Motor effect: predicting force direction

Student activity • observation and reasoning

YEAR 11 / LESSON 82 / PHYSICS + SCIENCE (DOUBLE AWARD)

The question

How do current and magnetic-field directions determine the force?

Use three-dimensional direction cards and an original model of the motor effect; no high-current apparatus is required.

Equipment

• Booklet, pencil, ruler and labelled direction cards

Desk-based direction models only. No electron-beam tube, high-voltage supply, high-current wire or strong magnet is operated.

Course coverage: Shared Physics / Double Award: 6.12–6.14. Force on a current-carrying conductor and Fleming's left-hand rule. Physics-only extension: 6.11P moving charge.

Plan, model or apparatus sketch

Draw labelled magnetic-field, current and force arrows where relevant.

Method and reasoning

Read the whole sequence before starting

YEAR 11 / LESSON 82 / PHYSICS + SCIENCE (DOUBLE AWARD)

1. Draw a wire between magnetic poles. Set the field left to right and conventional current out of the page, using a dot for out and a cross for into the page.

2. Use the left hand: first finger field, second finger current and thumb force, with the three directions perpendicular. Predict the force and label all three arrows.

3. Reverse only the current, then only the magnetic field. Predict each force direction separately. Finally reverse both and compare with the starting case.

4. Compare otherwise identical cases with a larger current or stronger field. Describe a greater force qualitatively without inventing measured values.

5. Draw a wire parallel to the field and explain that this alignment gives no magnetic force on the current in the ideal uniform-field model.

6. Physics-only extension: compare a positive and negative charge moving in the same direction perpendicular to a field. Double Award alternative: apply the rule to a second wire diagram and explain the current direction.

Cleanup

- Retain corrected diagrams and collect cards.

Record your evidence

Blank spaces are for your own work

YEAR 11 / LESSON 82 / PHYSICS + SCIENCE (DOUBLE AWARD)

Reference and task data

For the chosen diagram, field right and conventional current out of the page give upward force. Reversing exactly one direction reverses the force; reversing both preserves it. Electron motion is opposite to conventional current.

Case	Field / current	Predicted force
Starting case		
Current reversed		
Field reversed		
Both reversed		
Parallel		

Show your calculations, labelled model or correction here.

Explain and evaluate

Use evidence and show calculation steps where relevant

YEAR 11 / LESSON 82 / PHYSICS + SCIENCE (DOUBLE AWARD)

1. Predict the starting force.

2. What if current alone reverses?

3. What if both current and field reverse?

4. What happens for parallel current and field?

5. How does increasing current affect force at fixed geometry?

6. Extension: how do opposite charges compare?