The Amazing Inductor – Part 2 | How current creates a magnetic field

Recap from last week:

THE AMAZING INDUCTOR
– PART 1 –
WHAT IS AN INDUCTOR?

WHAT IS AN INDUCTOR?

An inductor is a coil of wire that **stores energy** in a magnetic field when current flows.

INDUCTANCE

DEFINITION

Inductance is the property of a coil that **opposes changes in current** by storing energy in a magnetic field.

SI UNIT:	VARIABLE:
Henry (H)	L

WHY IS THE SYMBOL "L"?

- Many people expect inductance to use the letter I, but I is already used to represent **electric current**.
- The letter L is used instead.
- It is commonly associated with **Heinrich Lenz**, whose work led to **Lenz's Law**, explaining that an induced voltage always opposes the change that created it.

I = Current L = Inductance

HEINRICH LENZ (1804–1865)

German-Russian Physicist

Famous for ***LENZ'S LAW:***

The induced voltage always opposes the change in current or magnetic field that created it.

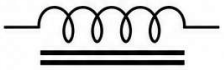
➡ This explains why inductors resist sudden changes in current.

SCHEMATIC SYMBOLS

1. AIR-CORE INDUCTOR

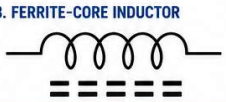
No magnetic core inside the coil.

2. IRON-CORE INDUCTOR



Soft iron core greatly increases the magnetic field and inductance.

3. FERRITE-CORE INDUCTOR



Ferrite core increases inductance and works very well at higher frequencies.

THE HENRY (H)

The SI unit of inductance is the **henry** (H).

It is named after **Joseph Henry** (1797–1878), an American physicist who independently discovered electromagnetic induction and made major contributions to electromagnets and self-inductance.

1 Henry = 1 volt-second per ampere

$$1H = 1\,\frac{V \cdot s}{A}$$

CORE MATERIALS

CORE		BEST USE
AIR		RF circuits, simple demonstrations
IRON		Transformers, electromagnets, power applications
FERRITE		Switching power supplies, high-frequency electronics

KEY TAKEAWAYS

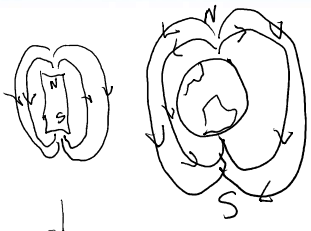
- ✓ An inductor is a coil of wire.
- ✓ Current creates a magnetic field.
- ✓ Inductors store energy in that magnetic field.
- ✓ Inductors resist changes in current.
- ✓ Inductance is measured in **henrys** (H).
- ✓ L represents inductance.
- ✓ Lenz's Law explains why inductors oppose changing current.

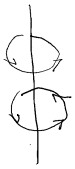
QUICK REFERENCE

$v_L = -L\,\frac{di}{dt}$	Voltage across an inductor
$L = \frac{N\Phi}{I}$	Inductance definition
$E = \frac{1}{2}\,L\,I^2$	Energy stored in an inductor

-BUILD UNDERSTANDING.
BUILD CIRCUITS. BUILD THE FUTURE!

BUILD CIRCUITS WITH RICH



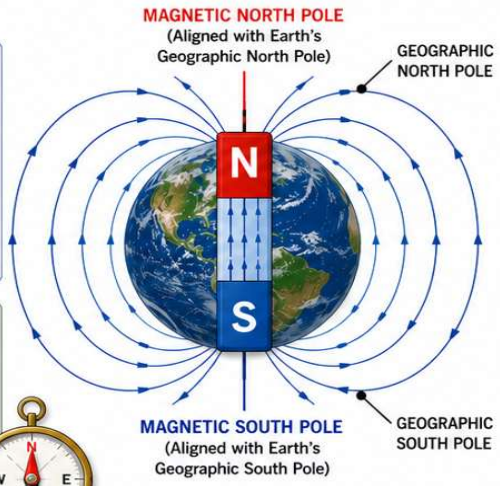


MAGNETIC FIELDS: EARTH vs BAR MAGNET

Magnetic field lines are invisible, but they show the direction a north pole would move.
Outside a magnet (or Earth), field lines go from MAGNETIC NORTH to MAGNETIC SOUTH.

EARTH'S MAGNETIC FIELD

Earth behaves like a giant bar magnet.
Its magnetic field extends thousands of miles into space and protects life on Earth from harmful particles.



