D.3

Magnetism and the Right Hand Rule

IB PHYSICS | FORCE FIELDS

Magnetic Domains

Domains Before Magnetization

Domains After Magnetization

In order for a material with domains to become magnetic, the domains have to be aligned by an external magnetic field.

If enough of a materials domains become aligned, the material forms a magnetic dipole and becomes a permanent magnet

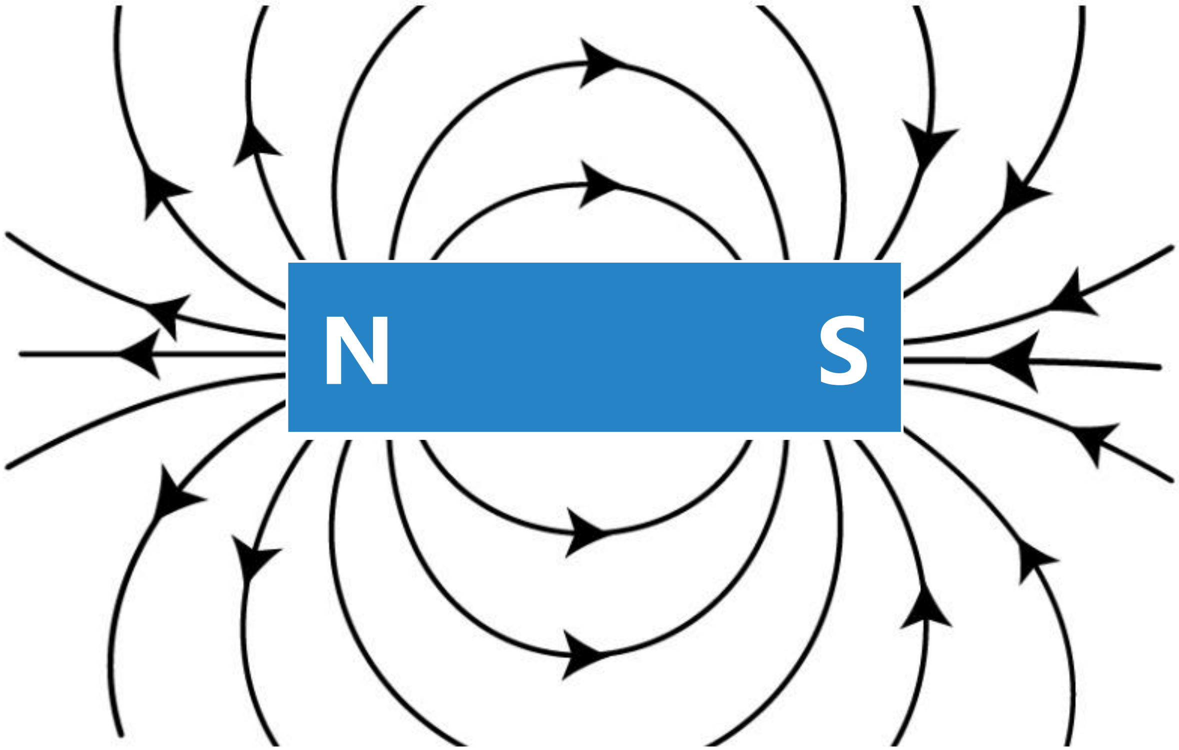
Cutting Magnets in Half

Poles cannot be isolated – a magnet cannot be broken to get a separate north and south pole. Instead, it creates two magnets, each with a north and south pole

Review: Magnetic Fields

D.3

Magnetic field lines point from North to South



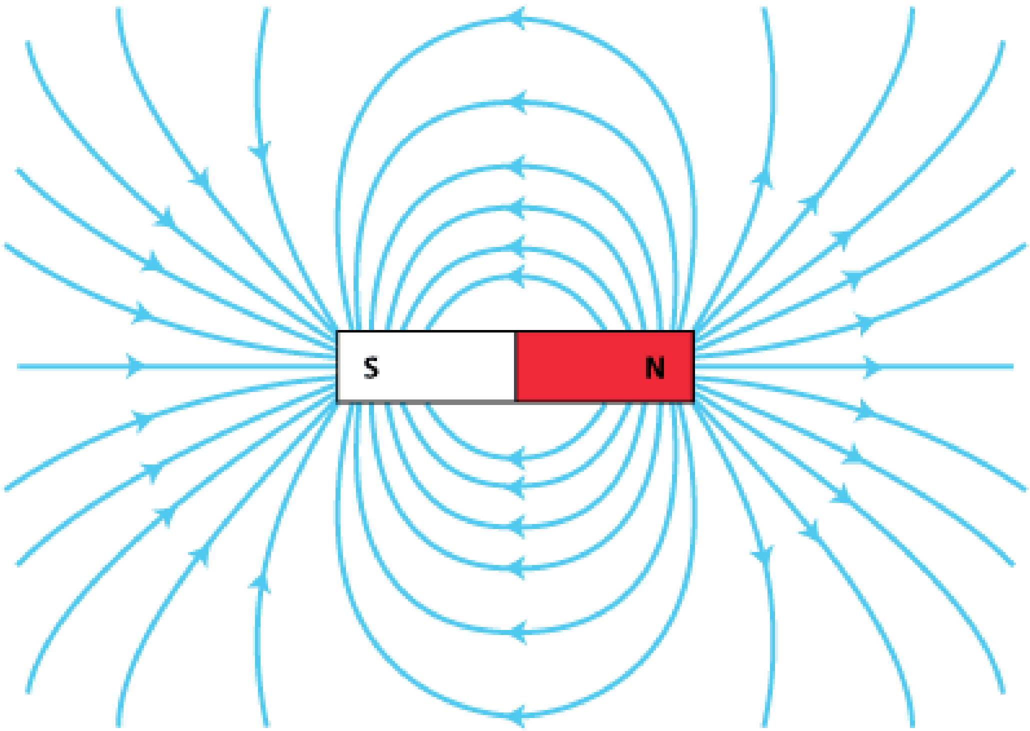
A compass would align with these field lines

Review: Magnetic Fields

A horseshoe magnet is just a bent bar magnet. The rules for magnetic fields still apply.

