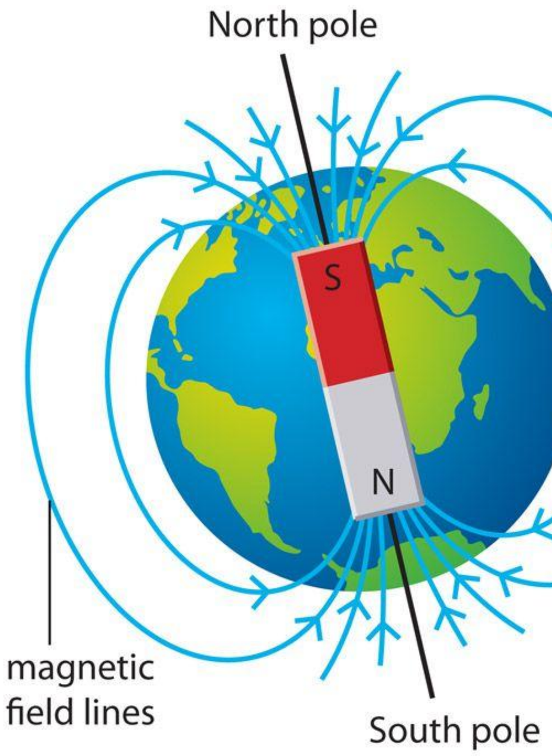
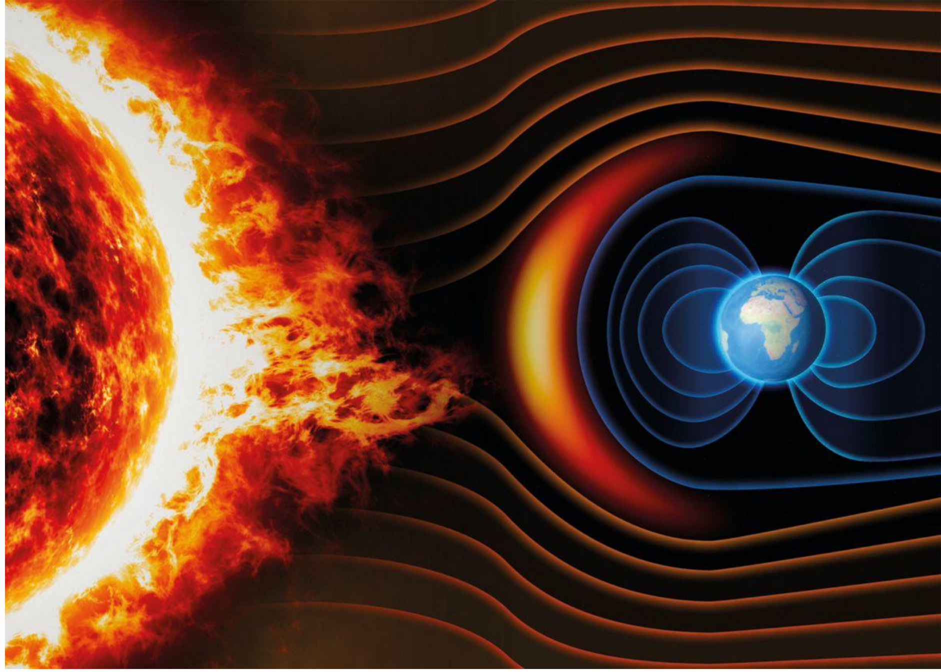


# Chapter 17

## Magnetic field

**Prepared & Presented by: Mr. Mohamad Seif**

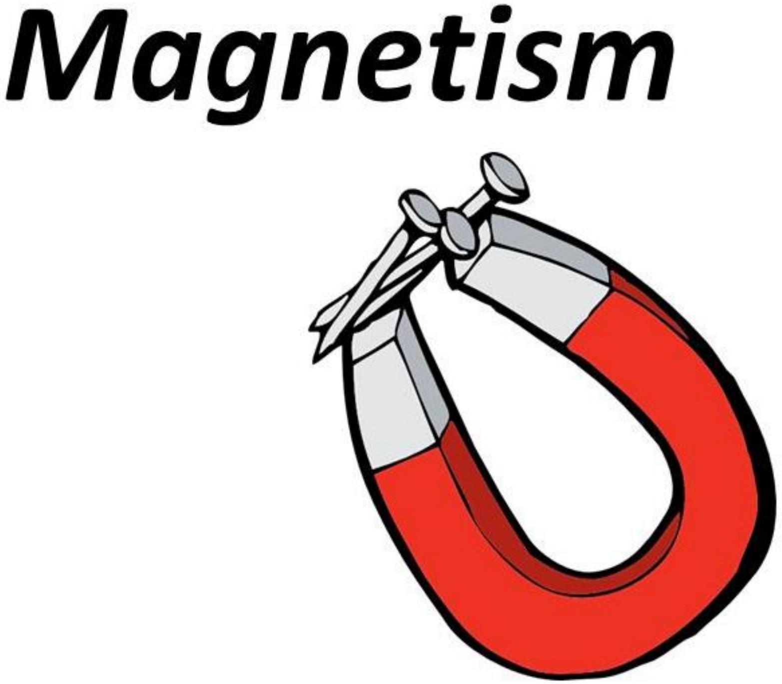
# OBJECTIVES

1. Introduction about magnetism
2. Definition and properties of magnet
3. Magnetic field lines

# Introduction about magnetism

**Magnetism** is one of the important branches in physics.

**Magnetism:** refers to a phenomenon associated with magnetic fields, which arise from the motion of electric charges.

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# Definition and properties of magnet

**Magnet:** is a material or object that produces a magnetic field.

The magnetic field produced by the magnet is invisible but is responsible for the most notable property of a magnet:

The property of a magnet is the attraction of some materials, such as iron, steel, nickel, and cobalt.

