5.2 Magnetism and electromagnetism

Name: _____ Class: _____ Date: _____ **Total: 23 marks**

KEY WORDS induced magnet • solenoid

Objective

Build the skills to answer exam questions on **magnetism and electromagnetism** : poles and fields, permanent and induced magnets, the Earth's field, the field around a wire, solenoids and electromagnets.

You must be able to:

- describe the forces between poles and draw magnetic field lines
- tell permanent magnets from induced magnets
- describe the magnetic field around a wire and a solenoid
- explain how electromagnets are made stronger and how they are used

1 Key knowledge and worked examples

Magnetism and electromagnetism

idea	equation or rule
poles	like poles repel, unlike poles attract; field lines go from N to S
permanent and induced	a permanent magnet makes its own field; an induced magnet (iron, steel, nickel, cobalt) is magnetic only inside a field and is always attracted
Earth's field	the Earth has a magnetic field; a compass needle lines up with it and points north
wire with a current	circular field lines around the wire; reverse the current and the field reverses
solenoid	a coil of wire with a field like a bar magnet's; stronger with more turns, more current or an iron core (an electromagnet)
uses	an electromagnet can be switched off: scrap-metal cranes, relays, electric bells

Worked example 1: a compass. A compass is placed just next to the N pole of a bar magnet. Which way does it point?

1. Known: field lines leave the N pole.
2. Rule: a compass needle points along the field lines, from N to S.
3. Apply: next to the N pole the field lines point away from the magnet.
4. Result: **the compass points away from the N pole**.

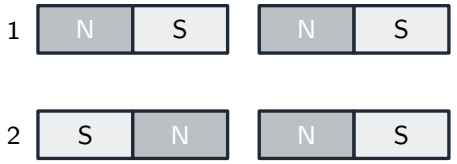
Worked example 2: a stronger electromagnet. An electromagnet lifts 4 nails with a current of 0.5 A. Give two ways to make it lift more nails.

1. Known: the strength depends on the current, the turns and the core.
2. Rule: more current or more turns give a stronger field.
3. Apply: increase the current to 1.0 A; wind more turns of wire on the core.
4. Result: **more current, more turns (or an iron core)**.

Answer shapes: draw field lines with arrows from N to S that never cross; an induced magnet is always attracted, never repelled.

2 Practice

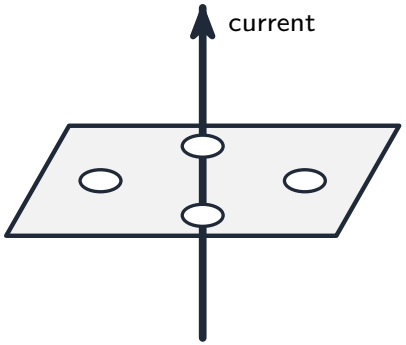
2.1 The diagram shows two pairs of magnets. Does each pair attract or repel? [2]



2.2 Which of these materials are attracted by a magnet? [2]

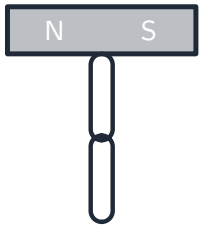
iron | copper | steel | aluminium | nickel

2.3 Plotting compasses are placed around a vertical wire with a current in it. Describe the shape of the magnetic field. What happens to the compasses when the current is reversed? [2]



3 Exam-style questions

3.1 A steel paper clip hangs from a magnet. A second clip hangs from the first. Explain why. What happens if the clips are made of soft iron and the magnet is taken away? [3]



3.2 A student makes an electromagnet by winding wire around an iron nail. She counts how many paper clips it lifts with different numbers of turns. The current is 1.0 A each time.



turns	10	20	30	40	50
clips lifted	3	6	9	11	12

(a) Describe the relationship between the number of turns and the number of clips. [3]

(b) Give two variables she must keep the same. [2]

(c) Explain why the core is made of iron. Explain why a scrap-metal crane would not use a steel core. [3]

(d) Describe how the student did this investigation. Include how she kept the test fair and safe. [6]

Solutions

Marking: **M1** a correct method, **A1** the correct answer, **B1** an independent mark.

Each answer shows the steps, then the **result**.

2.1

- pair 1: **attract** (N next to S); pair 2: **repel** (N next to N)

2.2

- iron and steel; nickel

2.3

- circles around the wire; the compasses turn to point the opposite way

3.1

- the first clip becomes an **induced** magnet in the field of the magnet
- so it attracts the second clip
- soft iron loses its magnetism (almost) at once, so the clips fall

3.2

(a) more turns lift more clips; up to 30 turns the number of clips is proportional to the turns; after that the increase gets smaller

(b) any two: current, size or type of core, type or size of clip, how the clips are picked up

(c) iron becomes an induced magnet and adds to the field, so the electromagnet is stronger; iron loses its magnetism when the current is switched off; steel stays magnetised, so the crane could not drop the scrap

(d) points to include:

- wind the turns tightly round the nail and connect the wire to a power supply, ammeter and variable resistor
- set the current to 1.0 A using the variable resistor, and check it each time
- dip the nail into a pile of clips, lift it and count the clips held
- change the number of turns in steps of 10; repeat each test three times and find means
- switch off between readings because the coil gets hot

Levels: **5–6** a full, logical answer with correct physics and correct terms; **3–4** several correct points, partly linked; **1–2** one or two relevant points.

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