12 Magnetic fields and forces – Part 1

Name: _____ Class: _____ Date: _____

Vocabulary

Write each word three times.

English	**Write it 3 times** (English)		
magnetic field			
magnetic force			

Recall

You have played with magnets before:

- A magnet has a north and a south pole; like poles repel, opposite poles attract.
- Magnets pull on iron and steel.
- A coil of wire carrying a current becomes a magnet – an electromagnet.

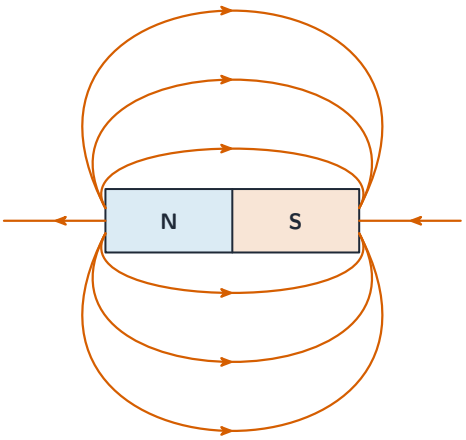
This sheet adds the forces that magnetic fields make. Each idea has a worked example.

New ideas

■ 1 Magnetic fields

A **magnetic field** B surrounds every magnet. Field lines run from the **north** pole to the **south** pole outside the magnet, and closer lines mean a stronger field. Poles always come in pairs – cut a magnet in half and you get two smaller magnets, never a single pole.

field lines run from **N** to **S** outside the magnet



2 Force on a moving charge

A charge moving across a magnetic field feels a **magnetic force** :

$$F = qvB\sin\theta,$$

where θ is the angle between the velocity and the field. The force is at right angles to the motion, so it bends the charge into a **circle** without changing its speed.

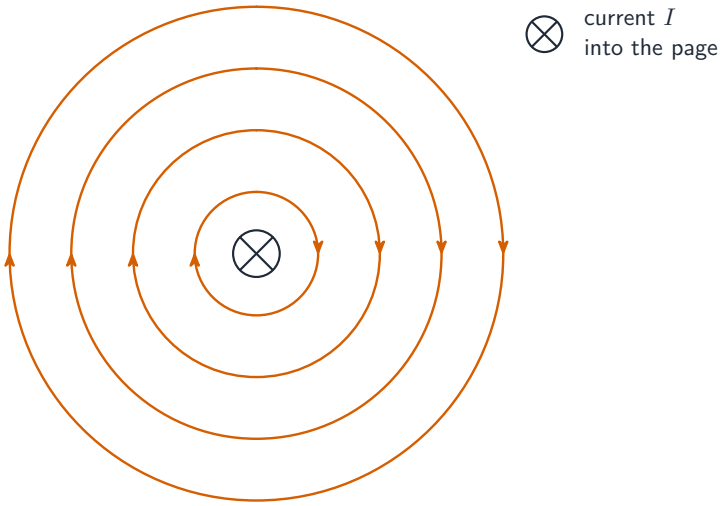
Worked example. A charge of 1.6×10^{-19} C moving at 2.0×10^{5} m/s across a 0.50 T field feels $F = qvB = 1.6 \times 10^{-19} \times 2.0 \times 10^{5} \times 0.50 = 1.6 \times 10^{-14}$ N.

3 Force on a current-carrying wire

A current is moving charge, so a magnetic field pushes on a **current-carrying wire**:

$$F = BIL.$$

This push is what turns the coil in an electric motor.



circular field lines (right-hand grip rule)

Worked example. A 0.30 m wire carrying 4.0 A across a 0.20 T field feels $F = BIL = 0.20 \times 4.0 \times 0.30 = 0.24$ N.

Watch out: a charge that is **not moving**, or one moving **along** the field lines, feels **no** magnetic force. The charge must move **across** the field to feel a push.

Practice

Try these in order. The methods are all above.

2.1 State what happens when you cut a bar magnet in half. [1]

2.2 A charge of 2.0×10^{-19} C moves at 1.0×10^{5} m/s across a 0.40 T field. Find the magnetic force on it. [3]

2.3 A 0.50 m wire carries 3.0 A at right angles to a 0.10 T field. Find the force on it. [2]

2.4 State the direction of the magnetic force on a moving charge, relative to its velocity. [1]

2.5 Explain why a charge moving straight along a magnetic field line feels no magnetic force. [2]