Creating Science – Marvellous Magnets

How do we make magnets? What are they attracted to? ***#CreatingScienceMagnets***

Suggested Outcomes

(NOTE: This is by no means an exhaustive list of possible outcomes, neither is it intended that ONLY these outcomes can or should be met. Science is a deeply interrelated activity, and you may find cross curriculum links you can and should use.)

Science understanding

- Chemical sciences 1: Everyday materials can be physically changed in a variety of ways.
- Physical sciences 2: A push or a pull affects how an object moves or changes shape.
- Physical sciences 5: Forces can be exerted by one object on another through direct contact or from a distance.

Science inquiry skills

- Processing and analysing data and information 5-6: Compare data with predictions and use as evidence in developing explanations

Science as a human endeavour

- Use and influence of science 5: Scientific knowledge is used to solve problems and inform personal and community decisions (ACSHE083)

Science vocabulary words

Tier 1 (Everyday words) – magnet, push, pull.

Tier 3 (Specialised vocabulary)

- Force – something which is able to create a push, pull or (in some definitions) a twist.

Warning

- Small magnets can create a severe hazard if swallowed. Please warn children and exercise all appropriate caution.
- Neodymium magnets are unbelievably strong. They can easily pinch skin quite painfully if they are allowed to snap together. Exercise all appropriate caution.
- Banging magnets, as well as heating them up, destroys their magnetism. Be careful.
- In order to be so magnetically strong, the neodymium is not much sturdier than thick powder. This means the stronger the magnet is, the more fragile it will be. Most neodymium is coated with a non-metallic substance such as plastic to increase its strength. Even so, avoid dropping or banging magnets to prevent them from breaking.

Preparation

- A class set of magnets, available at shopping centres or many educational outlets. Or see www.CreatingScience.Org for our science kits.
- A set of non-magnetic metals such as:
  - Australian coins
  - Bronze or nickel keys
  - Aluminium drinking cans
  - Gold rings
  - Basically anything made out of metal that doesn't stick to a magnet – which is helpful, since most metals don't stick to magnets anyway. Iron is the only strongly magnetic metal, and almost all magnetic things have iron in them.
- Some plastic lids and paperclips (plastic coated are safer)
- A cup of water to float the super simple compass in.

Learning Intent (student friendly)

'We are learning to' (WALT) – recognise what magnets do.

Success criteria

'What I'm looking for' (WILF) – correct and safe handling of magnets, and an appreciation that 1/ magnets do not stick to most metals, they are really only strongly attracted to things with Iron in them. And 2/ Magnets can push, as well as pull.

Student learning goals

Help students make a self-monitored learning goal for this lesson, such as 'find out what magnets stick to', or 'find out how magnets work'.

Evidence of learning

How will you know when the learning goal is achieved? What EVIDENCE do you have that your students have met or exceeded the learning expectations?

Students will successfully make and explain the super simple compass from the activities for today.

Suggestions for other year levels

As always, more material is presented here than can be used by the average class during the average lesson time. However, since the student's questions can and should guide student learning, more material is presented for your convenience. Remember, it is not uncommon for students to only remember those points which answered their personal questions.

Younger:

This activity is well suited to this age group. Children at this age can have difficulty with focus. Avoid tangents if you're attempting to make a key point.

Middle:
While not immediately obvious, all materials respond to magnetism – even water. Challenge students to find out what they are and how it happens.

Teen:
Challenge students to build a device that uses magnetism, such as an electromagnet.

Engage
- ⇨ Note the Learning Intention of this lesson for students.

Grab out the magnets and let the students explore freely for a while.

Note down, and have them share with the group, any questions they have at this time. Listen to their explanations without comment at this time. If you do feel compelled to clarify a misconception, you might find it more empowering for the student if you phrase it as a suggestion at this time, i.e., 1/ “Some scientists would think magnets don’t work on all metals,” or 2/ “How can you go about testing that idea?”

