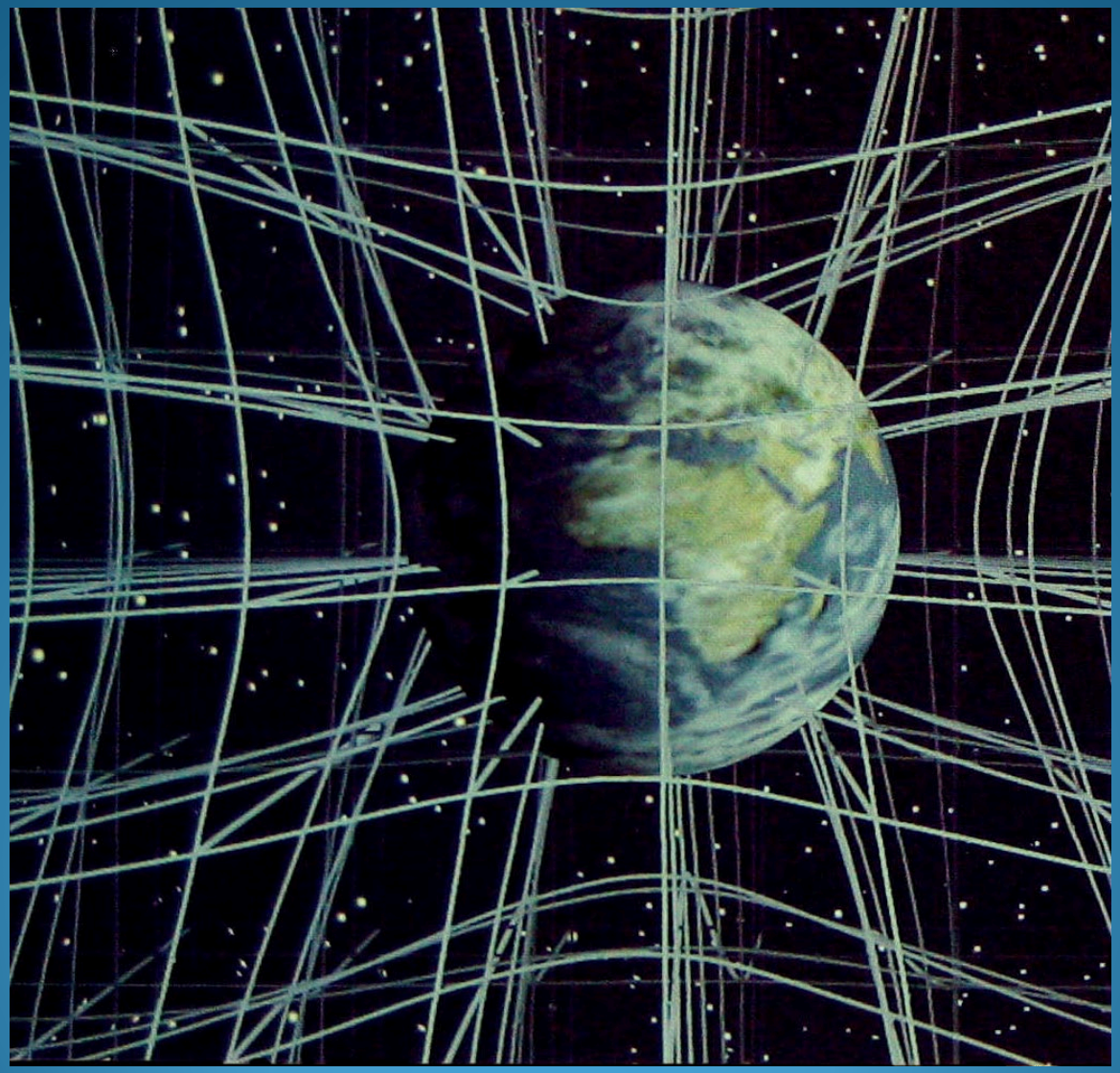
Fields



Curriculum

- define a field as a property of space around a mass, an electric charge or a magnet that causes another mass, electric charge or magnet introduced in to this region to experience a force
- compare the interaction between static electric charges with the interaction between magnetic poles and with the interaction between two masses at a distance
- compare the basic properties (source, direction and strength) of vector fields (gravitational, electric and magnetic), as determined by a test object
- draw diagrams to represent fields (*e.g., gravitational, electric or magnetic fields*), using field lines

