

Pupil worksheet

Magnetic resonance imaging (MRI)

An MRI scanner uses magnetic fields to take pictures of the brain. The scans are very detailed. They help doctors to diagnose disease and they help researchers to find out about the brain.

Your task

You work in a hospital. The communications department wants to make a leaflet or video to help patients prepare for an MRI scan. Your group will plan and write the leaflet or video storyboard.

Preparation

- Decide who will take each role and give everyone their briefing sheet.
- Read your briefing sheet.
- Answer the questions on the briefing sheet.

The meeting

- In your group, take it in turns to explain to the communications worker what you want to include in the leaflet or video.
- As a group, produce an outline plan for your leaflet or video. Decide who will contribute what.

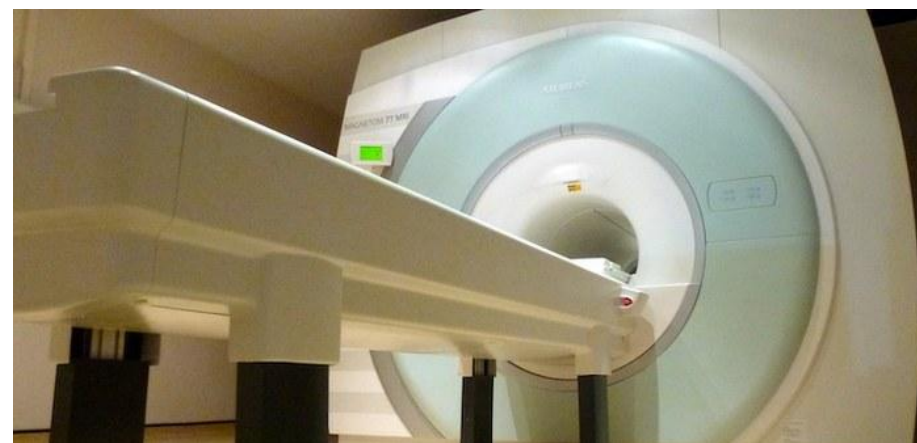
Leaflet or video production

- Individually, write your section of the leaflet or video storyboard.
- As a group, put together your leaflet or video storyboard.

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The roles

- 1 Hospital communications worker** – Has overall responsibility for producing the leaflet or video.
- 2 Radiographer** – Prepares patients for their scans and makes sure they will be safe. Operates the scanner.
- 3 Radiologist (a doctor)** – Interprets MRI scans. Can explain how to use MRI scans to see which parts of the brain are active and which parts are damaged.
- 4 Physicist** – Ensures staff safety, and understands magnetic fields and their strength.
- 5 Researcher** – Uses an extra-powerful MRI scanner to study the brain in action. Keen to share research findings with others.





Key Stage 3 - MRI Brain briefing

Peer assessment

Study the leaflet or video produced by another group. Then complete this form.

Issue	Did the group address this issue?	How clear is the information? 1 = not clear 3 = very clear
Why might a patient have an MRI scan?		
How does MRI allow us to see which parts of the brain are active?		
How can patients be safe in the scanner?		
What have we learnt from FMRI research?		
How strong are MRI magnets?		

1. What were the two best things about the leaflet or video storyboard?



2. Suggest one improvement.



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1. What were the two best things about the leaflet or video storyboard?



2. Suggest one improvement.

Role 1

Hospital communications worker



Your role is to co-ordinate the production of the leaflet or video storyboard that will help patients prepare for an MRI scan.

Here are some patient questions:

- Why am I having an MRI scan?
- How does MRI allow us to see which parts of the brain are active, or which parts are damaged?
- How can I make sure I am safe in the scanner?
- What have we learnt from fMRI research?
- How strong are MRI magnets? How do they compare to normal bar magnets?

Tasks

A Look again at the roles of the others in your group. Decide who will answer each question.

B What else would you like to include in your leaflet or video storyboard?

Group roles

- 2 Radiographer** – Prepares patients for their scans, and makes sure they will be safe. Operates the scanner.
- 3 Radiologist (a doctor)** – Interprets MRI scans. Can explain how to use MRI scans to see which parts of the brain are active, or which parts are damaged.
- 4 Physicist** – Ensures staff safety, and understands magnetic fields and their strength.
- 5 Researcher** – Uses an extra-powerful MRI scanner to study the brain in action. Keen to share research findings with others.

Role 2

Radiographer



At hospital, your role is to prepare patients for scans and operate the scanner. You must make sure patients will be safe in the scanner.

