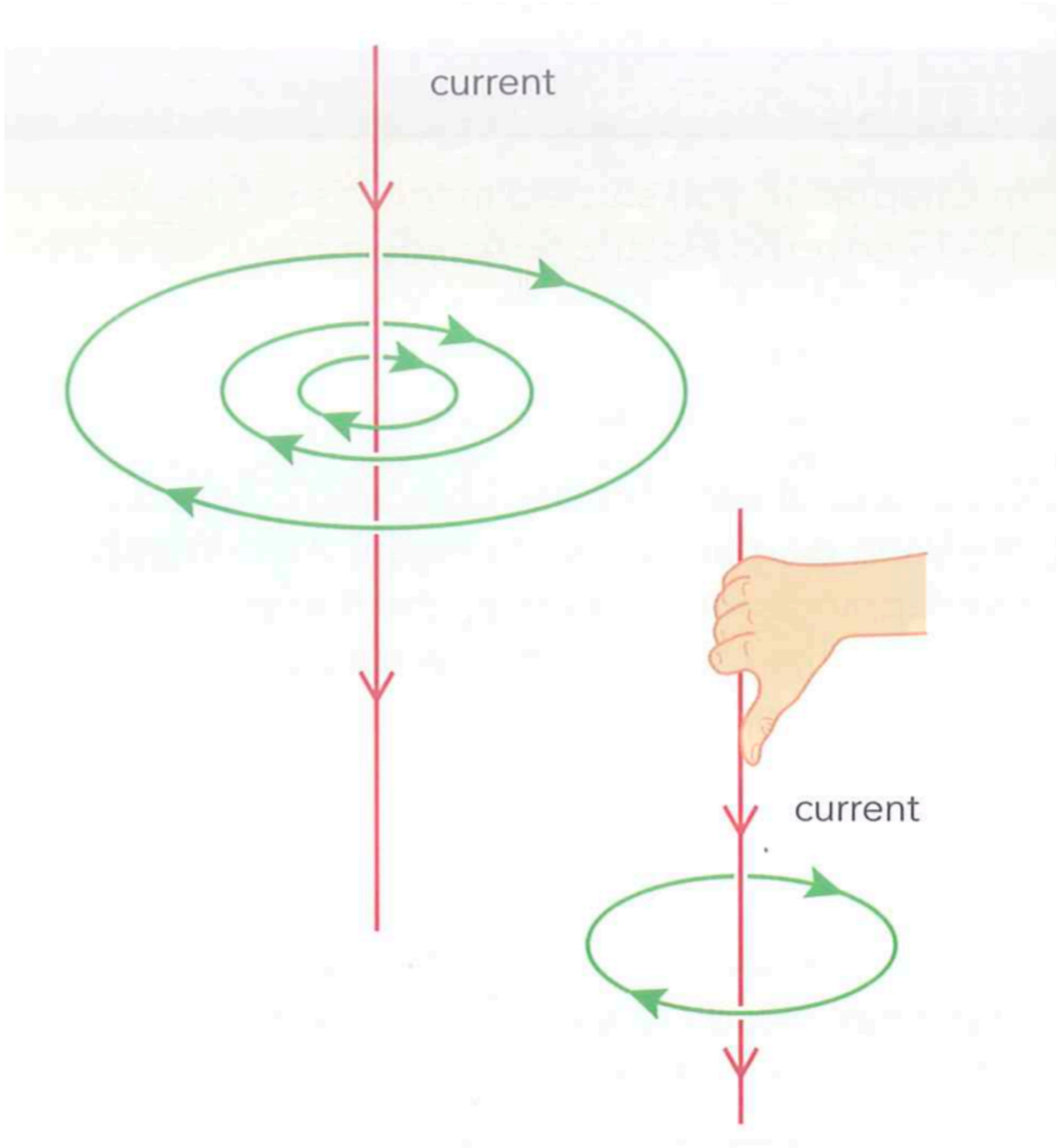
Chapter 20. Electromagnetic Forces

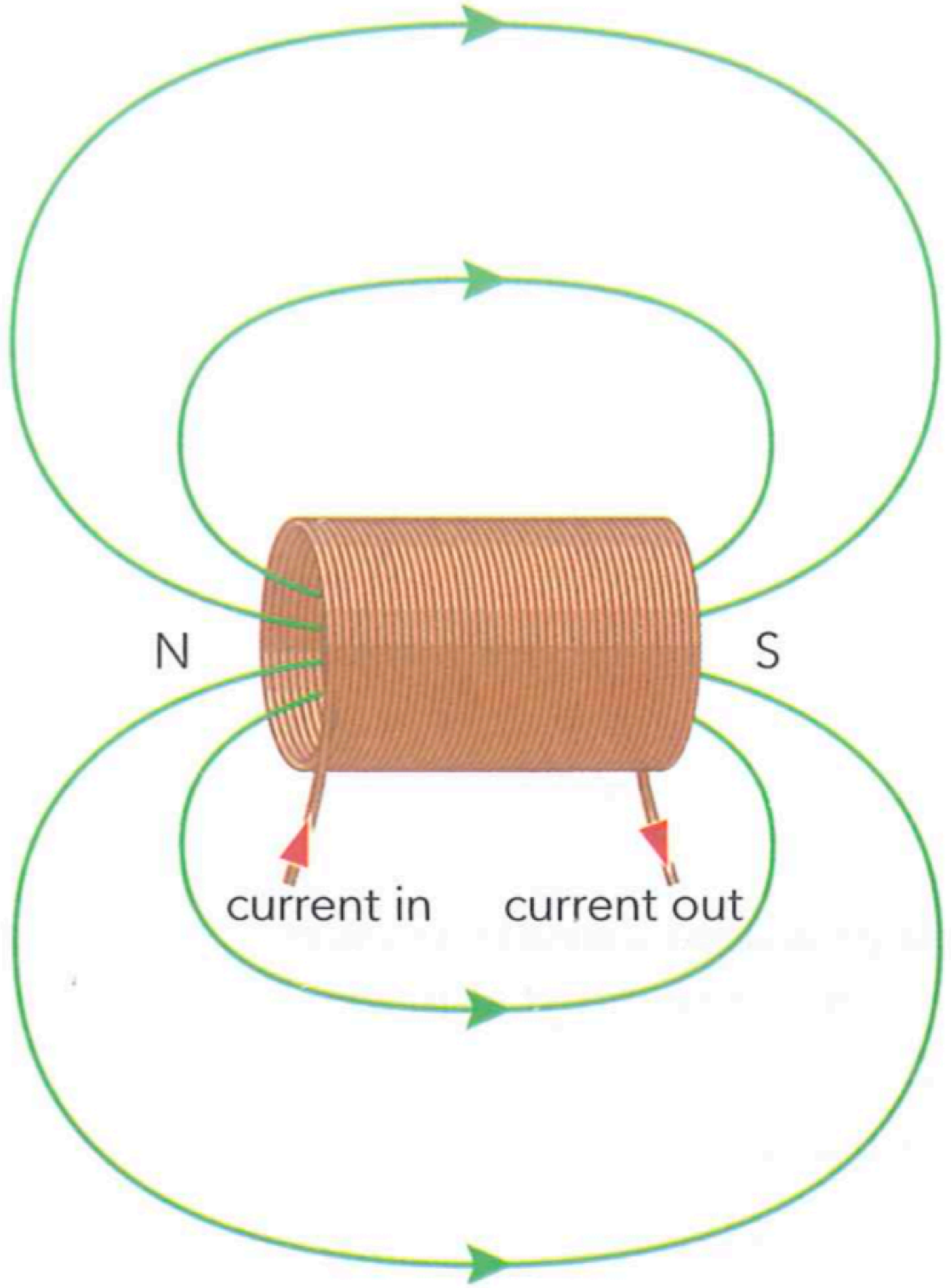
G2 | Ji Yutong | 09/2023

The Magnetic Effect of a Current - Summary



1. Magnetic field(B) direction: **right hand grip rule**
2. Outer => weaker
3. Increase **I** => increase **B**

The Magnetic Effect of a Current - Summary



1. Magnetic field(B) direction: **right hand grip rule**
2. Inside: uniform B, outside: weaker and weaker
3. Increase **I** => increase **B**

The Magnetic Effect of a Current - Summary

Exercise 20.1:

Complete the following sentences.

There is a magnetic field around a conductor when it carries ___________

The field lines around a straight wire are ______________

The direction of these field lines cam be found using ________________

The field around a solenoid is the same as that around a _________________

The Magnetic Effect of a Current - Summary

Exercise 20.1:

Complete the following sentences.

There is a magnetic field around a conductor when it carries ____current___

The field lines around a straight wire are ____circular_______

The direction of these field lines cam be found using ____right-hand grip rule___

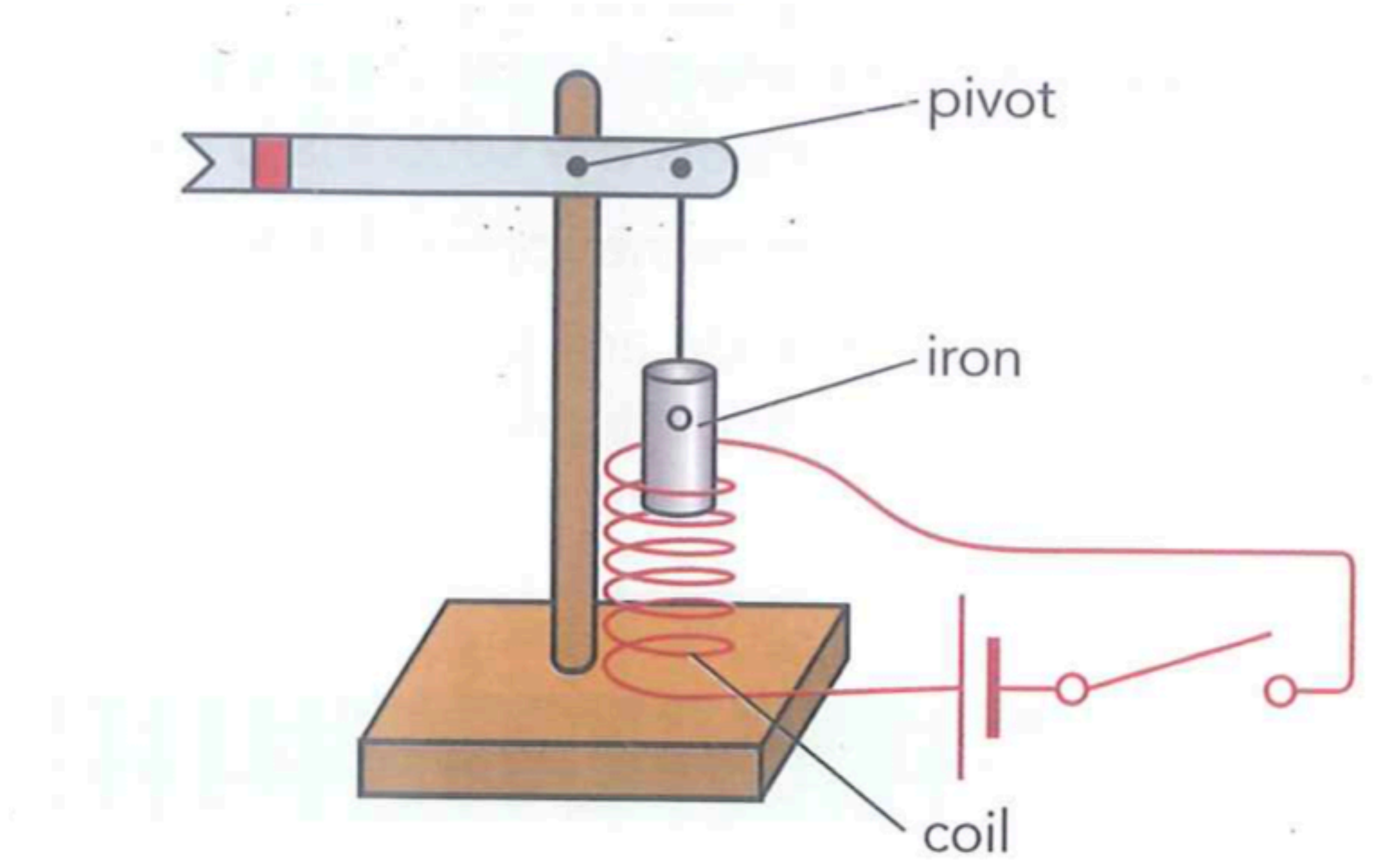
The field around a solenoid is the same as that around a ___bar magnet_______

The Magnetic Effect of a Current - Summary

Exercise 20.2:

The figure below shows an electromagnet in use in a signal for a model railway set.

Explain what happens when the switch is closed, and then when it is re-opened.

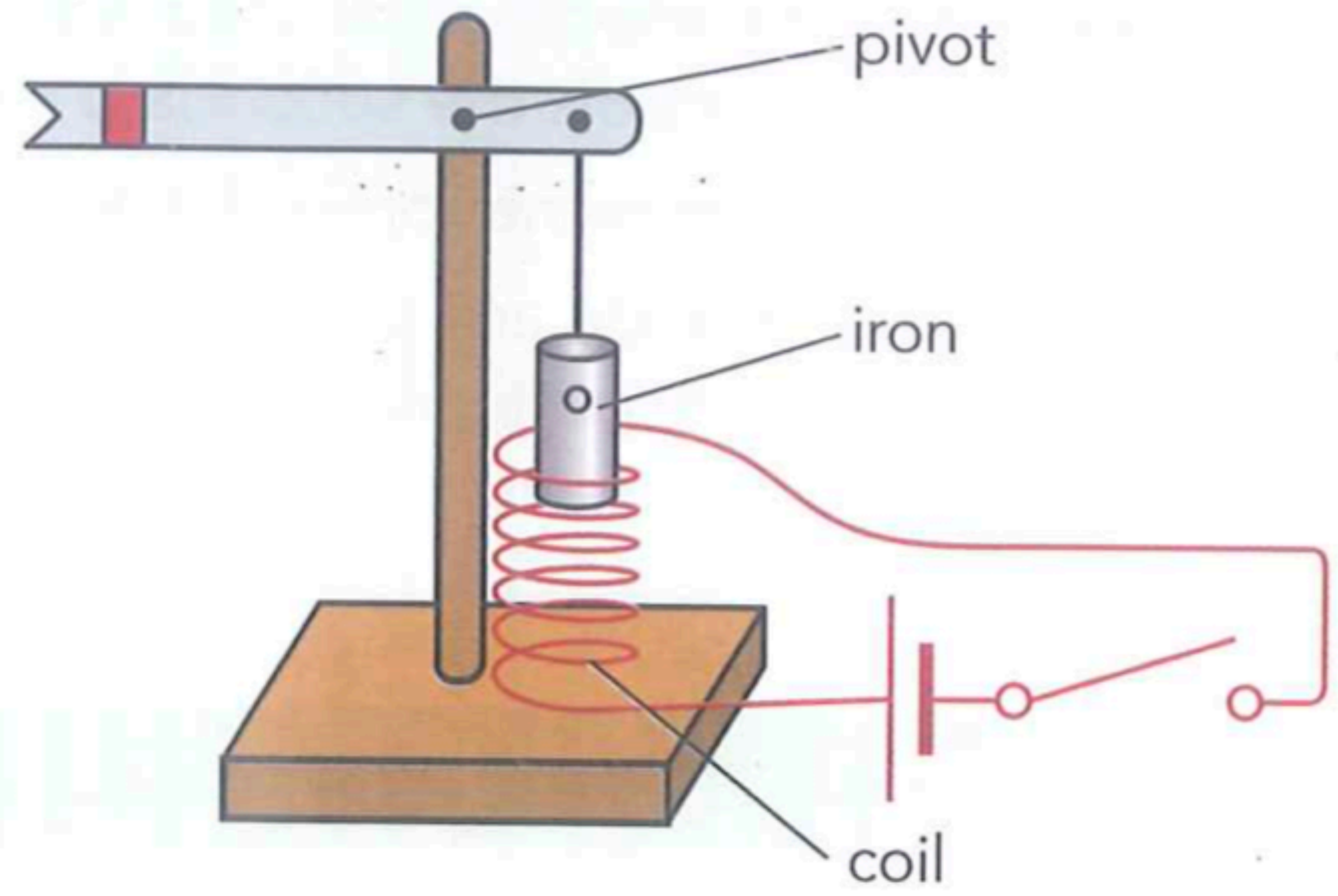


The Magnetic Effect of a Current - Summary

Exercise 20.2:

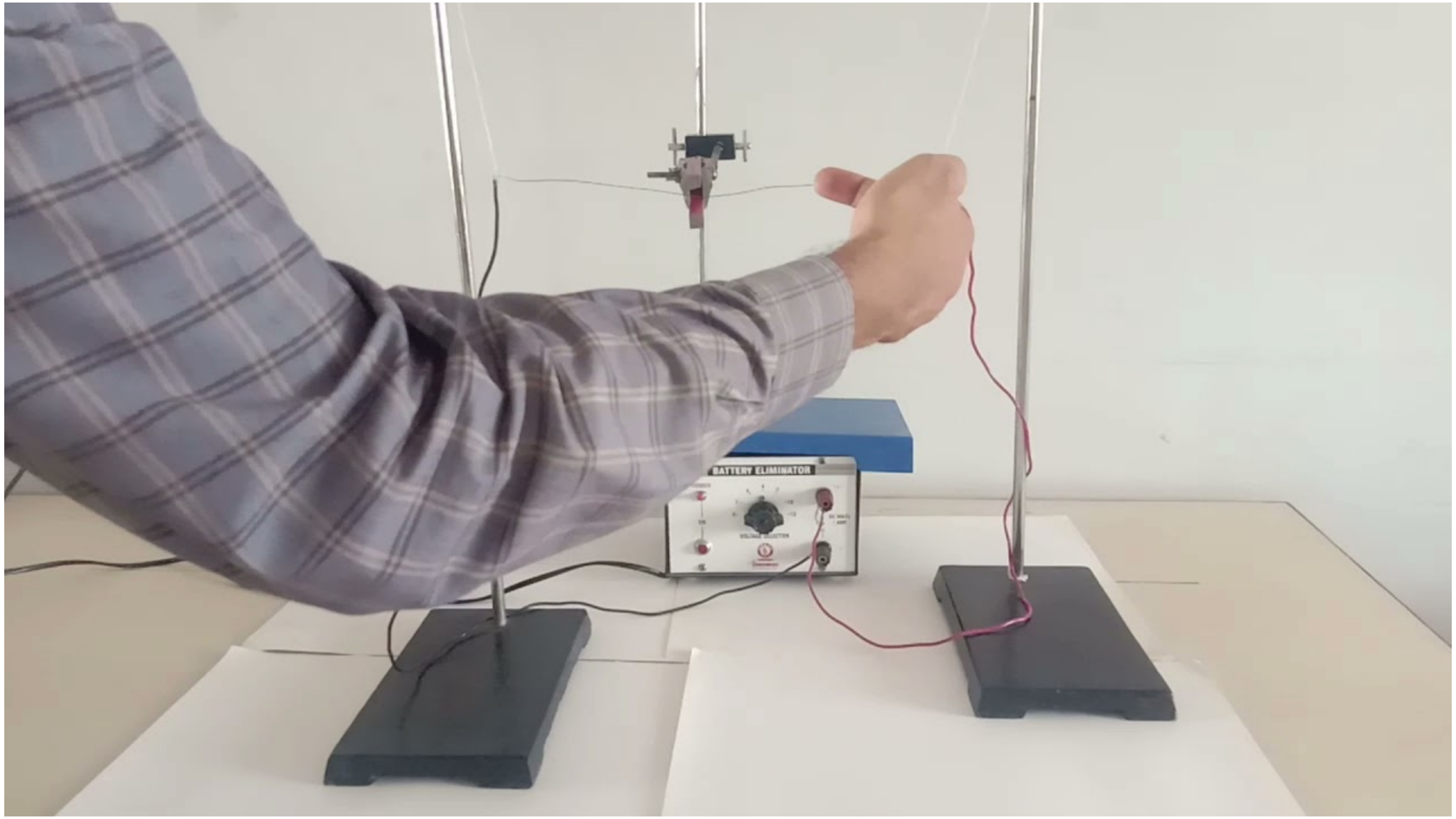
The figure below shows an electromagnet in use in a signal for a model railway set.

