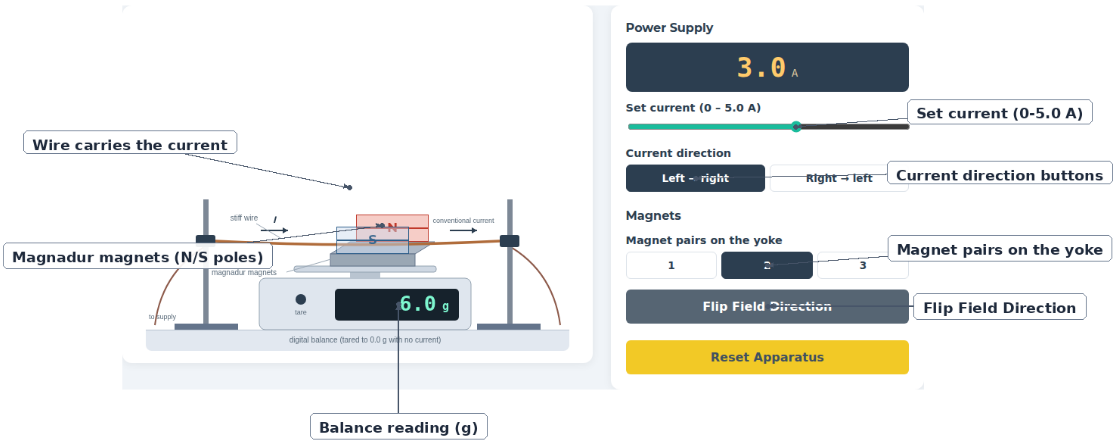
Investigating the Motor Effect

Force on a Current-Carrying Wire

Aim:

You are investigating what determines the size and direction of the force on a current-carrying wire in a magnetic field.



Prediction:

With the current at 0.0 A, the balance reads 0.0 g. What do you predict will happen to the wire and to the balance reading when you slide the current up to 2.0 A?

Test it in the simulation before you start your method.

Method:

1. Set **1** magnet pair. With the current at 0.0 A, check the balance reads 0.0 g, then slide the current up to 2.0 A and note what happens to the wire and the balance.
2. Note the sign of the balance reading and which way the wire bows. Record the **current direction** and **field direction** (the pole letters on the magnets) in your table.
3. Flip only the **Current direction** buttons and record the new row. Put the current direction back, then flip only the field using **Flip Field Direction** and record that row too.
4. With 1 magnet pair, take balance readings at 1.0, 2.0, 3.0, 4.0 and 5.0 A using the **Set current** slider, recording each in your table.
5. Fix the current at 3.0 A and take readings with **1, 2 and 3** magnet pairs on the yoke.
6. Leave the **Your force, F (N)** column blank for now — you will complete it on paper in the Analysis section.

Results:

#	Magnet pairs	Current (A)	Current direction	Field direction	Balance reading (g)	Your force, F (N)

Analysis:

weight (N) = mass (kg) × g,   g = 10 N/kg

The balance reading is a mass in grams. Use the equation above to convert every balance reading in your table into a force in newtons, and complete the force column.

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Look at your rows from steps 2 and 3. What happens to the direction of the force when you reverse only the current? What happens when you reverse only the field?

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Look at your rows from step 4. What happens to the force when you double the current?

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Look at your rows from step 5. What happens to the force when you double the number of magnet pairs?

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Plot a graph of force, F (N) on the vertical axis against current (A) on the horizontal axis, using your step 4 readings. Describe the shape of your graph.

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Explaining why:

The wire never touches the magnets or the balance.

What must be acting between the wire and the magnets for the balance reading to change at all?

The direction pattern you found is called Fleming's left-hand rule: the First finger points along the Field (N to S), the seCond finger points along the Current, and the thuMb gives the direction of the resulting Motion (force).

Look up Fleming's left-hand rule and check that it correctly predicts every direction result in your table.

The force you calculated acts on the wire, yet it is the balance under the magnets whose reading changes. What does this tell you about the pair of forces acting between the wire and the magnets?

Only about 5 cm of the wire sits between the pole faces. Suggest what would happen to the force if a longer length of wire were inside the field, and how you could test that idea with this apparatus.