Fri Jan 11th
Mon Jan 14th

Unit 5 : Electricity and Magnetism - day 4 / 5

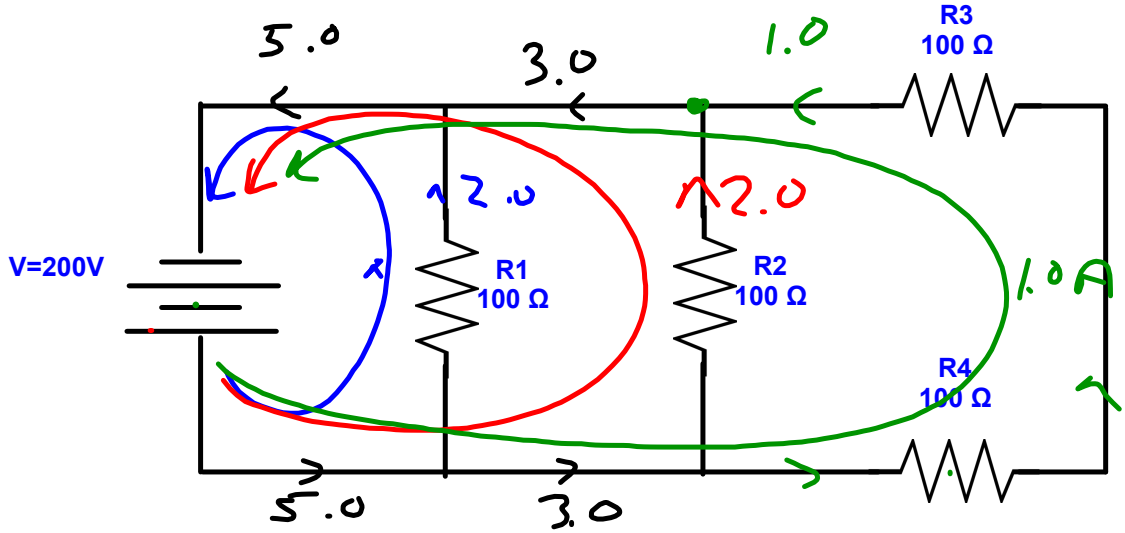
Today's Plan

1. Complete Kirchoff's Laws (incl electrical power)
2. Introduce Magnec Fields - demo fields
3. Introduce Electromagnesm and the motor principle

Next Day

Electric Motor Principle

Series and Parallel Circuit Analysis



Show the direction of current in the above circuit.
Characterize the circuit
- find voltage and current for each resistor.
- find total current and total (equivalent) resistance for the circuit

Calculate the overall power used in the circuit.

$V_1 = 200V$, $I_1 = 2.0A$

$V_2 = 200V$, $I_2 = 2.0A$

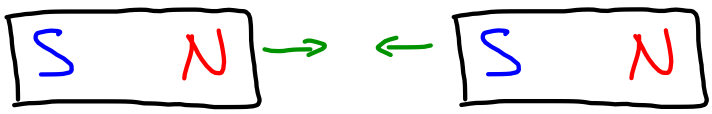
$V_3 = V_4 = 100V$, $I_4 = I_3 = 1.0A$

$5.0A$

$$R_T = \frac{V_T}{I_T} = 40\Omega$$

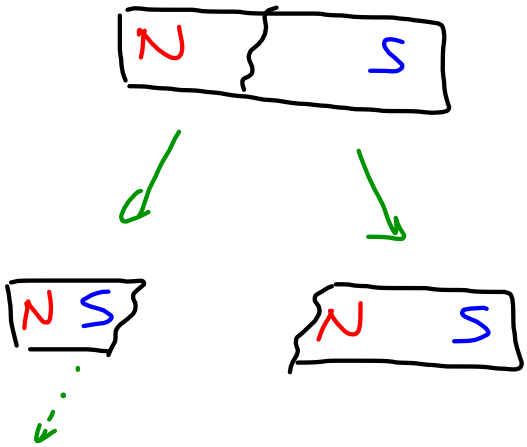
$$P = V_T I_T = 1000W$$

Magnetism



Opposite Poles Attract.