Explore
- ⇨ Encourage and validate student explanations of this phenomenon. You may like to ask students to write or draw their explanation personally to avoid embarrassment to students unfamiliar with this material. Remember, ‘I don’t know’ is a valid explanation in science – it is the beginning of learning new things!

1/ Goal: To discuss what magnets stick to.
Set up the non-magnetic metals where students can see them.

<u>Ask</u>: These objects are all metal, which ones do you predict will stick to this magnet?

Demonstrate: the magnet will stick to none of them.

Discuss: student ideas as to why.

2/ Goal: To discuss the way in which magnets work.
Ask: What do magnets do? (‘They stick to metal’ is a common answer).

Set up two magnets so that they will repel.

Demonstrate: Here is a magnet, if I bring this other magnet close, what do you think it will do?

(They push each other away)

Ask: Why did they do this?

Explain

1/ Scientists believe that the only pure metal that attracts strongly to magnets is called IRON, and most other pure metals are considered non-magnetic (and there are over 70 of them!)

So the quest for what sticks to a magnet is not the quest for *metal*, but the quest for what has *iron* in it. Lots of things have iron in them, especially steel.

2/ Scientists use the following explanation: All magnets have two sides

- ⇨ Suspend a bar magnet by a string, one side will turn to face north and the other south[1]. Thus the sides of a magnet are known as the 'northward facing' and the 'southward facing' – or north and south for short.

Try it out: two of the same side will always push each other away.

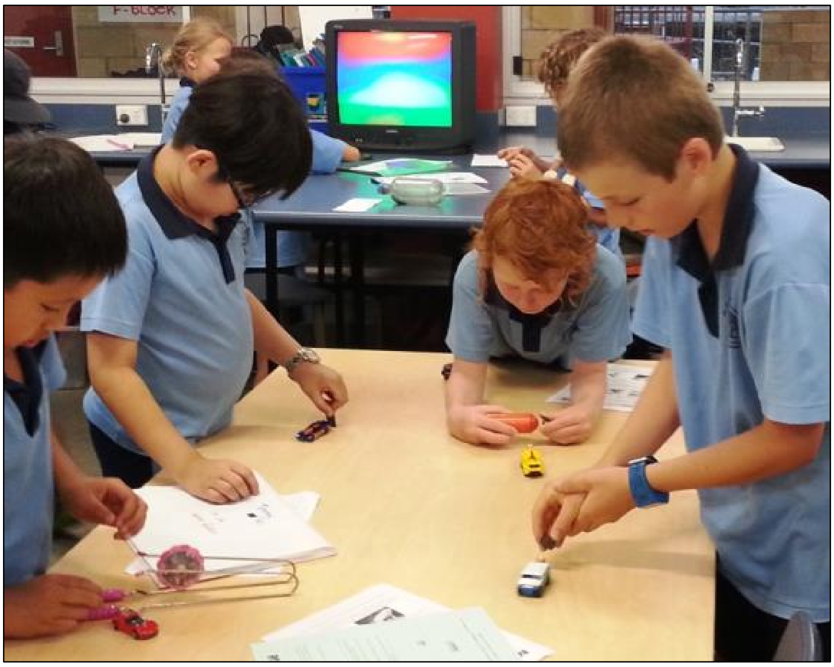
Try it out: two opposite sides (north and south) will pull each other together.

Remember: magnets don't just push, *magnets can pull **and** push!*

Make a magnetic racer!

- ⇨ Glue a powerful magnet onto the back of a toy car. You can now push, or pull, the car using another magnet.

Can you make a magnet race? Try competing with your friends to move your car along the track to the finishing line first. This activity of skill and strength takes loads of practice. Remember, you're disqualified if your magnet actually touches your car! Magnetism only!



[1] It might take 10 minutes to settle down. Also, this activity only works with bar magnets, not magnets with their poles on the same side, such as horseshoe magnets.