Explain what happens when the switch is closed, and then when it is re-opened.

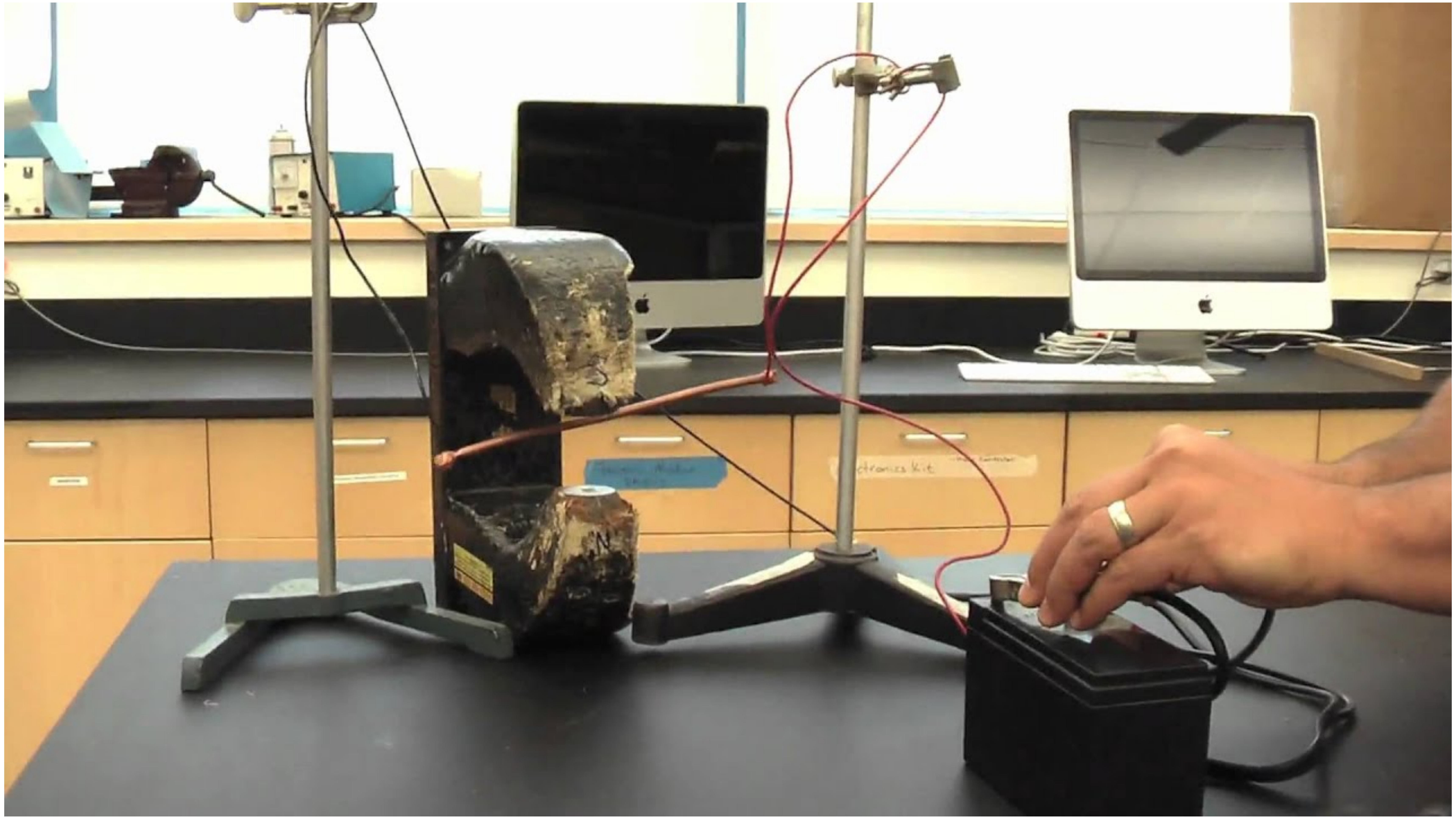


When the switch is closed current flows through the coil creating a magnetic field. This attracts the iron, pulling it down, so the signal lifts up.
When the switch is opened, no current flows. The field is lost, so gravity pulls the signal back down.

Force on a Current - Carrying conductor

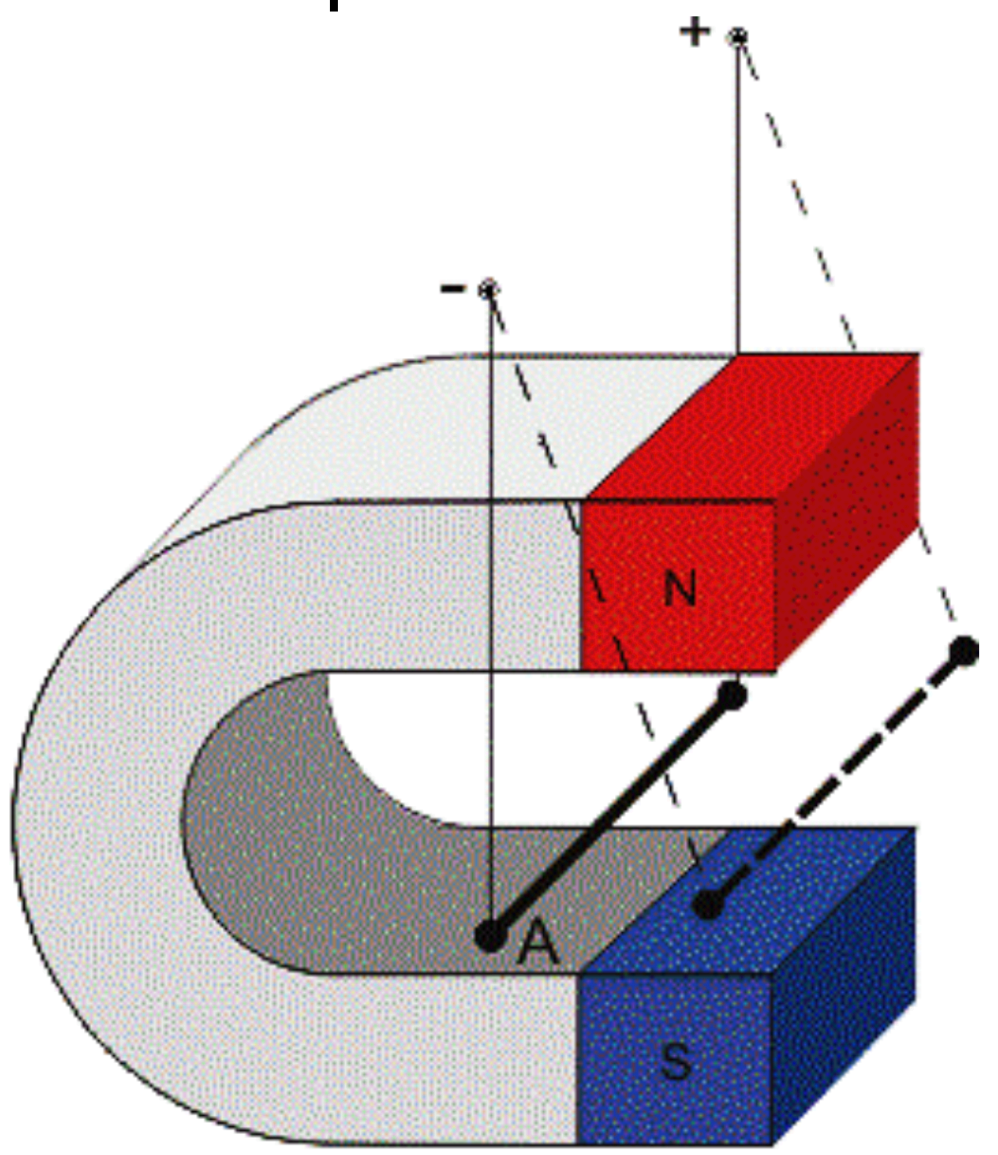


Force on a Current - Carrying conductor



Force on a Current - Carrying Conductor

Motor effect: When current flows in a wire in a magnetic field which is not parallel to the current, a force is exerted on the wire



Basic requirements for motor effect:

A magnetic field
A current flowing which cuts across the magnetic field lines

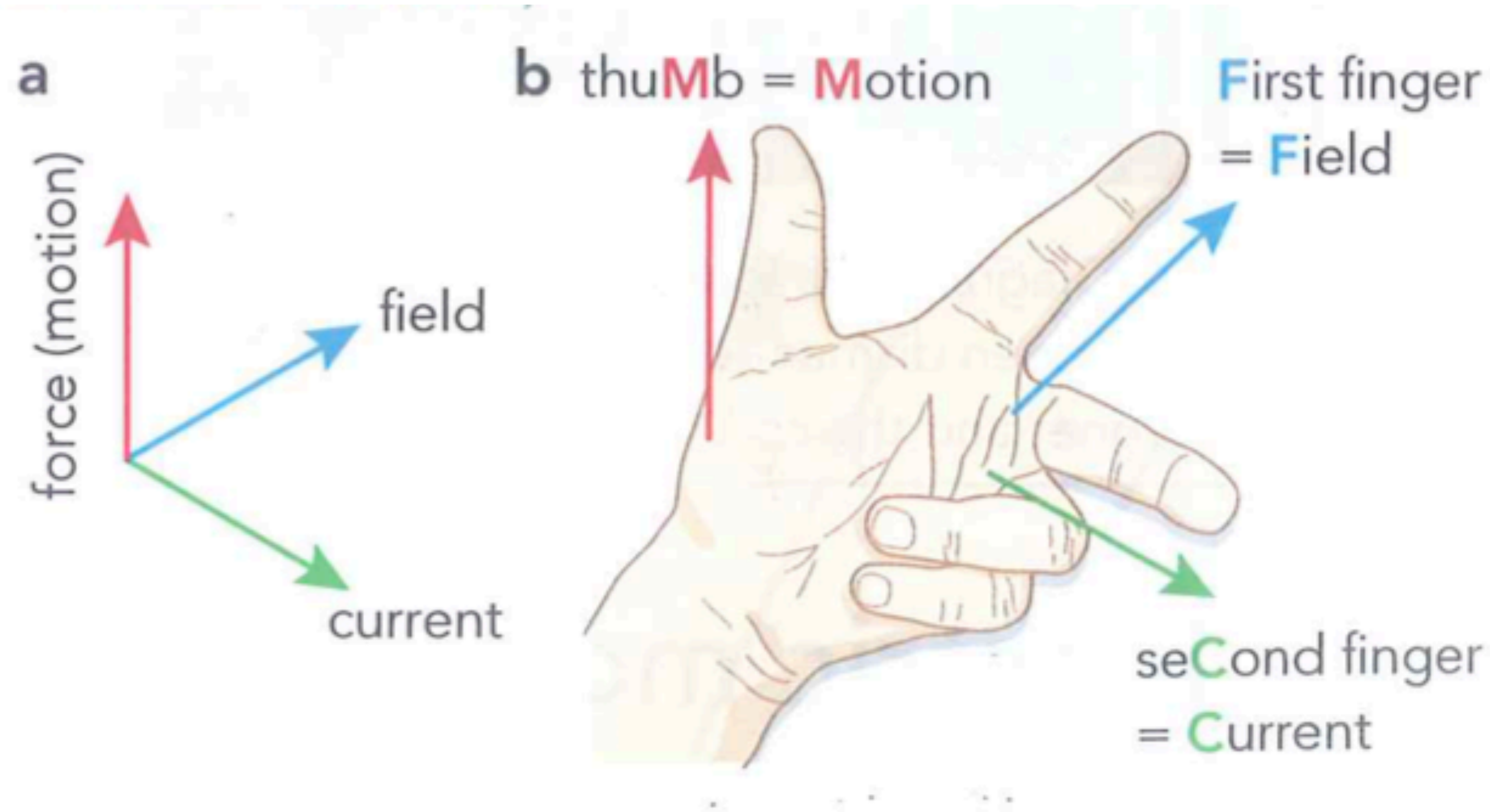
The direction of force can be reversed by:

Reversing the direction of current
Reversing the direction of the field of the permanent magnet

Motor effect application

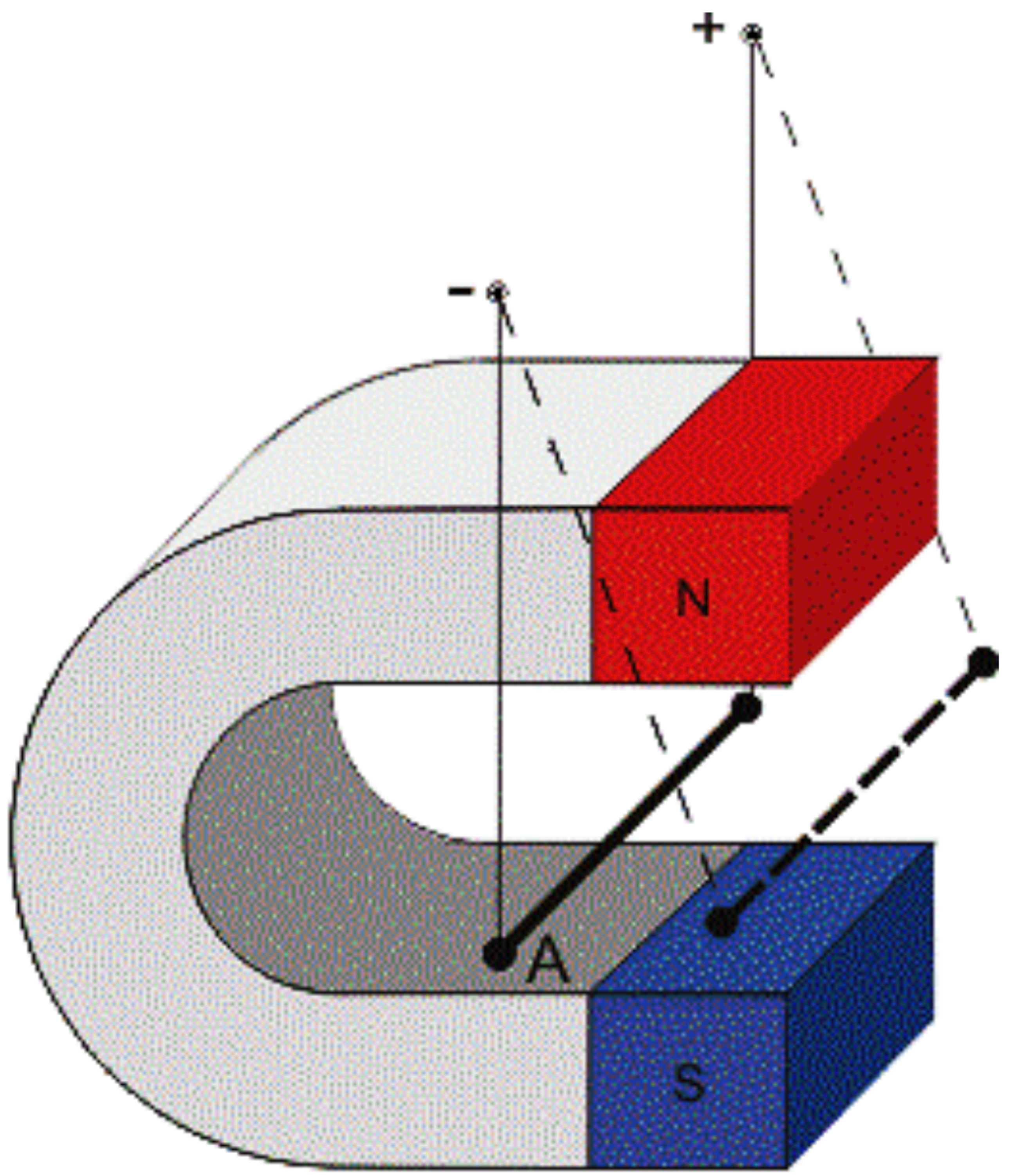
Fleming’s Left-hand Rule

How do we determine the direction of force (Ampere’s force)? **=> Fleming’s left-hand rule**



