Electricity and Magnetism: Teaching Approaches 06

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This is the 'Teaching Approaches', showing selected possible activities suitable for the classroom. To develop your expertise in the episode, work with the 'Physics Narrative' and the 'Teaching and Learning Issues'. Navigate to any part of the topic using the Topic Menu, or use the tabs below to stay within this episode.

Meeting magnets

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Meeting magnets

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Hanging with magnetism!

What the activity is for

This is a simple demonstration which is guaranteed to capture the pupils' interest at the start of the topic on magnetism.

What to prepare:

- clamp stand
- eclipse Major magnet (a very powerful permanent magnet)
- 100 g mass hanger
- thread

Clamp the magnet at the top of the stand. Tie the mass hanger to one end of the thread, secure the other end to the foot of the clamp stand and hold the hanger towards the magnet. If the gap between magnet and hanger is not too great, the hanger will "hover in space"!

What happens during this activity

Use this as a demonstration at the start of the work on magnetism. It provides a highly visual display of magnetic action-at-a-distance at work.

You might also try slipping different materials in the gap between the magnet and the hanger to find out if the hanger can be "shielded" from the force of the magnet. The hanger falls away when a sheet of magnetic material is placed in the gap.

The magnetic force and the magnetic field

What the activity is for

You can use this activity to introduce the idea of a magnetic field as a region of space where forces are exerted. You introduce a tangible, visible analogue of the magnetic field, that fills a region of space and exerts a force on objects that enter that space.

What to prepare:

- a pair of model railway trucks on a short section of track (or low mass, low friction trolleys that track well) with a strong button magnet mounted on the end of each, with similar poles facing
- a pair of model railway trucks on a short section of track (or low mass, low friction trolleys that track well) with a piece of very soft foam mounted on the end of each

What happens during this activity

Push the magnetic trucks together and feel them resisting, even when the trucks are not touching. There seems to be something there, even though we cannot see it. You find it hard to make one magnet invade the space around the other. Release the trucks and let them spring apart, noticing that one magnet throws the other out of its space. As you do this you'll want to talk the pupils through these thoughts.

Repeat the sequence with the two trucks that have foam on the ends. Here, draw attention to the things in the space around the end of the truck becoming pushed out of shape, and show that it pops back when the trolleys spring apart again.

Drawing parallels between the two situations

There is something in the space beyond the truck. If you try and invade that volume of space, then a force is exerted on the thing that does the invading. Once the invader has retreated, then the space is again filled by the thing, back in its original shape.

You might then suggest, with some confidence, that the magnetic fields and the foam have plenty in common. A fruitful way of thinking with magnetic fields is to consider their shape and how it is distorted and pops back, so exerting a force.

You might take this further by:

- reversing one magnet and swapping the foam for rubber bands, so modeling attraction rather than repulsion.
- comparing this attraction to gravity modeled by a spring.
- exploring similarities with a spring of compressed air, felt in a sealed syringe.

Exploring a 3D space

What the activity is for

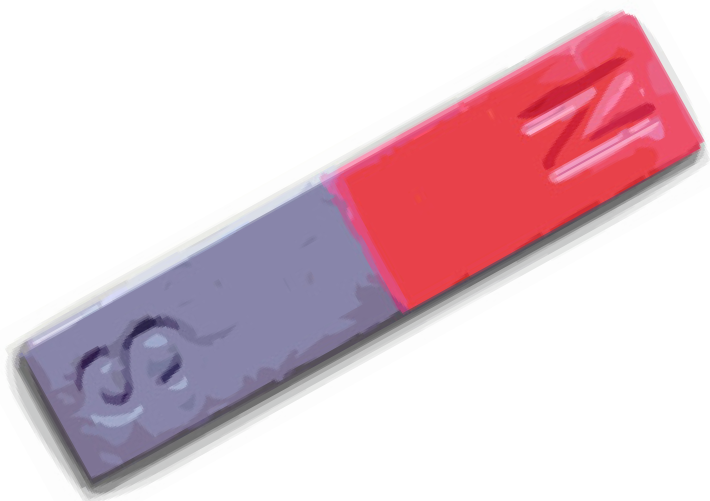
You can use this activity to explore the magnetic field in the region of space all around that magnet.

What to prepare:

- a bar magnet with the poles at the ends
- a slab magnet with the poles on the faces
- a small gimballed bar magnet free to spin in all 3 planes (a probe)

What happens during this activity

Pupils hold the bar magnet in one hand and trace out the magnetic field. You'll have to model this for them.