A magnet can attracts or repels other magnets.

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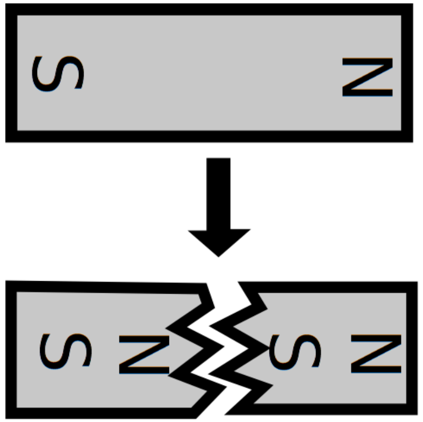
# Definition and properties of magnet

**Natural magnets:** are the one which exist naturally in the earth as lodestone.

**Artificial magnets:** are the ones manufactured in factories as the magnet used in loudspeakers.

**Every magnet has two poles, the north pole (N pole) and the south pole (S pole)**

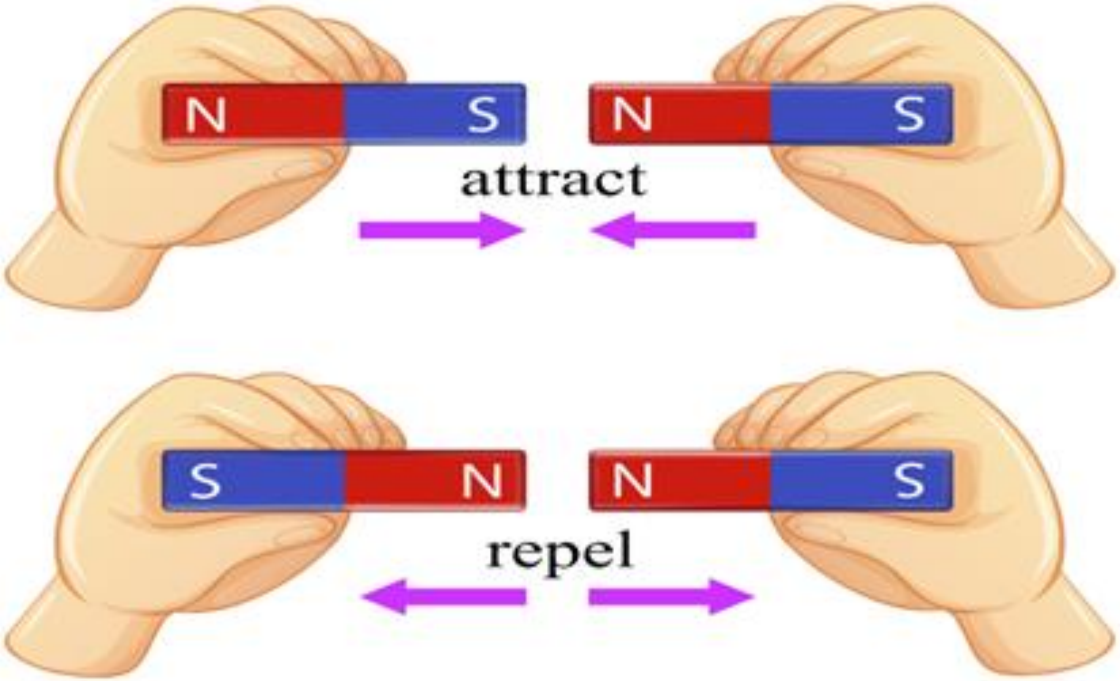

**We can’t separate the poles of a magnet, so if we break the magnet, we will obtain two magnets each with north and south poles..**



# Definition and properties of magnet

If we put two magnets near each other, we notice that:

- The unlike poles attract each other.
- The like poles repel each other.




**The magnetic effect of a magnet is strongest at the poles.**

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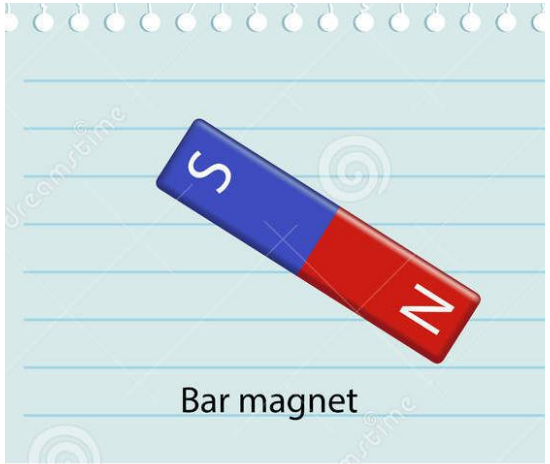
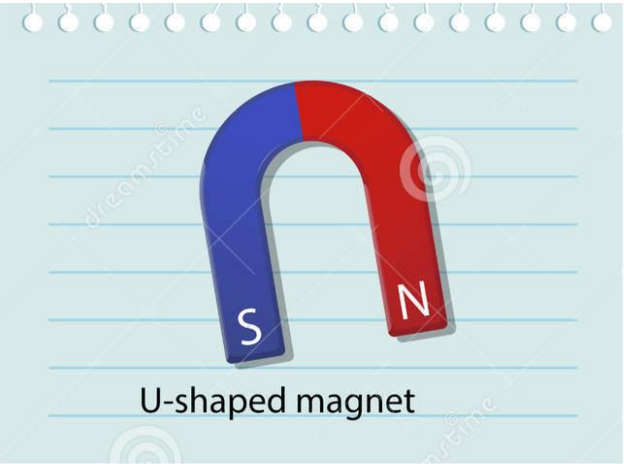
# Definition and properties of magnet