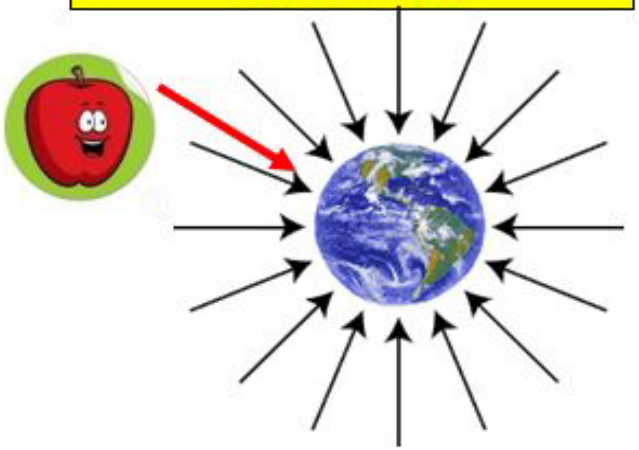
What is a field?

- A field is an invisible area of influence around an object
- If you place another object in the field it will experience a force
  - 1 object is said to be causing the field
  - The other object is experiencing the field is called test object

Gravitational field

- Things falling to Earth
- The Earth orbiting the sun

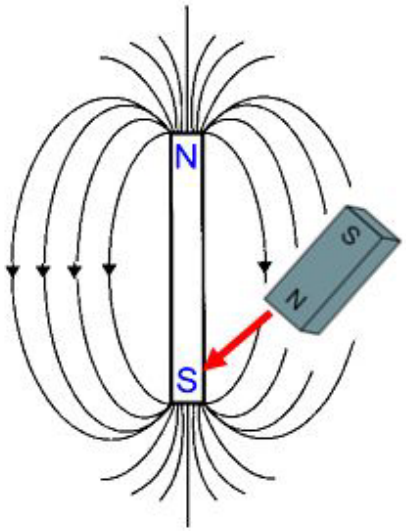
Test object: Anything with mass



Examples of **magnetic fields**:

- Magnets
- Using a compass

Test object: magnet



Gravitational Field

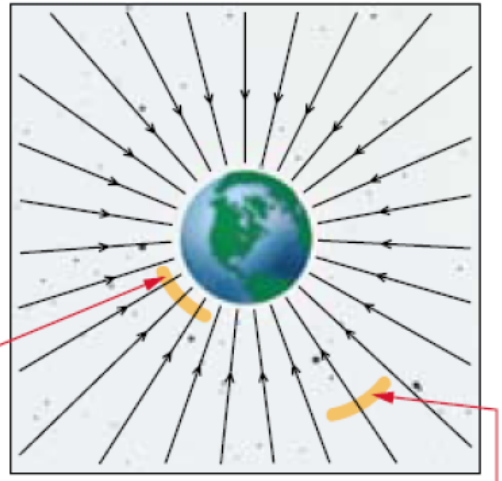
- Any object with **mass** creates a gravitational field
- A field is a 3D area of influence around it
- When the correct object is placed in the field, it will experience a force
- We can represent gravitational field with field lines

Field lines

- We often use field lines to represent the strength, direction and shape of field

Image of Earth from Space with Gravitational Field Lines Added

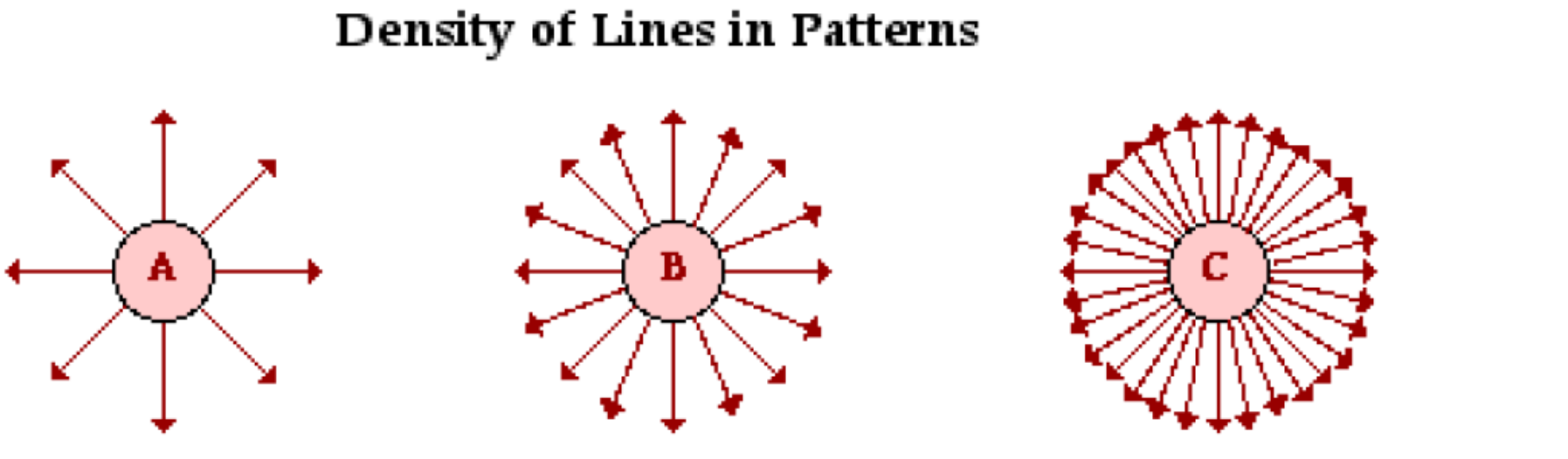
Although Earth's gravitational field is present, it is invisible.



