces sound.

In an electric motor, electricity passes through a coil of wire and turns it into a magnet. This is pushed and pulled by the other magnets in the motor. The motor is designed so that these pushes and pulls make the coil spin.

If the children try the complementary work they will find that not all metals are magnetic. This fact is used to separate metals such as steel and aluminium, which are both used to make cans. The separated metals are then taken away for recycling.

Teacher's sheet: activity

Based on **pages 14 and 15** of *Springs and magnets*

Introducing the activity

(a) Use this activity either before the children study pages 14 and 15 in the pupil book, and use the pictures of the loudspeaker and the motor to confirm the investigation here. Or you can use the activity after the pages in the pupil book have been studied in order to extend the work on magnet shapes and show magnets used in real equipment.

Using the sheet

(b) Give the children the sheet, let them write their names and form on it, then go through task 1.

(c) Let the children try task 1.

(d) Go through task 2, then let the children try it.

(e) Go through tasks 3, 4 and 5, then let the children try them (see note (i)).

(f) Go through task 6, then let the children try it (see note (ii)).

(g) Go through task 7, then let the children try it (see note (iii)).

Completing the activity

(h) Let the children compare their results.

Conclusion

The paperclips collect at the ends of the bar magnet. They do not collect in the middle. The paperclips collect at the ends of the horseshoe magnet. They do not collect at other parts. The paperclips collect on each side of the ring or disc. They do not collect around its circumference.

The magnet in a loudspeaker is at the bottom of a paper or plastic cone. The magnets in an electric motor are found around a central coil of wire.

Teaching notes

(i) The children may need to be told not to test the magnet with the paperclips until they have drawn how they predict the paperclips will be arranged around the magnet.

(ii) The loudspeaker should have been separated from its cabinet by an electrician or a similarly competent person. There must be no wire which can be used to connect it to a music system.

(iii) The motor should be a battery-powered model. It should not be connected to a battery.

7 Teacher's sheet: comprehension

See **pages 16 and 17** of *Springs and magnets*

Answers

1. **(i) The arrow should be drawn from the centre of the nail pointing right towards the tip of the nail; (ii) Turn the magnet round and stroke the other end of the magnet across the other half of the nail.**
2. **A permanent magnet.**
3. **Iron and steel.**
4. **It becomes a magnet.**
5. **(i) Nothing, the other paperclips stay in place; (ii) They fall away from each other. They have lost the magnetism that held them together.**

Complementary work

(a) The children could test the strength of a magnet by measuring the distance from which it can pull a paperclip to itself. This could be done by placing the magnet at one end of a ruler and moving the paperclip towards it until the paperclip jumps to the magnet. If this was demonstrated to the children, they could use the sheet in activity 7 for this activity too.

(b) A needle may be turned into a magnet by placing it next to a strong magnet for a few days. You may demonstrate this for the class.

Teaching notes

The children may ask what the little magnets inside magnetic material are made of. These little magnets are called domains. They are made of groups of tiny particles called atoms. When the children study electricity they may learn that a current of electricity is made by electrons flowing along a wire. Electrons are particles which are even smaller than atoms and are found inside atoms. It is thought that the way some of the electrons spin around inside the atoms of magnetic materials makes the groups of atoms or domains behave like tiny magnets. Although this information may seem too technical at this level, some children have heard of atoms, and in the study of materials later, you may wish to explain changes in terms of particles (that is, the atoms and molecules from which all matter is made).

If the children try to make a magnet as suggested on page 16, they may find the nail will turn into a magnet only after it is stroked about 60 times with a magnet. The nail may then be able to lift a paperclip.

7 Teacher's sheet: activity

Based on **pages 16 and 17** of *Springs and magnets*

Introducing the activity

(a) You could begin by asking the children if a magnet can attract more than one thing at a time. Plunge the end of a bar magnet into a dish of paperclips and ask the class to predict what will happen. Raise the bar magnet and show the class how the paperclips cling on to the end in a bunch.

Ask the class how you could compare the strengths of magnets. If you receive a reply that you should count the number of paperclips sticking to an end, remove them all and then put one below another. Tell the children that this may help them with their investigation.

Using the sheet

(b) Give out the sheet and let the children fill in their names and form, then go through task 1 and let the children try it.

(c) Go through task 2, then let the children try it (see note (i)).

(d) Go through task 3, then let the children try it (see note (ii)).

(e) Let the children try task 4 (see note (iii)).

(f) Let the children try task 5.

Completing the activity

(g) Let the children compare their results.

Conclusion

The strongest magnet has the longest paperclip chains from both its ends. The weakest magnet has the shortest paperclip chains. The largest magnet is not necessarily the strongest magnet.