An MRI scanner includes a huge electromagnet. Objects made of magnetic materials move towards the magnet when it is switched on. If a patient has any magnetic metal in their body – perhaps a tiny piece of steel in their eye – the magnetic field makes it move. The moving object may damage the body. Magnetic fields also interfere with heart pacemakers.

Magnetic or not?

Magnetic metals	Non-magnetic metals
iron	aluminium
steel	titanium
cobalt	copper
nickel	stainless steel



Objects people might have on (or in) them

Object	Metal	Object in person	Metal
keys	steel	hip replacement	titanium
watch	steel	joint pin	stainless steel
hair clip	steel	tooth fillings	mixture of mercury, silver, tin, copper
coins	steel, nickel, copper	steel fragment (eg in a welder)	steel
		heart pacemaker	various, including magnetic switch

Tasks

A Decide which objects are safe to take into the scanner.

B Which objects inside a person may make having an MRI scan unsafe?

Role 3



Radiologist (a doctor)

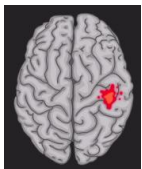
At hospital, you interpret MRI scans and use them to diagnose disease. You also teach medical students how to use MRI scans to see which areas of the brain are active and which areas are damaged.

How MRI shows which brain areas are active

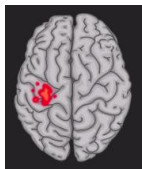
There is a strong magnetic field in the scanner. This means we can detect changes in blood oxygen levels in different brain areas. Here is how it works:

- If you wiggle your left fingers, there is more electrical activity in the areas of the brain that make this movement happen.
- These brain areas need more oxygen, which the blood quickly delivers.
- The more oxygen that is in the blood, the lower the MRI signal. These areas are shown in red in the pictures below.

Different brain areas do different jobs



Left finger wiggling



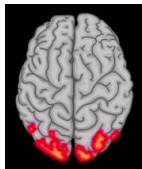
Right finger wiggling



Talking



Experiencing pain



Watching a film



Listening to music

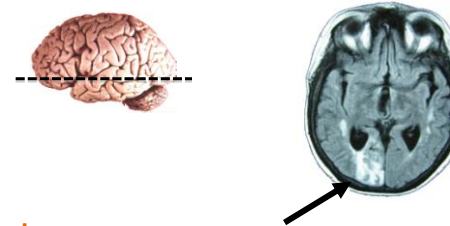
Task

- A** Explain how MRI allows us to see which parts of the brain are active. Be prepared to tell the others in your group about this.

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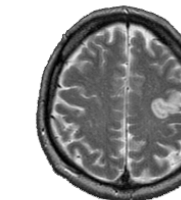
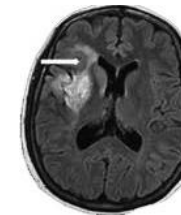
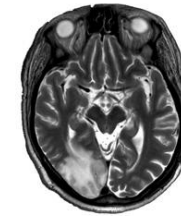
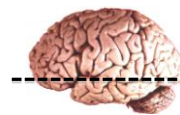
How MRI shows which brain areas are damaged

Below is an MRI scan of a patient who had a stroke a long time ago. The scan shows a 'slice' taken through the brain, as shown by the brain picture on the left. The MRI scan shows that the brain tissue in the area affected by the stroke has broken down. This area is filled with liquid, which shows up in white on this kind of MRI scan. The arrow points to the area of the stroke.



Task

- B** Below are more MRI scans of stroke. The brain pictures on the left show where in the brain the slices were taken from. Match the area of damage to the activity in the box that is likely to be affected. Use the pictures of brain activity on the left part of this sheet to help you.



Activities

Moving left hand

Speaking

Seeing

Role 4

Physicist

You have an excellent knowledge of MRI scanners and their magnets. At hospital you use data about magnets to help keep people safe.

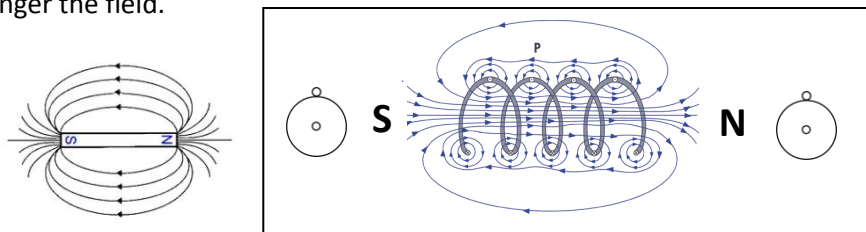
Magnetic fields

MRI uses a strong magnet. Magnetic field is measured in Tesla, T.