The lower concentration of field lines indicates that the field is weaker here.

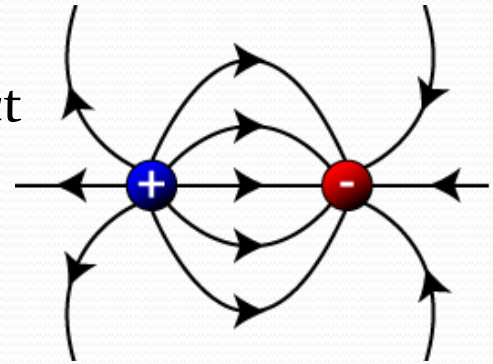
The higher concentration of field lines indicates that the field is stronger here.

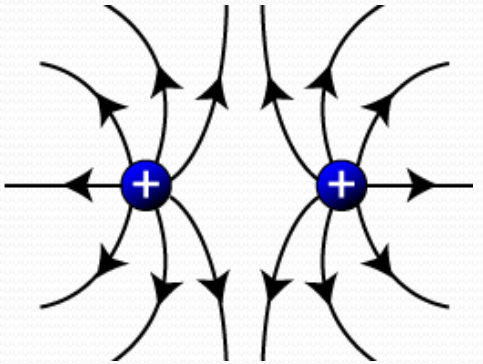
- More field lines indicate a stronger field
- The further you get from the charge, the weaker the field



Electric field

- A region of space around a charged object within which any charged object will experience a force.
- Any **charged** object surrounds itself with a field.
- Forces experienced may be attractive or repulsive forces.
  - Like charges repel
  - Unlike charges attract