Elaborate

- ⇨ Ask students if they can design new ways to test this explanation, is it really sufficient? Can they think of further or better explanations, and the experiments needed to test them?

1/ Go around the room and try to find out what IS made of iron.

Remember: There are other things that have lots of iron in them that do not respond to magnets in this way, such as blood.

Also, there are lots of things that respond to magnetism even though they don't have iron in them:

DANGER: Electronic equipment, in particular, can be very sensitive to magnets since the magnetism can create electric charges in the metals. This can sometimes cause very dangerous currents in electronic gear, so make sure you keep magnets well away from electronic equipment.[2].

DANGER: Also, some equipment uses magnetic particles to keep information, such as credit cards, or old cassette and video tapes. Running a magnet along them can rearrange the particles and destroy valuable information, so be careful! [3]

2/ Believe it or not, *all substances* respond to magnetism in one way or another.

For example, water *pushes away* from a magnet, but only very gently. However, scientists have magnets so powerful they can levitate mice or a not too happy frog (http://www.youtube.com/watch?v=A1vyB-O5i6E). Maybe one day they'll have magnets ten thousand (10,000) times more powerful … that can even float us!

3/ Build a simple little compass of your own (see attached sheet).

One of the most amazing and useful tools we have today, and maybe have had for thousands of years, is a good, reliable magnet. But what are magnets? While they are old, there are still a lot of mysteries surrounding them, not to mention the plethora of myths and misunderstandings! So let's explore magnets:

All you'll need is a paper clip, a permanent magnet, the lid from a milk jug, and a cup of water.

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[2] MAGNETS PUSH ELECTRICITY! This is an important fact for science, and the basis of many things such as motors and generators. However, it can also be used to damage things that rely on electricity, such as credit cards and smart phones. This is why we say never put magnets near such things!

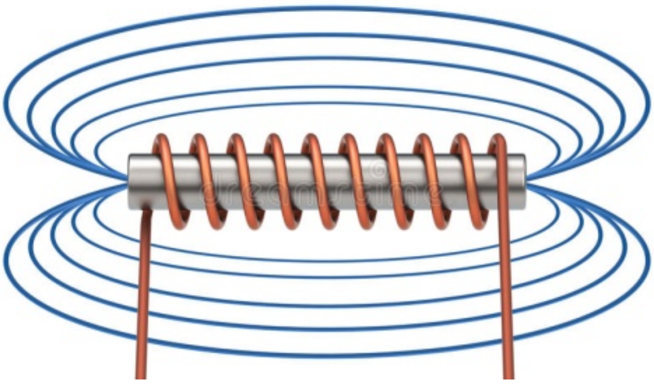
[3] HOWEVER – magnetism doesn't kill smart phones on its own, it has to be strong magnetism vibrating backwards and forwards at just the right amount. It can happen, but rarely does. Even so, we rarely tell kids that it requires a moving magnet to kill electronic equipment, just in case – and it helps to keep magnets away from electronic devices in the first place.

Stroke your paperclip with the magnet at least 20 times, in the same direction each time. 	Rest your paperclip in the upside down lid. 	Float the lid on a full cup of water and you've got yourself a super simple compass! 

Tips: 1/ If you lid is iron or steel, this won't work – you need a nonmagnetic lid. 2/ If you fill the cup right to the top, the lid will end up floating in the middle due to the *van de walls* force. This also means that when the cup is only partly full the water tries to climb up the sides, and pulls the lid with it, making it rest along the side and making it difficult for your compass to turn around.

A thousand years ago, this device you can now potentially whip up in under five minutes was worth quite a bit of money and expense!

So what is magnetism?



Magnetism is caused by moving electrical charges.

And moving magnets can also create electrical charges.