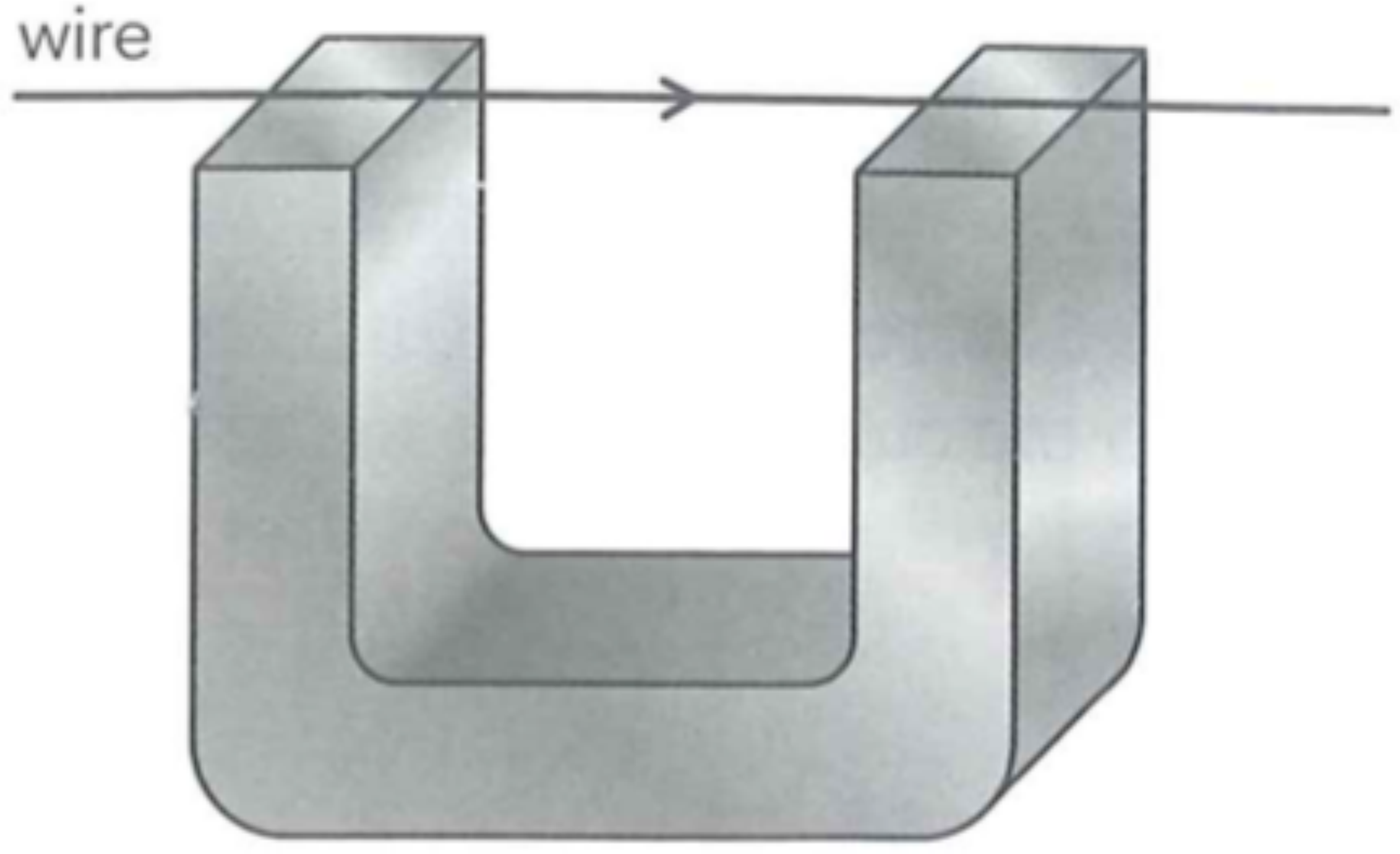
- the First finger is Field
- the seCond finger is Current
- the thuMb is force or Motion.

Fleming's Left-hand Rule



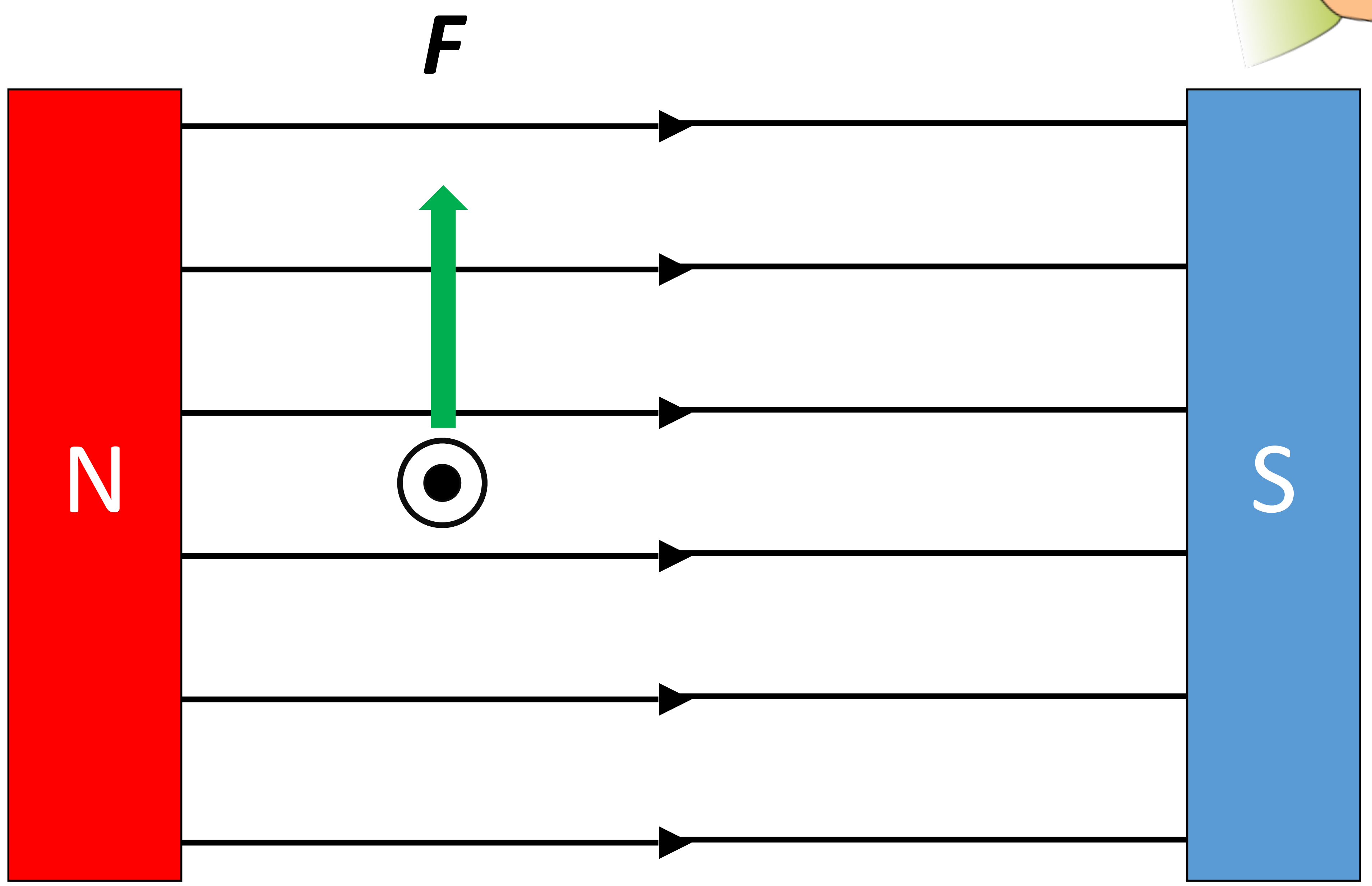
Fleming's Left-hand Rule

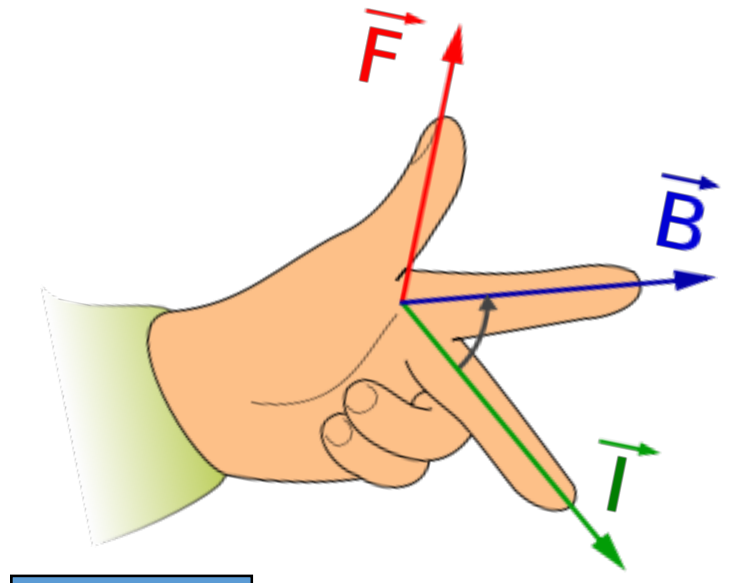
Explain why the wire will **not** move.



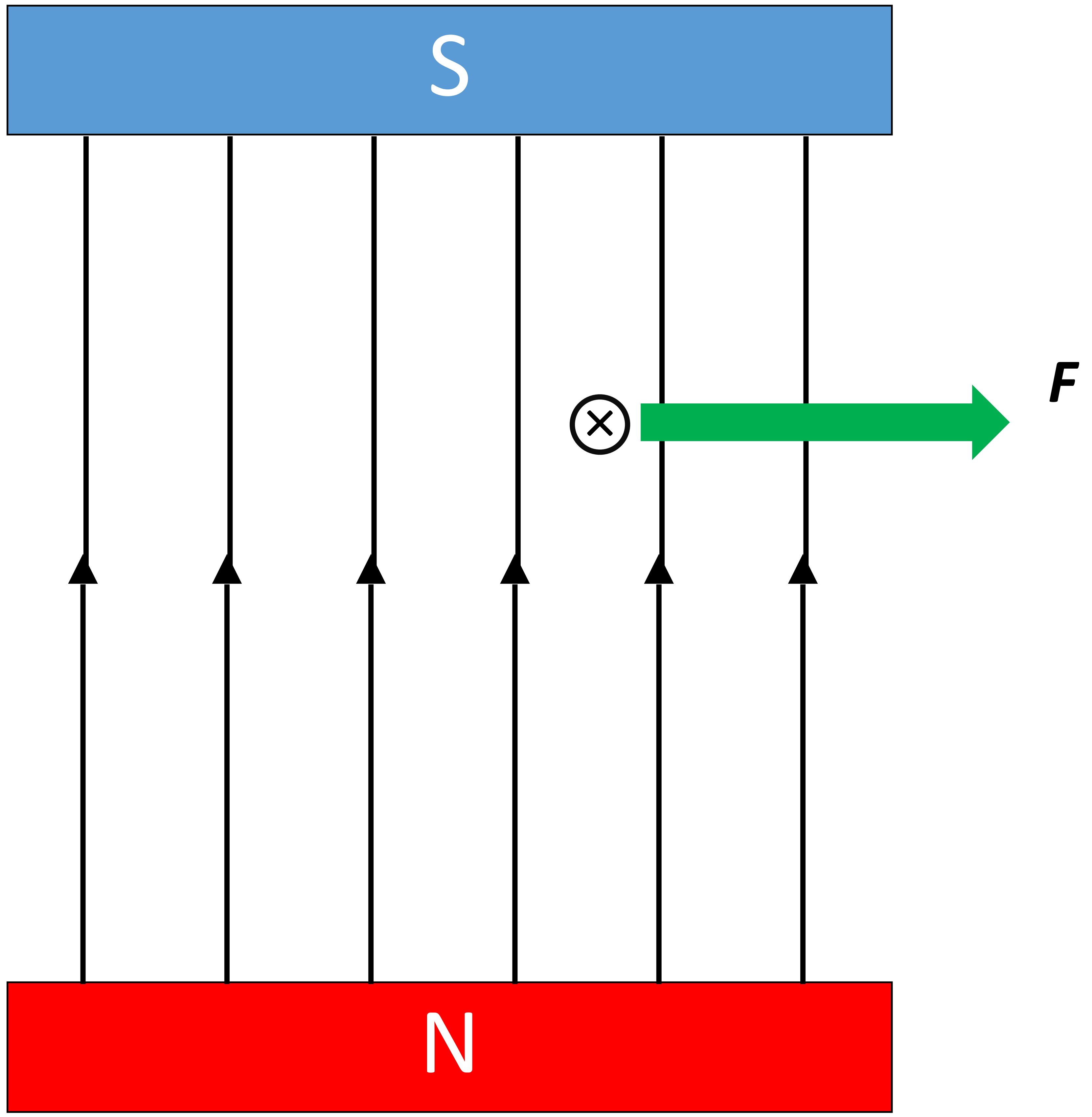
current is **parallel** to direction of magnetic field

