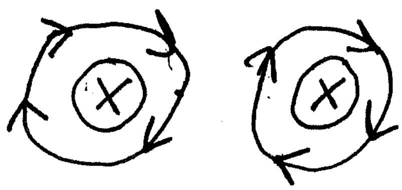
Magnetic Force

With permanent magnets ___Opposite___ poles attract and ___like___ poles repel each other.

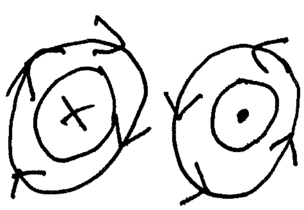
Surrounding a current carrying wire there is a ___magnetic field___. So we will assume the wire will be affected by magnetic forces.

Two parallel wires carry current in the same direction. Will the wires attract each other or repel each other?



Attract because fields are in opposite directions

Two parallel wires carry current in opposite directions. Will the wires attract each other or repel each other?

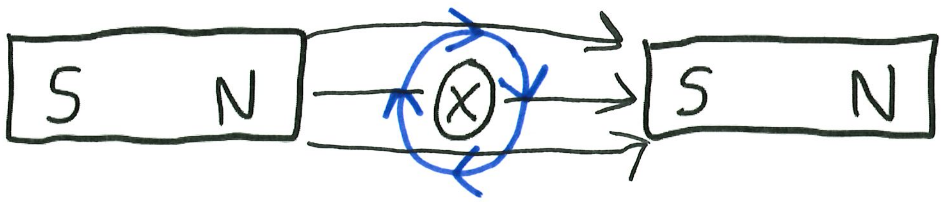


Repel since fields point in same direction

Wires in Magnetic Fields

A current carrying wire in a magnetic field will experience a magnetic force

A current carrying wire is placed between two permanent magnets as shown

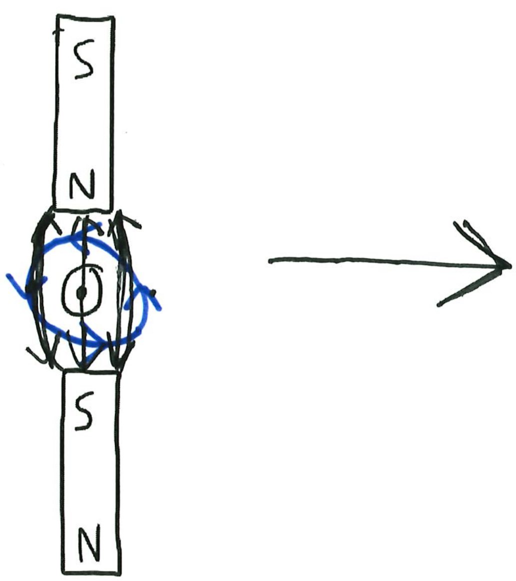


Above the wire, both the permanent magnetic field and the field generated by the wire point in the same direction. These fields will repel each other.

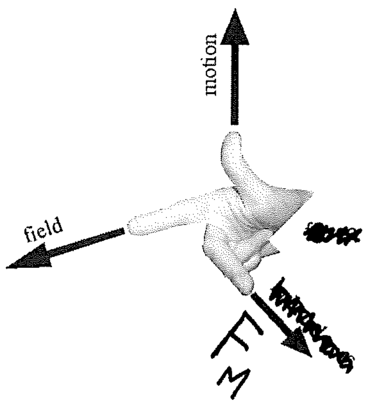
Below the wire the permanent magnetic field and the field generated by the wire point in different directions. These fields will attract each other.

The result is a downward force from above the wire and an downward force from below the wire. The wire will move down the page.

Example: In which direction will the current carrying wire shown be pulled by magnetic force?



The 3[rd] Right Hand Rule:



The magnitude of the magnetic force on a conduction can be calculated as

$$F_M = BI\ell \sin\theta$$

- B ← magnetic field strength
- I ← current
- ℓ ← length of wire in field
- θ ← angle between magnetic field and current

Note that if the conduction is perpendicular to the magnetic field this formula becomes

$$F_M = BI\ell \quad \text{since } \sin 90^\circ = 1$$

If the conduction is parallel to the magnetic field then

$$F_M = 0 \quad \text{since } \sin 0 = 0$$

Example: Calculate the magnetic force on a wire of length 0.10 metres, which runs perpendicular to a magnetic filed of strength $6.2\times 10^{-2}\ T$, if there is a current of 1.2 A flowing through the wire.