HOW TO READ THE FIELD LINES

- Arrow shows the direction a north pole would move.
- Inside Earth, field lines go from South to North.

COMPASS

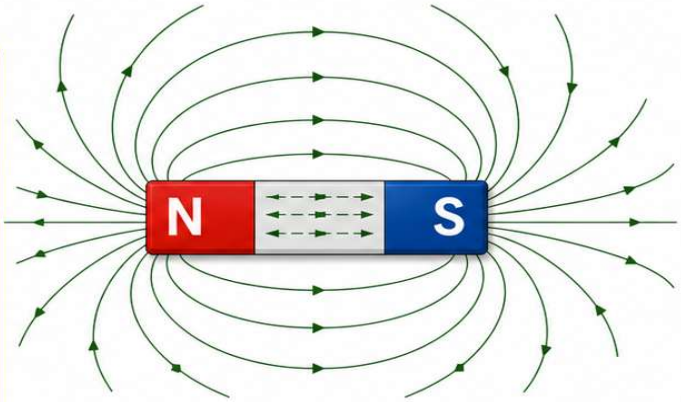
The north end (red) of a compass points toward Earth's Magnetic North Pole, which is aligned with the Geographic North Pole.

SIMILARITIES

- ✓ Both have a North (N) and South (S) magnetic pole.
- ✓ Field lines form closed loops.
- ✓ Outside: lines go from North to South.
- ✓ Inside: lines go from South to North.
- ✓ Field is strongest where lines are closest together (near the poles).

BAR MAGNET'S MAGNETIC FIELD

A bar magnet has its own magnetic field.
The pattern is the same as Earth's field.



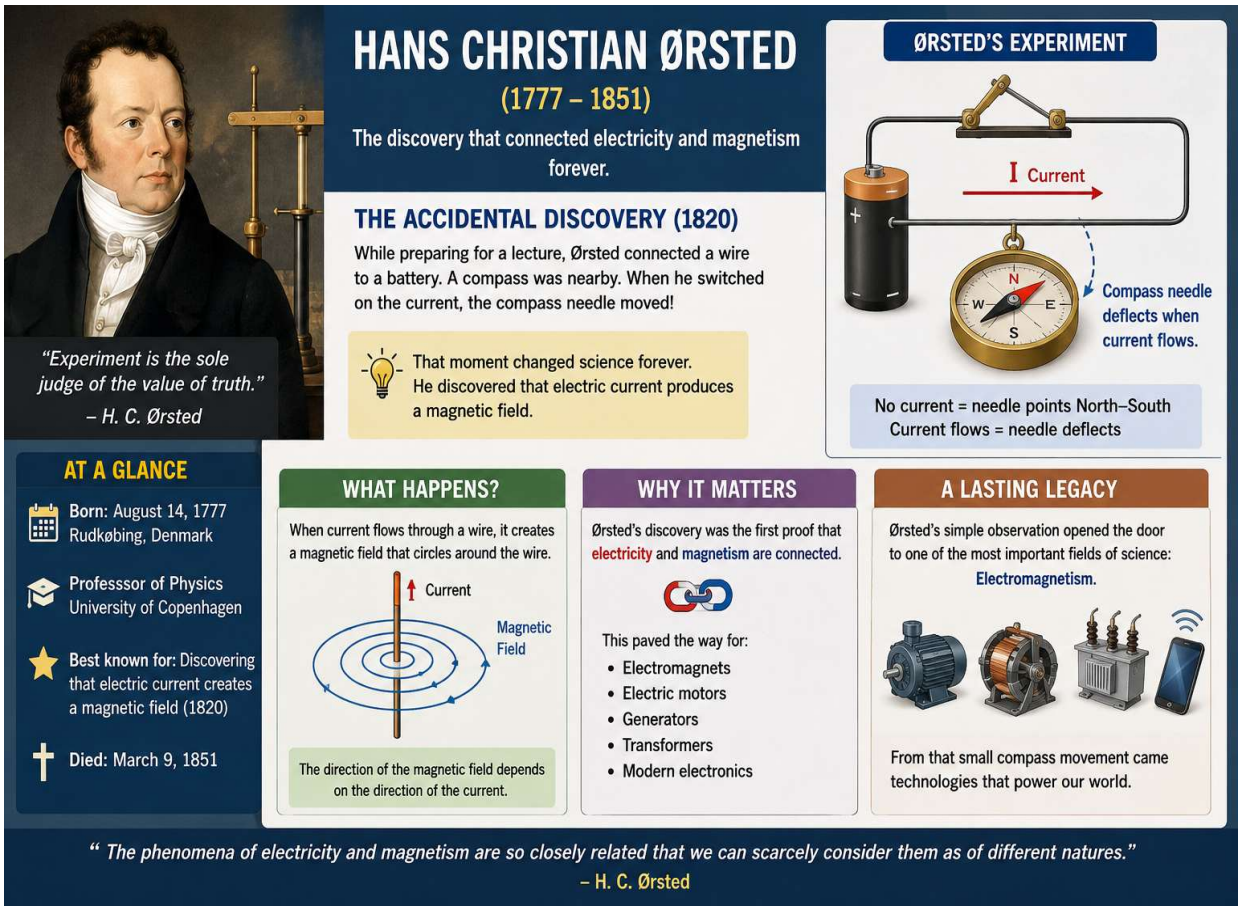
OUTSIDE THE MAGNET:
Field lines go from MAGNETIC NORTH (N) to MAGNETIC SOUTH (S).