Teaching notes

(i) Remind the children that there are two ends, or poles, to a magnet but ask them if both are the same strength. They should think about this in their planning. Suggest that the children may like to predict an order of strength for the magnets, starting with the strongest.

(ii) The table could have two columns headed: 'Magnet' and 'Number of paperclips'. In the magnet column there should be two entries for each magnet. The entries should be headed 'End 1' and 'End 2'.

(iii) The plan should state that a chain of paperclips will be made from each end of the magnet to test the magnet's strength.

8 Teacher's sheet: comprehension

See **pages 18 and 19** of *Springs and magnets*

Answers

1. **(i) The arrows should show the magnets pushing apart; (ii) Push.**
2. **(i) The arrow should show the magnets pulling together; (ii) Pull.**
3. **N.**
4. **(i) Attract; (ii) Repel.**
5. **The magnets would hold each other to the wood, they would be attracted because their magnetism works through wood.**

Complementary work

The children could stick a bar magnet to the top of a lightweight plastic car and see if they could move it by bringing a second magnet near the first magnet.

Teaching notes

The children may wonder why the ends of the magnets are labelled N and S instead of A and B. Although this aspect of magnetism will be addressed in Unit 10, it may be useful here just to say that when a magnet is allowed to hang from a string, one end always points to the north and the other to the south. The ends are named after the directions in which the freely swinging magnet points.

The place where the magnet has its greatest power is not right at its end but a little way in from the ends. These places are called the poles. The pole which is in the end that points north is called the north-seeking pole. The pole which is in the end that points south is called the south-seeking pole.

Some magnets are coloured red and blue. The red end contains the north-seeking pole and the blue end contains the south-seeking pole.

8

Teacher's sheet: activity

Based on **pages 18 and 19** of *Springs and magnets*

Introducing the activity

(a) Use this activity after the children have studied pages 18 and 19 in the pupil book. Tell the children that they are going to use the information they have just studied to make further investigations on how magnets push and pull.

Using the sheet

(b) Give out the sheet and let the children fill in their names and form, then go through tasks 1 and 2 with the children (see note (i)).

(c) Let the children try tasks 1 and 2.

(d) Go through tasks 3 and 4, then let the children try them.

(e) Let the children try task 5 (see note (ii)).

(f) Go through tasks 6 and 7, then let the children try them.

(g) Let the children try task 8.

Completing the activity

(h) Let the children compare their results.

Conclusion

The N end of the floating magnet is pushed away or repelled by the N end of the second magnet. The N end of the floating magnet is drawn to or attracted to the S end of the second magnet.

Teaching notes

(i) The children do not need to know that N stands for north and S stands for south although some of them may know this from general knowledge.

(ii) The children should say that the prediction and result matched, partly matched or did not match. They should not use phrases like 'It was OK'.

9 Teacher's sheet: comprehension

See **pages 20 and 21** of *Springs and magnets*

Answers

1. **On top of the card is a pile of iron filings and a track which matches the movement of the arrow beneath. There could also be an arrow above the card showing how the iron filings move. This matches the arrow under the card.**

2. **Iron filings.**

3. **They move about and form trails.**

4. **Tap it.**

5. **(i) The ends; (ii) They are the parts where the trails go in and out.**

Complementary work

After the children have studied activity 9, you could tell them that each iron filing behaves like a magnet, just as the paperclips on pages 16 and 17 of the pupil book behaved as magnets. Point out that the iron filings made loops between the ends of the magnet. Hang panel pins from the end of a bar magnet and challenge a child to loop them up. The panel pins should form a loop, just like the iron filings.

Teaching notes

There are two kinds of forces – contact forces and non-contact forces. Examples of contact forces are impact forces, such as pushes between cars or people, friction and air resistance. These forces touch the object they affect.

Examples of non-contact forces include magnetism, gravity and the electrostatic force that makes hair stand on end when brought near a rubbed piece of plastic. These forces are generated by an object and act in a region around the object. This region is called a field or force field. You may have heard of the term 'gravitational field'. This refers to the region around the Earth in which any object will feel the pull of the Earth's gravity. In a similar way, there is a magnetic field around each magnet. This is the region in which the magnetic force of the magnet is active.

Iron filings are used to show the size of the magnetic field. When the iron filings are in a magnetic field they behave as tiny magnets and become lined up. They make a pattern of lines (sometimes called lines of force) which is called the magnetic field pattern.

9 Teacher's sheet: activity

Based on **pages 20 and 21** of *Springs and magnets*

Introducing the activity

(a) Use this activity after the children have studied pages 20 and 21 in the pupil book. They will benefit by seeing how iron filings behave with a magnet, and will have an idea of what to look for in their investigation.