## Types of magnets







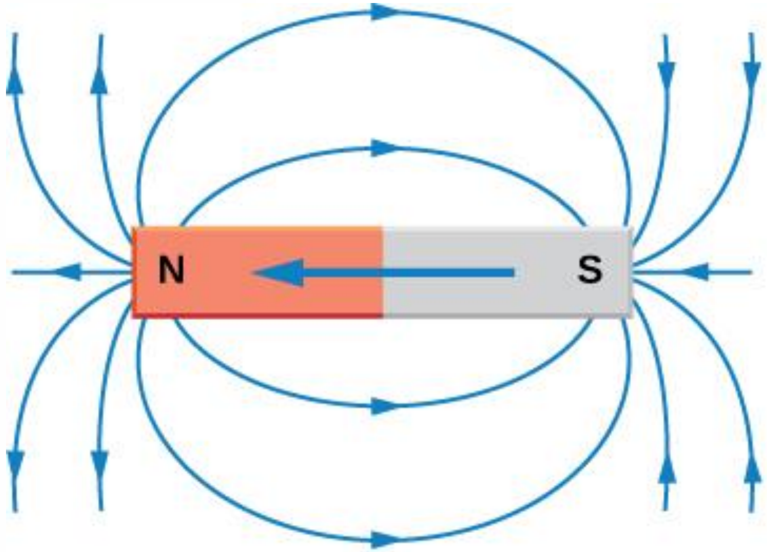

**Bar magnet** **Ring magnet** **U-shape magnet**

# Magnetic field lines

A magnetic field exists in a region surrounding a magnet.

These lines represent the magnetic field lines of the bar magnet

The magnetic field lines are imaginary lines that are drawn so that:




- Out side the magnet the lines directed from north pole to south pole.
- Inside the magnet, the lines directed from south pole to north pole

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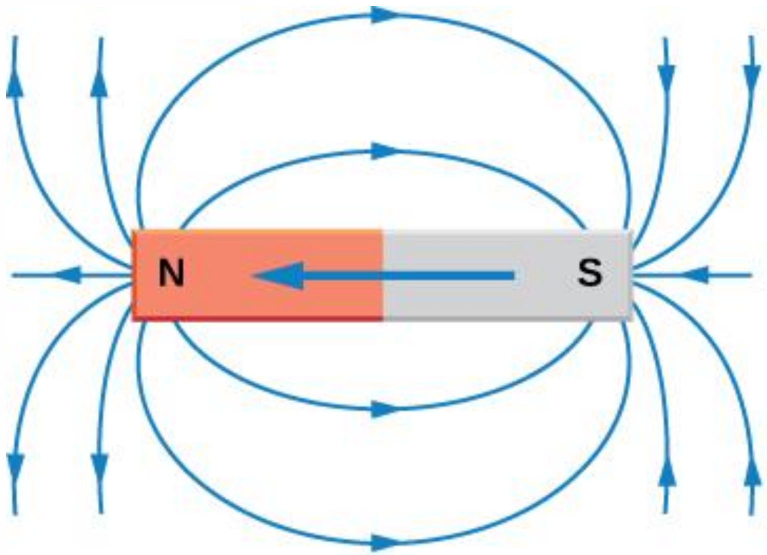
# Magnetic field lines

The symbol of magnetic field is $\vec{B}$ exists in a region surrounding a magnet.
The SI unit of the magnetic field is tesla (T).
Tesla is very large unit of magnetic field, so we use the sub units as milli-Tesla (mT) and micro-Tesla ($\mu T$).




Milli-Tesla ($mT$) $\xrightarrow{\times 10^{-3}}$ Tesla ($T$)

micro-Tesla (µ$T$) $\xrightarrow{\times 10^{-6}}$ Tesla ($T$)

# Magnetic field lines

## Measurement of magnetic field strength:

The magnitude B of the magnetic field is called magnetic field strength.

The magnetic field strength is measured by tesla-meter.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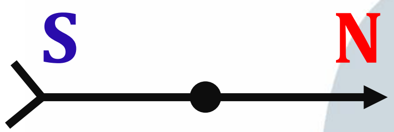
# Magnetic field lines

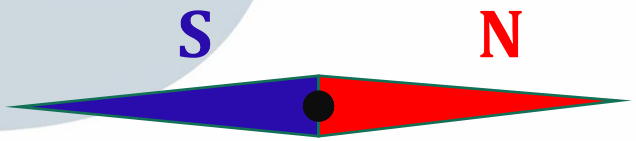
## Magnetic needle:

The magnetic needle is a permanent magnet used to indicate the direction magnetic field.