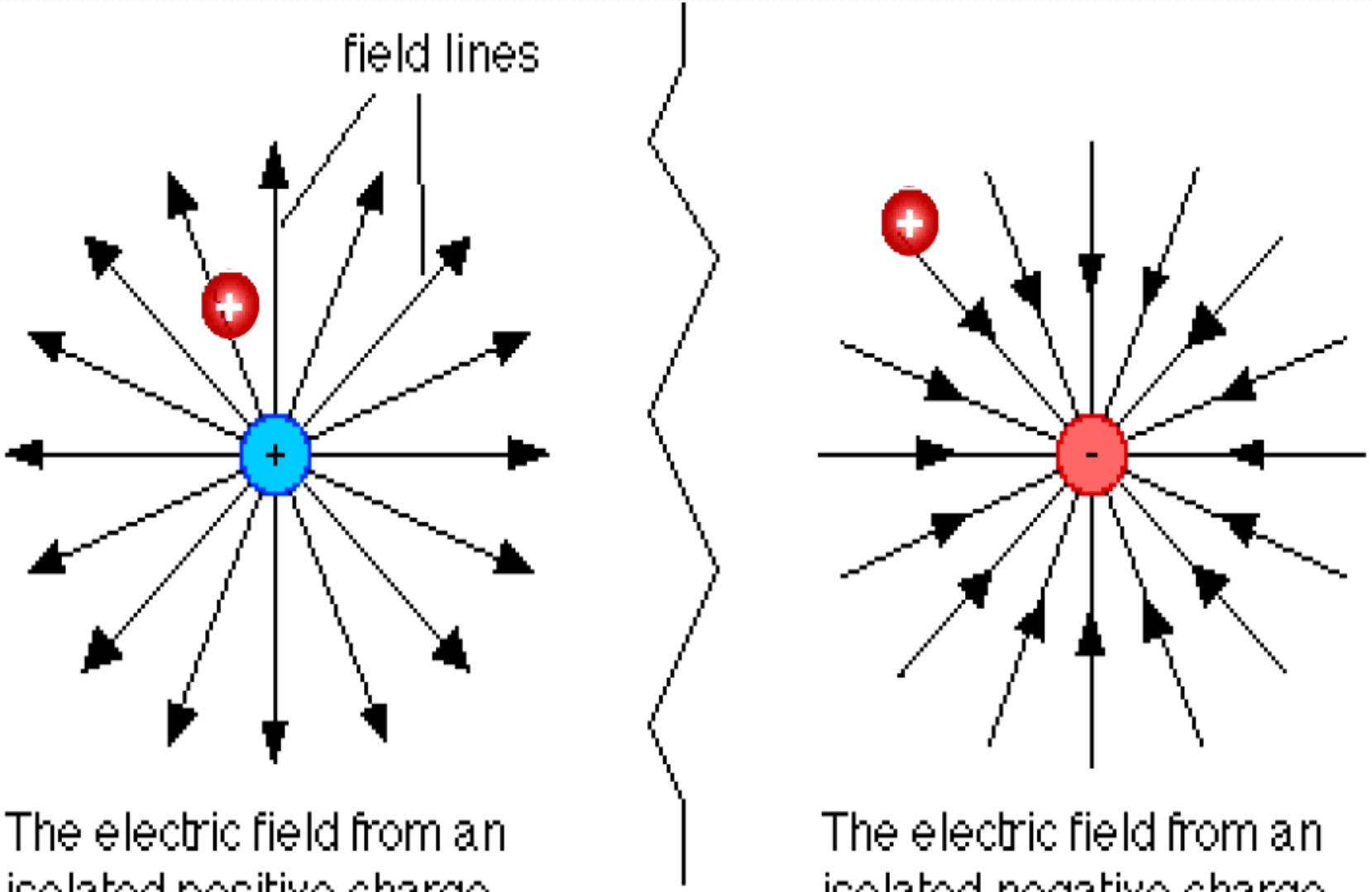




Direction of Electric Fields

- A **positive test charge** is used to determine the strength and direction of an electrical field

- The direction of an electric field is the direction a positive test charge would move when placed in an electric field



The electric field from an isolated positive charge

The electric field from an isolated negative charge

Magnetic field

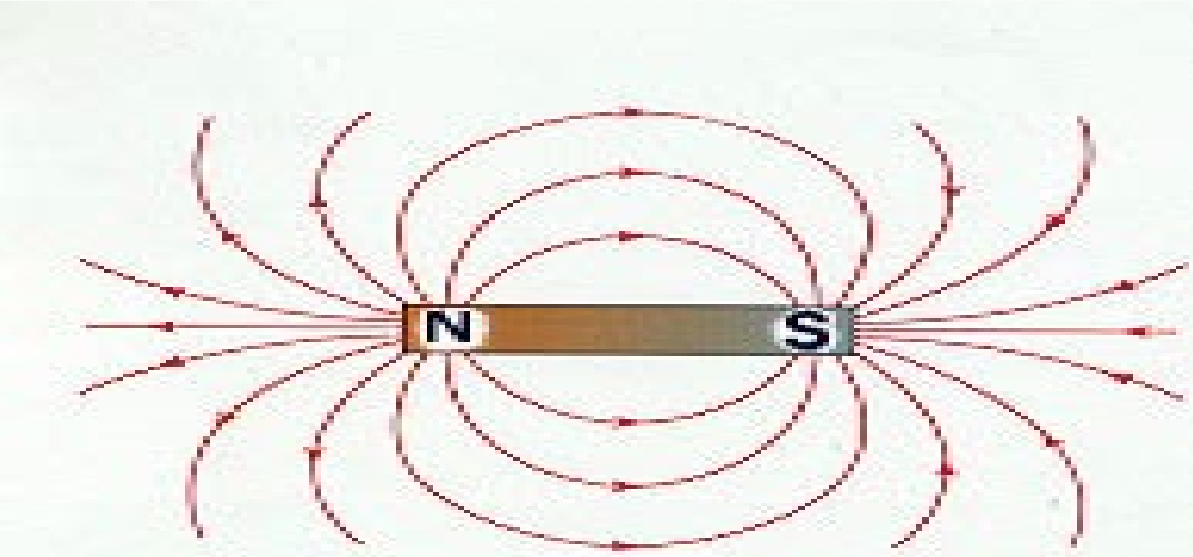
- Magnets also create fields.
- The forces experienced by magnets are both attractive and repulsive.