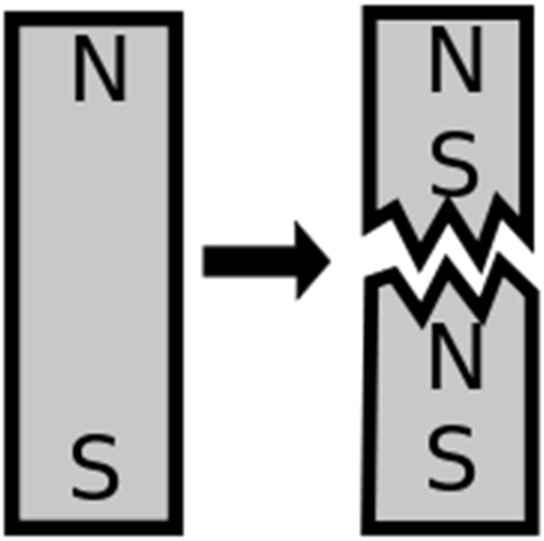
Like Poles Repel



N e S

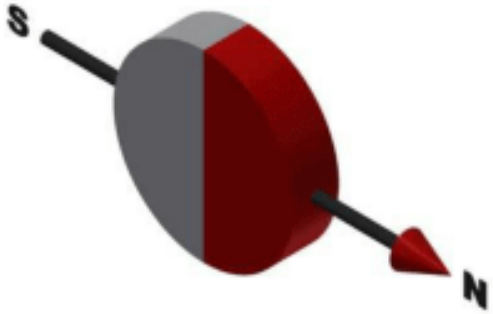
magnets must always have a N and a S pole (magnetic monopoles do not exist)