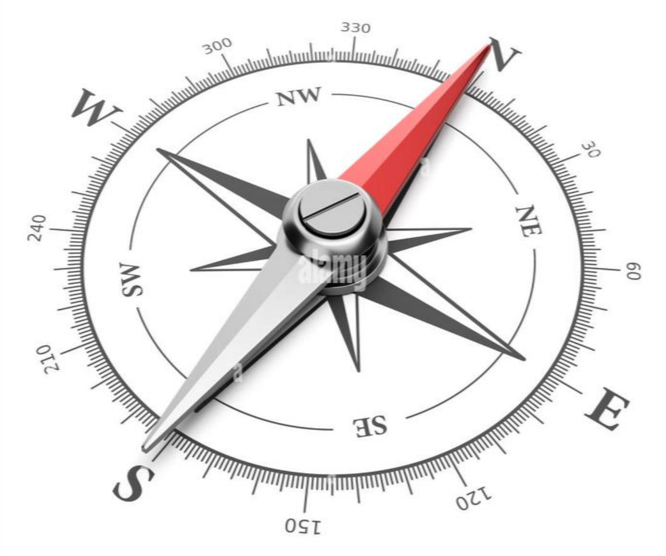
The magnetic needle can be represented by two forms as in figure (1) and (2)




(1)

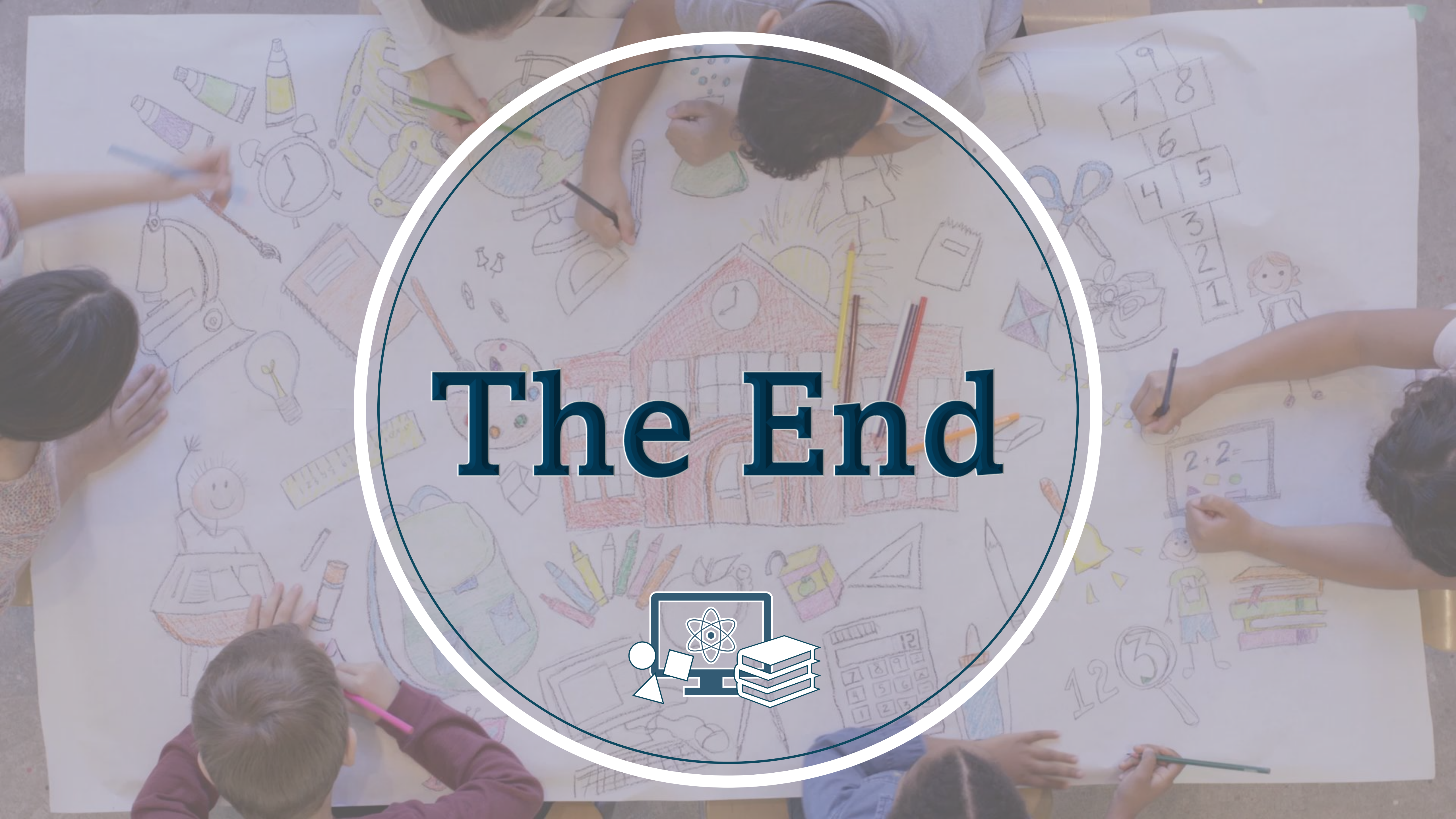



(2)




The center of magnetic needle is placed at point A as shown in the figure.