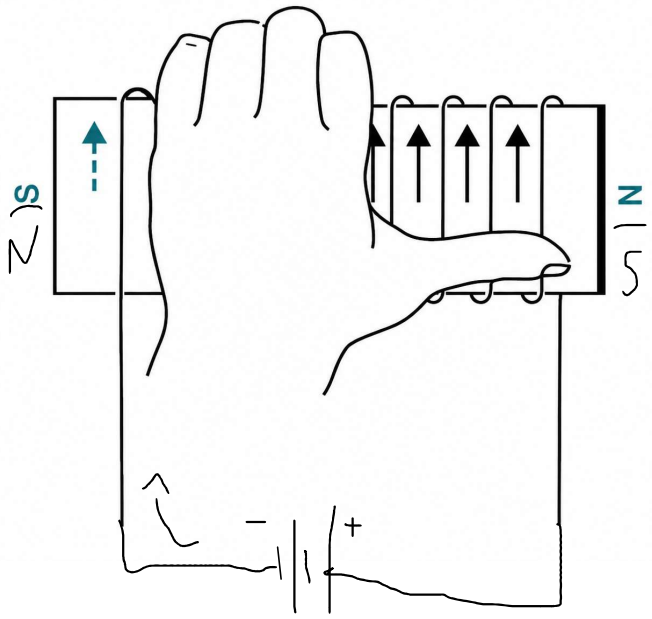
INSIDE THE MAGNET:
Field lines go from MAGNETIC SOUTH (S) to MAGNETIC NORTH (N).

KEY IDEA: Earth's magnetic field is created by electric currents in the moving molten iron of its outer core. This makes Earth act like a giant bar magnet.

REMEMBER:
Magnetic North ≈ North-seeking pole
Magnetic South ≈ South-seeking pole

Like poles repel. N ↔ N
Unlike poles attract. N ↔ S


HANS CHRISTIAN ØRSTED
(1777 – 1851)
The discovery that connected electricity and magnetism forever.
"Experiment is the sole judge of the value of truth."
– H. C. Ørsted
THE ACCIDENTAL DISCOVERY (1820)
While preparing for a lecture, Ørsted connected a wire to a battery. A compass was nearby. When he switched on the current, the compass needle moved!
That moment changed science forever. He discovered that electric current produces a magnetic field.
ØRSTED'S EXPERIMENT
I Current
N
W
E
S
Compass needle deflects when current flows.
No current = needle points North–South
Current flows = needle deflects
AT A GLANCE
Born: August 14, 1777 Rudkøbing, Denmark
Professsor of Physics University of Copenhagen
Best known for: Discovering that electric current creates a magnetic field (1820)
Died: March 9, 1851
WHAT HAPPENS?
When current flows through a wire, it creates a magnetic field that circles around the wire.
Current
Magnetic Field
The direction of the magnetic field depends on the direction of the current.
WHY IT MATTERS
Ørsted's discovery was the first proof that electricity and magnetism are connected.
This paved the way for:
• Electromagnets
• Electric motors
• Generators
• Transformers
• Modern electronics
A LASTING LEGACY
Ørsted's simple observation opened the door to one of the most important fields of science: Electromagnetism.
From that small compass movement came technologies that power our world.
" The phenomena of electricity and magnetism are so closely related that we can scarcely consider them as of different natures."
– H. C. Ørsted


S
N
N
S
−
+