Summary Notes Magnetism



Axially Magnetized Disc

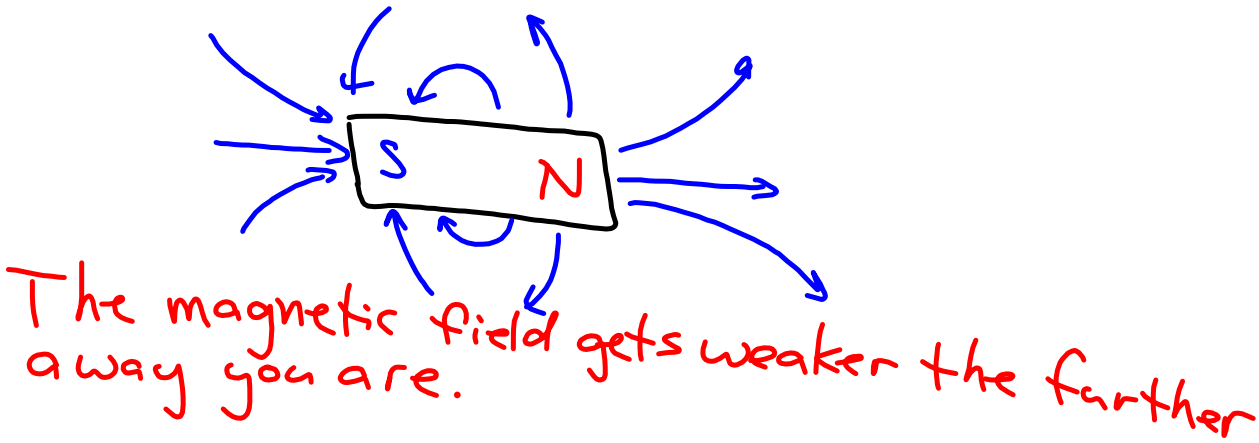
Diametrically Magnetized Disc



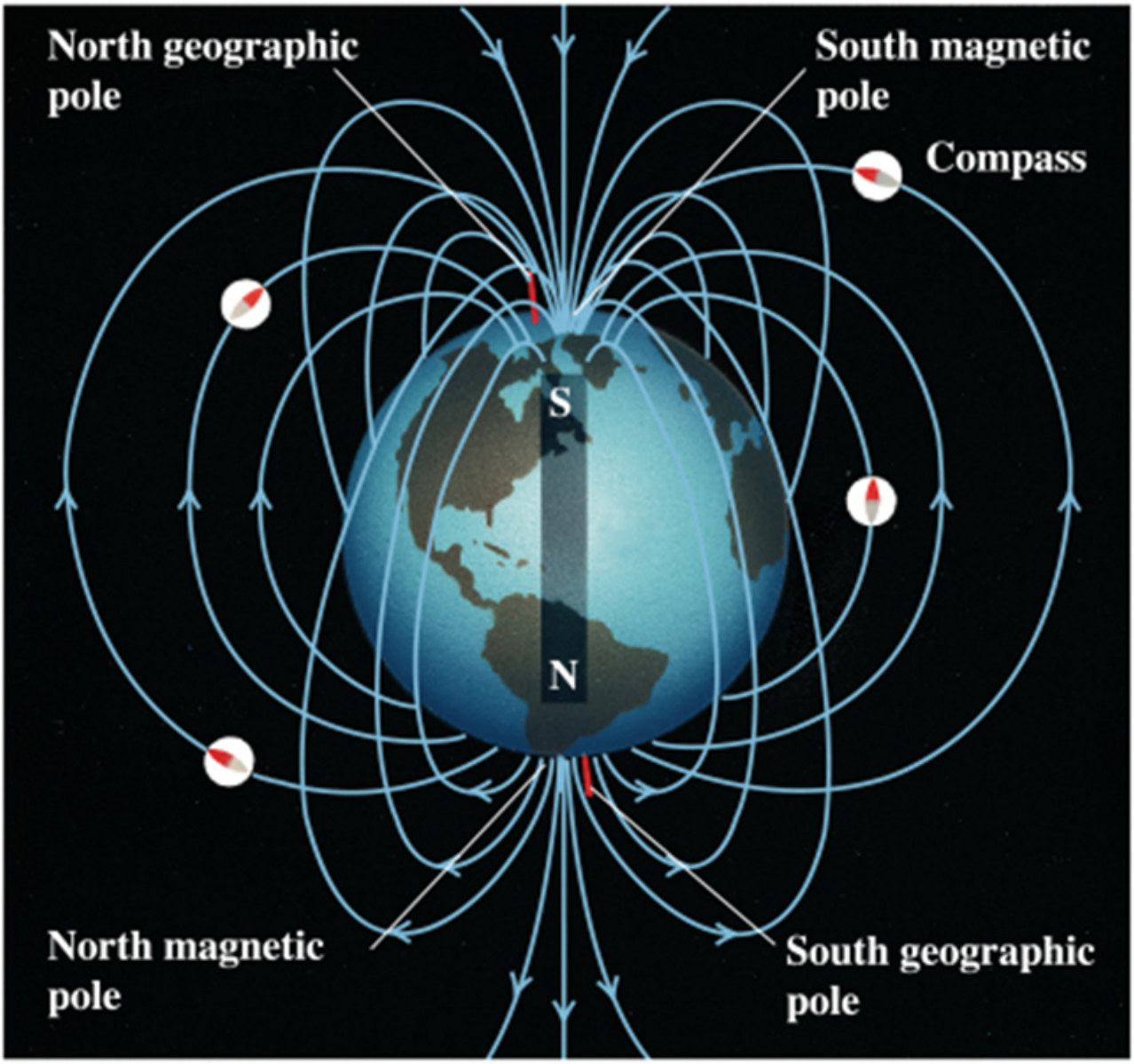
Magnetic Field Lines

Magnetic field lines always go from North to South (point in the direction a north pole of a magnetic would be directed).