B-Field

B → Magnetic Field Strength



Units
Tesla [T]

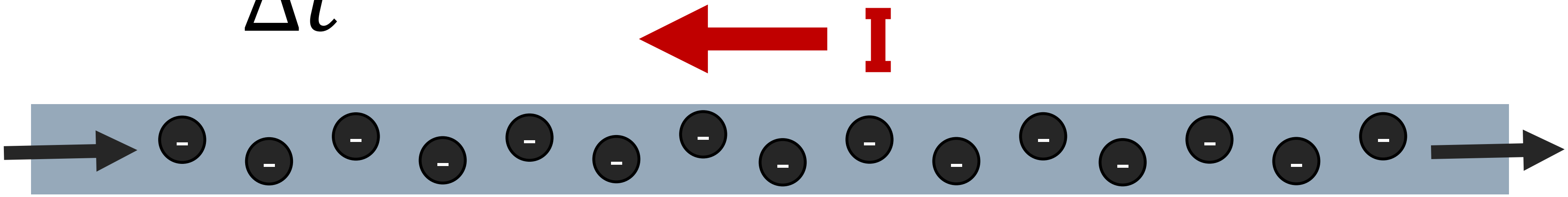
Introducing... Current

The rate at which charges move through a conductor

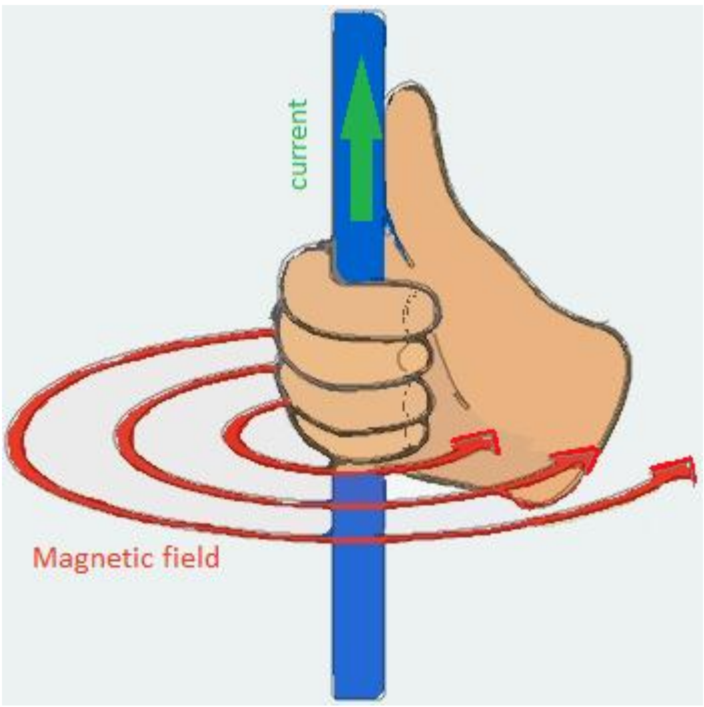
Symbol: I	Unit: Ampere [A]

$$I = \frac{\Delta q}{\Delta t}$$

Current is defined as the direction of positive flow



Right Hand Rule #1



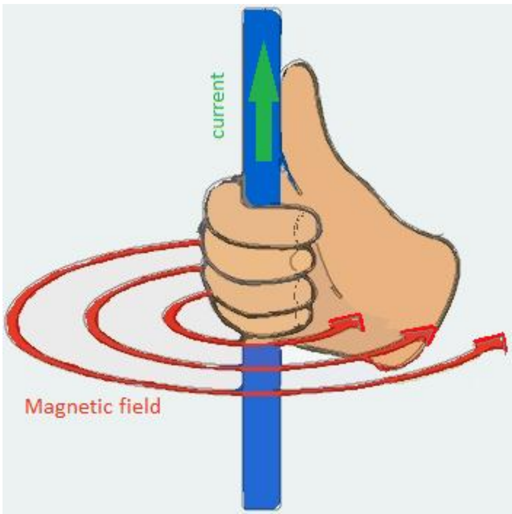
When current flows through a wire, a magnet is produced wrapping around that current-carrying wire

The direction of the magnetic field produced can be predicted by the "**Right Hand Rule**"

Thumb points in direction of the **current**

Fingers point in direction of the **field lines**

Drawing in 3D



It can be hard to translate a 3rd dimension into a 2-dimensional diagram so there some conventions to help us out

How do you represent a direction that's perpendicular to the paper?