$$F_M = BI\ell$$

$$= (6.2\times10^{-2})(1.2)(0.10)$$

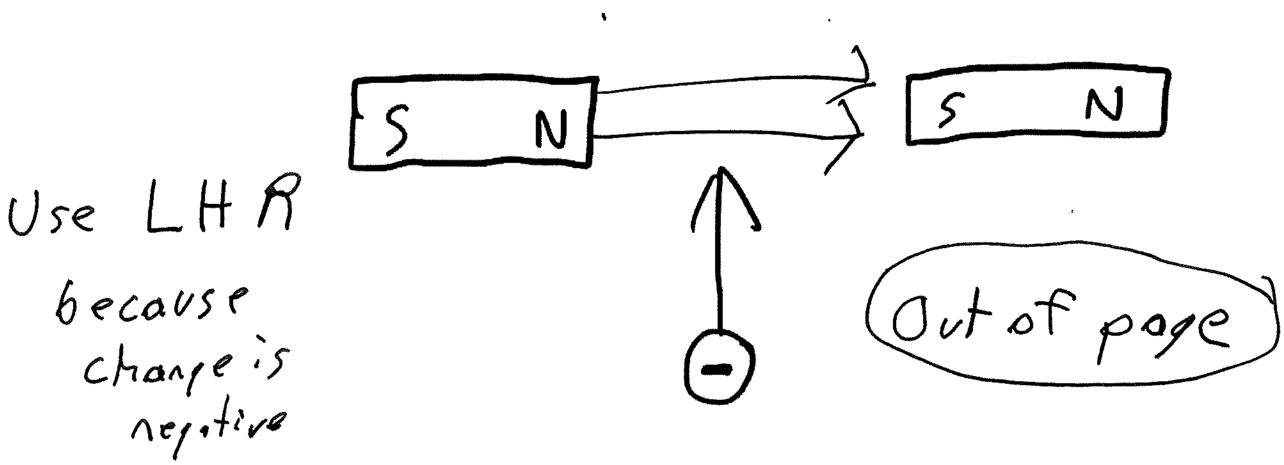
$$= 0.0074\ N$$

Moving Charges in Magnetic Fields

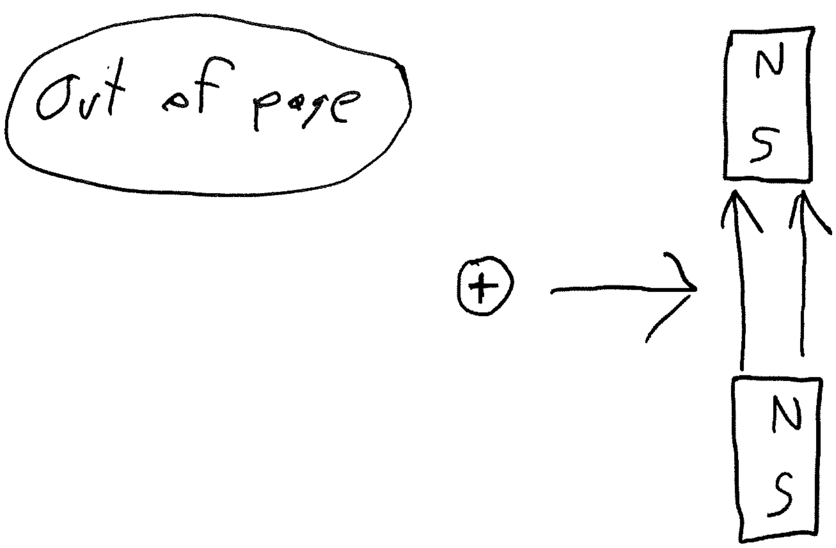
In the same way that charged particles moving through a wire will experience a force in a magnetic field so will charged particles.

To determine the direction the force acts on a particle we use the third right hand rule if the object is positively charged, and since it will be opposite if the object is negatively charged we use the same rule but with our left hand for negatively charged particles.

Example: In which direction will the negatively charged particle be pushed by the magnetic field?



Example: In which direction will the positively charged particle be pushed by the magnetic field?



The magnitude of force acting on a moving charged particle in a magnetic field can be found using the equation

$$F_M = B\,Q\,V \sin\theta$$

- B — Magnetic Field strength
- Q — charge of particle (don't write negative)
- V — velocity of particle
- θ — angle between direction of particle and magnetic field

$F_M = Bqv$ if pependicular to field

Example: A +62 μC particle is moving at 620 m/s perpendicularly through a magnetic field of strength 0.0056 T. What is the magnetic force being applied to the particle?

$$F_M = (0.0056)(62\times10^{-6})(620)$$

$$= 0.000021526\ N$$

$$= 0.00021526$$

$$\approx 2.2\times10^{-4}\ N$$