You might ask them to close their eyes and visualise all the lines they have just traced out, or even have a wire and cardboard box model of it, but it would be an act of cruelty to ask them to represent this on paper.

Drawing magnetic field patterns

What the activity is for

The aim of this activity is to develop the idea of a magnetic field by engaging pupils in drawing some magnetic field patterns.

What to prepare:

- bar magnets
- plotting compasses
- iron filings

What happens during this activity

The point has already been made that some care needs to be taken in leading pupils to draw magnetic field patterns. Rather than getting the pupils to start with iron filings and make their own drawings, we would suggest starting with a compass needle demonstration, which helps pupils to understand and recognise what it is that they are drawing, and then progressing to drawing the iron fillings.

Drawing magnetic field patterns

Compass needle demonstration

Take a bar magnet and place it on the glass of an overhead projector. Switch on the projector and bring the magnet into focus on the screen. The idea is to use about 12 small plotting compasses to act as "magnetic field detectors" to out the magnetic field pattern.

Now then, we know that there is a magnetic field around the bar magnet. But how does the magnet actually pull and push magnetic objects in that space or field? In what direction? To find out we can use these small plotting compasses, specially made to find out magnetic field patterns.

If you remember, each of these compasses is simply a suspended magnet.

If I place this first plotting compass close to the north pole of the bar magnet, notice what happens to the plotting compass needle: It lines up so that the south pole of the compass needle is attracted to the north pole of the magnet.

If I place this second compass at the other end of the magnet, the north pole of the compass needle is attracted in towards the south pole of the magnet.

How about if I place this compass down the side of the magnet. It points along the side and towards the south pole of the bar magnet.

By placing the plotting compasses in key positions around the bar magnet it is possible to start sketching out the shape of the magnetic field pattern, with magnetic lines of force following continuous loops from the north pole of the magnet round to the south. To make this as plain as possible, choose the new position of the compass by moving it in the direction indicated by the needle to form one continuous curved line. It is a good idea to place the bar magnet on an overhead transparency so that you can start sketching out (with a felt-tip pen) the magnetic field lines, which the pupils can then see on the screen. This is the first time that the pupils will have seen this distinctive magnetic field shape.

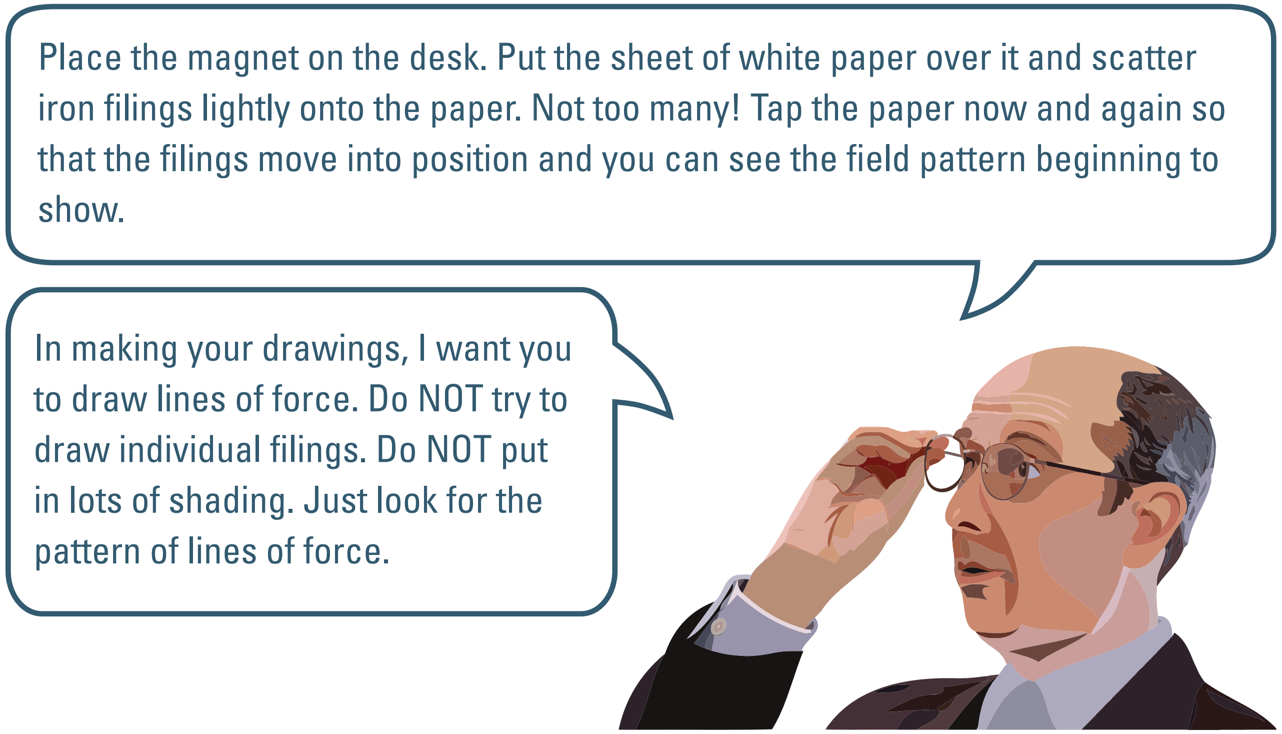
So we can see the plotting compasses lining up and the lines of force looping round from the north pole of the magnet to the south. We call these lines that I'm drawing lines of force and these show the direction in which the force due to the bar magnet acts on the compass needle.