Into the paper	✖

Out of the paper	●

Drawing in 3D

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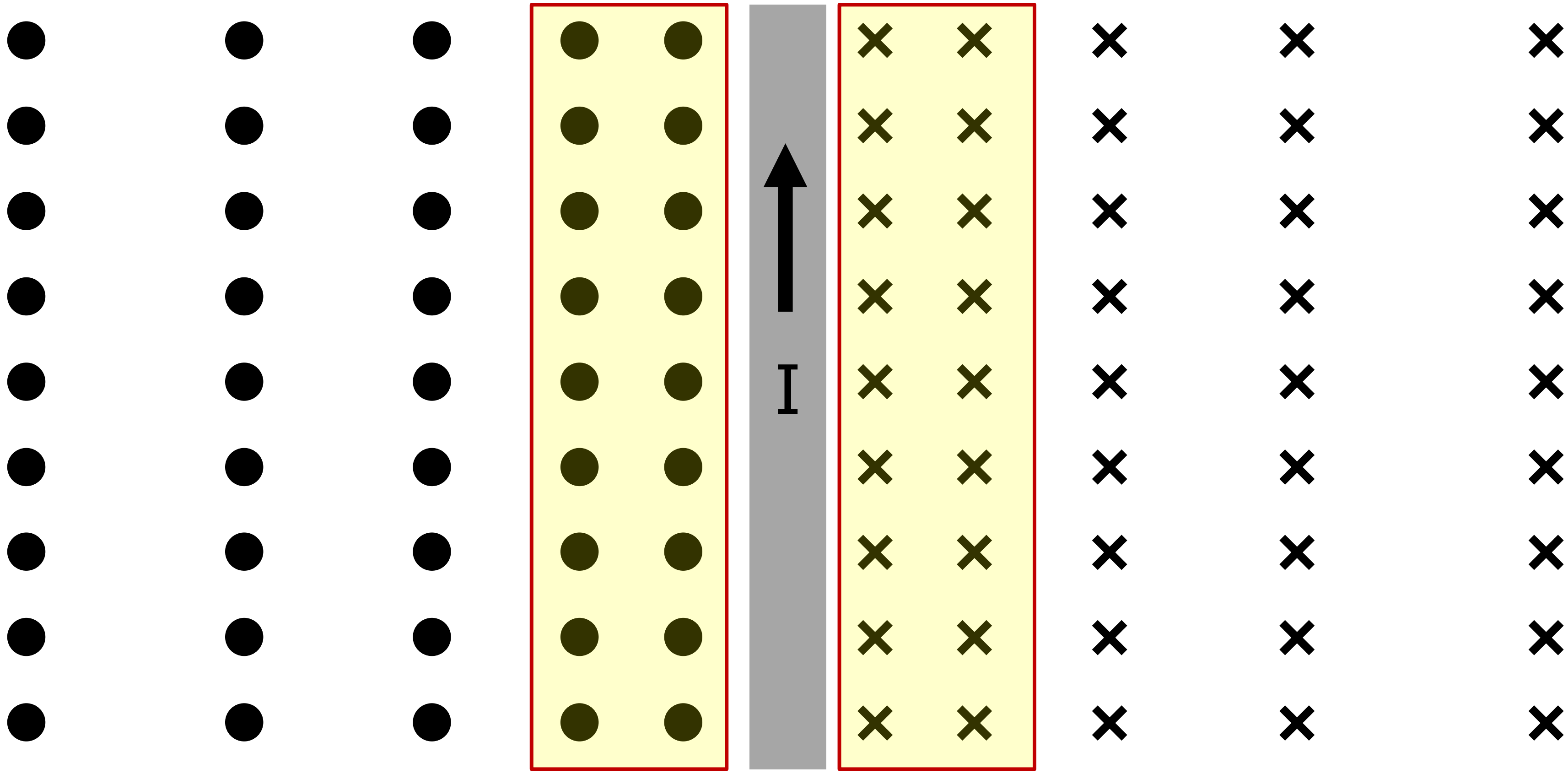
Where is Magnetic Flux Density the highest?