The N pole is directed towards the magnetic field $\vec{B}$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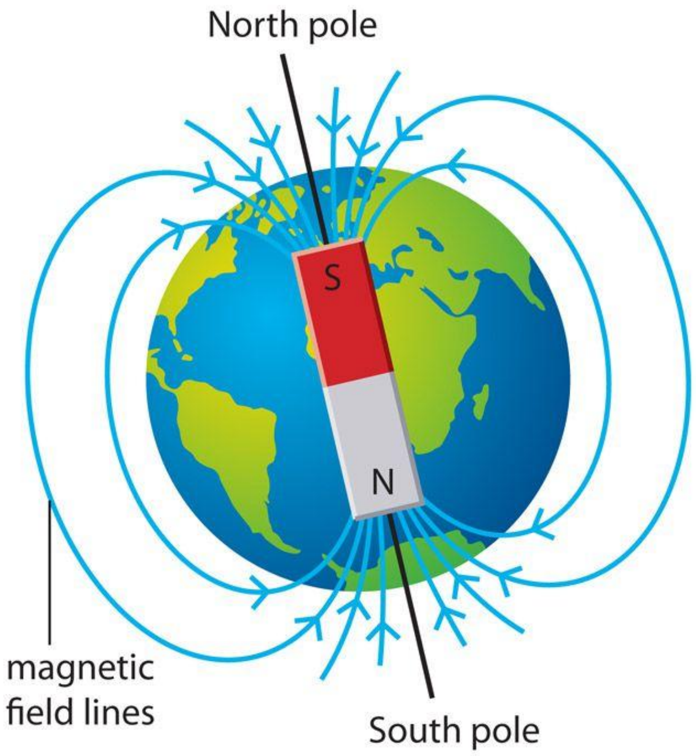


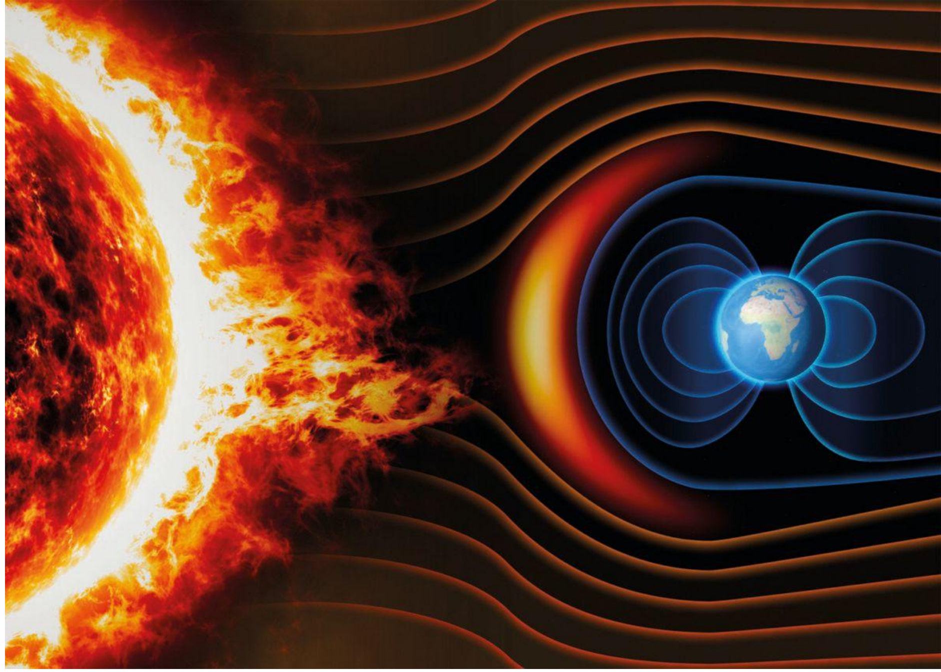

# Chapter 17

## Magnetic field

**Prepared & Presented by: Mr. Mohamad Seif**

# OBJECTIVES

1. Determine the Resultant magnetic field
2. Terrestrial magnetic field

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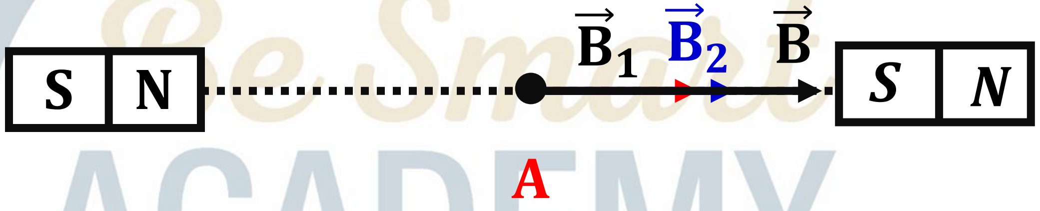
# Resultant magnetic field

**The resultant magnetic field $\vec{B}$ of two magnetic fields $\vec{B}_1$ and $\vec{B}_2$ is given by :** $\boxed{\vec{B} = \vec{B}_1 + \vec{B}_2}$

**In order to calculate the value of the resultant magnetic field $\vec{B}$:**

**1) If $\vec{B}_1$ and $\vec{B}_2$ are parallel and having same direction then:** $B = B_1 + B_2$




**Example:**

$B_1 = 0.5T$ and $B_2 = 1.2T$

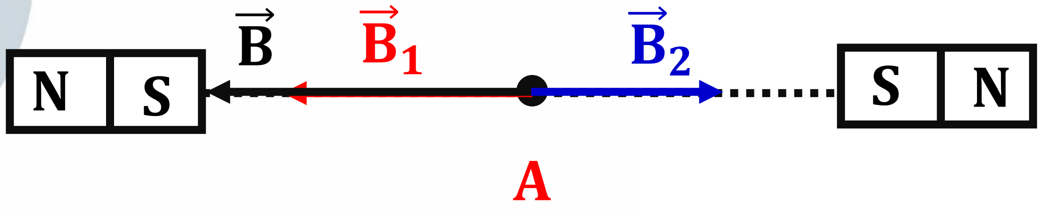
$\vec{B} = \vec{B}_1 + \vec{B}_2$ ➡ $B = B_1 + B_2 = 0.5 + 1.2$ ➡ $B = 1.7T$