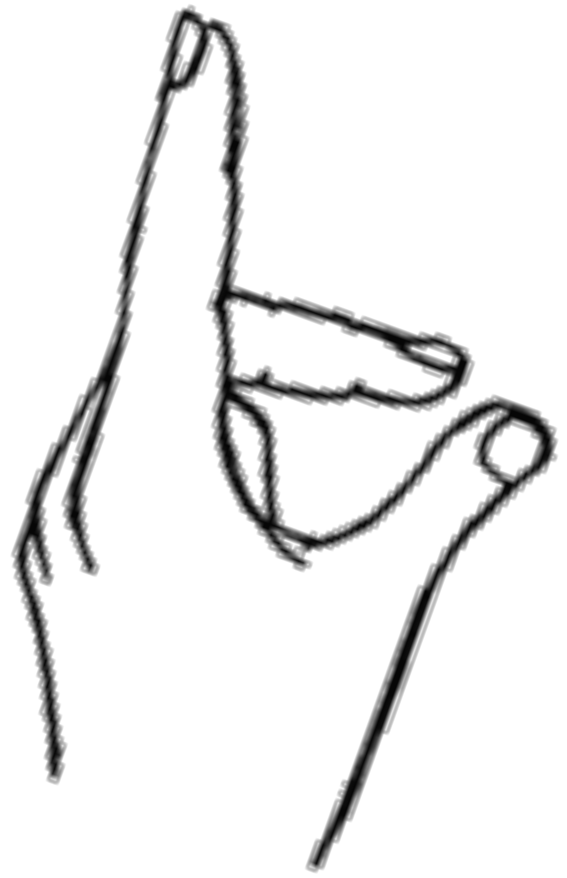
Fleming's Left-hand Rule



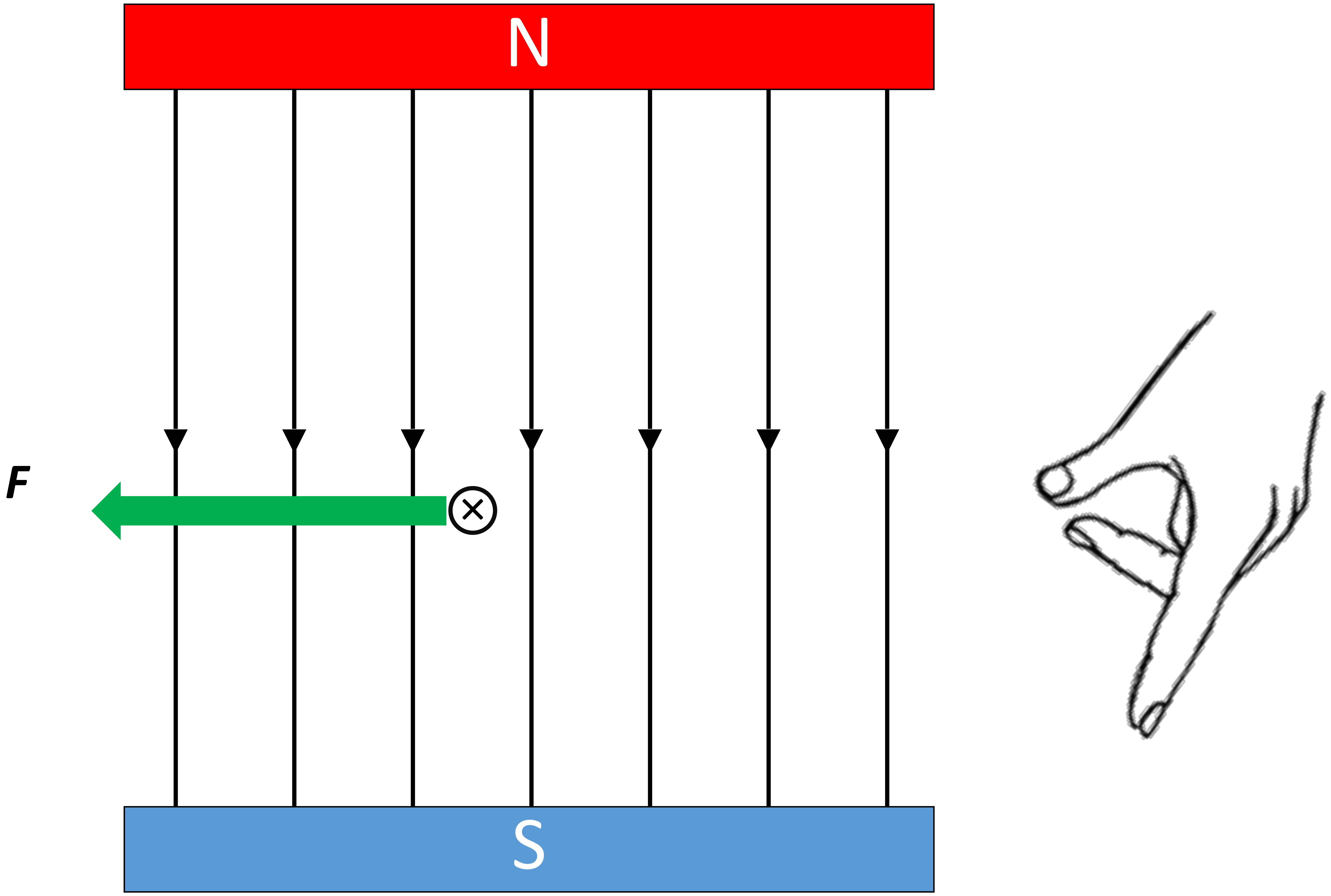


Fleming's Left-hand Rule

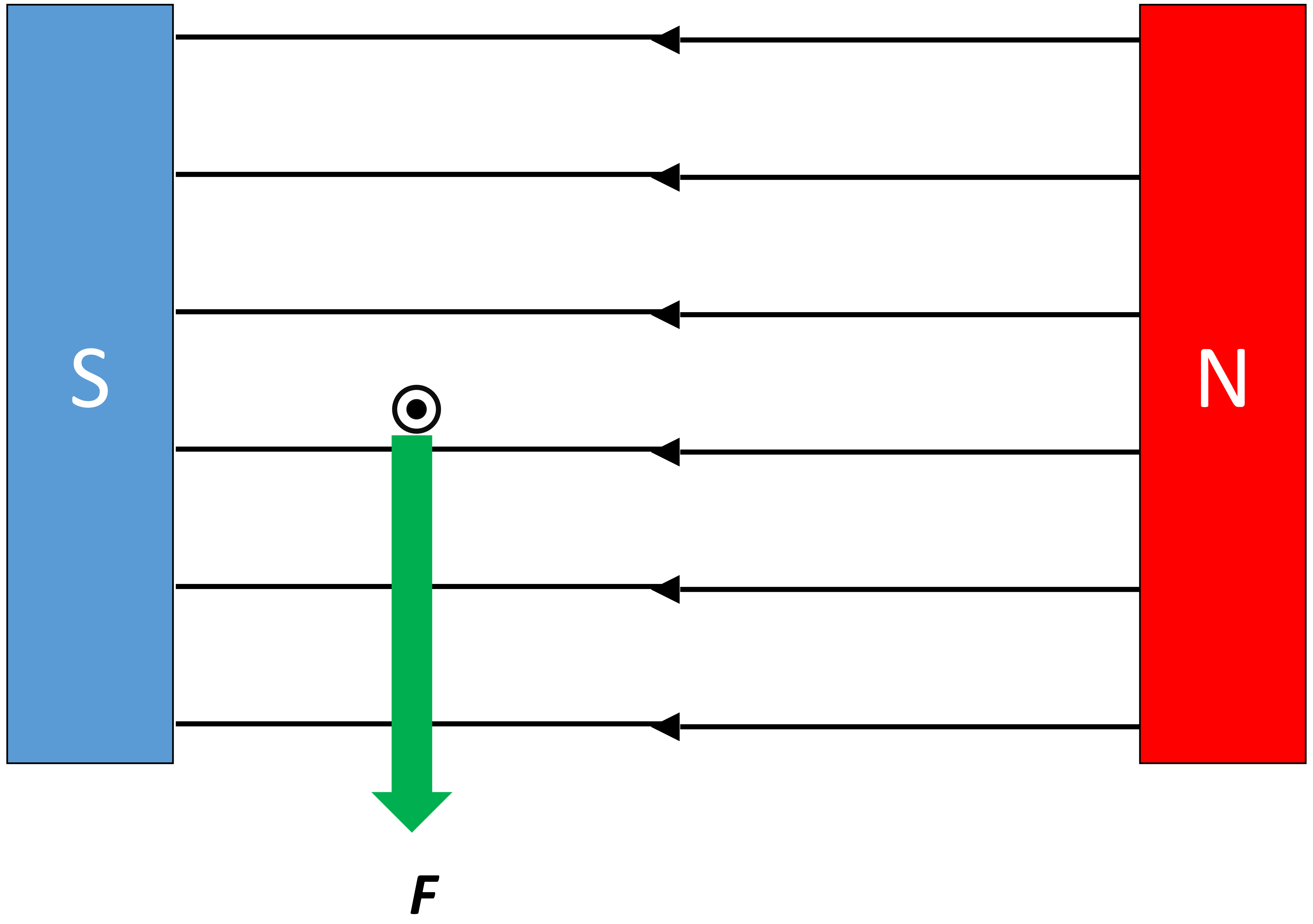


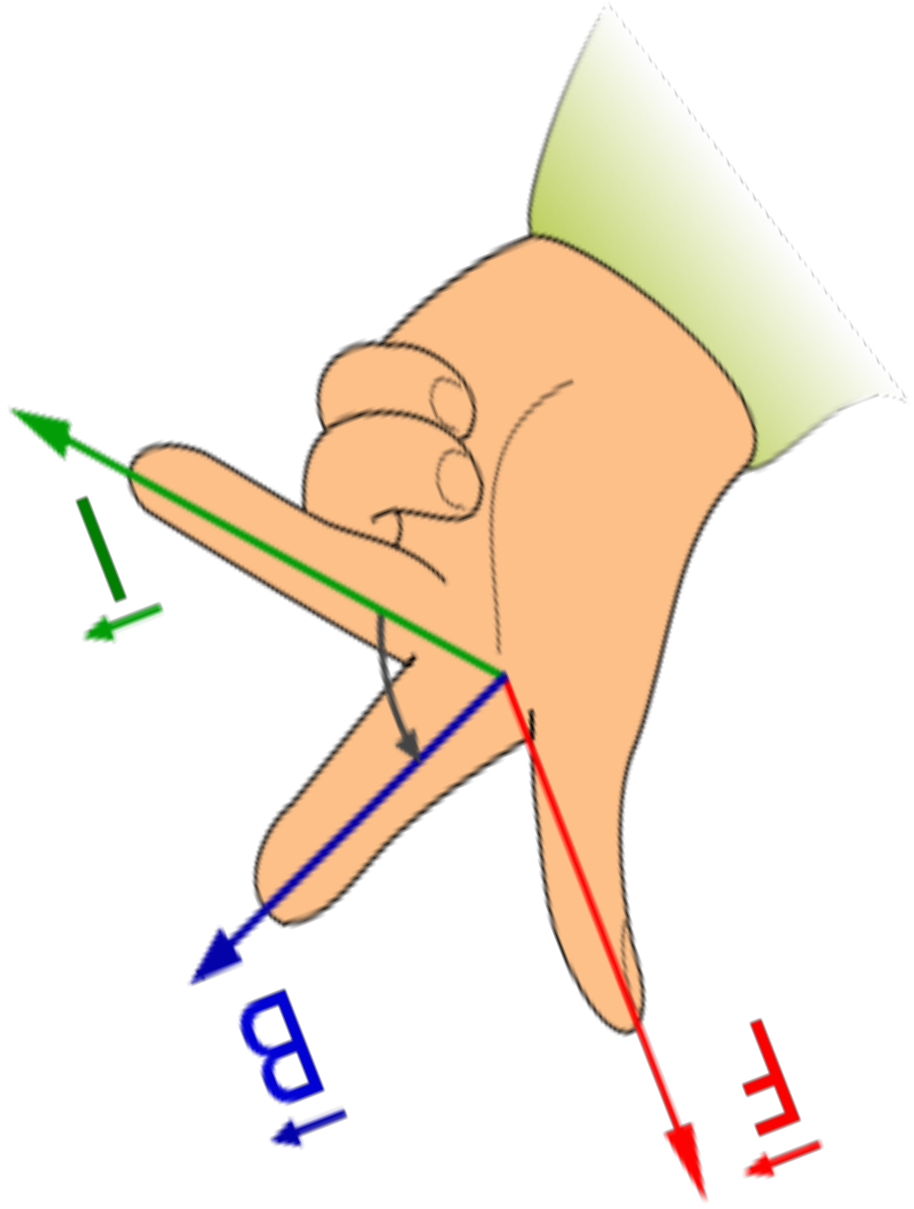


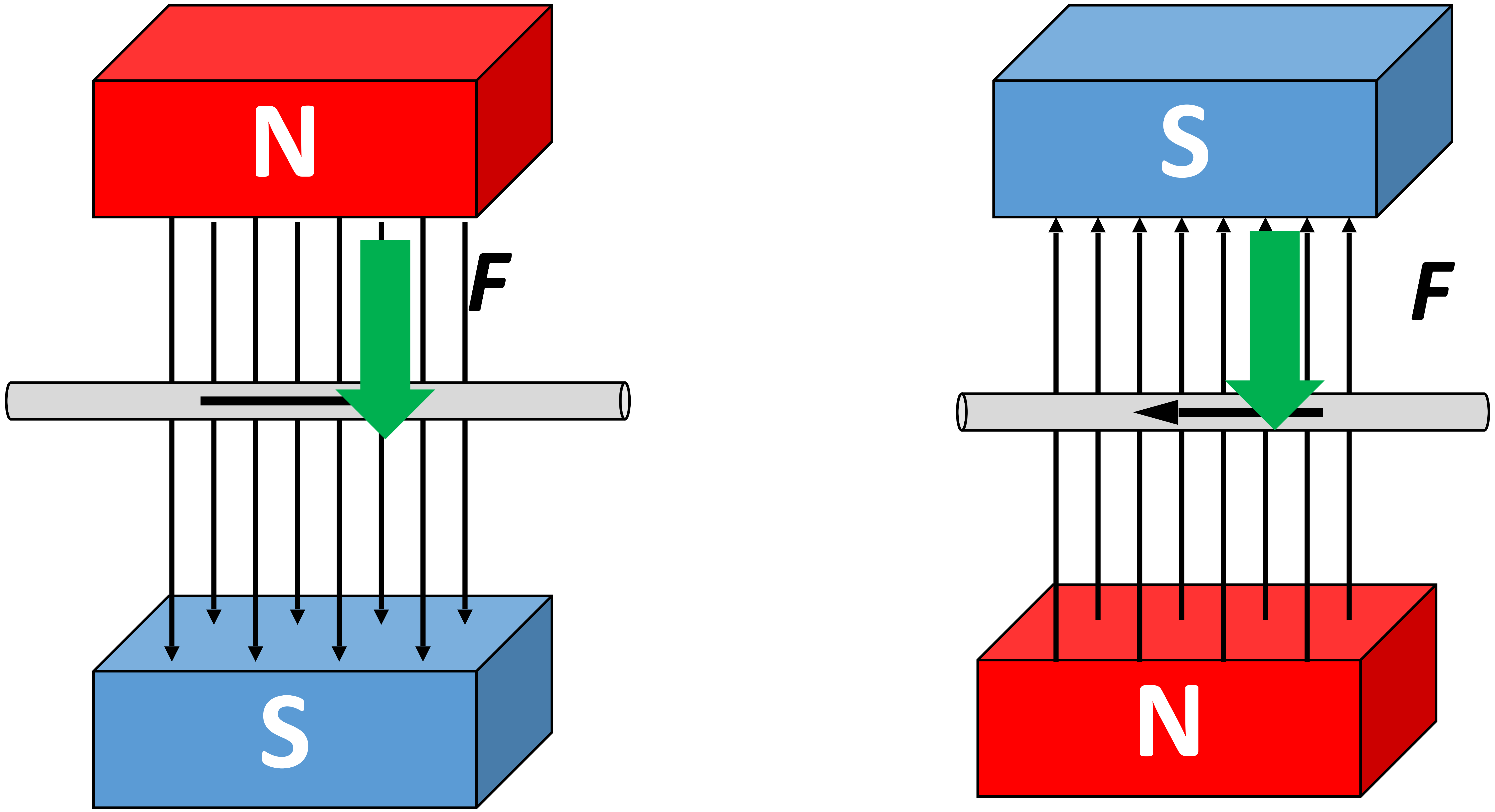
Fleming's Left-hand Rule

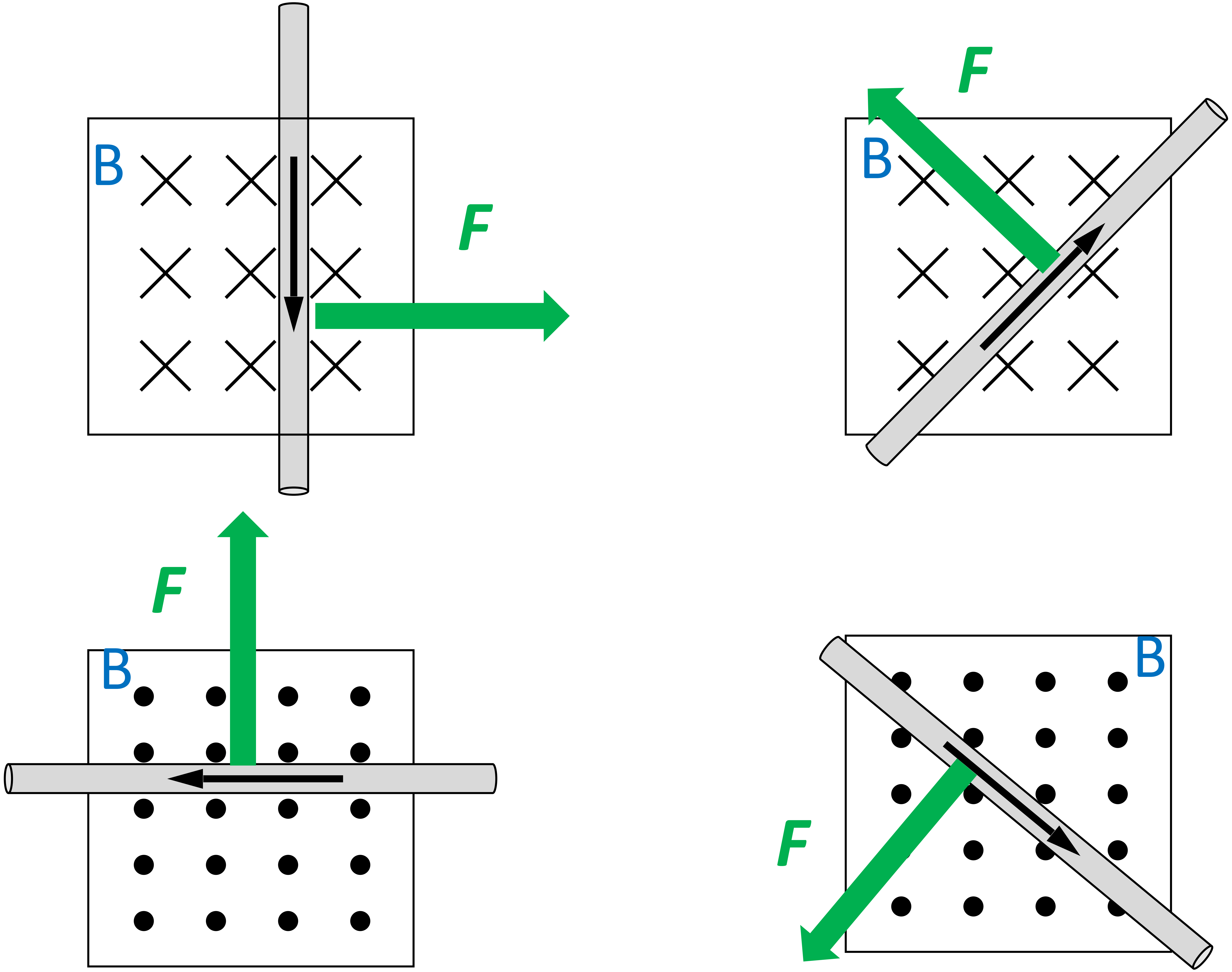


Fleming's Left-hand Rule

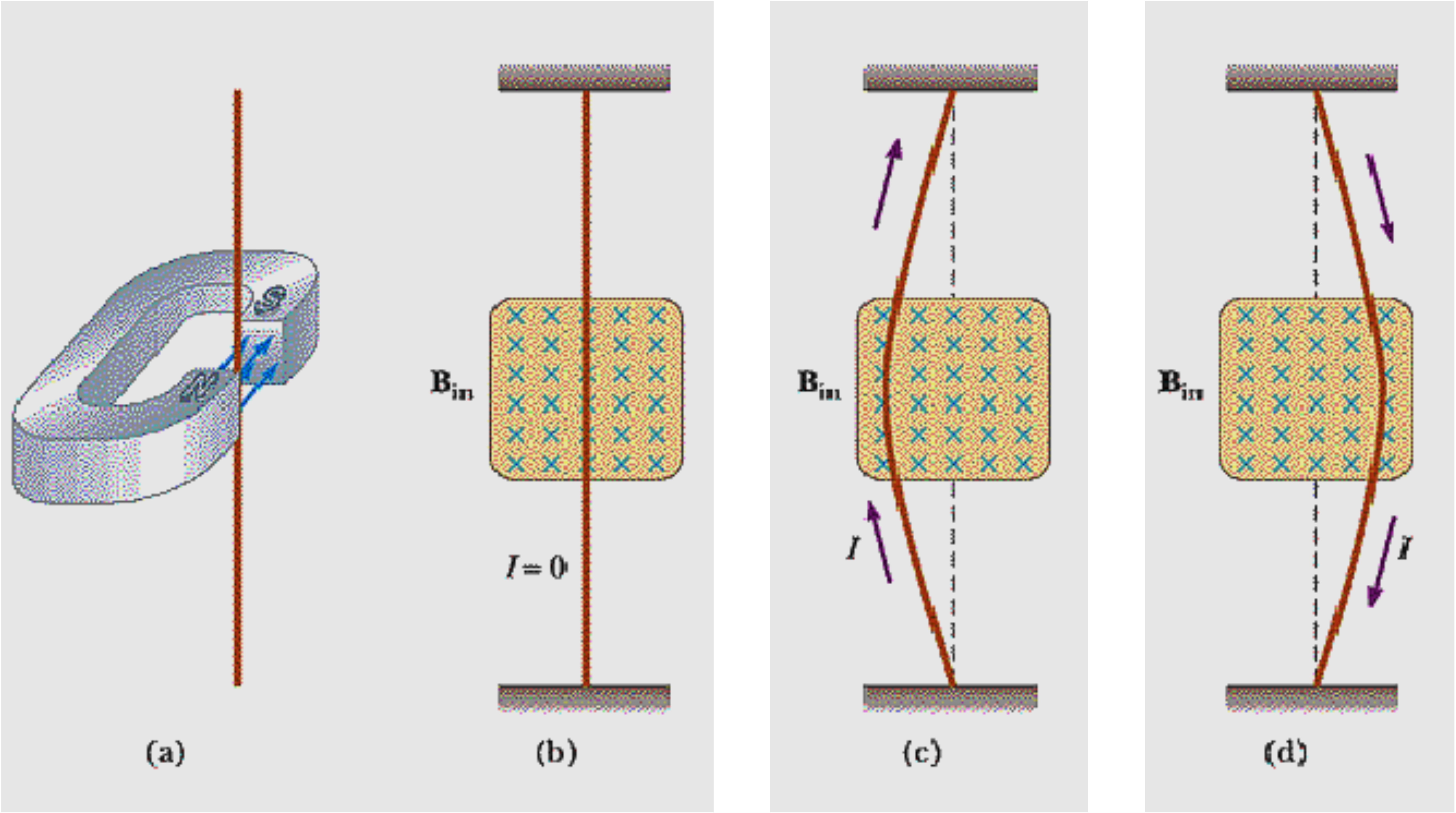