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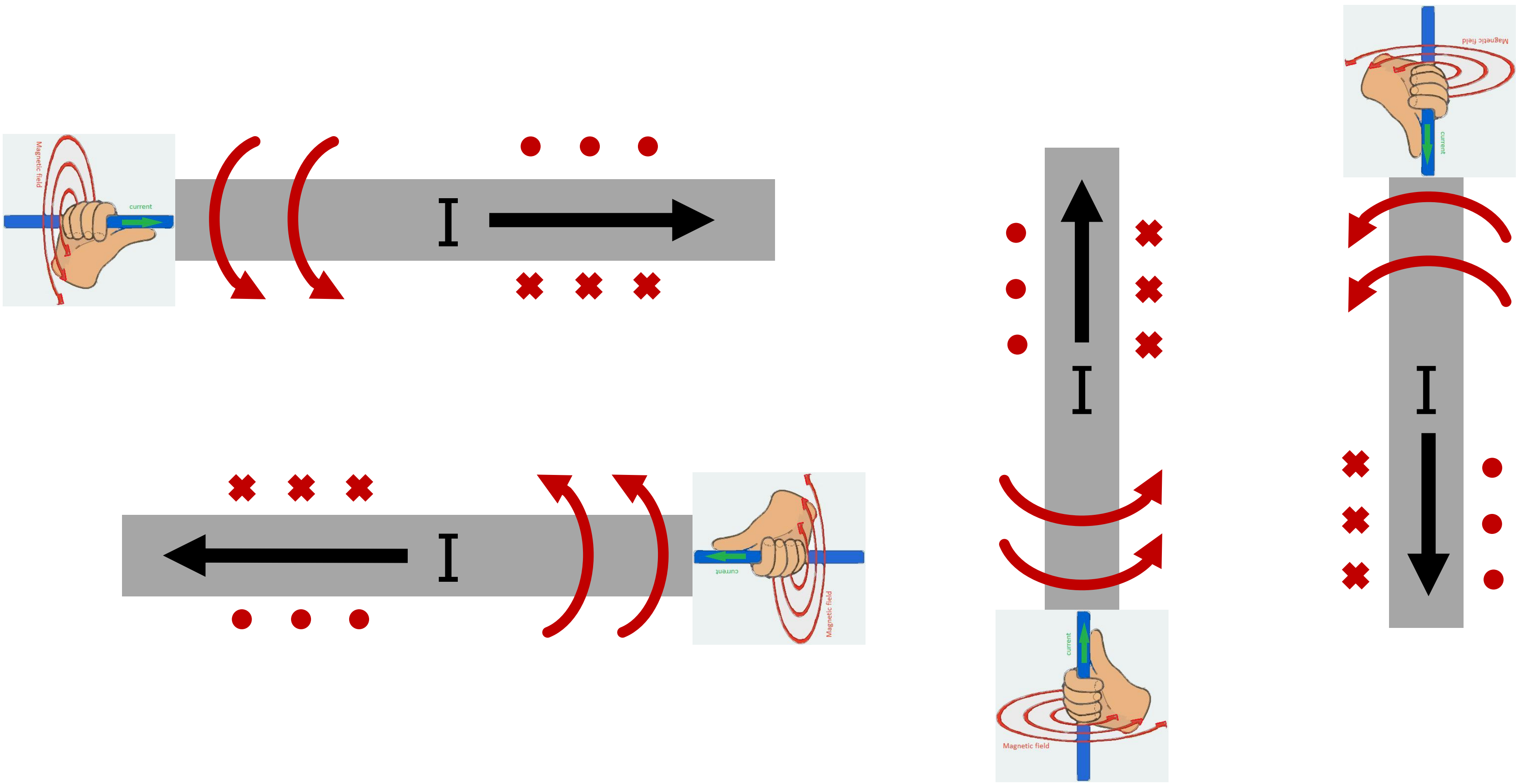
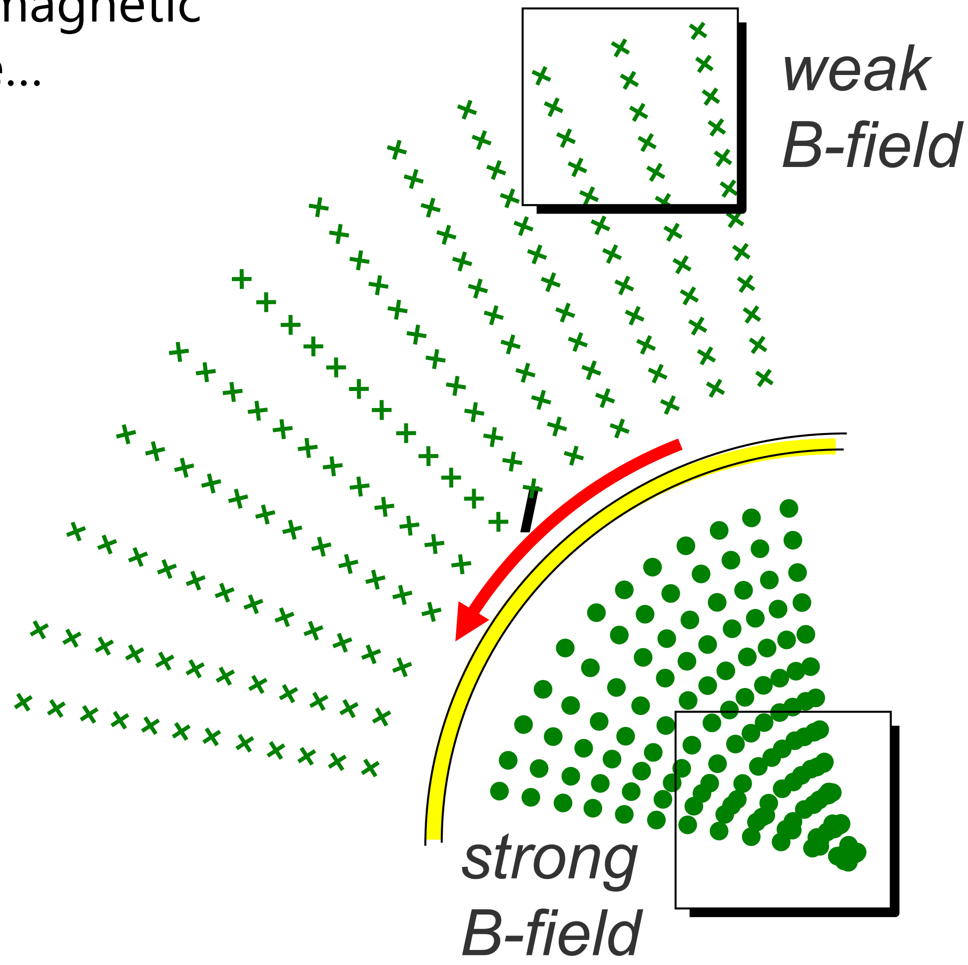
Right Hand Rule #1

