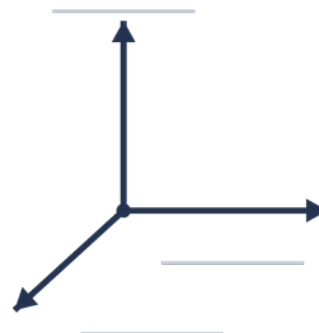
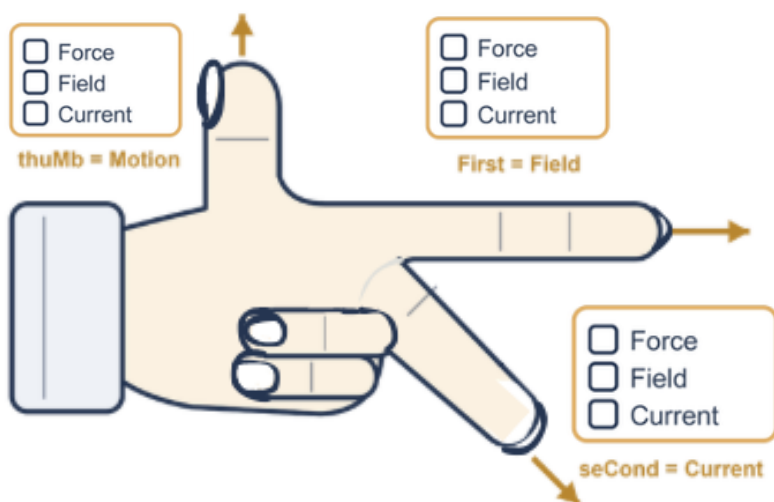


# Fleming's Left-Hand Rule

## The left-hand rule

tick a label on each finger



Use your **left** hand. Hold the thumb and first two fingers at **right angles** to each other.

**Thumb** → \_\_\_\_\_ (motion)

**First finger** → \_\_\_\_\_, from \_\_\_\_\_ to \_\_\_\_\_

**Second finger** → \_\_\_\_\_, from \_\_\_\_\_ to \_\_\_\_\_

## Which way is the force on the wire?

tick one direction for each

Find the **field** (N → S) and the **current** (+ → -; the **long** line of a cell is +). ⊙ = current out of the page, ⊗ = into the page. Find the force on the **thick** wire.

1



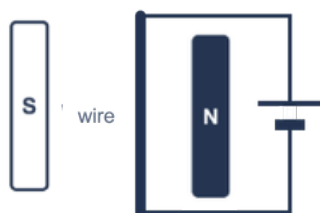
- ☐ ↑ up
- ☐ ↓ down
- ☐ ← left
- ☐ → right
- ☐ ⊙ out of page
- ☐ ⊗ into page

2



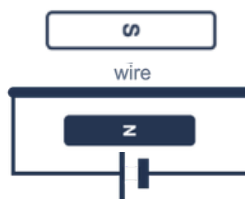
- ☐ ↑ up
- ☐ ↓ down
- ☐ ← left
- ☐ → right
- ☐ ⊙ out of page
- ☐ ⊗ into page

3



- ☐ ↑ up
- ☐ ↓ down
- ☐ ← left
- ☐ → right
- ☐ ⊙ out of page
- ☐ ⊗ into page

4



- ☐ ↑ up
- ☐ ↓ down
- ☐ ← left
- ☐ → right
- ☐ ⊙ out of page
- ☐ ⊗ into page

# Force on a Moving Charge *Triple only*

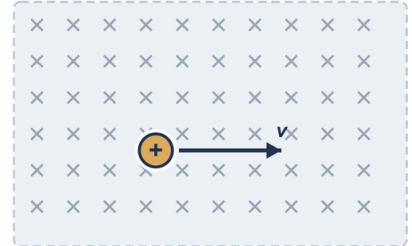
## 1 · The rule, and an example to do together

always a proton (+)

There is a \_\_\_\_\_ on a \_\_\_\_\_ particle when it \_\_\_\_\_ in a magnetic field, as long as its motion is not \_\_\_\_\_ to the field.

**A moving proton is a current** in the direction it moves. Left-hand rule: **F**irst = field · **s**eCond = the way the proton moves · **t**huMb = force. **No force** if it is still or moves **parallel** to the field.

**Example.** A proton moves to the right through a uniform magnetic field directed into the page. Draw an arrow to show the force on it.



- 1 First finger (field): \_\_\_\_\_
- 2 Second finger (the way the proton moves): \_\_\_\_\_
- 3 Thumb (force): \_\_\_\_\_

## 2 · Your turn: a proton in a magnetic field

tick one box for each

- 1 Find the **force** · field out of the page
- ☐ ↑ up  
☐ ↓ down  
☐ ← left  
☐ → right  
☐ ⊙ out  
☐ ⊗ in  
☐ – no force

- 2 Find the **force** · field into the page
- ☐ ↑ up  
☐ ↓ down  
☐ ← left  
☐ → right  
☐ ⊙ out  
☐ ⊗ in  
☐ – no force

- 3 Find the **force** · field to the right
- ☐ ↑ up  
☐ ↓ down  
☐ ← left  
☐ → right  
☐ ⊙ out  
☐ ⊗ in  
☐ – no force

- 4 Find the **force** · field to the left
- ☐ ↑ up  
☐ ↓ down  
☐ ← left  
☐ → right  
☐ ⊙ out  
☐ ⊗ in  
☐ – no force

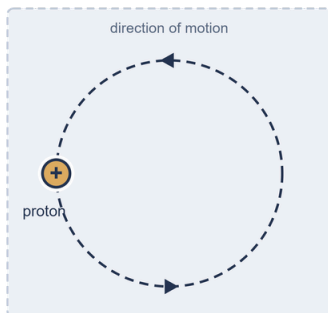
- 5 Find the **field**
- ☐ ↑ up  
☐ ↓ down  
☐ ← left  
☐ → right  
☐ ⊙ out  
☐ ⊗ in  
☐ – no force

- 6 Find the **motion** · field out of the page
- ☐ ↑ up  
☐ ↓ down  
☐ ← left  
☐ → right  
☐ ⊙ out  
☐ ⊗ in  
☐ – no force

## 3 · Exam-style question

9 marks

A proton moves in a circle at constant speed in a uniform magnetic field.



- (a) Draw an arrow on the diagram to show the direction of the force on the proton. [1]

- (b) Use the left-hand rule to find the direction of the magnetic field. [1]

- (e) A neutron enters the field in the same way. Describe its path and explain why. [2]

- (c) The diameter of the path is 6.0 cm. The proton goes round once in  $8.7 \times 10^{-6}$  s. Calculate its orbital speed. Use  $v = 2\pi r / T$ . [3]

- (d) State **two** ways to make the force on the proton bigger. [2]