N
F
S
S
F
N

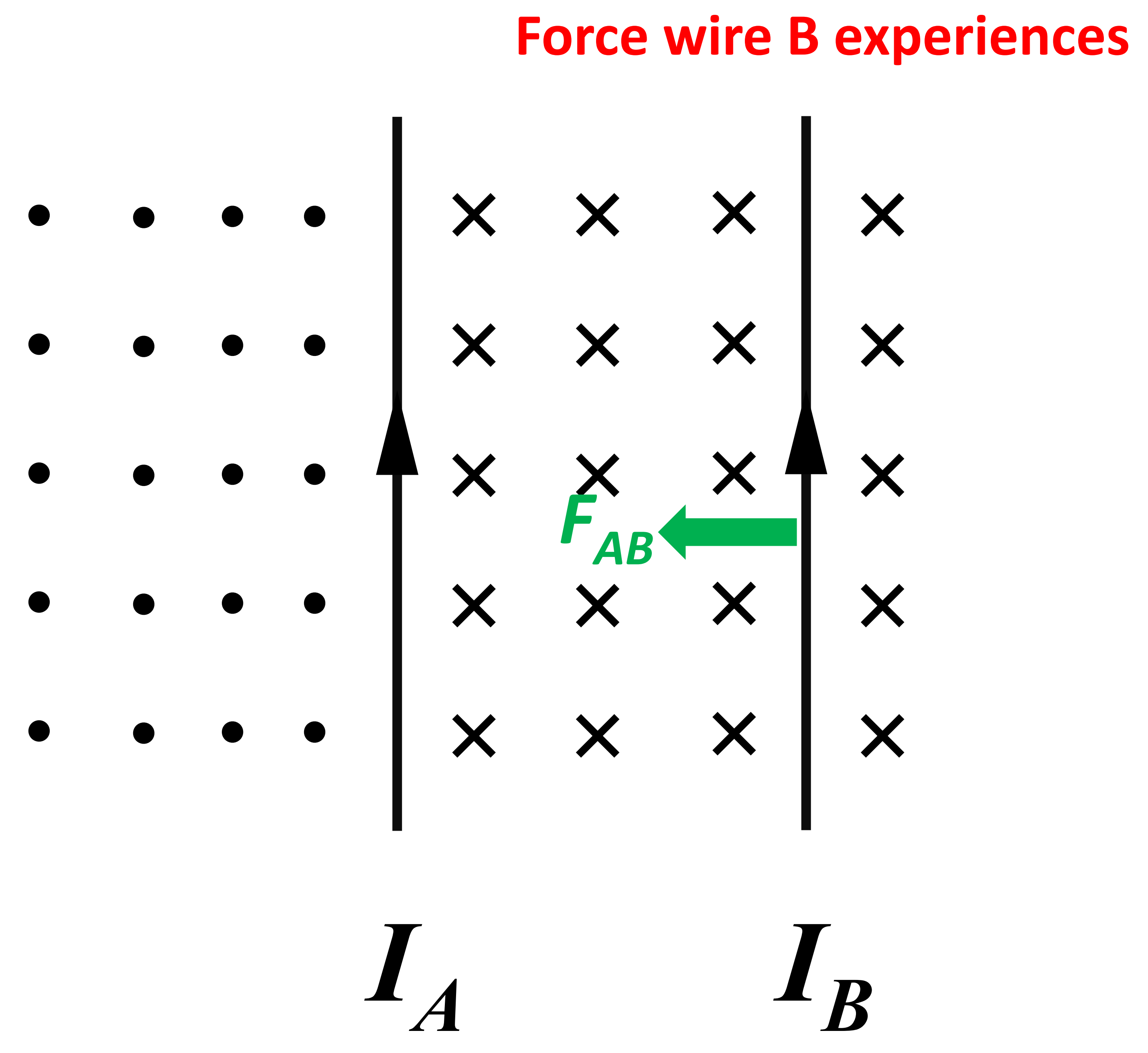


B
F
B
F
F
B
F
B


B_in
I = 0
B_in
I
B_in
I
(a)
(b)
(c)
(d)

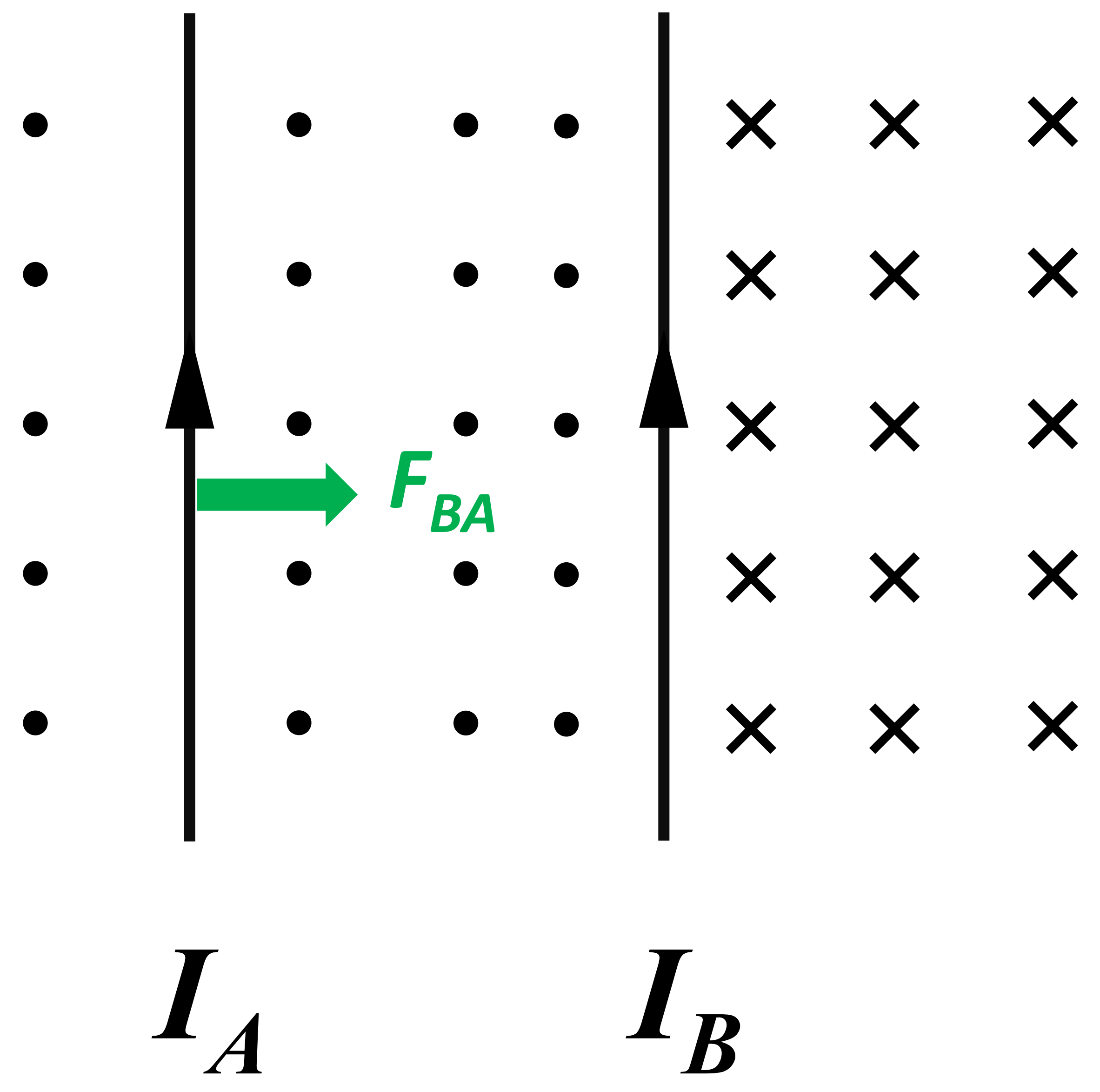
Fleming's Left-hand Rule

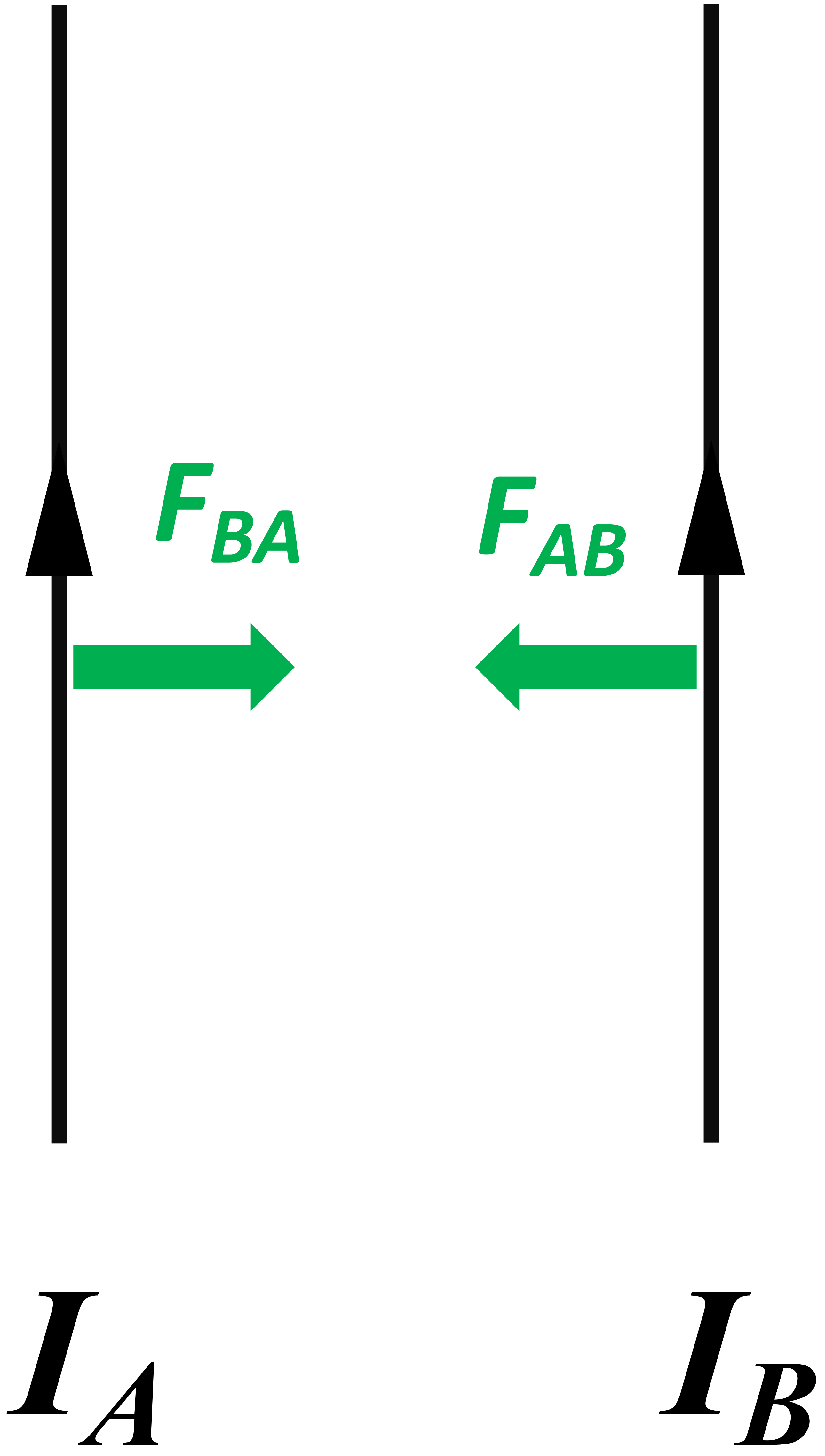
Can you use what you just learned to explain why two wires carrying same/opposite direction of current will appear attractive/repulsive to each other?