Draw in the magnetic field lines around these current carrying wires



Looped Wire

A wire in a loop has as stronger magnetic field inside the loop than outside…



Creating an electromagnet

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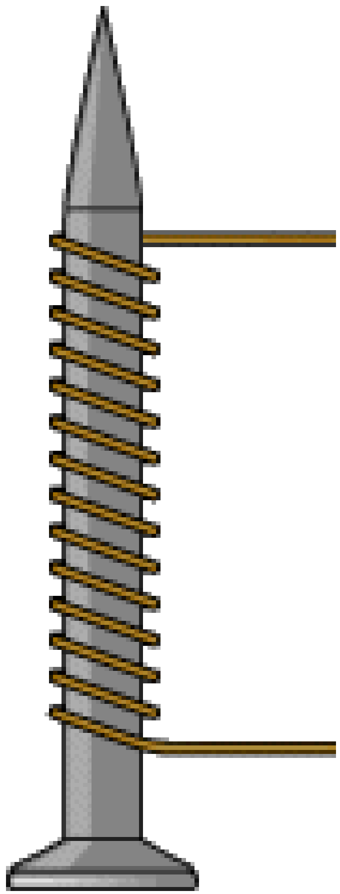
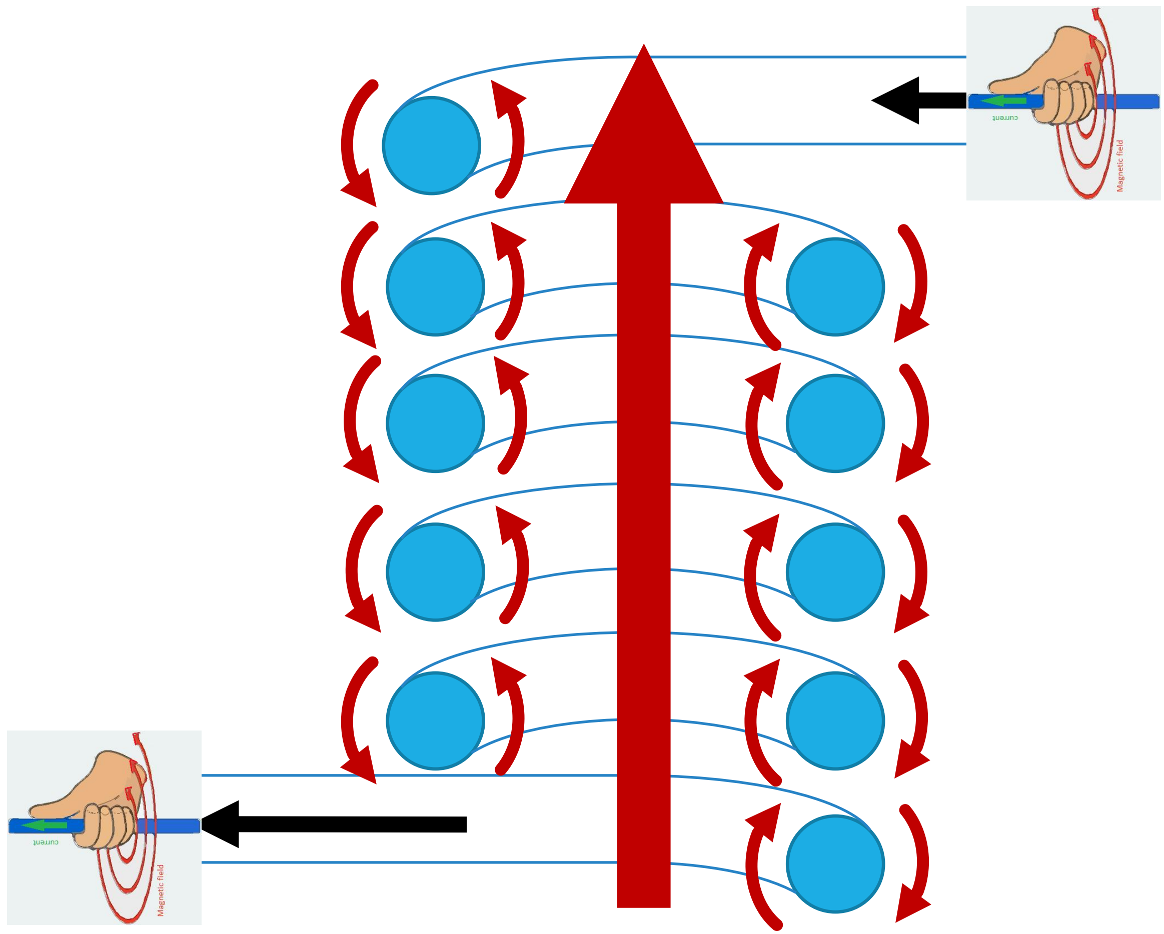
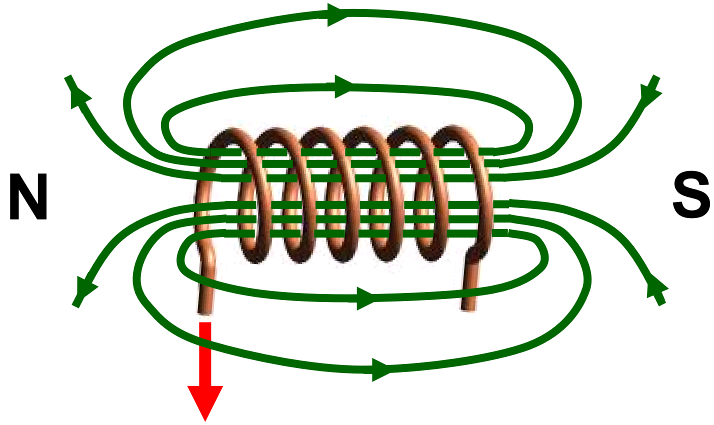
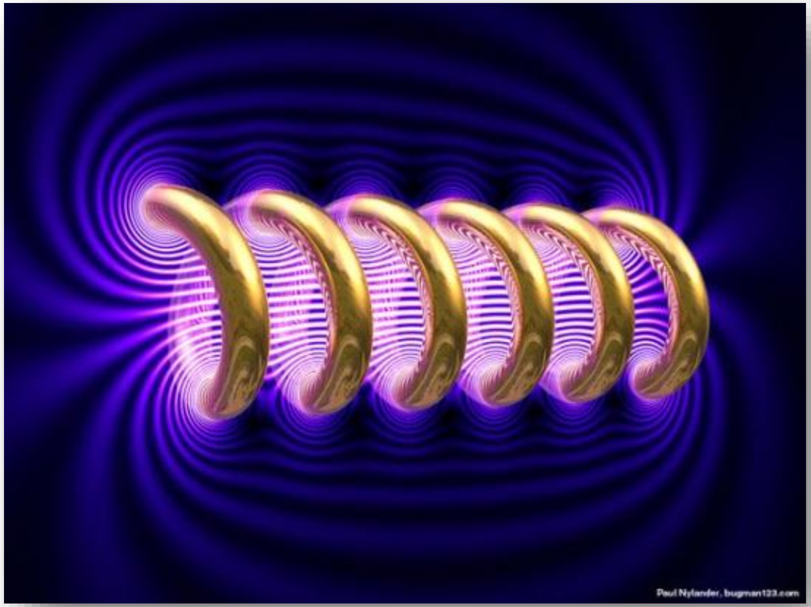




Magnetic Field





Electromagnet Applications

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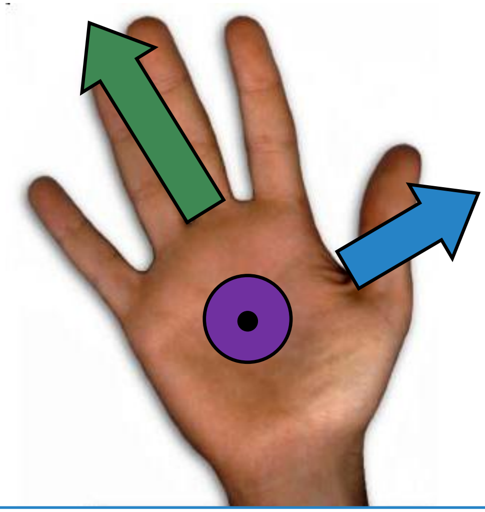
Right Hand Rule #2



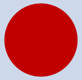
Thumb points in direction of the **current**

Fingers point in direction of the **field lines**

Palm points in direction of the **force**

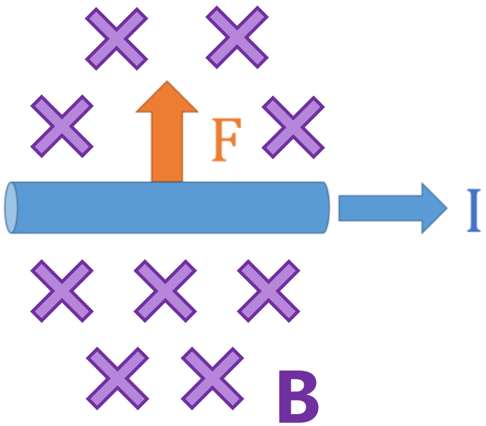
How do you represent a direction that's perpendicular to the paper?

