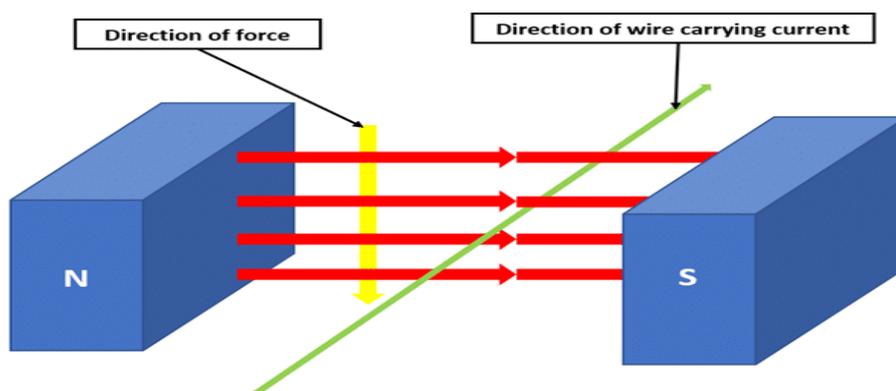


The Motor Effect

► Definition

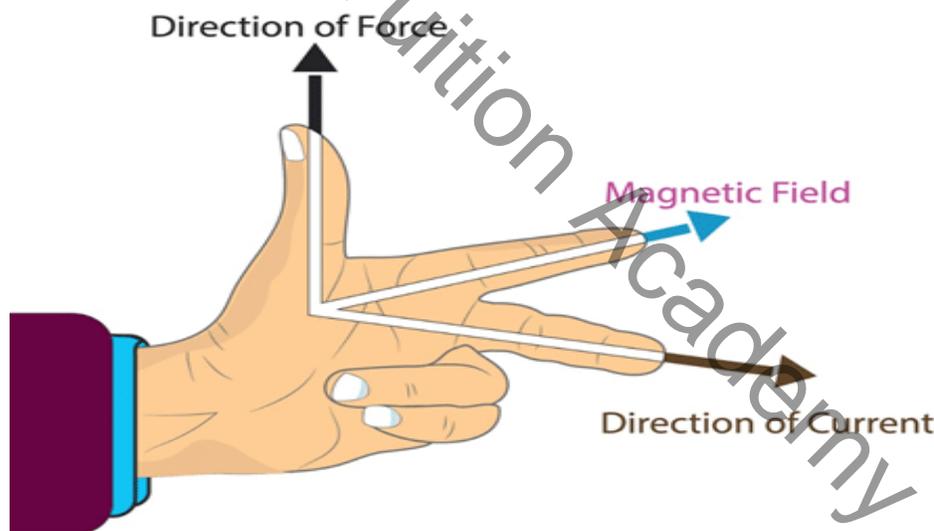
“A wire carrying a current will experience a force in the presence of a magnetic field. This is known as the motor effect.”

- A current-carrying wire produces its own magnetic field, as does a permanent magnet. This means that if we place the wire (or coil) between the north and south poles of two permanent magnets, then the two magnetic fields will interact.
- The interaction between the two magnetic fields will result in a force on the wire, pushing it out of the field. This force will be at a right angle to both the direction of the wire carrying current and the direction of the magnetic field.
- The force is always greatest when the direction of the current is 90° to the direction of the magnetic field.
- The direction of the force is always at 90° or perpendicular to both the direction of the current and the direction of the magnetic field.
- There is no motor effect force if the current and magnetic field are parallel to each other.
- To find the direction of the force, we need to know these directions :
 - The direction of the magnetic field
 - The direction of the current in the wire



Fleming's Left hand Rule

- To understand how the two factors affect the force, we can use a concept called Fleming's left-hand rule.
- Using your left hand, this rule involves:
 - Point your index finger forward – This represents the direction of the magnetic field, pointing from the north to the south pole.
 - Extend your middle finger to the side – This represents the direction of the current.
 - Point your thumb upward – The direction your thumb points indicates the direction of the force felt by the wire.



Calculating the motor effect force

- Not only do we want to know the direction of the force on the wire, but we also want to know how big this force is.
- If the wire is perpendicular to the magnetic field lines, the motor effect formula relates the current through the wire, the length of the wire that is in the magnetic field, and the magnetic field strength to the force that the wire experiences.

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- To calculate the force on a wire carrying a current at right angles to a magnetic field, use the equation:

$$\text{force} = \text{magnetic flux density} \times \text{current} \times \text{length}$$

$$F = BIL$$

This is when:

- F is force in newtons (N)
- B is magnetic flux density (magnetic field strength) in tesla (T)
- I is current in amperes - also referred to as amps (A)
- L is length in meters (m)

From this equation, we deduce that:

- **maximum force** occurs when the conductor is perpendicular ($\theta = 90^\circ$) to the magnetic field lines
- **minimum force (zero)** occurs when the conductor is parallel ($\theta = 0^\circ$) to the magnetic field lines

EXAMPLE

Q: 4 A of current flows through a 20 cm length of wire. The wire is placed at a right angle in a 0.6 T magnetic field. Calculate the force acting on the wire.

Solution:

Step 1: Identify the equation:

$$F = B \times I \times L$$

Step 2: List the known quantities:

$$B = 0.6 \text{ T}$$

$$I = 4 \text{ A}$$

$$L = 20 \text{ cm}$$

Step 3: Convert the length to meters:

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$$L = 20 \text{ cm}$$

$$20 \text{ cm} = 20 \div 100 = 0.2\text{m}$$

Step 4: Substitute the values into the equation:

$$F = 0.6 \times 4 \times 0.2$$

$$= \mathbf{0.48 \text{ N}}$$

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