Using the sheet

(b) Give out the sheet and let the children write their names and form, then let the children try task 1 (see note (i)).

(c) Go through task 2, then let the children try it.

(d) Go through tasks 3 and 4, then let the children try them.

(e) Go through task 5, then let the children try it.

(f) Go through tasks 6 to 8, then let the children try them.

(g) Go through tasks 9 to 11, then let the children try them.

Completing the activity

(h) Let the children compare their results.

Conclusion

When the end of a magnet is brought close to the container, the iron filings rise up and form columns which touch the inside surface of the container. When the end of the magnet is moved over the surface of the container, the columns of iron filings follow it. When a bar magnet is laid under the container of iron filings, the iron filings form lines which spread out from each end and form loops along the sides.

When two magnets are placed so that similar ends face each other, the filings move away from the gap between them. When two magnets are placed so that dissimilar ends face each other, the iron filings fill the gap.

Teaching notes

(i) Iron filings can stick to magnets, be a skin irritant and can cause pain if they enter the eyes. For these reasons, iron filings need to be treated with great care. Iron filings in plastic containers can be obtained from educational suppliers. Alternatively, they can be placed in a sealed plastic bag. A container made from a piece of card with a sheet of transparent plastic (from a plastic bag) stuck onto it may make a suitable container for use with some children.

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Teacher's sheet: comprehension

See **pages 22 and 23** of *Springs and magnets*

Answers

1. **(i) A = North Pole, B = South Pole, C = compass; (ii) North; (iii) Because it is a magnet.**
2. **Lodestone.**
3. **Black.**
4. **It always turns until it faces the same way. The same end always points north.**
5. **Iron at the centre of the Earth.**

Complementary work

You could put a piece of lodestone in a group of other small rocks and ask the children how they could find it. They should use paperclips or panel pins to find it. These items will only stick to the lodestone.

Teaching notes

In Unit 8 the children learned that two north poles repel each other, yet in this activity they may think that the north pole of the magnet is attracted to the north pole at the top of the Earth. At the top of the Earth are two poles. They are the north geographic pole around which the Earth spins and the north magnetic pole to which lodestones and magnets are attracted.

The correct term for the north pole of a magnet is north-seeking pole – it seeks the north magnetic pole. The correct term for the south pole of a magnet is the south-seeking pole – it seeks the south magnetic pole.

If we think of the Earth as containing a bar magnet, it does not have its north pole facing the north magnetic pole. It has its south pole facing that way. It is the south pole of this imaginary magnet which attracts the north-seeking poles of the bar magnets towards the magnetic north. In a similar way, it is the north pole of this imaginary magnet that attracts the south-seeking poles to the south magnetic pole. The children do not need to know this detail but it may help to give an explanation if children query the two 'north poles' being attracted to each other.

The poles of a magnet are not at its ends. They are a little way in from the ends and are the places where the magnet's power is greatest.

10 Teacher's sheet: activity

Based on **pages 22 and 23** of *Springs and magnets*

Introducing the activity

(a) If the children have done the activity in Unit 9, you may like to remind them of how the iron filings arranged themselves around a magnet. Remind the children that the Earth behaves as if it contains a huge bar magnet. Also remind them that if small bar magnets are allowed to move freely, they behave like the iron filings and line up in a certain way.

Tell the children that they are going to see if the power of the Earth's magnetism is working in their classroom and they will test it using bar magnets.

Using the sheet

(b) Give out the sheet and let the children fill in their names and form, then go through task 1 (see note (i)).

(c) Go through tasks 2 and 3, then let the children try them (see note (ii)).

(d) Let the children try tasks 4 and 5 (see note (iii)).

(e) Let the children try task 6.

(f) Go through tasks 7 and 8, then let the children try them (see note (iv)).

(g) Let the children try task 9.

Completing the activity

(h) Let the children compare their results.

Conclusion

A bar magnet which is free to move will line itself in a generally north-south direction.

Teaching notes

(i) The children can use the diagram as a simple guide. The dimensions of the paper holder will depend upon the size of the bar magnet. The children may need help attaching the thread. Alternatively, you can make the holders for the children before the lesson.

(ii) It does not matter at this stage that the children look for north or south, they could use things like the board, window or fish tank as markers.

(iii) The plan should suggest that the magnet is moved and left to settle again. Or, the support could be moved and the magnet allowed to settle again. The magnet or support may be moved several times. No other magnets should be close enough to affect the magnet in the holder.

(iv) A bar magnet should be set up on a float in a bowl of water and allowed to settle. The magnet should be moved a few times and allowed to settle again. The magnet should not touch the sides of the bowl. No other magnets should be near.