- Magnets do NOT create electric fields. They create magnetic fields. Magnets are not charged. They have **poles**!

- All magnets have a NORTH and a SOUTH POLE.
  - Two like poles will repel each other.
  - Two unlike poles will be attracted to each other.

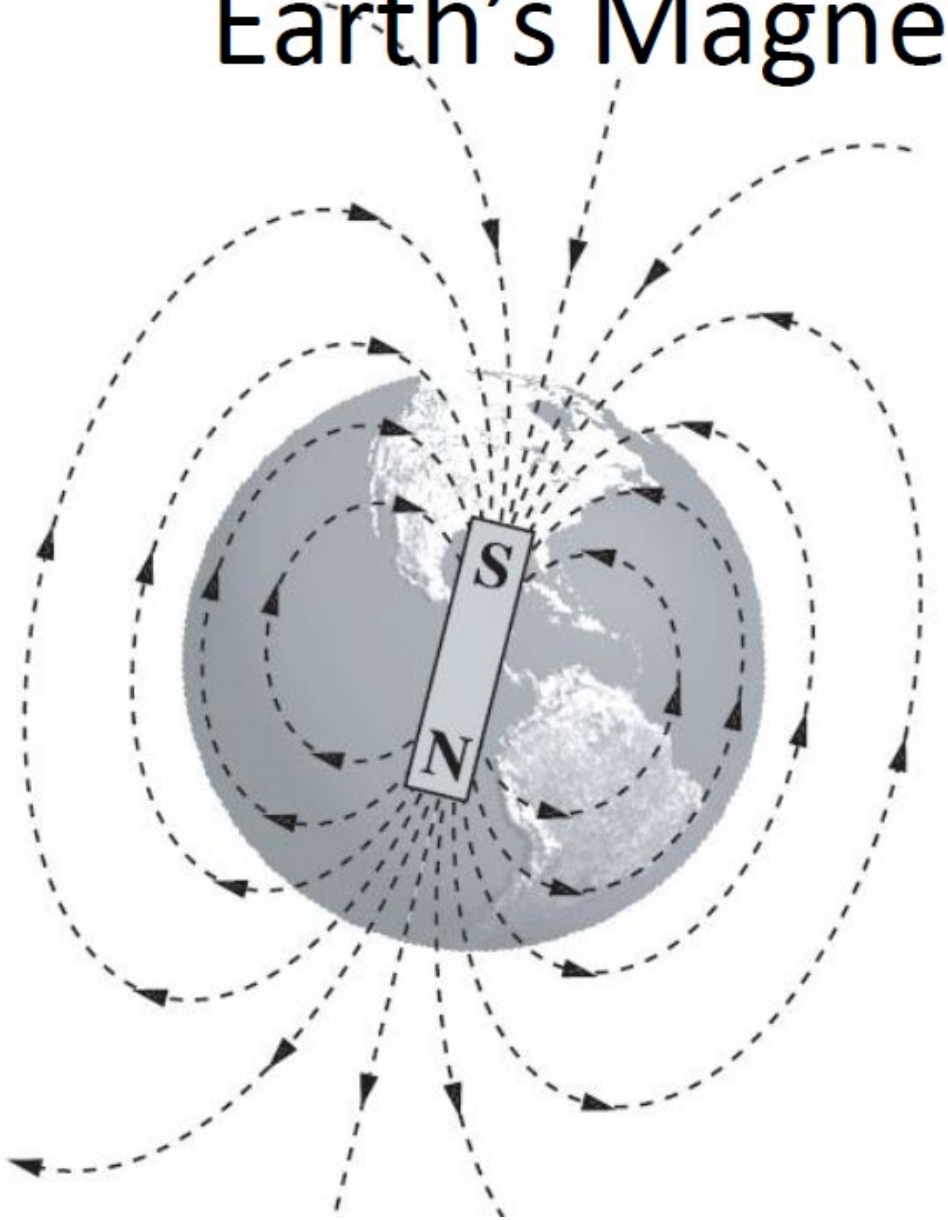
Drawing Magnetic Fields

- The electric field created by a magnet is away from the north pole and towards the south pole as below.