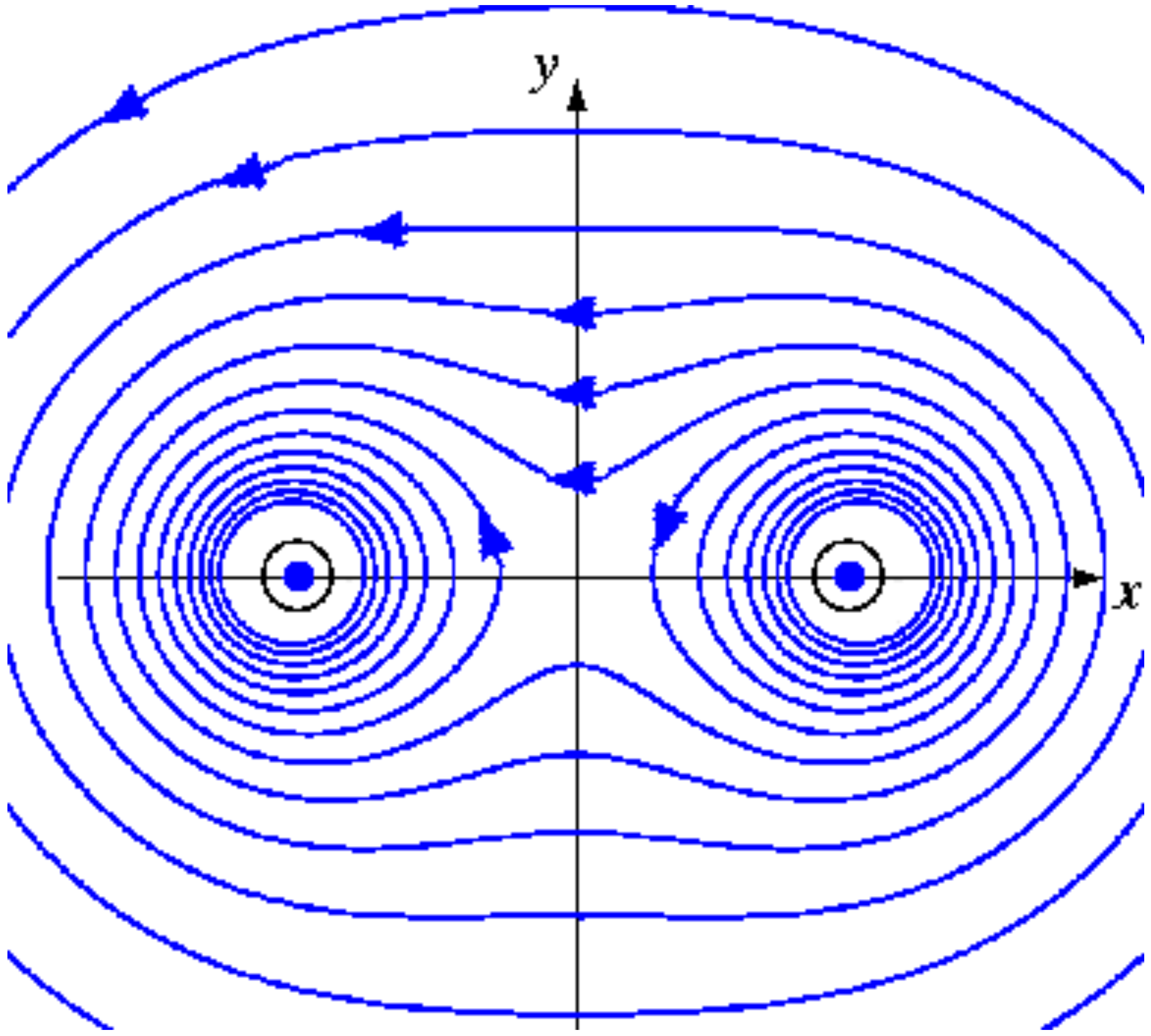
Fleming's Left-hand Rule

Force wire A experiences



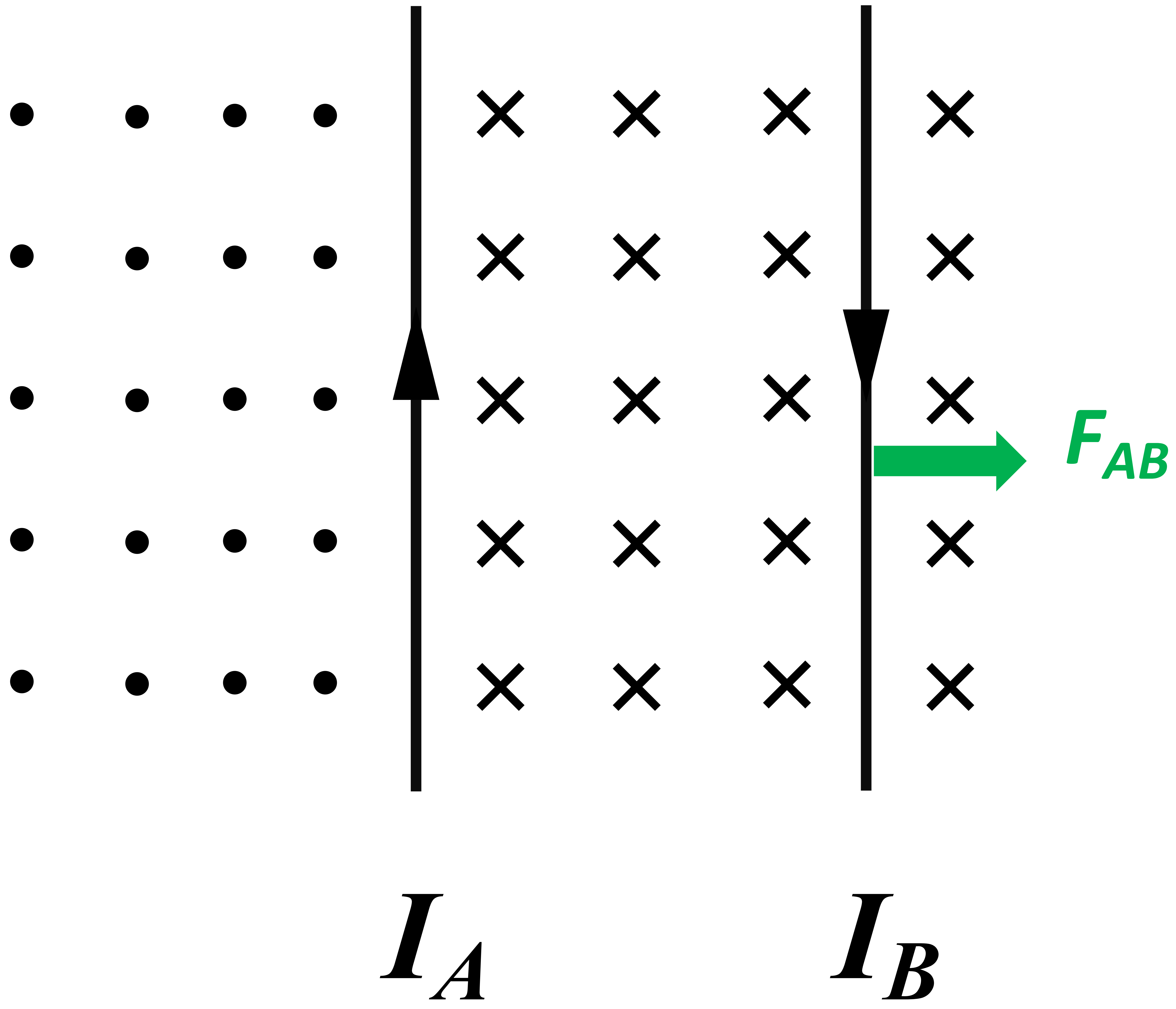


F_{BA}
F_{AB}
I_A
I_B

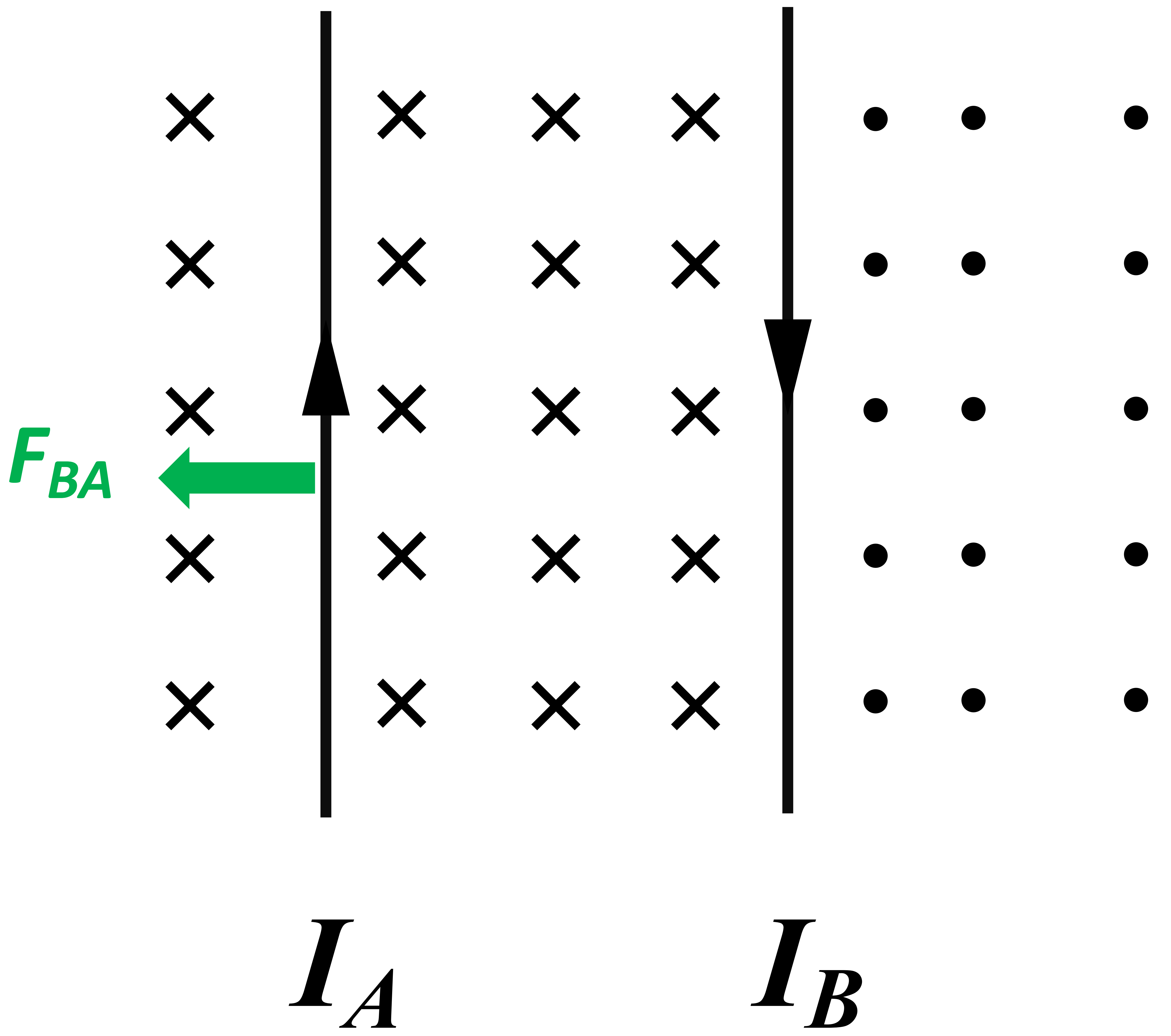


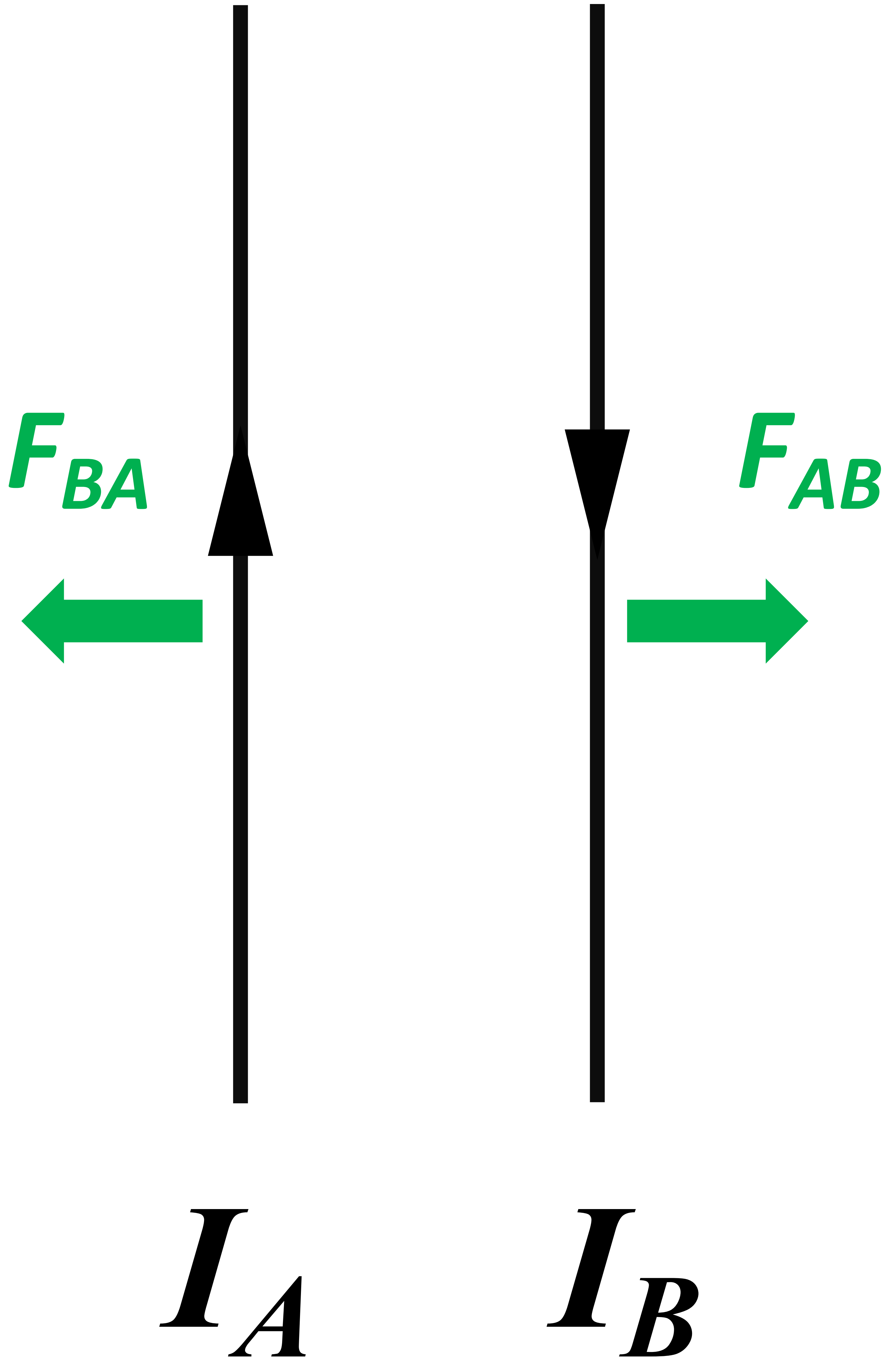
y
x

Force wire B experiences

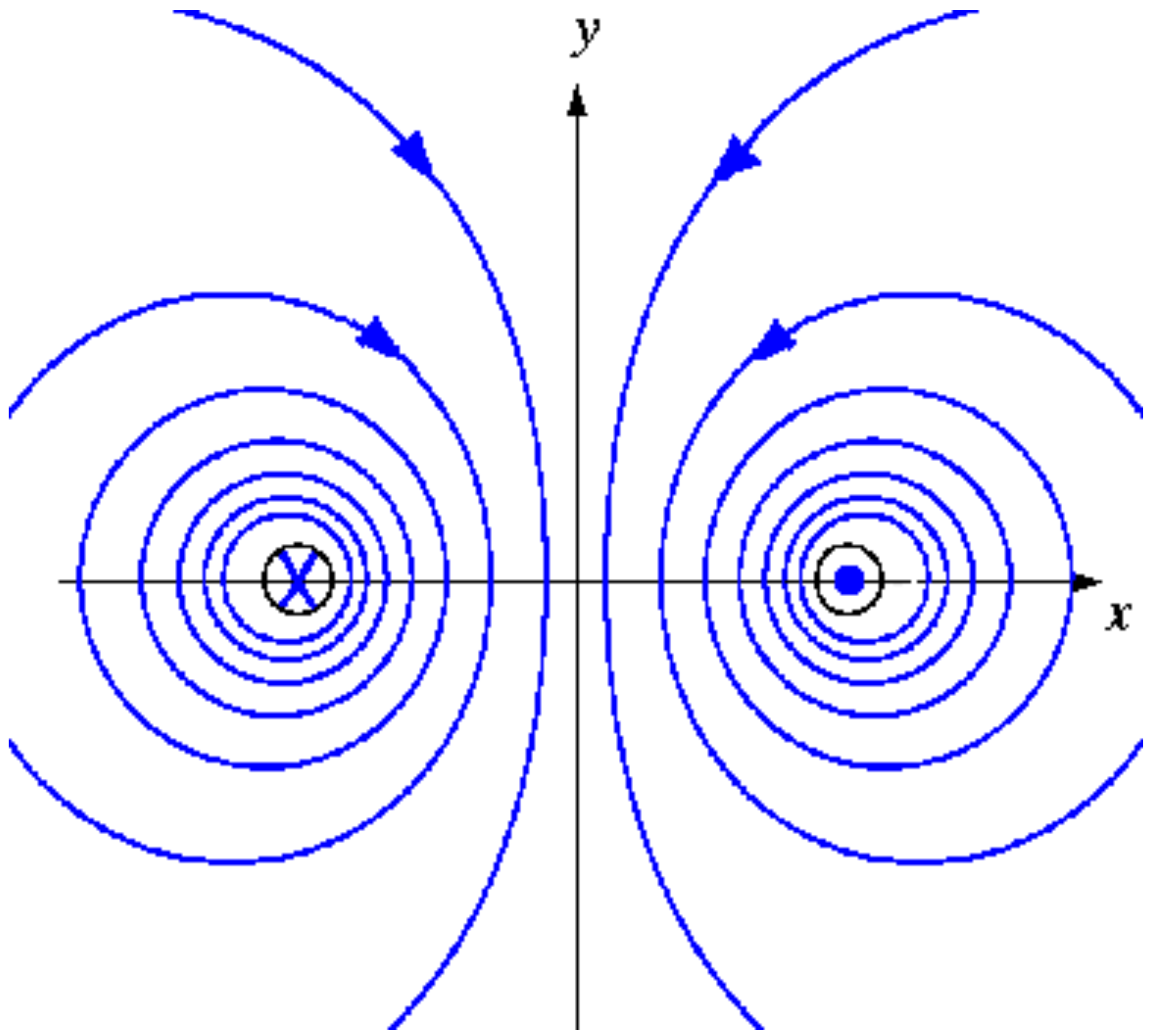


Force wire A experiences





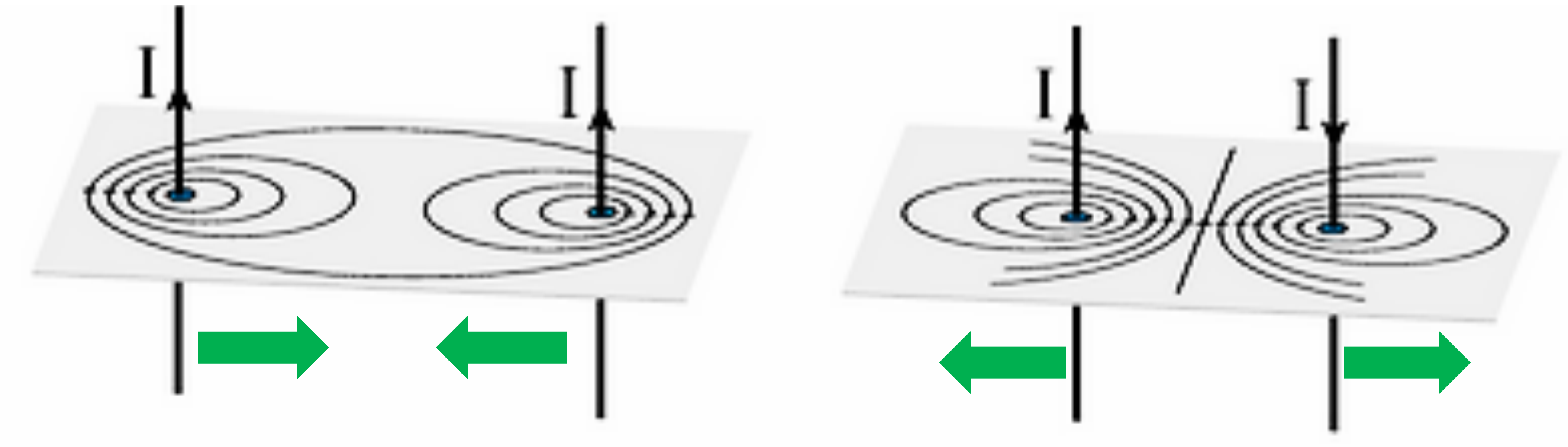
F_{BA}
F_{AB}
I_A
I_B



y
x

Current in the same direction

