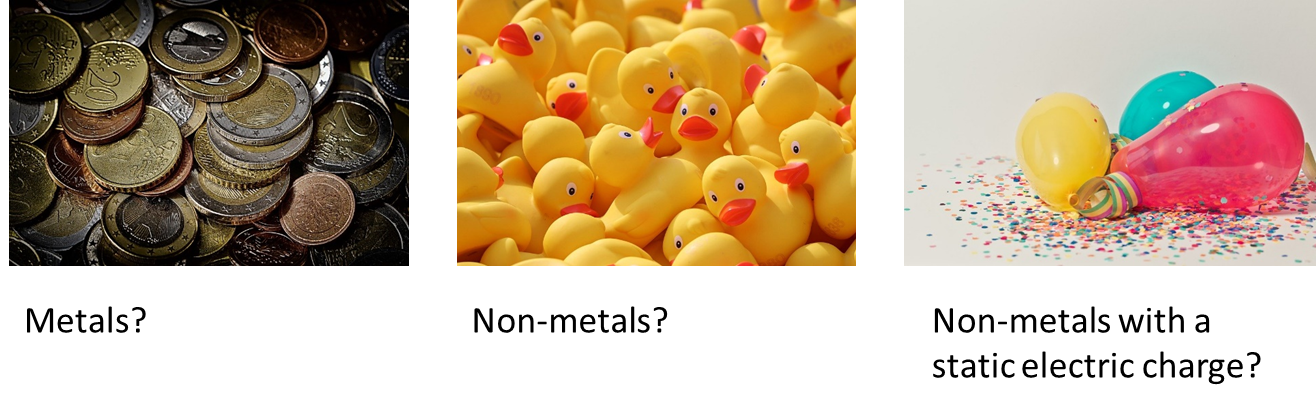
**Rules for magnetism**

Some things are magnetic.

A magnet attracts a magnetic object.

What sorts of materials are magnetic?



What do you think about these rules for magnetism?

*For each statement, tick (✓)* ***one*** *column to show what you think.*

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Rules for magnetism | | I am **sure** this is right | I think this is right | I think this is wrong | I am **sure** this is wrong |
| **A** | All metals are magnetic. |  |  |  |  |
| **B** | All non-metals are ***not*** magnetic. |  |  |  |  |
| **C** | Lots of metals are ***not*** magnetic. |  |  |  |  |
| **D** | Non-metals are magnetic if they have an electric charge. |  |  |  |  |

*Physics > Big idea PEM: Electricity and magnetism > Topic PEM3: Magnets and electromagnets > Key concept PEM3.1: Magnetic fields*

|  |
| --- |
| **Diagnostic question** |
| **Rules for magnetism** |

**Overview**

|  |  |
| --- | --- |
| Learning focus: | The magnetic field around a magnet can be represented by field lines, which indicate the size and direction of the force of the magnet on the north-seeking-pole of another magnet. |
| Observable learning outcome: | Identify magnetic materials that are attracted to both the north- and south-seeking-poles of a magnet. |
| Question type: | Confidence grid |
| Key words: | Magnetic, metal, non-metal, static electric charge |

|  |  |
| --- | --- |
| **P** | **PRIOR UNDERSTANDING**  This diagnostic question probes understanding of ideas that are usually taught at age 5-11, to aid transition from earlier stages of learning. |

**What does the research say?**

It is a common misunderstanding to think that all types of metal are magnetic (Hickey and Schibeci, 1999; Van Hook and Huziak-Clark, 2007; Lemmer and Morabe, 2017). Hickey and Schibeci (1999) found that 39% of trainee science teachers (n=56) thought that magnets attract all types of metal. This misunderstanding is consistent with thinking that magnetism is caused by a static electric charge. In a study of children aged 9-11 (n= 33), the great majority did not think that magnets could attract non-metals (Bradamante and Viennot, 2007).

When students start studying magnetism, over half believe an electrically charged plastic rod held near to a pivoted magnet will make the magnet rotate, because the electric charge attracts one pole of the magnet and repels the other (Knight, 2004). The idea that magnetism is caused by static electric charge is very common (Driver et al., 1994), even amongst undergraduate science students (Maloney, 1985), and sometimes students refer to the idea of a ‘magnetic charge’ (Lemmer and Morabe, 2017). To challenge this misunderstanding, Hood (2012) uses an electrically charged balloon to attract both ends of a magnetic compass needle; and contrasts this with the observation that a magnetic pole of a magnet can attract just one end and repels the other.