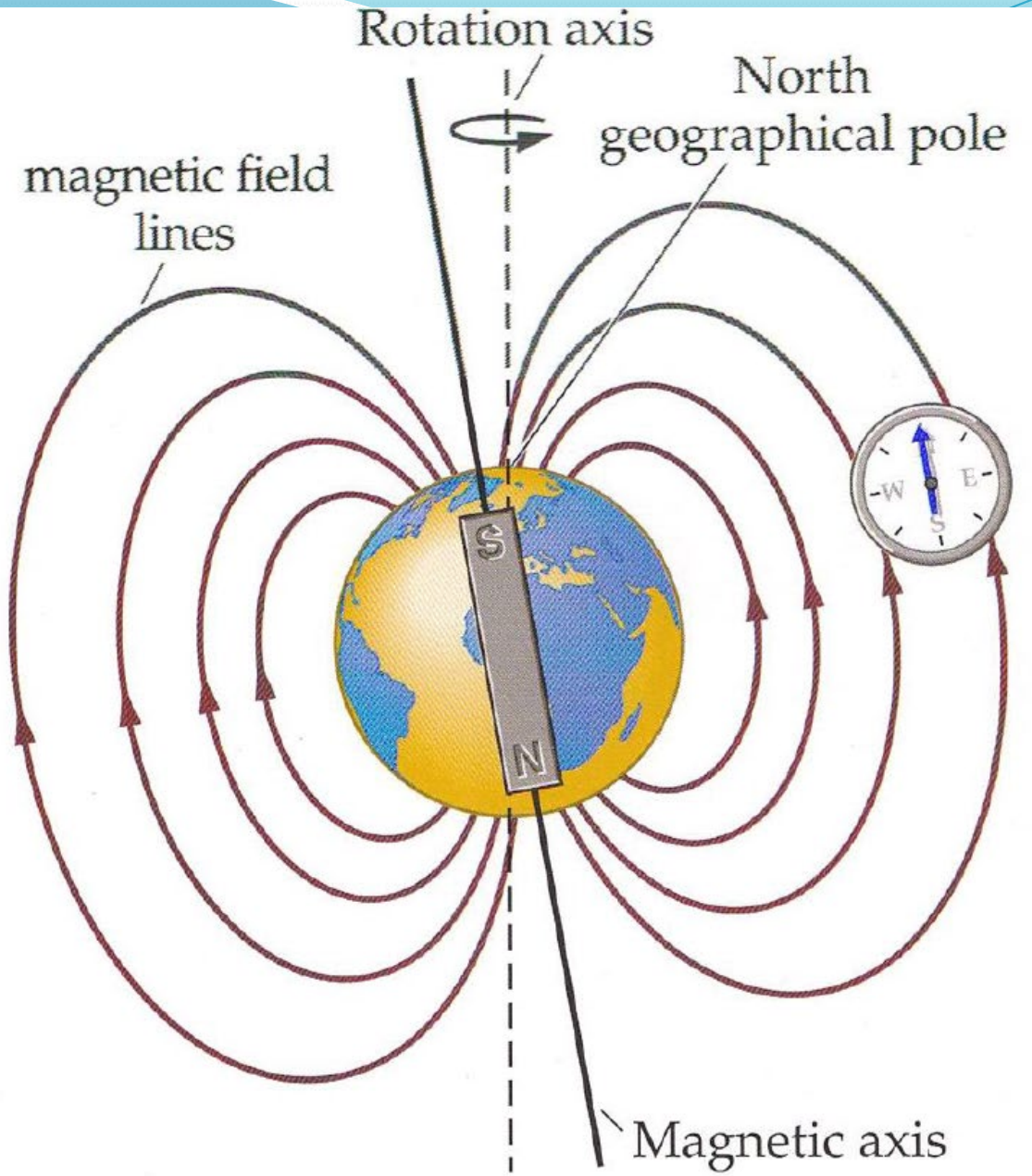
fields

Earth's Magnetic Field



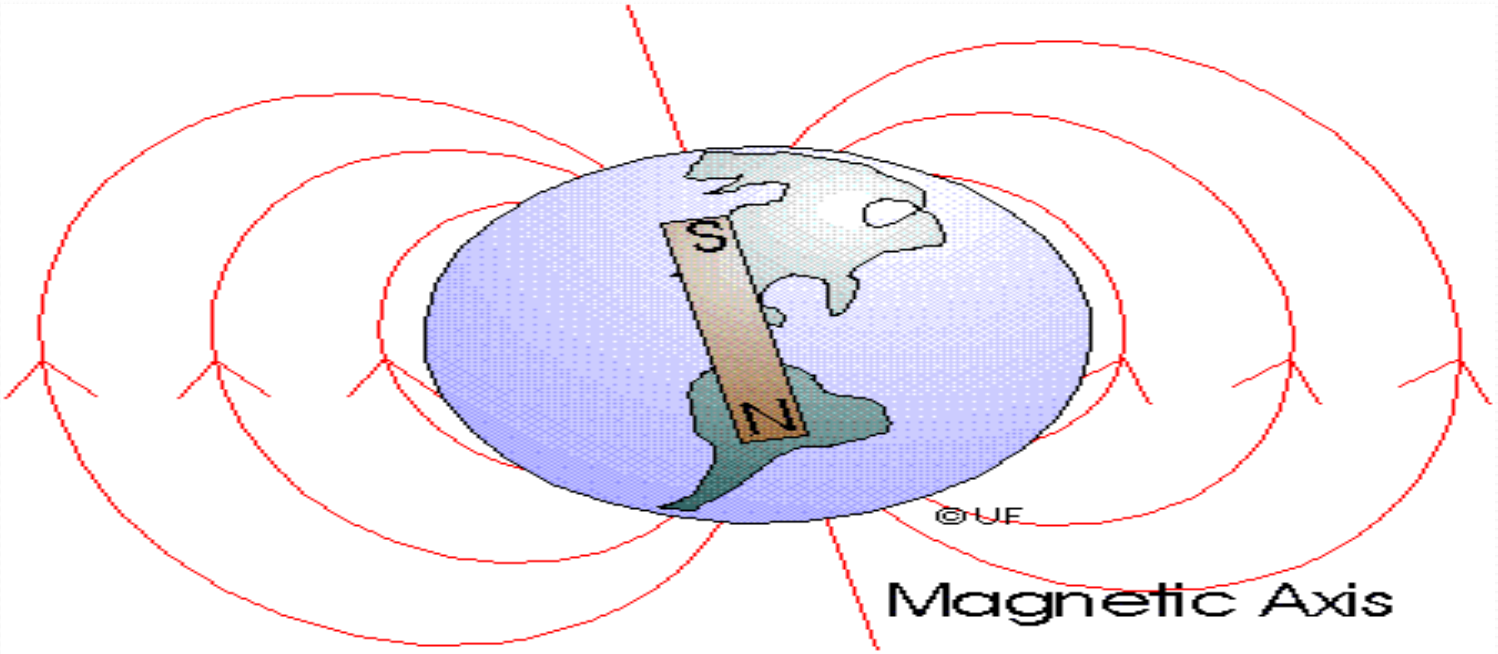
The geographic north pole is actually the magnetic south pole

- Compasses point north because they are attracted to a south magnetic pole