# Resultant magnetic field

3) If $\vec{B}_1$ and $\vec{B}_2$ are parallel and having opposite direction then:

$\vec{B} = \vec{B}_1 + \vec{B}_2$ ➡ $B = |B_1 - B_2|$

The direction of $\vec{B}$ is with the one of larger value




**Example:**

$B_1 = 0.95T$ and $B_2 = 0.4T$

$\vec{B} = \vec{B}_1 + \vec{B}_2$ ➡ $B = |B_1 - B_2| = |0.95 - 0.4|$

➡ $B = 0.55T$

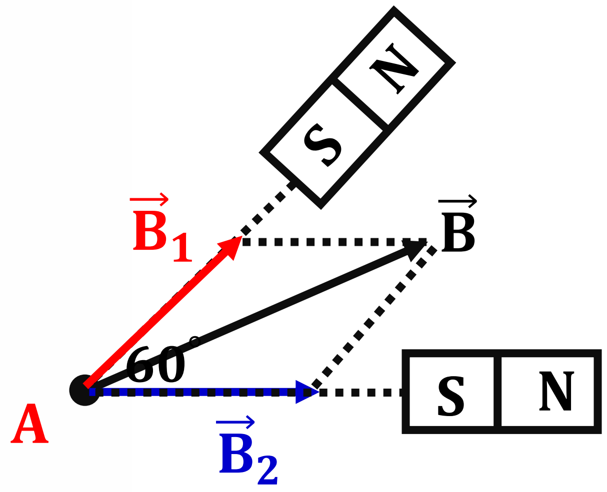
# Resultant magnetic field

**4) If $\vec{B}_1$ and $\vec{B}_2$ are making an angle $\alpha$ then:**

$$\vec{B} = \vec{B}_1 + \vec{B}_2 \Rightarrow B^2 = B_1^2 + B_2^2 + 2B_1B_2\cos\alpha$$

**Example:** $B_1 = 4T$ and $B_2 = 3T$

$$\vec{B} = \vec{B}_1 + \vec{B}_2 \Rightarrow B^2 = B_1^2 + B_2^2 + 2B_1B_2\cos\alpha$$