Drawing magnetic field patterns

Iron filings activity

Finally, and with the pupils in a position where they are aware of what they are actually looking for, the class can have a go at using iron filings to pick out the magnetic field patterns for various magnets and combinations of magnets.

This activity can be carried out in pairs or fours, with one set of apparatus per group. In briefing the pupils to make their drawings be clear about what it is that you want:



Given the build up to this activity, the pupils should have no problem in producing a drawing for the single bar magnet. It is then worth testing their ability to spot more complicated magnetic field patterns by setting them the task of investigating the following fields:

- two bar magnets attracting
- two bar magnets repelling

Focus the pupils' attention on what happens with the lines of force between the magnets:

- For magnets attracting, the lines of force link from the pole of one magnet to the opposite pole of the other magnet.
- For magnets repelling, the lines of force "push way from each other" between the similar poles of each magnet.

A 3D field viewer

What the activity is for

This is for a quick look only to show that it is possible to see magnetic fields in three dimensions, using iron filings. You may have a commercially available "3D field viewer", in which case this is less messy!

What to prepare:

- chopped fine iron wool, placed in cooking oil, in a clear container
- a strong magnet

What happens during this activity

Bring magnet in close enough and you will see the field in 3D. Do not try to record what you see. But do see how the two dimensional diagrams that you draw are simple sections through the whole pattern, which is three-dimensional.

Investigating the magnetic force

What the activity is for

The purpose of this activity is to allow pupils to design and carry out a simple investigation in the context of magnetism. You and the pupils should be encouraged that the correct answer is not a straight line through the origin!

What to prepare:

Per pair:

- bar magnet
- newtonmeter, 0-10 newton
- short strip of masking tape
- retort stand base
- 5 pieces of card (choose the thickness of the card to match the strength of your bar magnets: The force should fall significantly from the situation where there is no card between the magnet and the base to the situation where all five pieces of card separate the base from the magnet.)
- graph paper