Uses of Magnets:

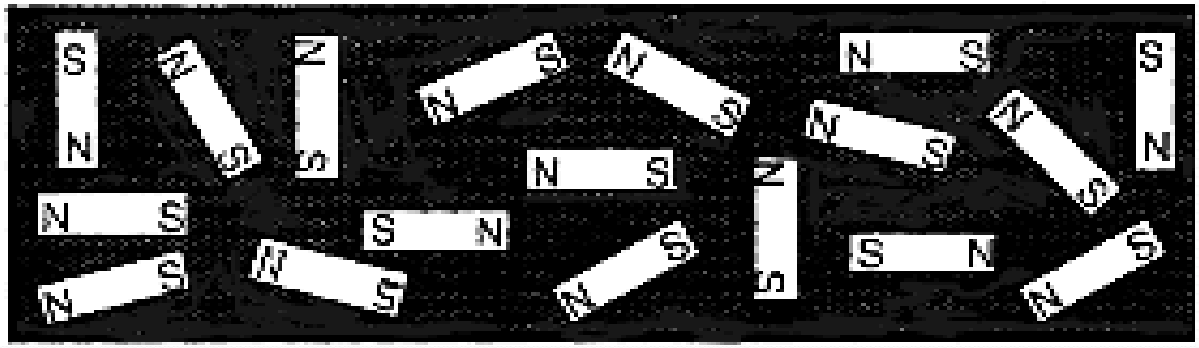
- Navigation



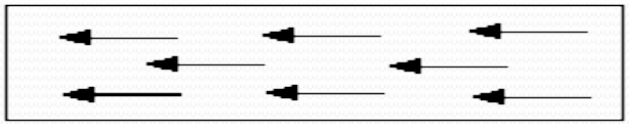
- generating electric currents
- motors

What makes some metals magnetic?