Into the paper	

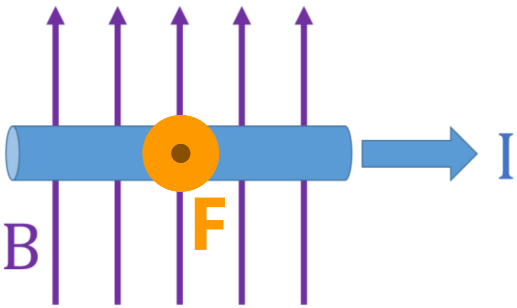
Out of the paper	

Right Hand Rule #2

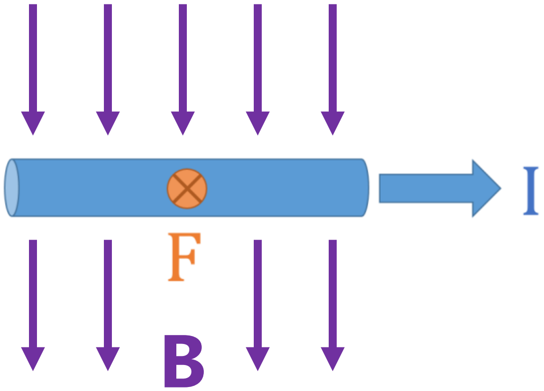
Draw in the magnetic field (B)



Draw in the force (F)

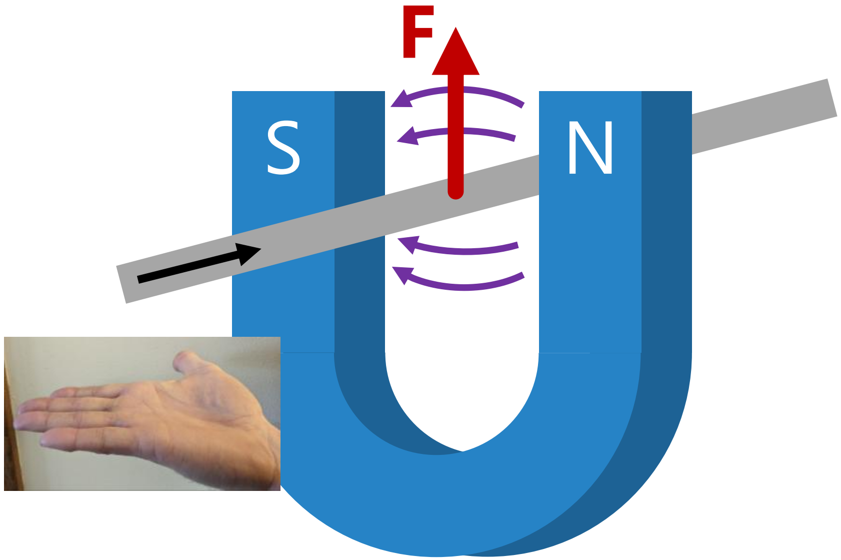


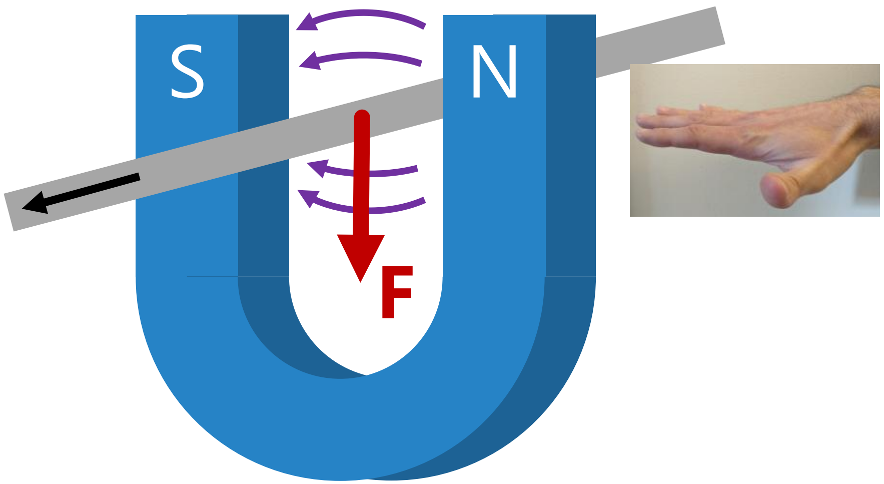
Draw in the magnetic field (B)



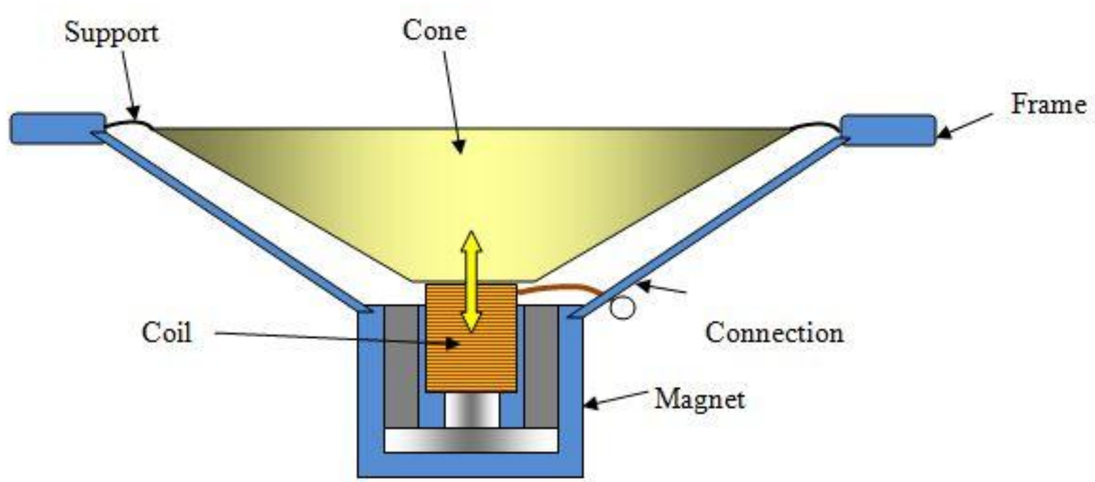
Right Hand Rule #2

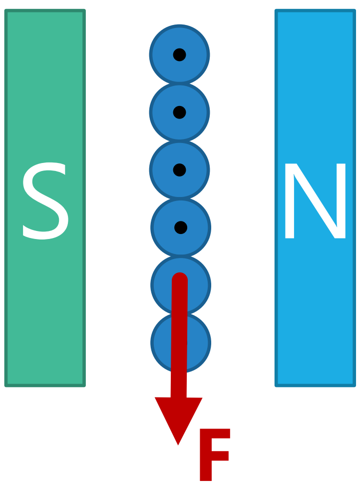
A current-carrying wire is placed in a magnetic field and the magnetic field exerts a force on the wire