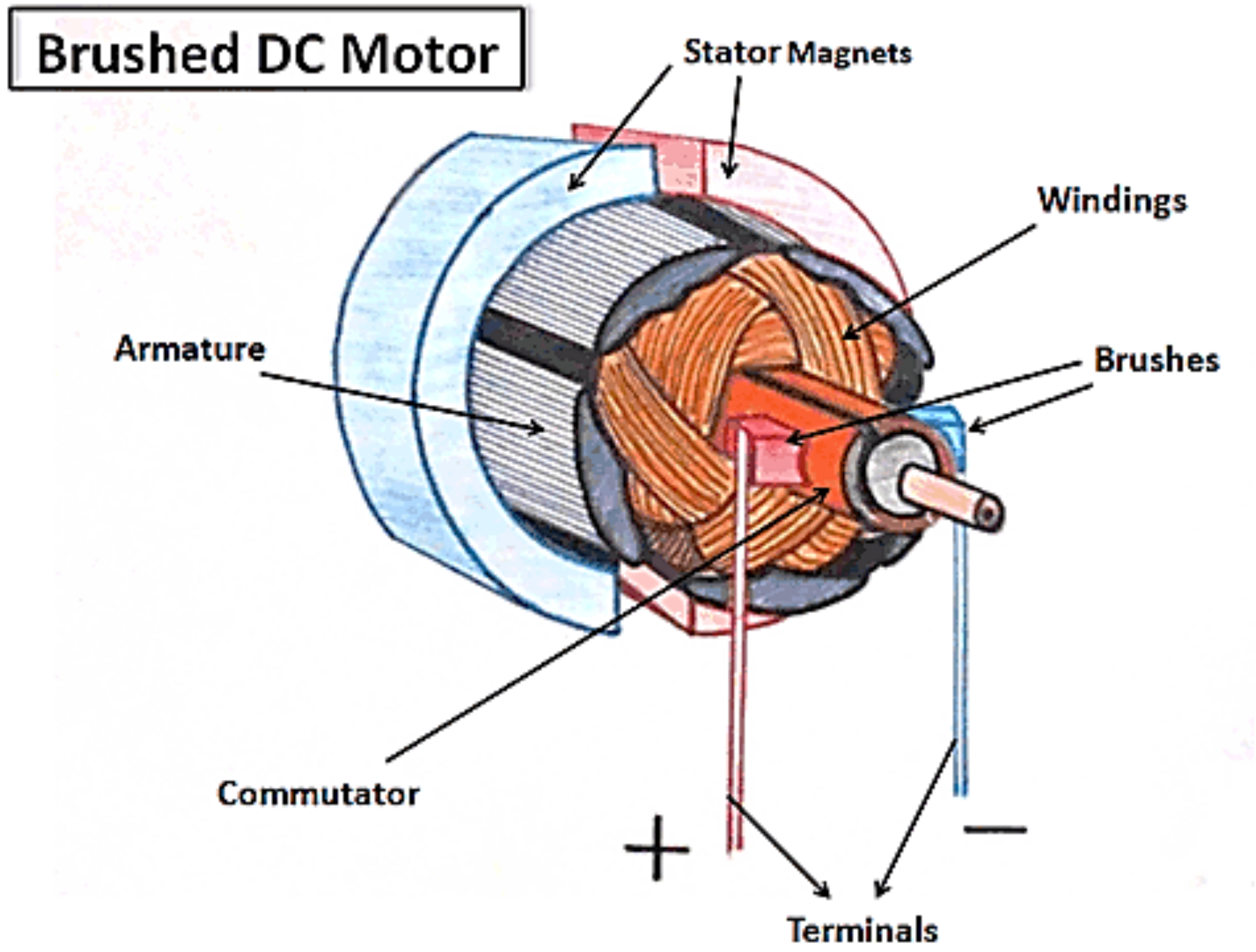
Current in the opposite direction



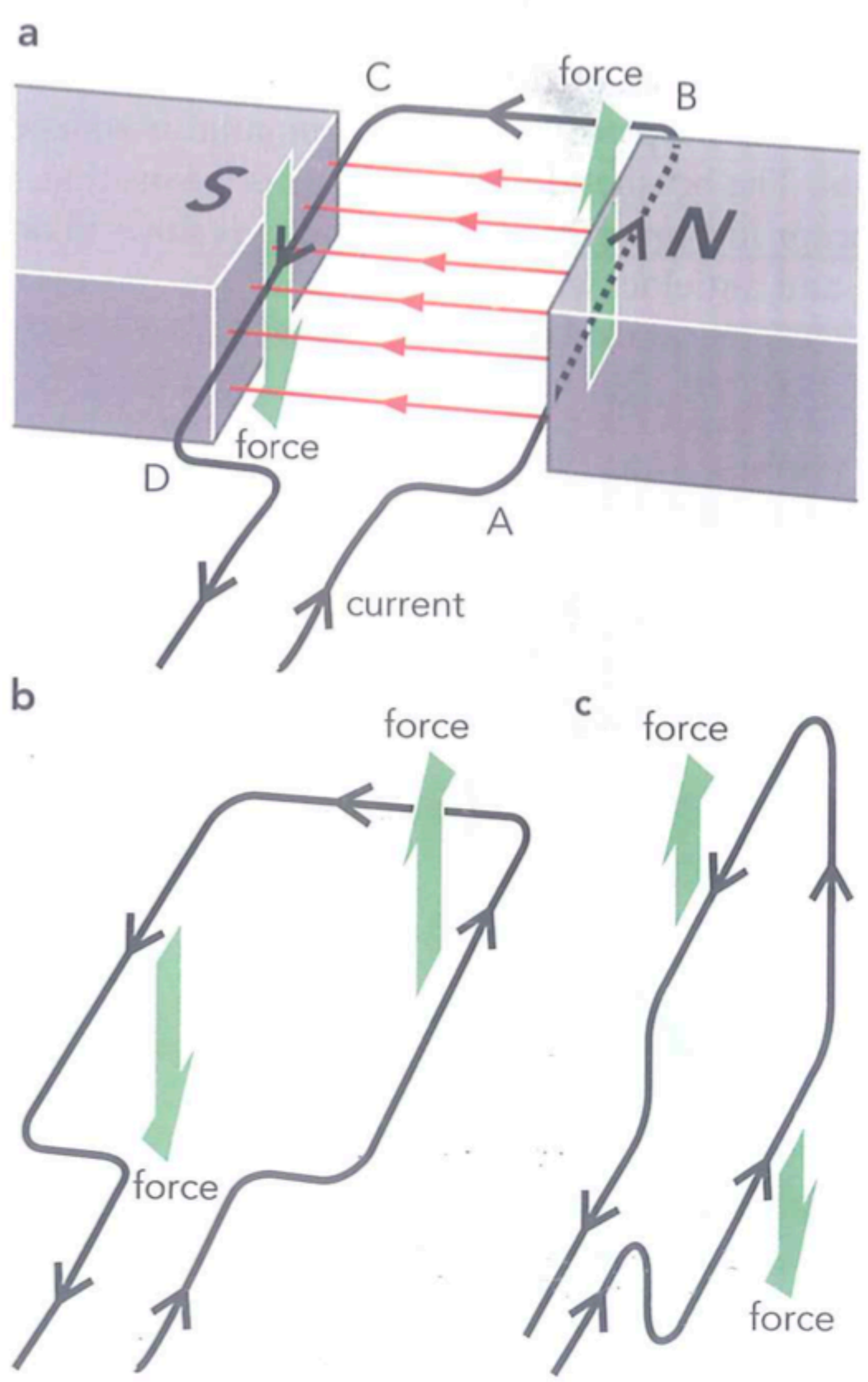
Attraction

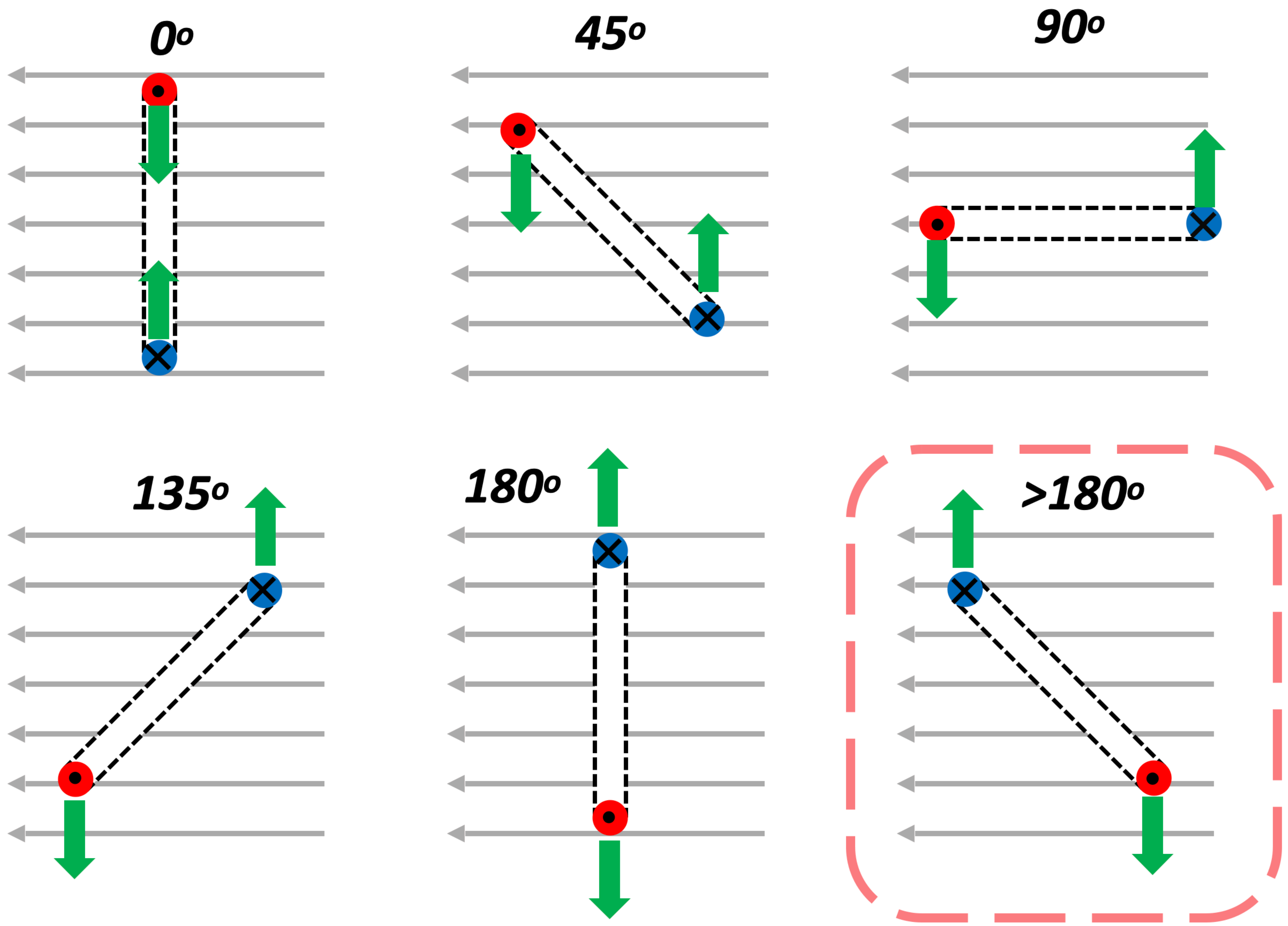
Repulsion

Electric Motors (d.c. motor)



How Motor Works

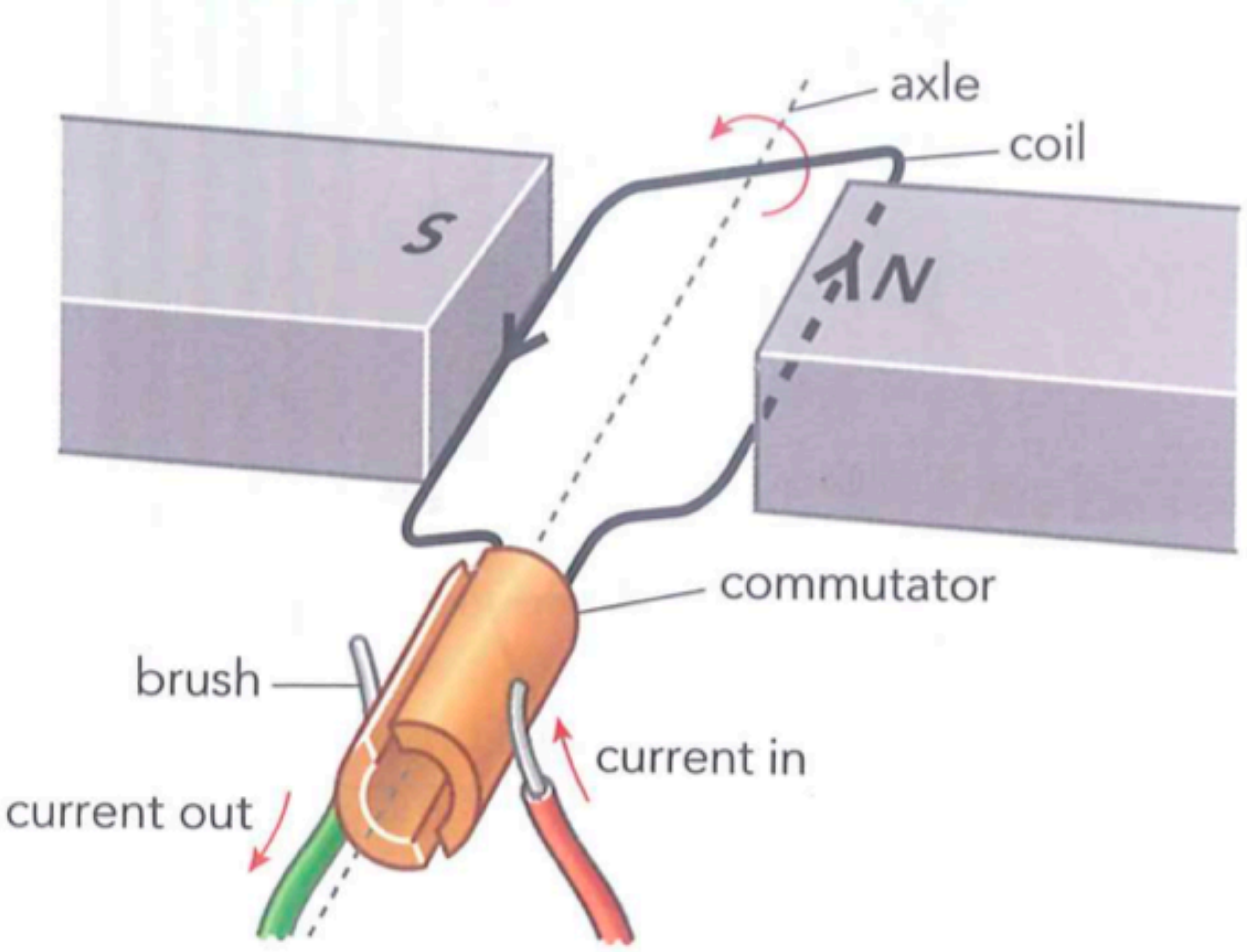


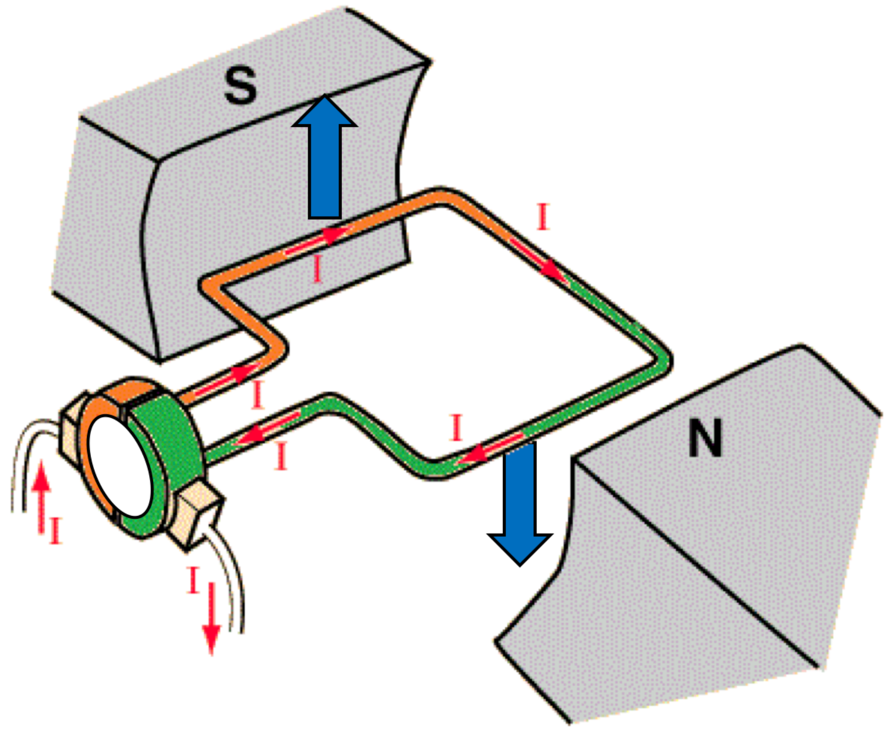


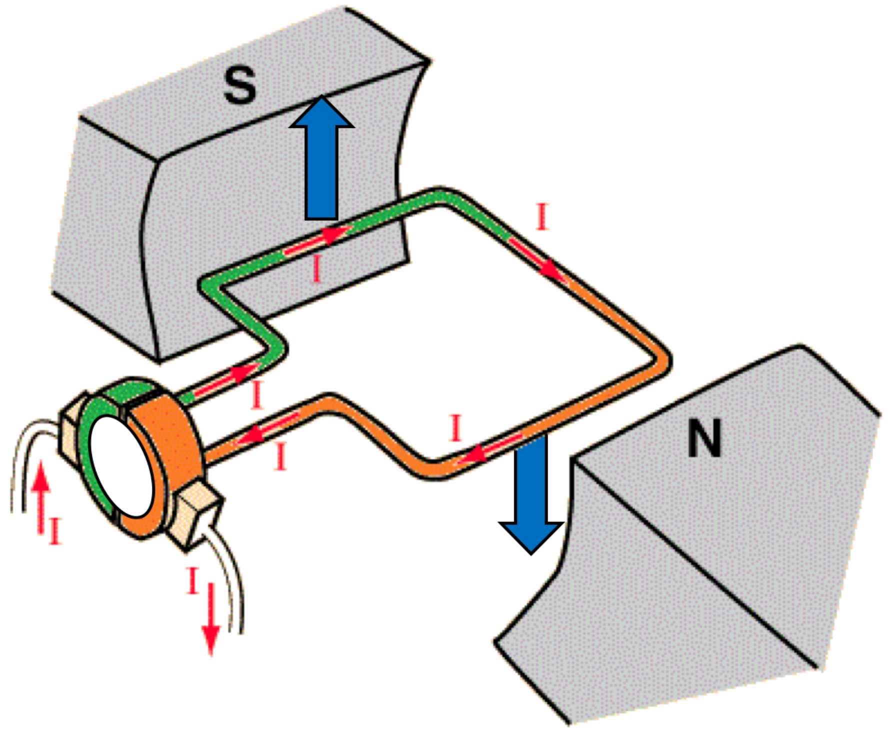
? keep the motor turning?

How Motor Works

!!Brush + Commutator!!