Examples



The Earth's Magnetic Field

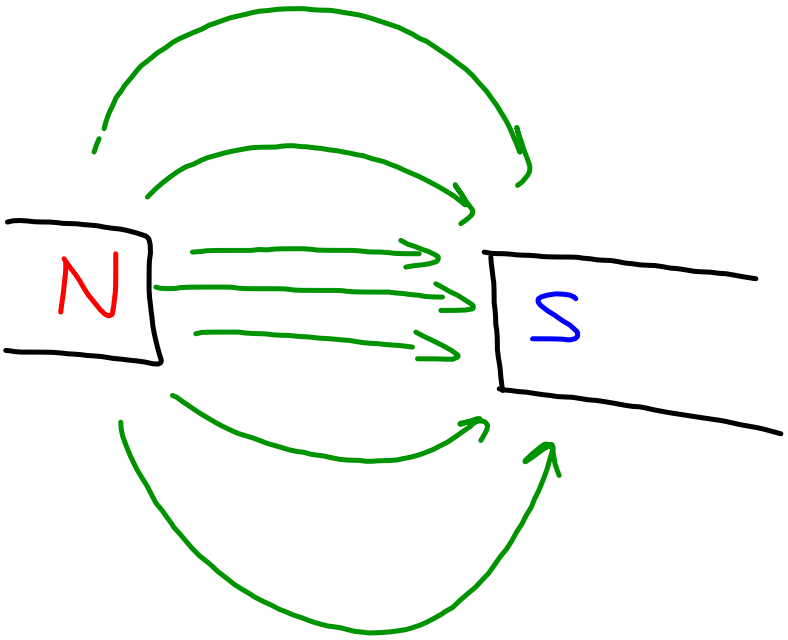


Measuring Strength of Magnets

The symbol used for magnetic field strength is $\vec{B}$.

Magnetic field strength is measured in Tesla's.

Magnet Type	Strength (Tesla's)
earth	50 μT (0.000005 T)
fridge magnet	1 mT (0.001 T)
MRI	1.5 T

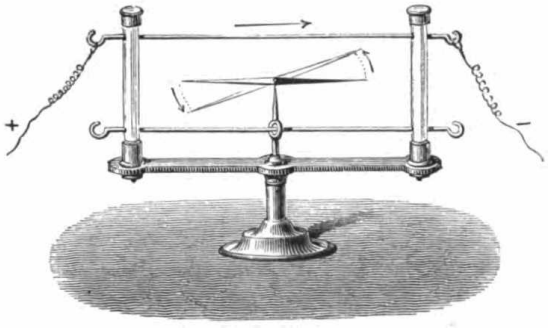


Electromagnetism

Principle of Electromagnetism (sometimes called Oersted's Principle)

- A flow of electric charge will create (induce) a magnetic field

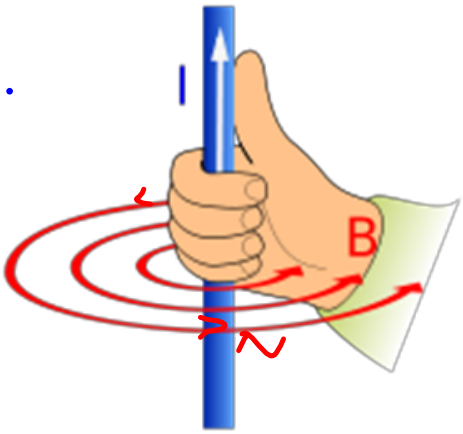
- The opposite is also true – a moving magnetic field will create (induce) an electric current



Right Hand Rule for a straight conductor

Magnetic field wraps around the conductor.

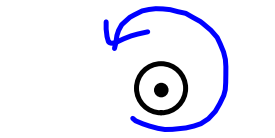
Rapidly decreases in intensity as distance from the conducter increases.



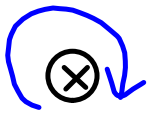
Right-Hand Rule for a Straight Conductor

Thumbs point in the direction of current flow (from + to -). Fingers curl around the conductor in the direction of the magnetic field lines.

