A-LEVEL PHYSICS • EXERCISE SHEET

20.4 Magnetic fields due to currents

Name: _____ Class: _____ Date: _____ **Total: 8 marks**

Objective

Build the skills to answer exam questions on **magnetic fields due to currents** and the force between currents.

You must be able to:

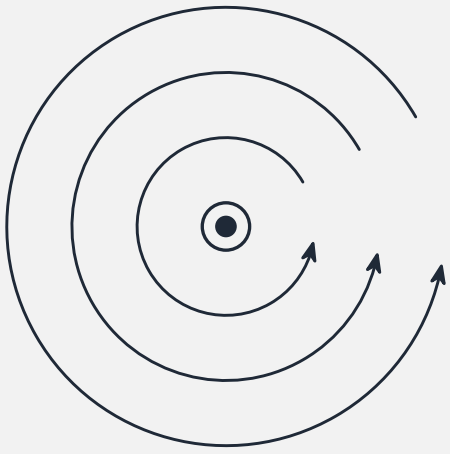
- sketch the field of a straight wire, a coil and a **solenoid**
- explain the **force between parallel currents**

1 Worked examples

Study these first. Each one shows the method for a question type used later —follow the steps and you can do the Practice and Exam-style questions yourself.

■ Field around a wire

A current in a long straight wire makes **concentric circular** field lines (use the **right-hand grip rule**):



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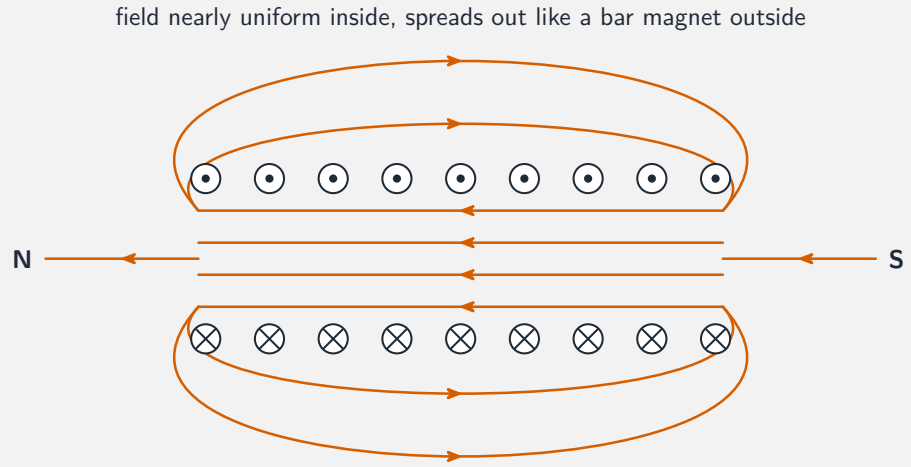

The magnetic field of a solenoid

A **solenoid** makes a field like a bar magnet (uniform inside); adding a **ferrous (iron) core** makes it much stronger.

■ Force between parallel currents

Each wire sits in the other's field. By Fleming's left-hand rule:

- currents in the **same** direction → **attract**;
- currents in **opposite** directions → **repel**.

2 Practice

Now apply the methods above.

2.1 Describe the shape of the magnetic field around a long **straight wire**. [1]

2.2 State **one** way to make a **solenoid's** field stronger. [1]

2.3 State whether two parallel currents in the **same** direction attract or repel. [1]

3 Exam-style questions

3.1 Two parallel wires carry currents in the **same** direction. They: [1]

- **A** attract

- **B** repel
- **C** feel no force
- **D** rotate

3.2 Sketch the magnetic field pattern around a long straight current-carrying wire. [2]

3.3 Explain why two **antiparallel** currents (opposite directions) **repel**. [2]

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4 Go further

You are now ready for the real exam questions on this subtopic. Open the **20.4 Magnetic fields due to currents** past-paper sheet in the Library, or try this in **Practice mode**:

- 9702/52 M25 —Q1 (magnetic field of a current-carrying coil)

The field patterns here also support the **20.2 Force on a current-carrying conductor** and **20.5 Electromagnetic induction** sheets, so practise those too.

Solutions

2.1 Concentric circles around the wire.

2.2 Any one: add a **ferrous/iron core**; increase the **current**; increase the **number of turns**.

2.3 They **attract**.

3.1 A —attract.

3.2 Concentric circles centred on the wire; closer together near the wire, with a direction (arrow) shown.

3.3 Each wire lies in the other's magnetic field and feels a force ($F = BIL$); for opposite-direction currents Fleming's left-hand rule gives forces pushing the wires **apart** (repulsion).