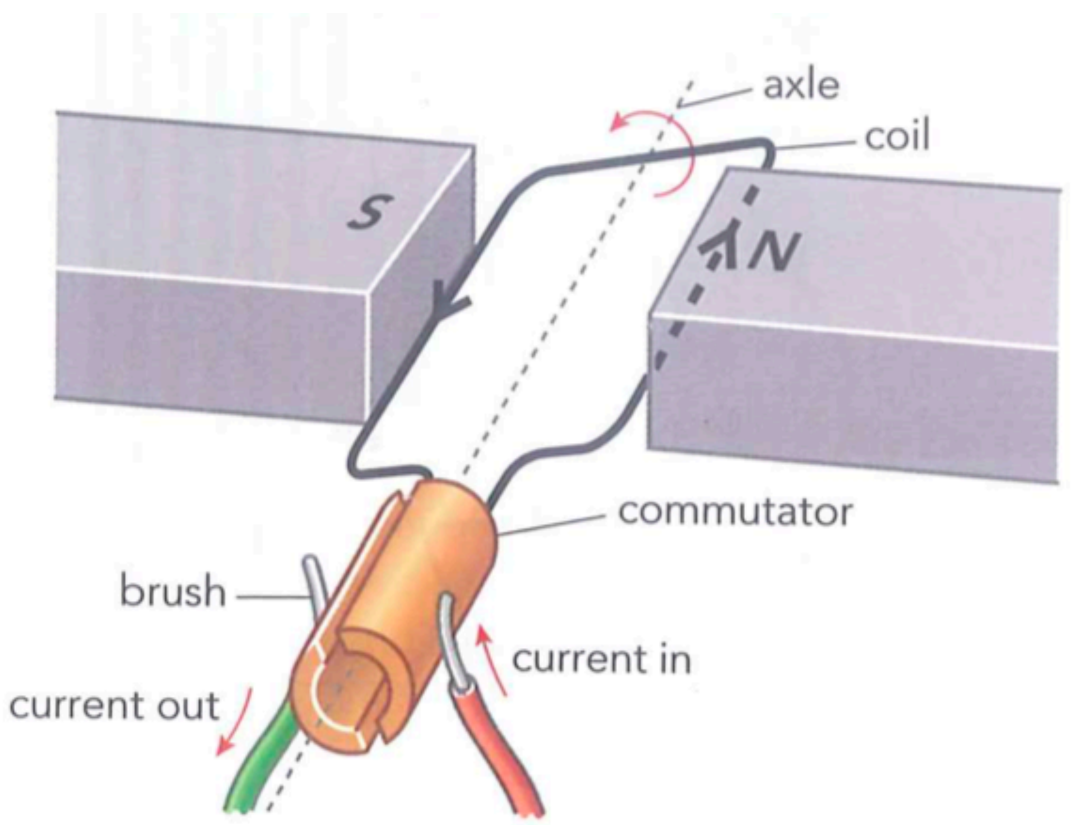


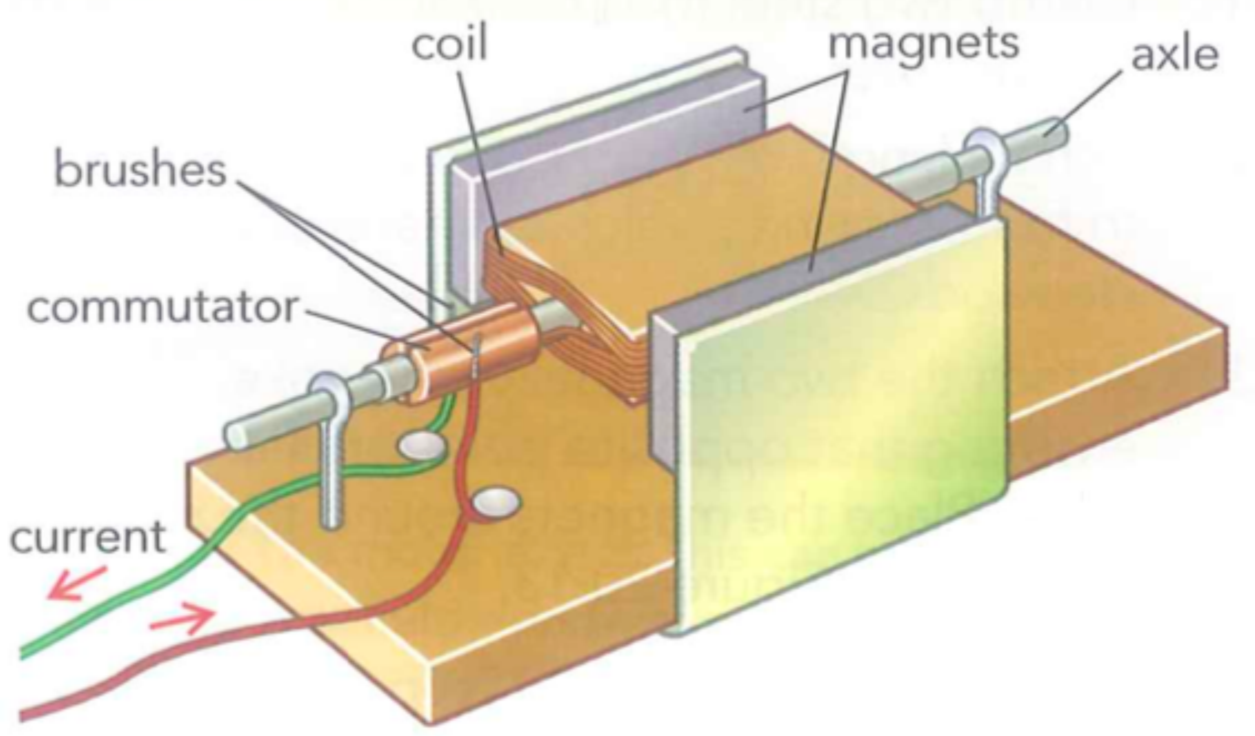


Electric Motors (d.c. motor)

How to increase turning effect?

1. Increase the current
2. Increase the number of turns of wire in the coil
3. Increase the strength of magnetic field/use a





Electric Motors (d.c. motor)

Exercise 20.6:

Describe the energy transfers that happen in

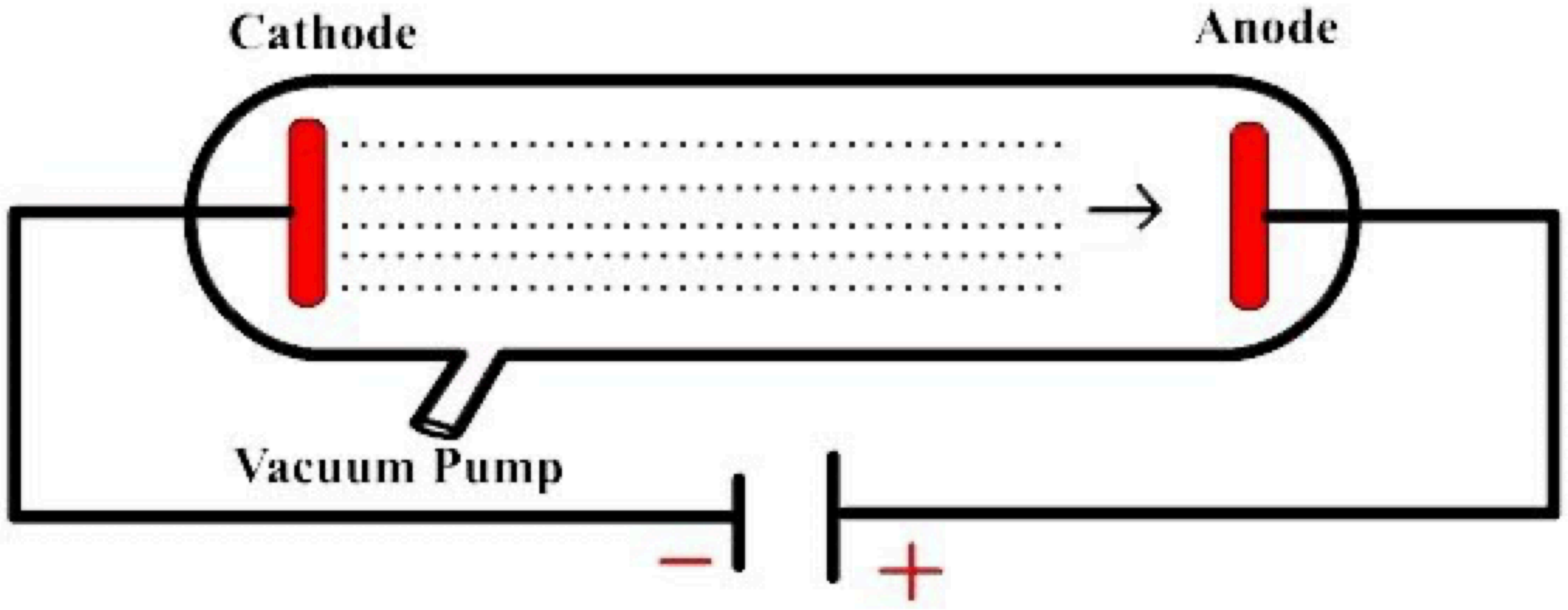
A. an electric motor

B. a loudspeaker

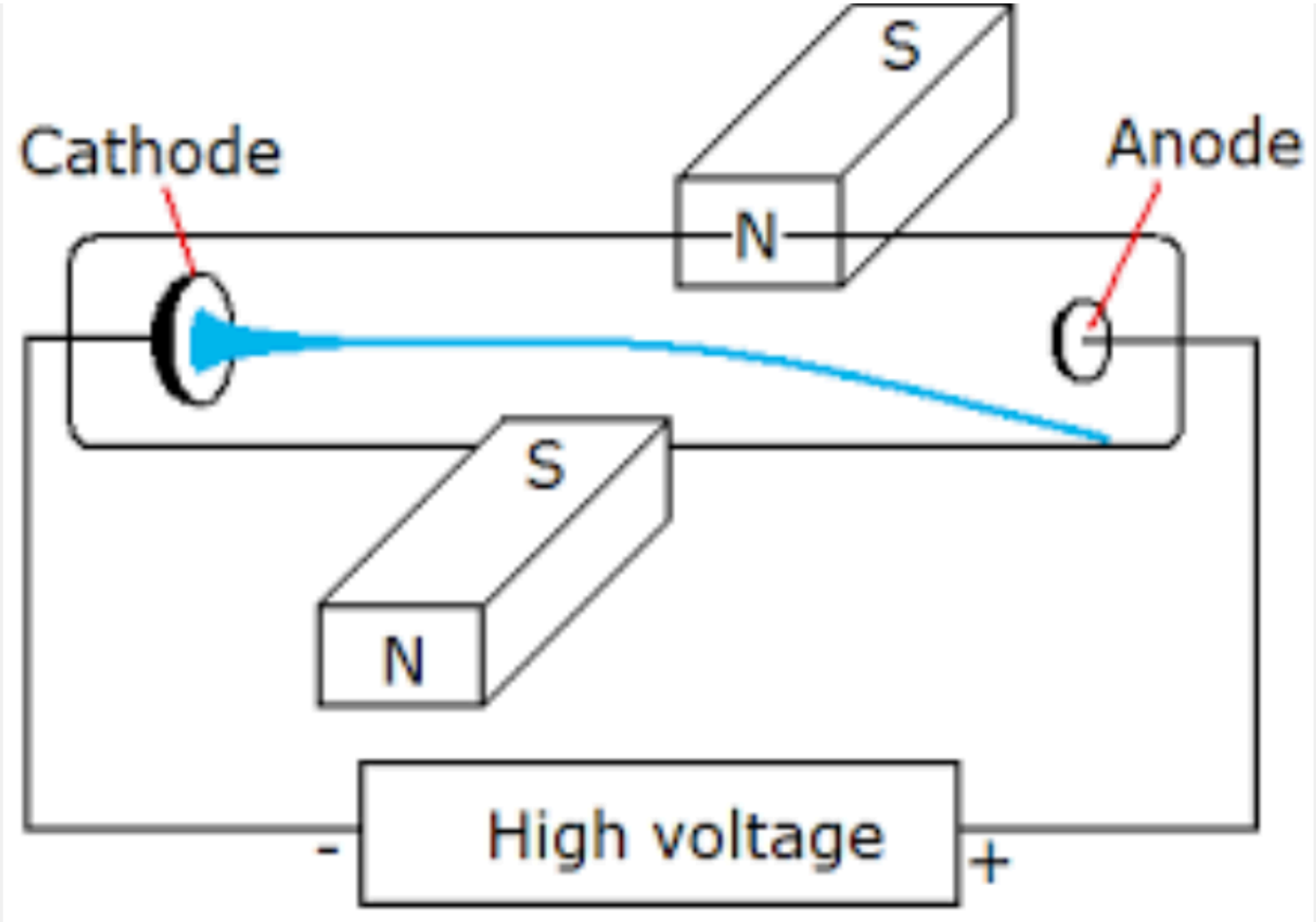
Exercise 20.7:

Describe the motion that would be seen if the coil in a motor was attached directly to a d.c. power supply without a commutator.

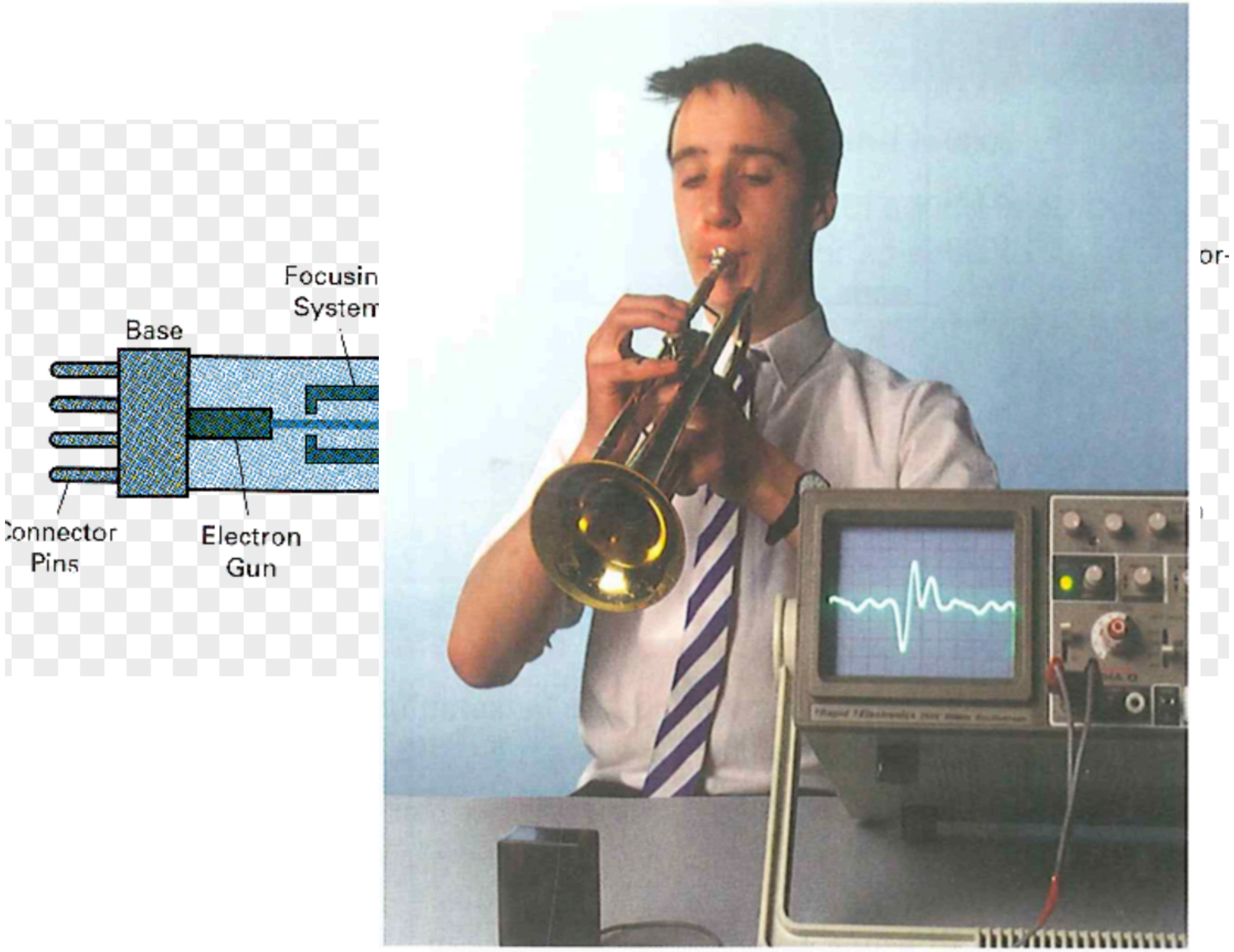
Applications: Cathode-Ray Tube

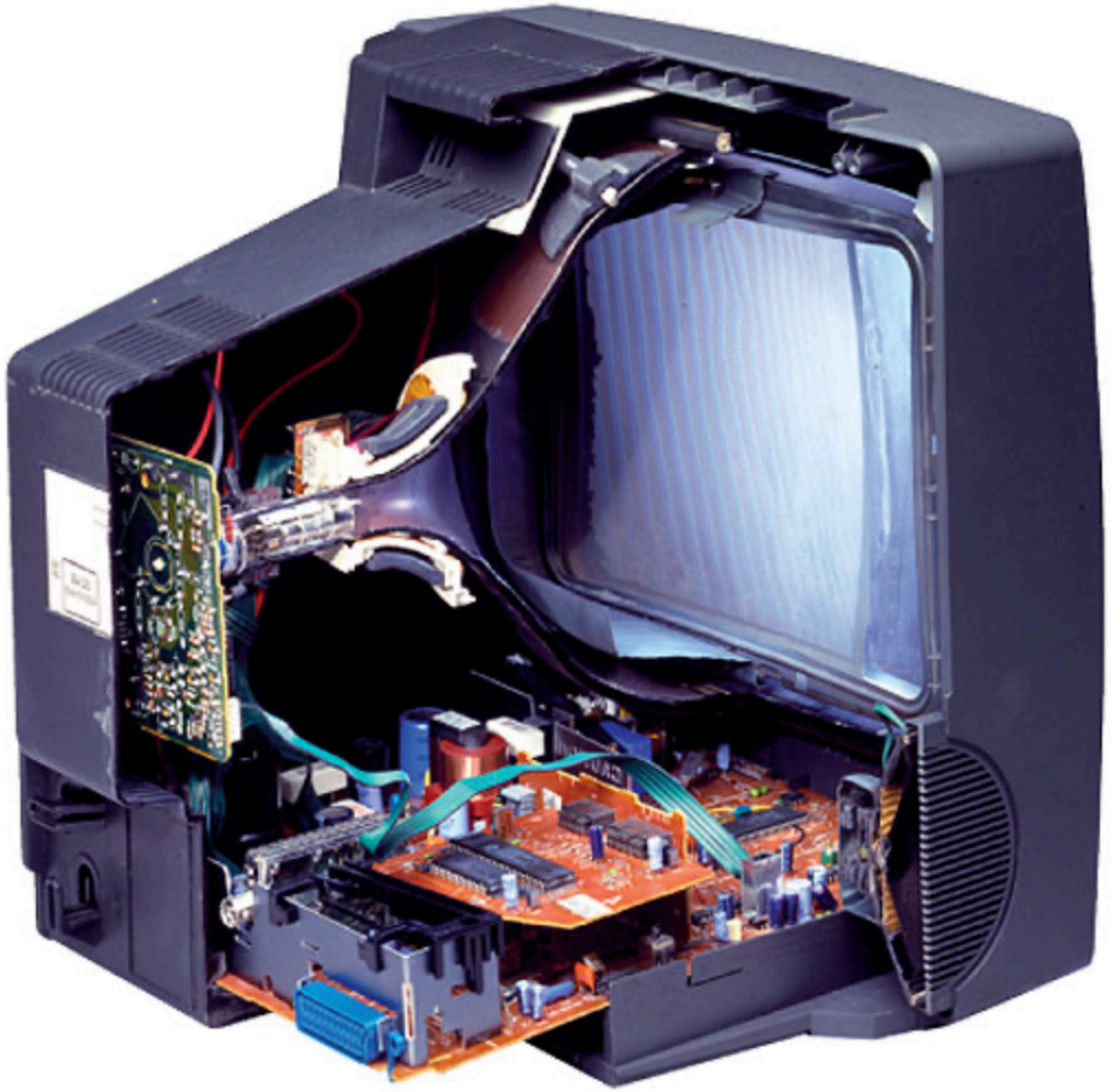


Electron beam in cathode-ray tube



Oscilloscope && CRT TV





Particle accelerator in CERN