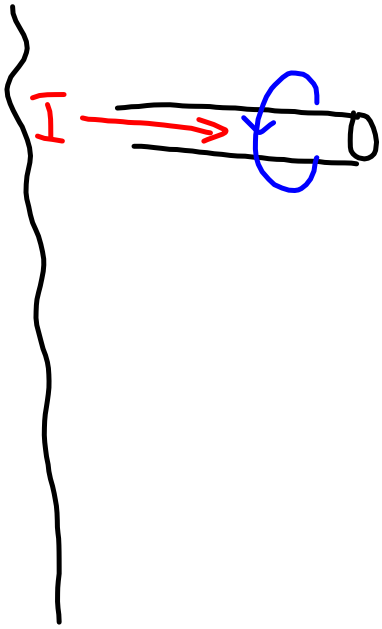
Conventions on drawing current flow



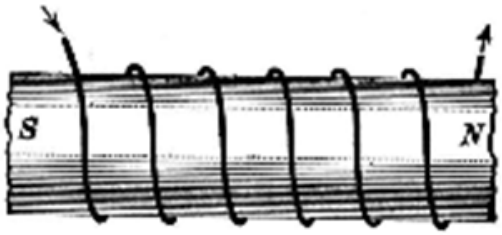
current coming out of page.



current going into page



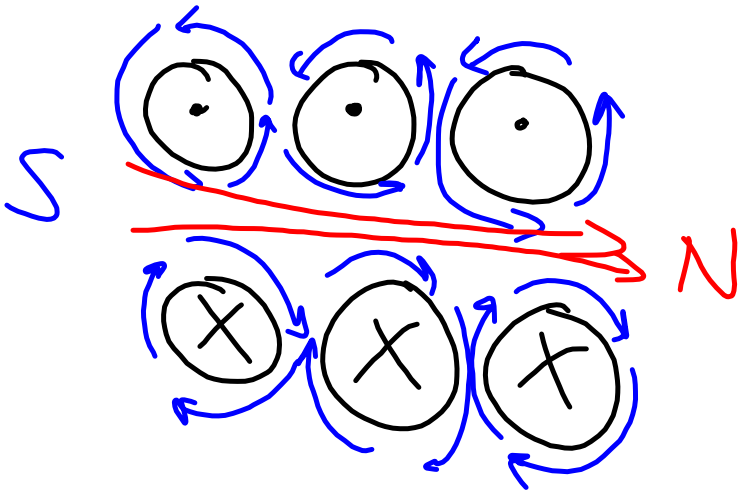
Electromagnets *(increasing or concentrating the magnetic field)*



To increase the magnetic field in a region of space, wire can be wound into a coil called a solenoid or helix.

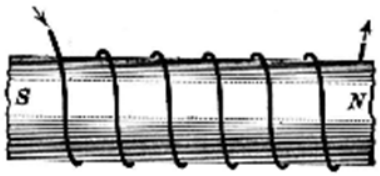
With more current travelling in a smaller space, there is more magnetic fields concentrated in this space.

To further intensify this field, a core material, such as iron, can be inserted into the centre of the coil.



Electromagnets *(cont'd)*

The direction of the current flow through and the magnetic field around an electromagnet are also linked by a right-hand rule