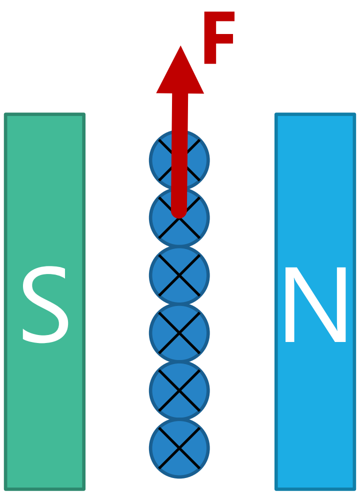


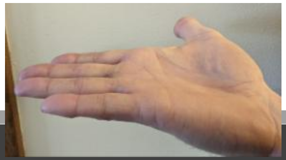


Speakers



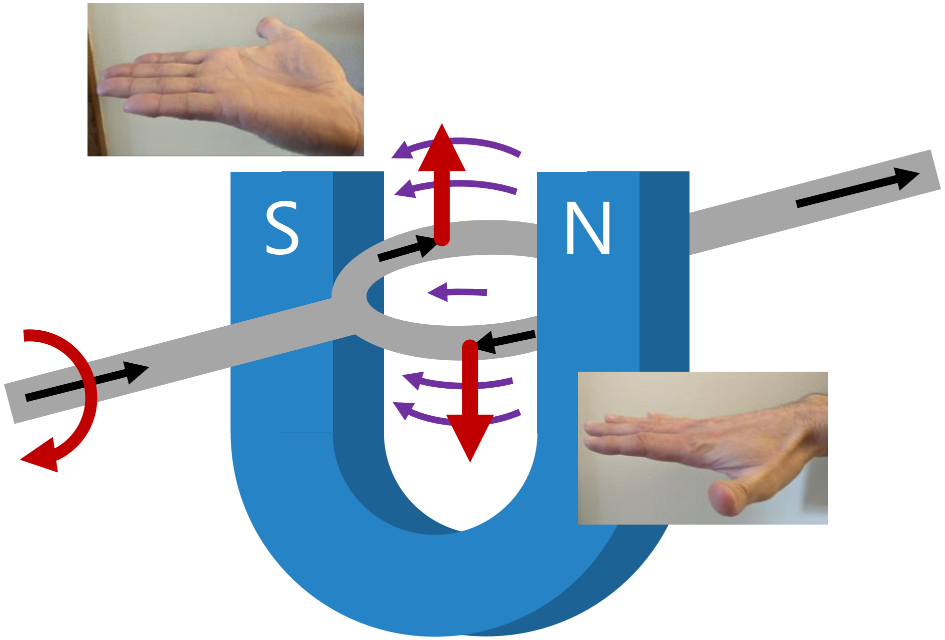






Designing a Motor

When electric current is passed through a magnetic field, you get motion



Motors vs Generators

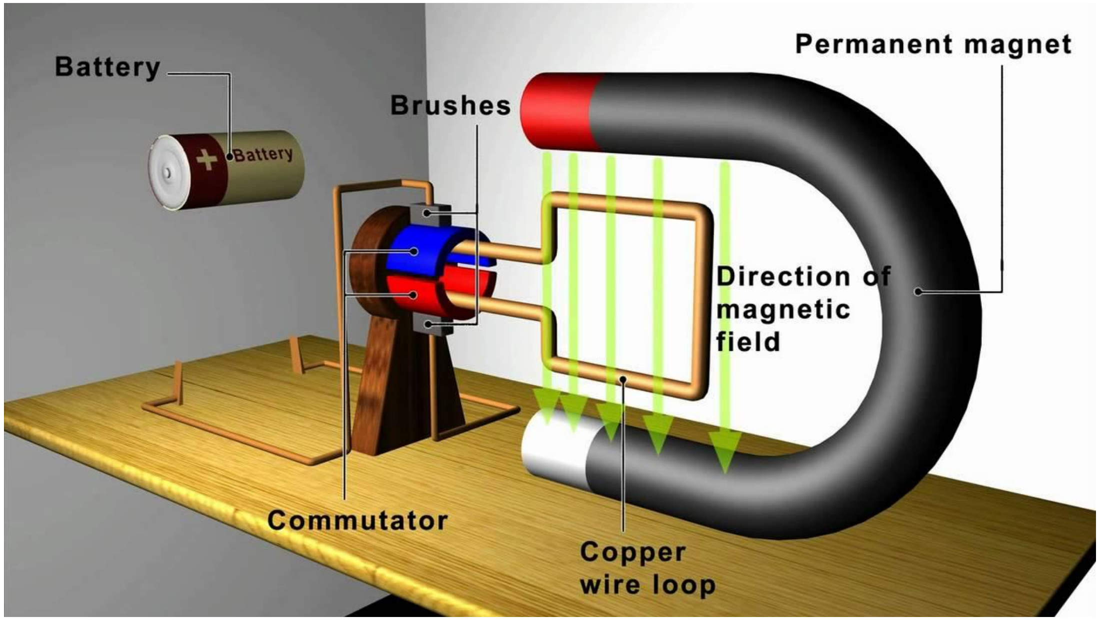
Electric Motors convert

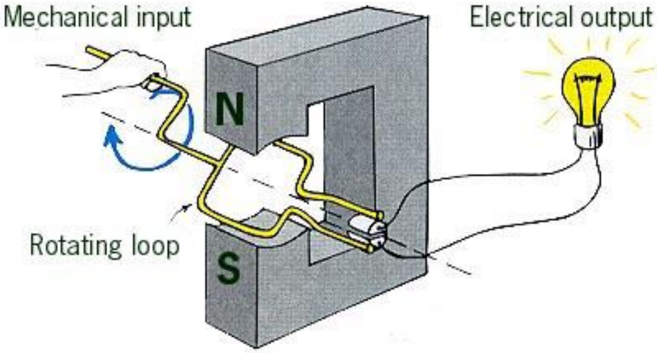
Electricity → Motion

Electric Generators convert

Motion → Electricity

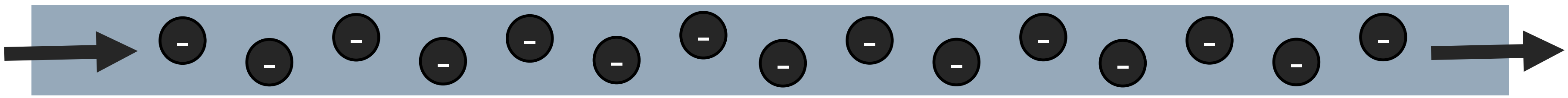
Examples


Battery
Battery
Brushes
Permanent magnet
Direction of magnetic field
Commutator
Copper wire loop


Mechanical input
Electrical output
N
S
Rotating loop

Particles Moving Across Fields

Remember: Current is defined as the direction of positive flow

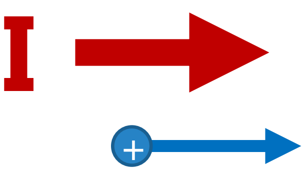