$$B^2 = (4)^2 + (3)^2 + 2 \times 4 \times 3\cos(60)$$

$$\Rightarrow B^2 = 37 \Rightarrow \mathrm{B} = 6.1\mathrm{T}$$

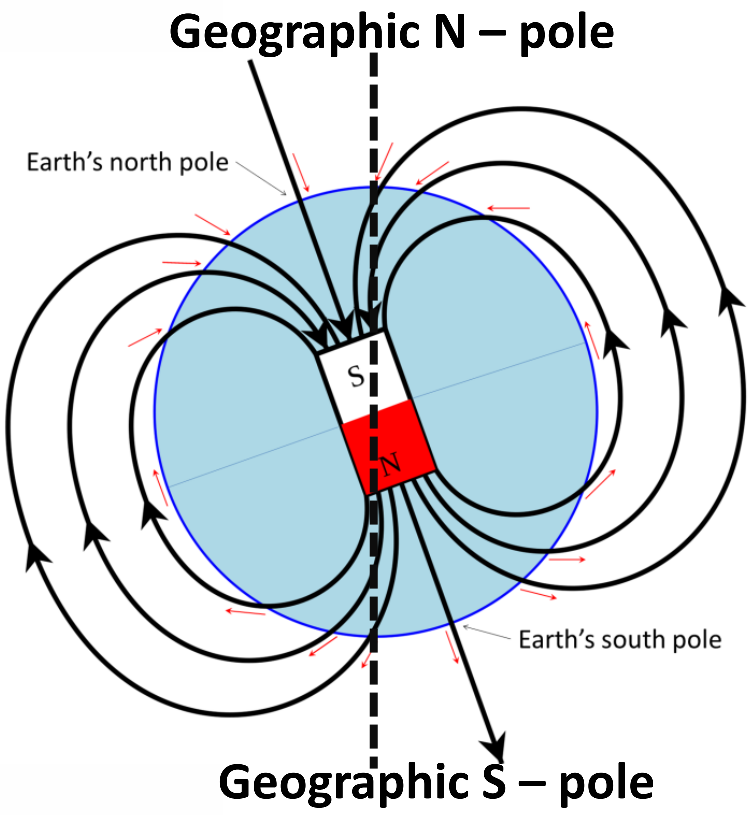
# Terrestrial magnetic field

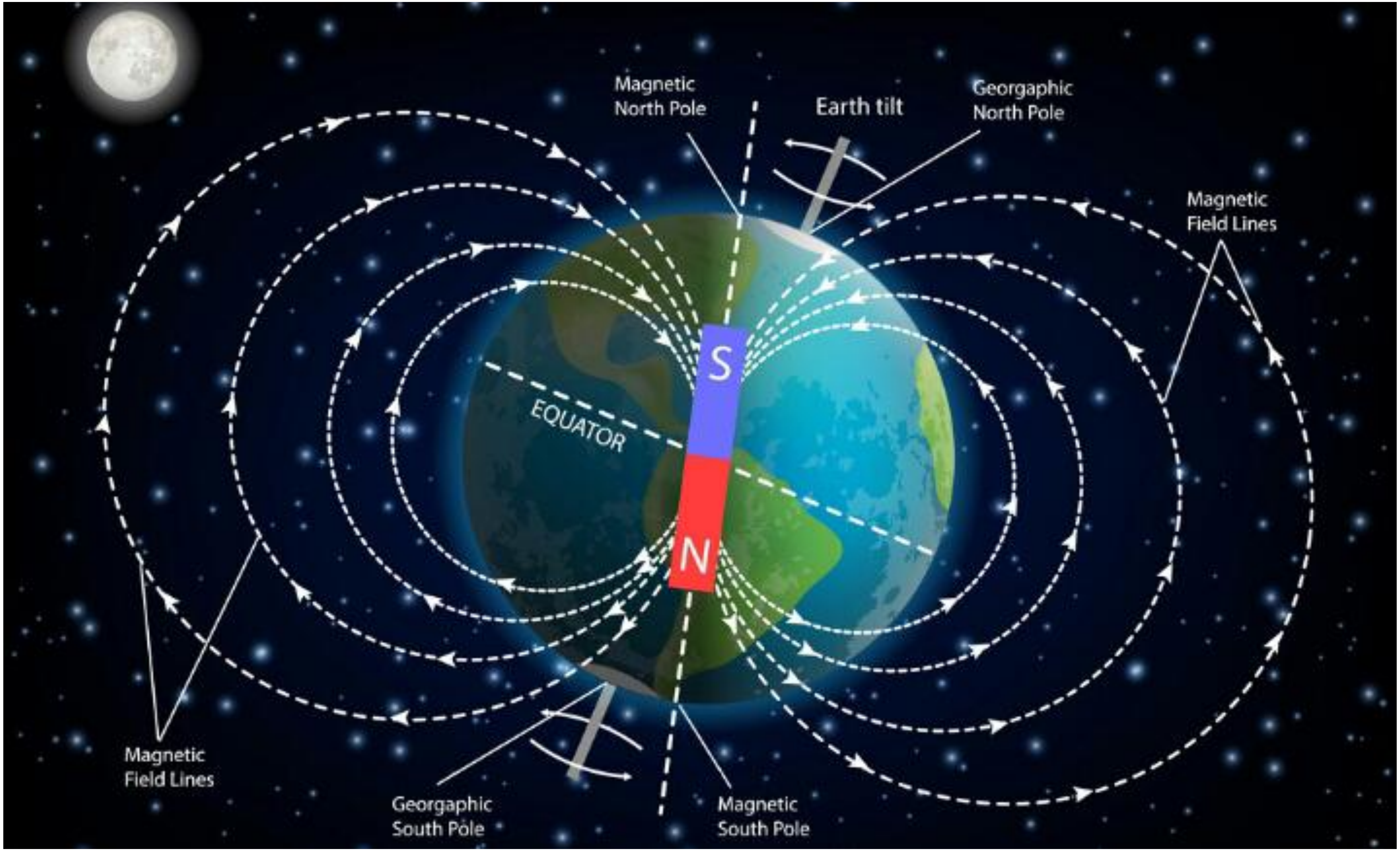
**The magnetic field created by the Earth is called terrestrial magnetic field ($\vec{B}_T$) or geomagnetic field.**

**The terrestrial magnetic field of the earth is equivalent to that created by a huge bar magnet inside the earth.**

**The S-pole of the earth's bar magnet is located near the N-pole of the earth.**

**The S-pole of the earth's bar magnet attracts the N-pole of a magnetic needle.**

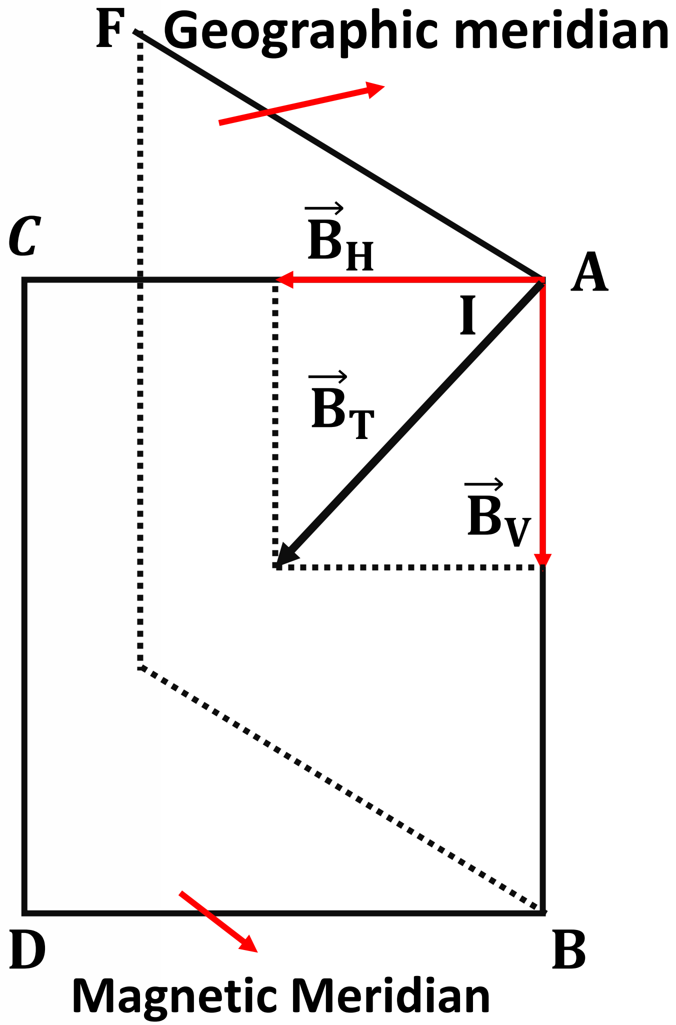



Magnetic
North Pole
Earth tilt
Georgaphic
North Pole
Magnetic
Field Lines
S
EQUATOR
N
Magnetic
Field Lines
Georgaphic
South Pole
Magnetic
South Pole