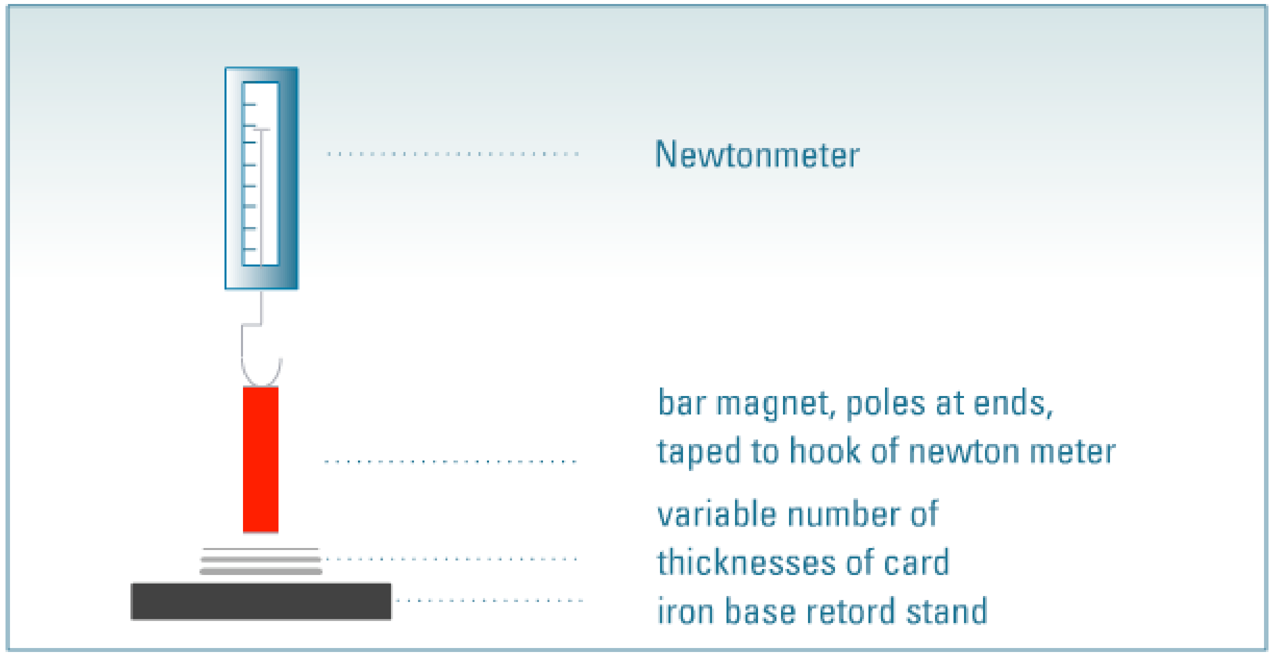
What happens during this activity

Pupils work together to investigate the force needed to drag the bar magnet from the iron base with 0, 1, 2, 3, 4 or 5 pieces of card between the magnet and base.

Before doing the experiment in full, you should get the pupils to sketch the shape of graph of force/separation that they expect, based on direct physical experience of pulling the magnet away from the base by hand. The experiment then acts as a more refined check on their first approximation.

Each group makes careful measurements of the forces needed with different thicknesses, preferably plotting the results as they go. This will help them to see the emerging shape. Point to the need to make several measurements for each data point, as they seek to find a true value.

Later you might ask them to produce a clean version of their graph, together with a written explanation of what it shows. They might usefully compare this to a force/extension graph for a spring, if they have already met that.



Finding north

What the activity is for

To introduce the idea of finding the magnetic north pole from anywhere on the Earth.

What to prepare:

- a strong bar magnet, suspended in a sling, so that it is free to pivot
- a walker's compass

What happens during this activity

Hang the magnet in a sling, taking care not to have any magnetic materials nearby that it might be attracted to. Point to the <pick a town just north of you> seeking pole. Mark it.

Ask what would happen if you went further north up this island. You'd still be pointing to a <town just north of you> seeking pole! You can use this continuing tendency to point to things north of you to introduce the idea of north seeking pole. This is usually contracted to the "north pole" of the magnet - really meaning the "north-seeking pole".

Show the walker's compass, asking how you know where north is with this. To take this further you might like to show how this alters over the Earth.

The Earth's magnetic field

What the activity is for

To explore a scale model of the Earth's magnetic field. Pupils can see how a compass reacts to this field.

What to prepare:

- a small bar magnet, embedded in the middle of a foam earth, about 15 cm in diameter, down a hole made radially through Hudson's Bay in Canada. The South pole should be pointing towards Hudson's Bay.
- a small gimballed bar magnet, free to spin in all 3 planes (a probe)
- a bar magnet, for comparison with the model Earth

What happens during this activity

Pupils explore the magnetic field, which is just like that of the Earth.

Particular points to look out for:

- The probe mostly points towards or away from the Earth, not aligned with the surface.
- The field is very like that of a bar magnet.
- The magnetic north pole and geographical North Pole are not in the same place.
- The magnetic south pole and geographical South Pole are not in the same place.
- There is a band around the Earth where the compass lies parallel to the surface: the magnetic equator.
- The effect of the field on the probe gets much weaker quite quickly as the probe moves further from the model Earth.

You might like to make the point that all this pointing up and down leads to hill-walking compasses being made for the Northern or Southern Hemispheres. If you take one from the UK to New Zealand, it does not work, dragging one end of the needle against the lid of the case.