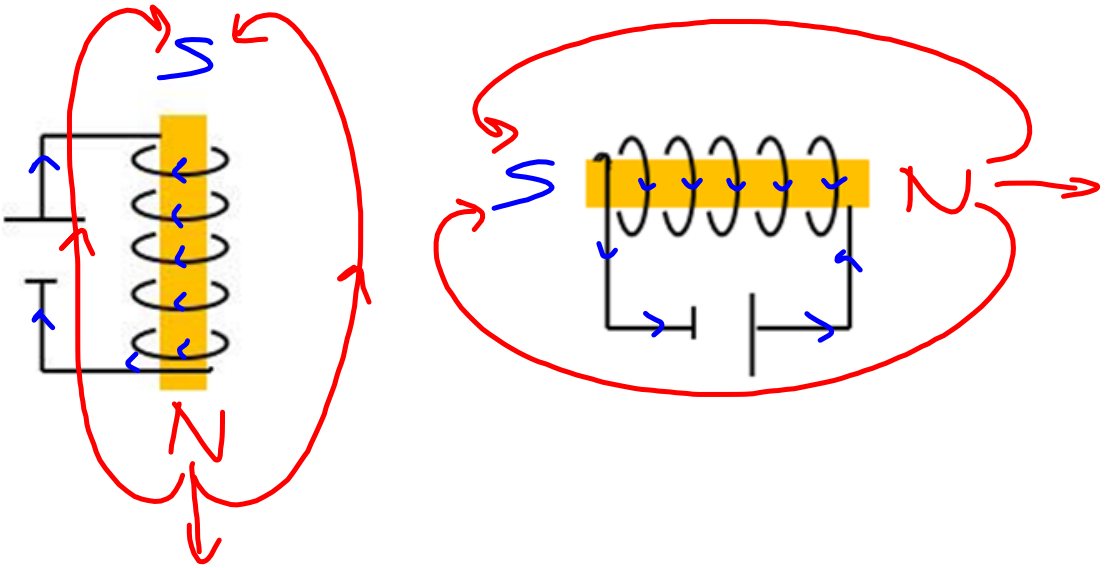


Right-Hand Rule for a Solenoid

Fingers curl around the solenoid in the direction of current flow (from + to -).

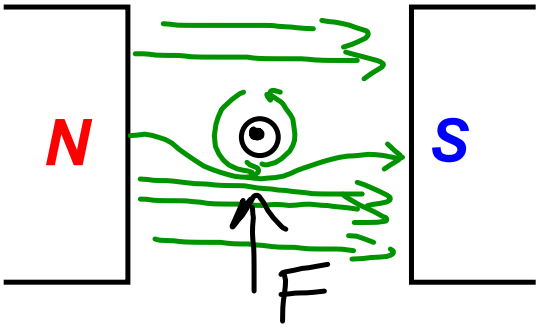
Thumb points toward the North pole of the electromagnet, in the direction of the magnetic field lines.

Check your understanding

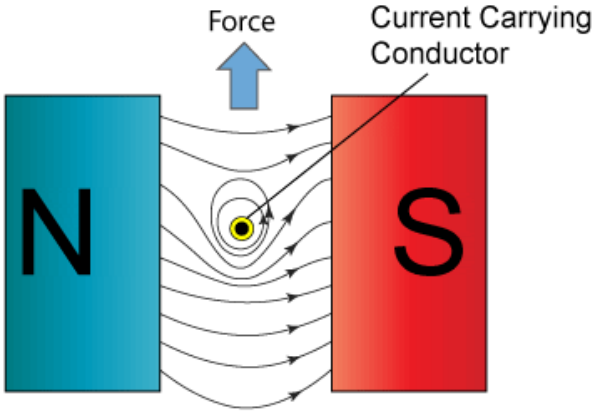


Motor Principle

See page 490 in text



concentration of magnetic field lines at bottom.



Motor Principle

See page 490 in text

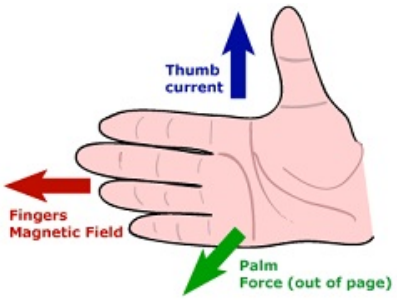
A current carrying conductor experiences a force when it is placed in an external magnetic field.