# Terrestrial magnetic field

## Components of terrestrial magnetic field:

- $\overrightarrow{B}_h$: horizontal component: parallel to the earth's surface and pointing to the geomagnetic north.
- $\overrightarrow{B}_v$: vertical component: directed towards the center of the earth.
- A magnetic needle, rotating in a horizontal plane, on vertical axis, indicates the direction of $\overrightarrow{B}_h$
- A magnetic needle connected to a string, indicates the direction of $\overrightarrow{B}_T$

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# Terrestrial magnetic field

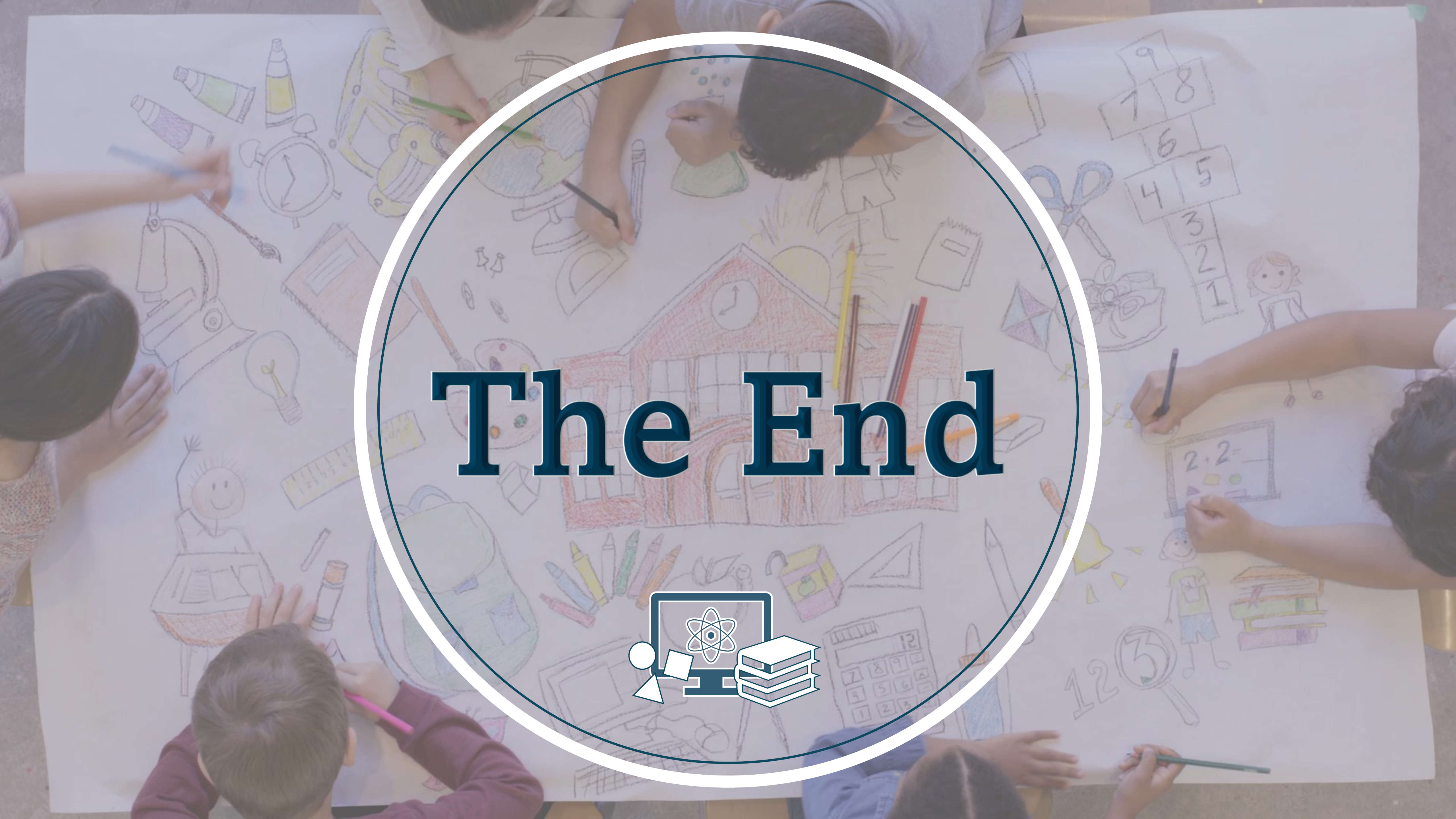
The terrestrial magnetic field is the vector sum of these two components: $\vec{B}_T = \vec{B}_H + \vec{B}_V$

Since $\vec{B}_H$ is perpendicular to $\vec{B}_V$ then the magnitude of the terrestrial magnetic field is:

$$B_T = \sqrt{B_H^2 + B_V^2}$$

Angle of inclination (I): the angle between the terrestrial magnetic field $\vec{B}_T$ and the horizontal component $(\vec{B}_H)$ of terrestrial magnetic field is:

$$\tan I = \frac{B_V}{B_H}$$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