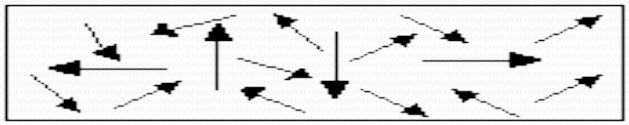
- Some metals called "**Ferromagnetic substances**" have strong magnetic properties. Examples: Iron, Cobalt, Nickel
- Inside these magnetic substances are "tiny magnets" called **DOMAINS**.



- If the ***domains are aligned*** the material is magnetized.
- If the domains are unaligned the material is not magnetized.



Magnetised
(domains lined up)



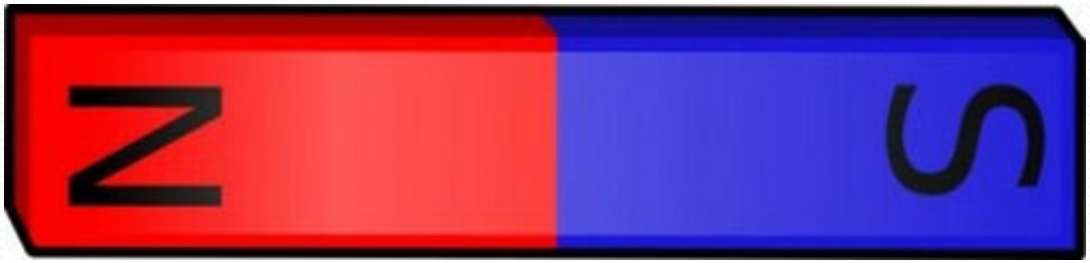
Unmagnetised
(domains mixed up)

Magnetic Fields

- What causes a magnetic field?

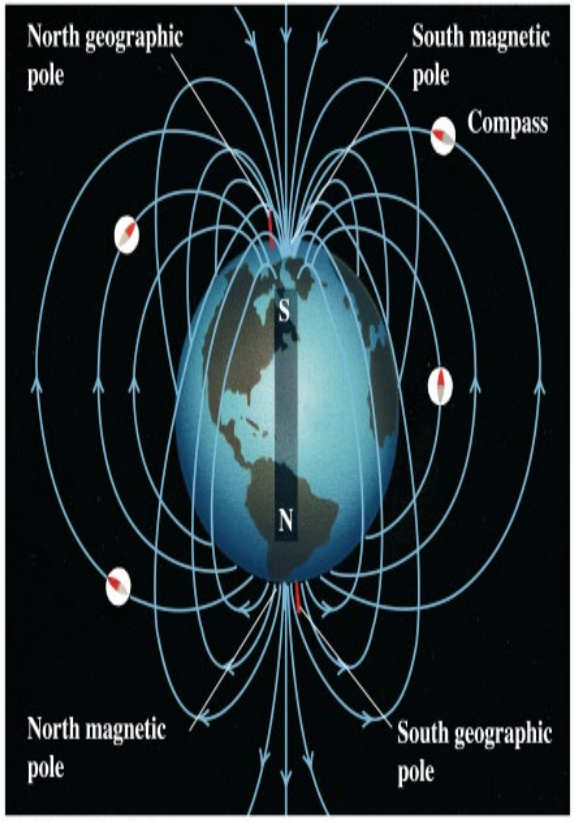
- What is affected by a magnetic field?

Direction of Magnetic Field



The Earth

- The Earth itself is a giant bar magnet
- Compasses work like iron filings and try to orient themselves with the Earth's magnetic field lines
- However, the north pole of a magnet always seeks the south pole of another magnet
- This means that geographic north is actually magnetic south and geographic south is magnetic north



Interactions Between Fields

- Gravitational forces always attract
- With magnets and charges, likes repel and opposites attract
- Example:

Van Allen Belts

- Ions (charged particles) from space get trapped inside the Earth's Magnetic Field in Van Allen Belts
- Depending on a particles momentum from space, a trapped particle will continue spiraling following the field lines until it reaches the north and south geographic poles
- Once at the poles, the ions enter and interact with the atmosphere to sometimes produce bright light

Van Allen Belts

- These are the northern and southern lights (the aurora borealis and aurora australis) which appear in the northern and southern latitudes close to the poles

Board Question

- Draw in the field lines for the following