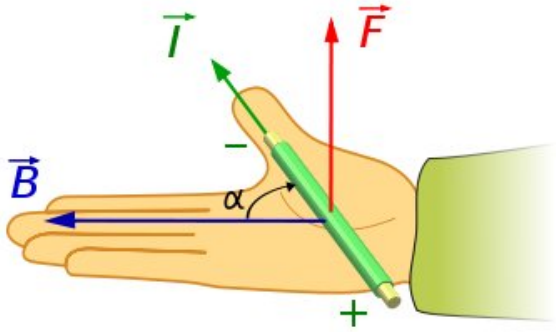
In other words...

if you put a wire with a current flowing through it near a magnet, you can make the wire move either up or down in the magnet field depending on the direction of the magnetic field and the direction of the current flow.

This is the basic principle that all electric motors and generators are based on.

Right Hand Rule for the Motor Principle

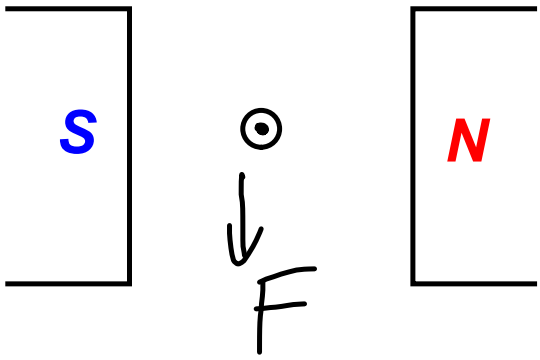




Right-Hand Rule for the Motor Principle

Thumb points in the direction of current flow (from + to -).
Fingers point in the direction of the magnetic field.
The palm of your hand will point in the direction of the force on the wire.

Example: What is the direction of the force on the current carrying conductor?

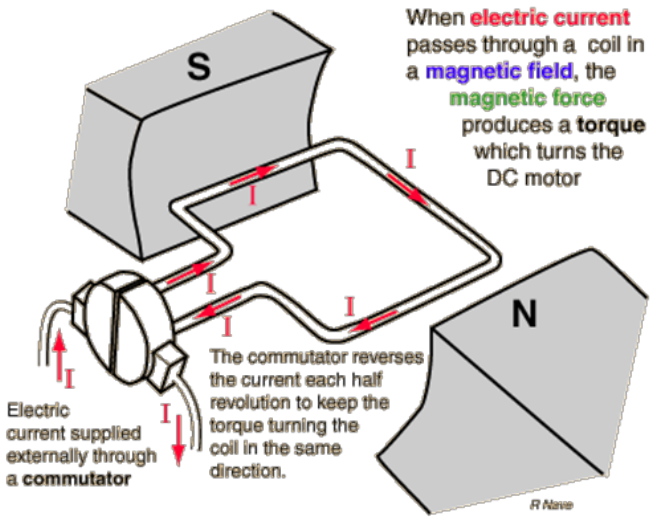


Summary Notes Magnetism

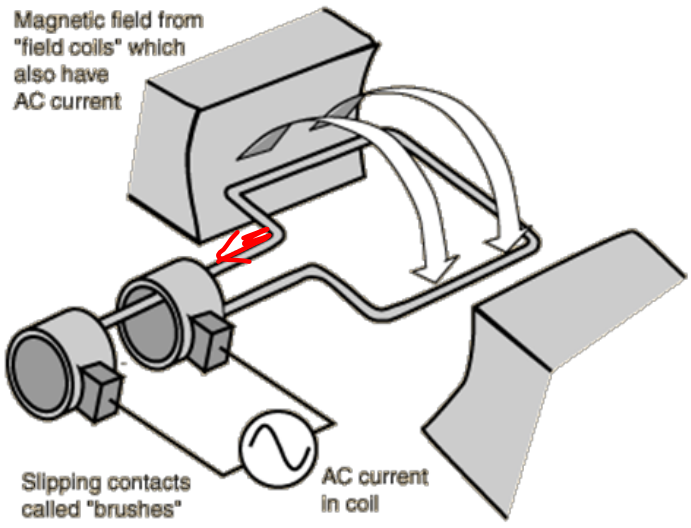
Electric Motor – uses moving charge (current) and magnet to create motion