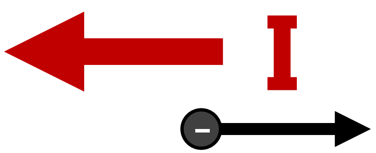
What if it's just one particle moving?

Thumb points in direction of the **current**

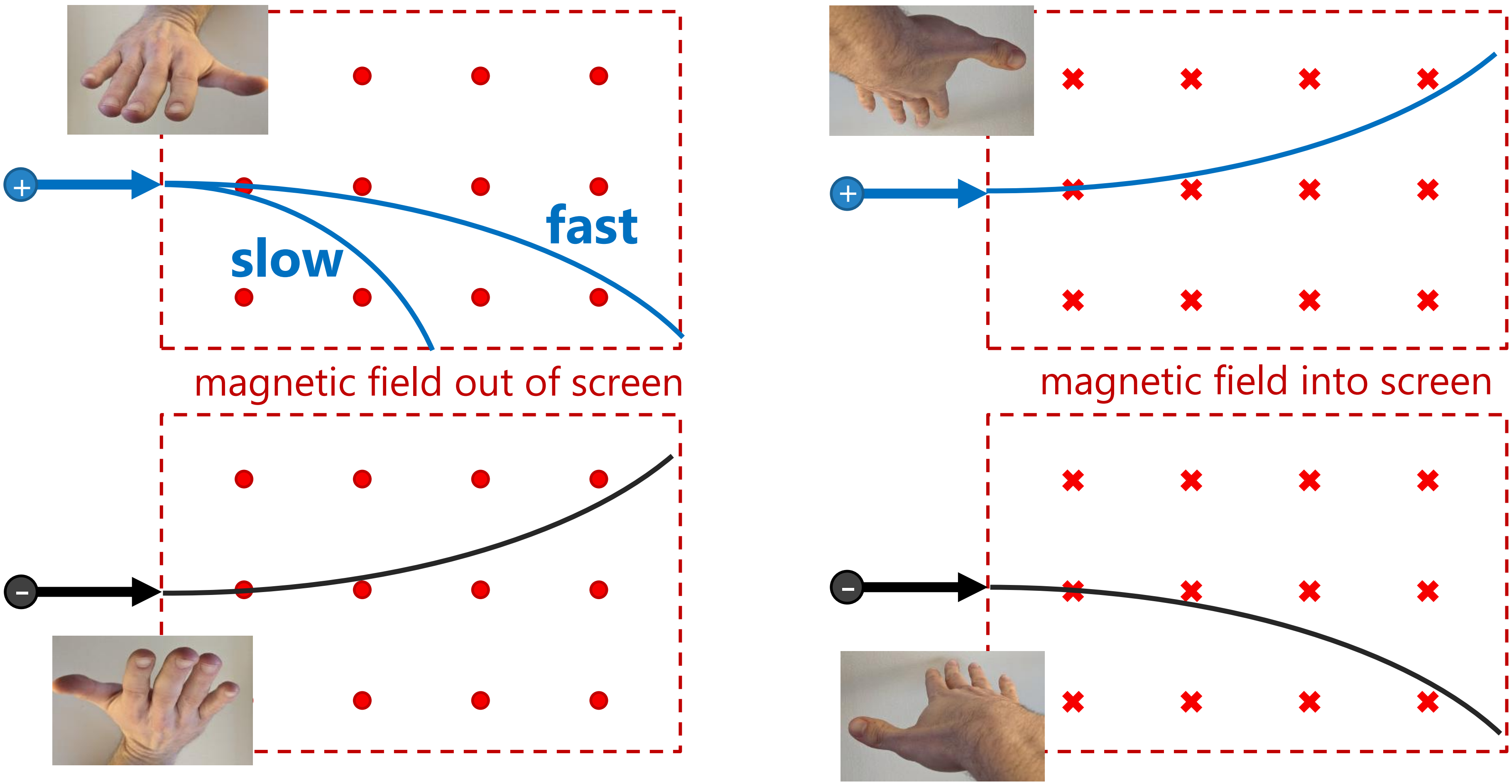
Fingers point in direction of the **field lines**

Palm points in direction of the **force**





Particles Moving Across Fields



Lesson Takeaways

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- ❑ I can describe how permanent magnets are created by aligned magnetic domains
- ❑ I can indicate a vector that is pointing into or out of the page
- ❑ I can use the right-hand rule to draw the magnetic field around a current carrying wire
- ❑ I can use the right-hand rule to predict the forces on a current carrying wire in a magnetic field
- ❑ I can predict the trajectory of a charged particle moving through a magnetic field at different speeds