A magnetic map

What the activity is for

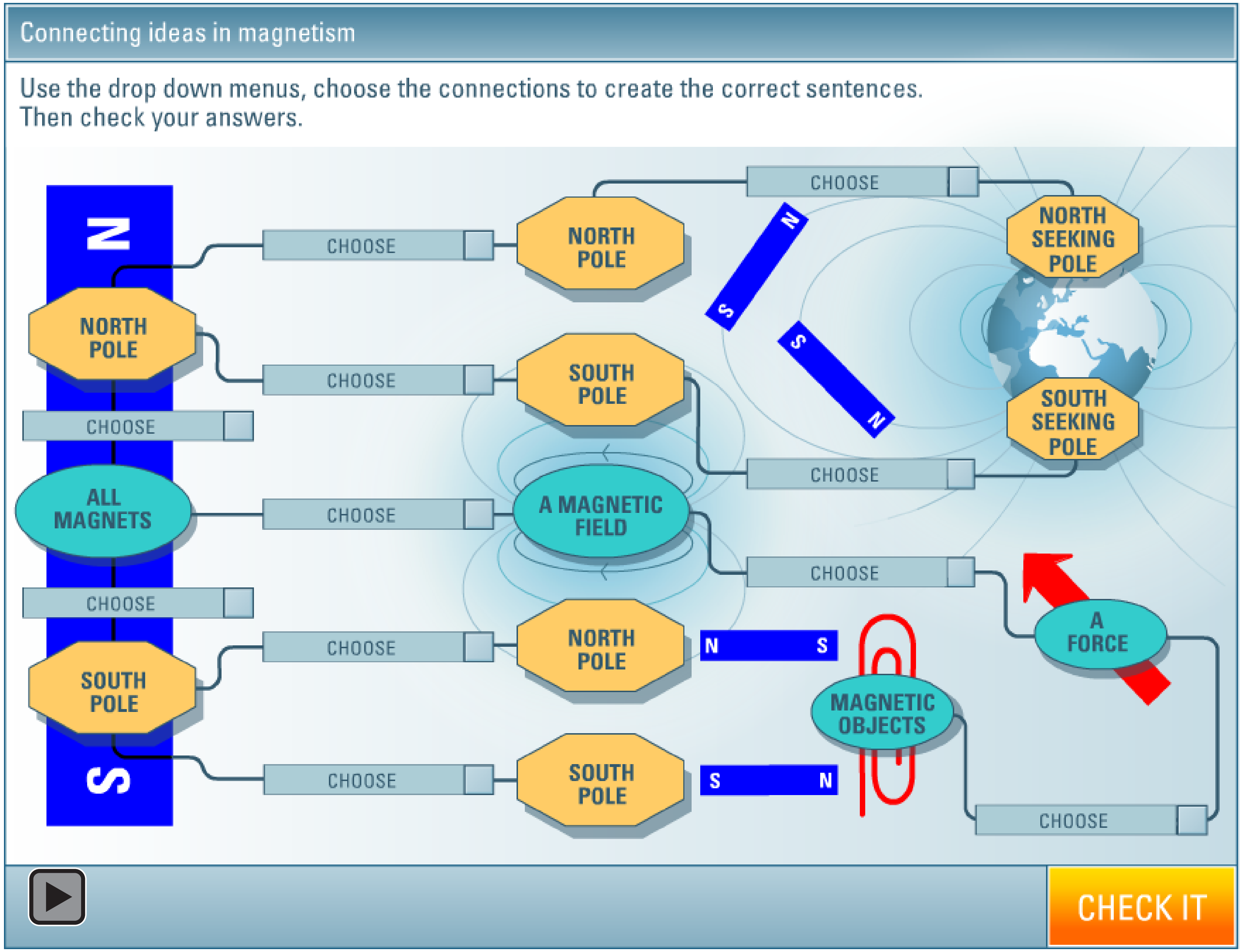
Pupils reinforce their understanding of permanent magnets by constructing a map, putting in the links.

What to prepare:

- access to this interactive object

What happens during this activity

Pupils can complete this individually, or work in pairs, or you might use the object to review what is known with the whole class. Because the activity is fairly convergent, it is best used towards the end of the learning.



Progress check

You can use the following questions to check your own understanding of this episode and your pupils' understanding.

Check your understanding of magnetism Question 1 of 4

1. Which of the following metals are attracted to magnets:

1. Aluminium
2. Cobalt
3. Iron
4. Nickel

	CORRECT	INCORRECT	DON'T KNOW
a) 1, 2 and 3?	☐	☐	☐
b) 1, 2 and 4?	☐	☐	☐
c) 2, 3 and 4?	☐	☐	☐
d) 3, 4 and 1?	☐	☐	☐
e) 3, 1 and 2?	☐	☐	☐

Once you are happy with your answer click 'check it' to continue

CHECK IT