Electric Generator – uses a moving magnet & a conductor (wire) to create current

DC Motor



AC Motor



3 main components of an Electric Motor

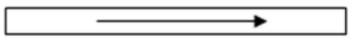
1. Source of current
2. Conductor
3. Magnet

Summary Notes Magnetism

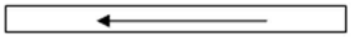
Practice Problems:

1. Draw the magnetic field lines around the following current- carrying conductors. The direction of the current is shown. "×" means the current is "going into the page, away from you", and "·" means the current is "coming out of the page, toward you".

(a)



(b)

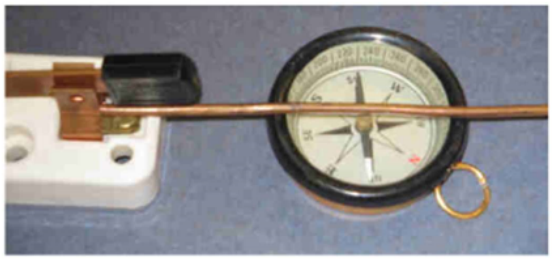


(c)

(d)

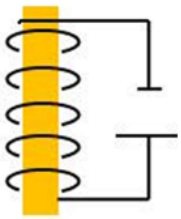
2.

If the white tip of this compass is the N-pole of the compass, which way is current travelling in this conductor?

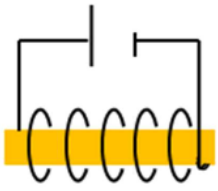


3. Show the direction of the magnetic fields around the two solenoids below.

a.



b.



Summary Notes Magnetism

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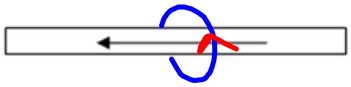
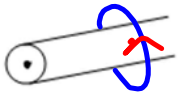
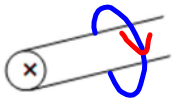
(b)



(c)



(d)



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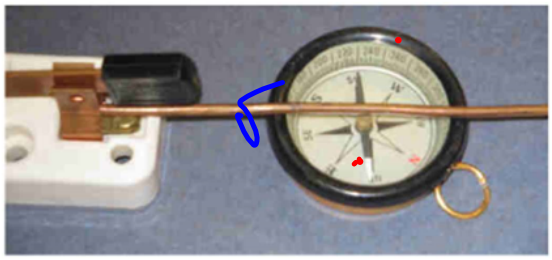

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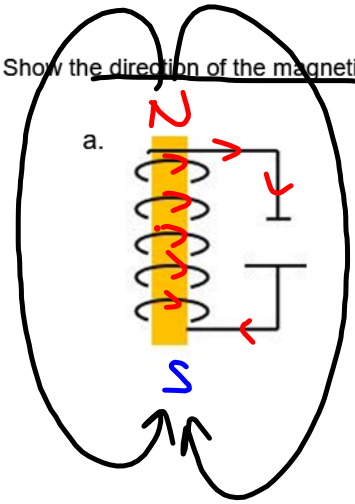
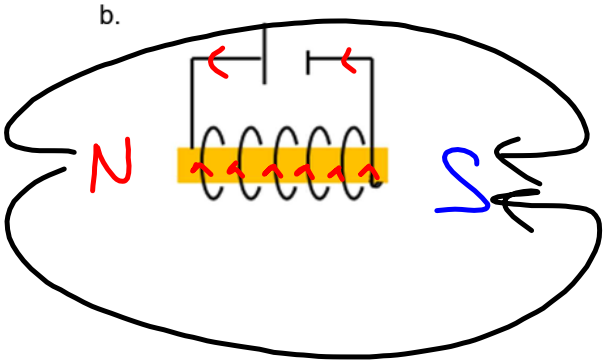


b.



Motor Principal

Show the magnetic field lines.
Show the direction of the force on the current carrying conductor shown below?