

Topic: Magnetic Fields and Electromagnets

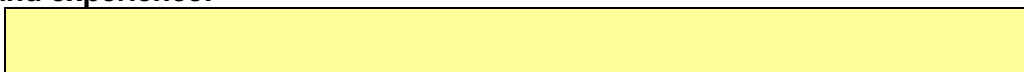
Prepared by: Charles Trotter and Paul Yapp

Issues tackled:

1. Key ideas, use of language and terminology - Describing magnets and magnetic fields.
2. Misconceptions - Correcting the common mistakes about magnetic materials.
3. Practical work (including Health and Safety) – The strength of electromagnets and viewing a magnetic field.

Issue 1: Key ideas, use of language and terminology – Describing magnets and magnetic fields

Prior knowledge and experience:



Possible tasks:

Preparation for tutorial:

1. Draw a concept map for magnetism. Words to include: bar magnet, North Pole, South Pole, core, solenoid, magnetic field, current, uses of bar magnets, uses of electromagnets.
2. Use the National Curriculum and QCA schemes of work to create a 'knowledge line' (a time line of facts taught) for magnets and electromagnets.

Possible activities during tutorial:

1. Go through the concept map. Identify how the concepts link together and discuss the best starting point for a topic on magnetism.
2. Go through the knowledge line. Discuss the reasons for including magnetism on the curriculum.

For both activities identify Key Ideas on magnets and electromagnets (pairs of poles, field lines, attraction and repulsion, permanent and temporary, magnetic materials and factors affecting electromagnets).

AST Input:

- Demonstrate the difference between a permanent magnet and a magnetic material using two magnets and a fake magnet made from a piece of steel.
- Talk about permanent and temporary magnets to include magnetising and demagnetising.
- Talk about loose language, strength of magnet, attraction not pull, repulsion not push. Use of current not 'amount of electricity'.

Reading: Subject knowledge and understanding

Read Key Stage 3 and Key Stage 4 text books on this topic that are available in school.

Subject pedagogy

Millar, R. (1989 or later edition) **Understanding Physics**, Collins Education, London.

Useful websites and applications

Information and a quiz about magnets

www.zephyrus.co.uk/welcometophysics.html click on magnetism

A searchable database by key stage and science strand with suggestions for practical activities:

www.scienceyear.com/sciteach

Focus on Fields CD ROM – mainly for A level use, but worth a look if available.

Demonstration and information available from www.focusededucational.com

Resources: Task 1

Cleminson, A. (ed) (2003). **Brunel University Physics** Materials contains resources for trainees to use to improve their subject knowledge using a self taught approach under [Magnetism and Electricity](#).

Task 2

QCA Scheme of work

www.standards.dfes.gov.uk/schemes3 and select Science Key Stage 3, then unit 8J Magnets and Electromagnets.

AST Input

Magnetic field viewer (SEP: Middlesex University teaching resources) www.sep.org.uk/
Then follow links to 'Resources', then 'Equipment materials', then 'Magnetic field viewer'.

Bar magnets, iron filings, soft iron and steel rods,

Simple electromagnet e.g. cells, insulated wire, croc clips and iron core (nail).

Issue 2: Misconceptions – Correcting the common mistakes about magnetic materials

Prior knowledge and experience:

Possible tasks:

Preparation for tutorial:

1. Design a practical and pupil worksheet for an experiment to show which materials are attracted to magnets (extension: and can be magnetized?).
2. Devise a starter activity for lesson 1 of a magnets topic to elicit preconceptions.
3. Find out why some materials are magnetic and others are not.

Possible activities during tutorial:

1. Demonstrate the practical and show how the worksheet supports the learning.
2. Demonstrate the starter activity and look at how it could be built upon when planning a sequence of lessons.
3. Present and discuss findings about the nature of magnetic materials.

Discuss common misconceptions about magnets, electromagnets and magnetic fields.

AST Input:

- Ensure trainee knows that only iron, steel, nickel and cobalt are magnetic.
- Show that iron compounds are not necessarily magnetic.
- Discuss with trainees why pupils may think all metals are magnetic, drawing on pupils experience – cartoons etc.

Reading: Subject knowledge and understanding

Old 'O' level textbooks often covered this topic well, for example
Abbott.A.F. (1977), **Ordinary Level Physics**, Heinemann, London.
Nelkon, M. (1975), **C.S.E. Physics**, Hart-Davis, St Albans.

Millar, R. (1989), **Understanding Physics**, Collins Education, London.

Subject pedagogy

Driver, R et al. (1994), **Making Sense of Secondary Science**, Routledge, London, pages 263-276.

Useful websites and applications

Resources: **Task 1**

Selection of magnetic and non magnetic materials, including Ni and Co if possible, and magnets (trainee could provide requisition sheet before tutorial).

Issue 3: Practical work (including Health and Safety) – The strength of electromagnets and viewing a magnetic field

Prior knowledge and experience:

Possible tasks:

Preparation for tutorial:

1. Carry out an experiment to find out the factors that affect the strength of a simple electromagnet and look for a quantitative relationship for each continuous factor. Consider the relative merits of steel and iron as a core.
2. Plan a practical demonstration to show the factors involved in the strength of an electromagnet.
3. Devise a practical activity/demo to show that the magnetic field of a bar magnet is 3-dimensional.

Possible activities during tutorial:

1. Present findings and discuss the possibilities to use this experiment for an investigation.
2. Give the demonstration and discuss how it could be improved.
3. Show the activity and discuss why this is an important concept to show.

AST Input:

- Highlight Health and Safety issues. Use of iron filings and protection of eyes. Overheating of wires when using electromagnets and strategies for overcoming this: variable resistor or current limiting resistor or verbal instruction to limit voltage. (*Note trainees have major problems in this area*).
- Advise on distributing and collecting attractive ‘pocketable’ equipment.

Reading: Subject knowledge and understanding

Ideas for experiments and demonstrations can be found in older physics books such as Nelkon, M. (1975), **C.S.E. Physics**, Hart-Davis, St Albans, pages 494-497.

Subject pedagogy

Millar, R. (1989), **Understanding Physics**, Collins Education, London.

Useful websites and applications

<http://web.channel4.com/learning> search for science 11-14 then look at programme notes for scientific eye, physical processes 3 and look at the programme on magnetism – includes ideas about the electromagnets practical.

www.upd8.org.uk go to the topic list and look for entries under magnetism. These may help to put the practical work in context.

Resources: **Tasks 1 and 2**

Practical equipment as requested by trainees.

Likely to include: C cores or nails and insulated wire, power pack or cells, connecting wires and crocodile clips, ammeter, voltmeter, paper clips or 0-10N Newton meter, variable resistor.

Task 3

Magnet, iron filings, plotting compasses, magnetic field viewer.