Magnet	Magnetic field (T)
Earth's magnetic field	0.00005
Bar magnet	0.01 – 0.1
Scrap yard magnet	1
Typical MRI scanner	1 – 3
Oxford University MRI magnet	7

Magnetic field lines

Here (below left) are the field lines of a bar magnet. The closer the lines, the stronger the field.



In an MRI scanner, the magnet is a solenoid (above right). A solenoid is a coil of wire. An electric current flows through the wire. The field lines are similar to those of a bar magnet. For MRI, the head is in the most uniform part of the magnetic field, in the middle of the solenoid.

Task

- A Add labelled compass needles to the circles in the diagram (below left) to show where they would point.

This is the Oxford University 7 T magnet.

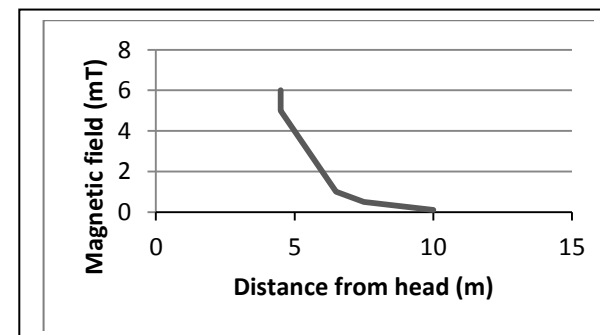
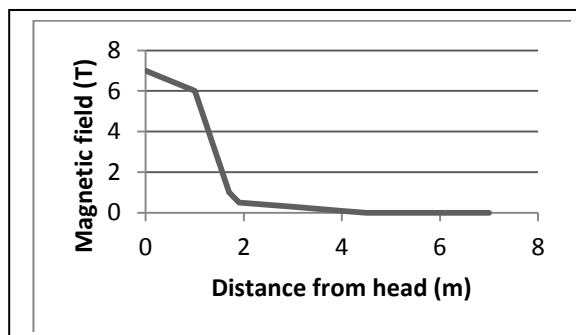


Keeping staff safe

As a physicist, you must keep people out of the area with a magnetic field of 0.5 mT (0.0005 T) or greater unless they have been screened. Both graphs show the change in magnetic field as the distance from the head increases. The graph on the right shows the magnetic field strength in milli-Tesla (mT) for distances of greater than 5 m from the head. The end of the magnet is 2 m from the head.

Tasks

- B At what distance from the head is the magnetic field strongest?
C Describe the pattern shown on the graphs.
D How far from the end of the magnet should you put this sign?



Role 5

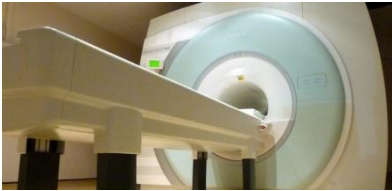


Researcher

You use an MRI scanner with an extra-strong magnet to study the brain in action. The purpose of your research is to find out more about the structure of the brain and how it works.

Your MRI scanner

Most hospital MRI scanners have a magnet of 1 to 3 Tesla. Your research scanner has a 7 Tesla magnet – it is one of the strongest in the world. MRI scanners measure changes in blood flow in different areas of the brain. An active area of the brain has increased blood flow. A stronger magnet measures this – and its location – more accurately.



What your team does

You have watched the brain in action in

- babies and children.
- healthy adults.
- adults with problems that affect their ability to move or see, to speak, to remember, or to learn.

Your team has also observed how the brain changes when it learns a new skill, such as juggling or reading, and how it compensates when someone recovers from brain damage.

Tasks

- A** Describe how your MRI scanner is different from a hospital MRI scanner.
- B** Give examples of what you have studied in your research.

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MRI leaflet help sheet

<p>Why am I having an MRI scan?</p> <p style="text-align: right;">picture</p>	<p>How can I make sure I am safe in the scanner?</p> <p style="text-align: right;">picture</p>
<p>How does MRI allow us to see which parts of the brain are active, or which parts are damaged?</p> <p style="text-align: right;">picture</p>	<p>What have we learnt from brain mapping?</p> <p style="text-align: right;">picture</p>
	<p>How strong are MRI magnets? How do they compare to normal bar magnets?</p> <p style="text-align: right;">picture</p>