Magnetism is one of the four fundamental forces of the universe, and since electricity and magnetism are always seen together, we call that force the electromagnetic force. This force can travel through the emptiness of space, at the speed of light! It makes lights glow, heaters heat up, motors run and generators generate. Electromagnetism is arguably the basis of our modern, electronic world. And electromagnetism is also what holds atoms together in chemicals.

Iron works by lining up all the little atoms in the same direction, called domains, multiplying their magnetic field. Heating or banging the magnet can cause it to lose its magnetism.

Do you know what the largest magnet on earth is? It's the earth itself. The rotation of our massive nickel/ iron core creates a huge magnetic field that reaches far out into space – helping protect us from some of the dangerous particles of the sun and causing the bright lights we call the Aurora Borealis and Aurora Australis, or in other words, the Northern and Southern Lights.

Evaluate

⇨ Review with students what they feel they learnt from this lesson. Did they have any questions at the start that they feel were answered?

Ask students;

- What do magnets stick to?
- Who invented magnets?
- How many sides do magnets have?
- What can push away from a magnet?
- How can I demagnetize something?
- How do I magnetise something?
- Can I demagnetise and then remagnetise something?
- How strong can magnets be?
- What is the biggest magnet in the world? In the solar system? In the known universe?
- How do we make baby mice levitate on magnets? What do we have to do before we can get humans levitating on magnets too?

Success criteria

⇨ Review the Learning Intentions of this lesson with students. Were they met?

At the end of each class, review the learning objective and see how we did. Ask:

- Did you achieve your learning goal?
- What did **you** learn?
- What worked to help you achieve it?
- What might you do better next time?
- (If needed) where can you go for extra help or information?

Assessment

Prior learning:

Set out a great sheet of paper and help students to brainstorm their questions about magnets. Take time to focus on planned content material during the engage phase, for example,

⇨ What are magnets?
⇨ What do magnets stick to?
⇨ Who invented the first magnet? [We don't know, but even the ancient Greeks knew about magnetism!]
⇨ What can we use magnets for?

Formative:

As students are learning, help them self-monitor their own learning and achievements.

Be sure to watch out for the following common alternative conceptions:

- Magnets stick to metals. [Most metals are NOT magnetic, only Iron is strongly magnetic, but it's *very* common, which is probably why we are tricked.]
- Magnets *stick* to things. [Magnets can push AND pull – if you set them up right.]
- Magnets don't affect some things. [Magnets affect every material thing, even if we cannot measure those effects with our bodies. Even water is affected by magnets, it is pushed away.]

Summative:

Have students investigate what things in the room are attracted to magnets, and have them make their *own* conclusion based on their *own* evidence. Do they support the scientific idea that only iron (which is in steel) is noticeably attracted to metals, or not…?

Help students consider ways they can communicate their new understanding to others, just as scientists need to do. Have students build their own compass and describe how it works, perhaps using a scrap book presentation.

⇨ Have students investigate one kind of magnet, or in older year levels, one kind of magnetism. Who discovered it? How is it made? What is it used for?

So what?

Only Iron is strongly attracted to magnets, not 'metals'.

We can use magnets to move things around, including moving electricity to generate power (or destroy smart phones).

We can use magnets to make fun things, like a compass or race car.

Creating science

Science understanding

As we explored the properties of magnets, we learnt that:

- Chemical sciences 1: Everyday materials can be physically changed in a variety of ways.
- Physical sciences 2: A push or a pull affects how an object moves or changes shape.
- Physical sciences 5: Forces can be exerted by one object on another through direct contact or from a distance.

Science inquiry skills

Though challenging our assumptions (that magnets are attracted to all metals, for instance), and building some science toys to test our ideas, we learnt about;

- Processing and analysing data and information 5-6: Compare data with predictions and use as evidence in developing explanations

Science as a human endeavour

As we explored uses for magnets in society, we;

- Use and influence of science 5: Scientific knowledge is used to solve problems and inform personal and community decisions (ACSHE083)

Tips from the Masters

Use your magnet to make a super simple compass