**Ways to use this question**

Students should complete the confidence grid individually. This could be a pencil and paper exercise, or you could use an electronic ‘voting system’ or mini white boards and the PowerPoint presentation.

If there is a range of answers, you may choose to respond through structured class discussion. Ask one student to explain why they gave the answer they did; ask another student to explain why they agree with them; ask another to explain why they disagree, and so on. This sort of discussion gives students the opportunity to explore their thinking and for you to really understand their learning needs.

*Differentiation*

You may choose to read the questions to the class, so that everyone can focus on the science. In some situations it may be more appropriate for a teaching assistant to read for one or two students.

**Expected answers**

Statements B and C are correct.

Statements A and D are wrong.

**How to respond - what next?**

The metals iron, cobalt and nickel are magnetic in normal conditions, as are the alloys that are made from them, such as steel. All other metals and all non-metals are not magnetic. This means that lots of metals are *not* magnetic, but we can also say that lots of metals *are* magnetic, because there are lots of common alloys that include iron or nickel.

It is very common for steel objects to be plated with other metals (coins or tin-cans for example). This can mislead a student with a magnet!

The fact that the most common metal in our lives is steel means that care needs to be taken with the word ‘most’ in rules for magnetism. Most metal elements are not magnetic, but it is not obvious whether most metal alloys are magnetic or not, or if most of the (pure) metal in the world is magnetic or not.

It is common for students to think that magnetism is caused by electric charge, so it is likely that some students will have the misunderstanding that non-metals that have an electric charge are magnetic.

If students have misunderstandings about which types of materials are magnetic, it can help to give students a magnet and a range of materials for them to investigate. Magnetic materials are attracted to the magnet and materials that are not magnetic are not attracted. Pieces of iron, steel, nickel, possibly cobalt, and other metals can be labelled and included in the sample, as well as plastic rods and balloons, which can be given an electric charge and then tested with a magnet.

Students could be given the opportunity to research any metal objects that appear to be made from a metal that is not magnetic, to find out whether they contain iron, nickel or cobalt. In the UK students could be given copper coins dated before and after 1992 and challenged to explain why the earlier coins are not magnetic, yet the later coins are, despite all the coins looking exactly the same.

**Acknowledgments**

Developed by Peter Fairhurst (UYSEG).

Images: Coins: <https://pixabay.com/photos/coins-money-currency-euro-specie-3652814/>; Ducks: <https://pixabay.com/photos/duck-meet-ducks-rubber-ducks-4127713/>; balloons: <https://pixabay.com/photos/carnival-color-desktop-background-3076952/>.

**References**

Bradamante, F. and Viennot, L. (2007). Mapping Gravitational and Magnetic Fields With Children 9-11: Relevance, difficulties and prospects. *International Journal of Science Education,* 29(3)**,** 349-372.

Driver, R., et al. (1994). *Making Sense of Secondary Science: Research into Children's Ideas,* London, UK: Routledge.

Hickey, R. and Schibeci, R. A. (1999). The attraction of magnetism. *Physics Education,* 34**,** 383-388.

Hood, T. (2012). A New Direction: How a Compass Pointed the Way to Clearing Up and Attractive Misconception. *The Physics Teacher,* 50**,** 398-399.

Knight, R. D. (2004). *Five Easy Lessons: Strategies for Successful Physics Teaching,* San Francisco, U.S.A.: Addison Wesley.

Lemmer, M. and Morabe, N. M. (2017). Concept confusion and concept discernment in basic magnetism using analogical reasoning. *Physics Education,* 52**,** 6.

Maloney, D. P. (1985). Charged poles? *Physics Education,* 20**,** 310-316.

Van Hook, S. J. and Huziak-Clark, T. L. (2007). Tip-to-Tail: Developing a Conceptual Model of Magnetism with Kindergartners Using Inquiry-Based Instruction. *Journal of Elementary Science Education,* 19(2)**,** 45-58.