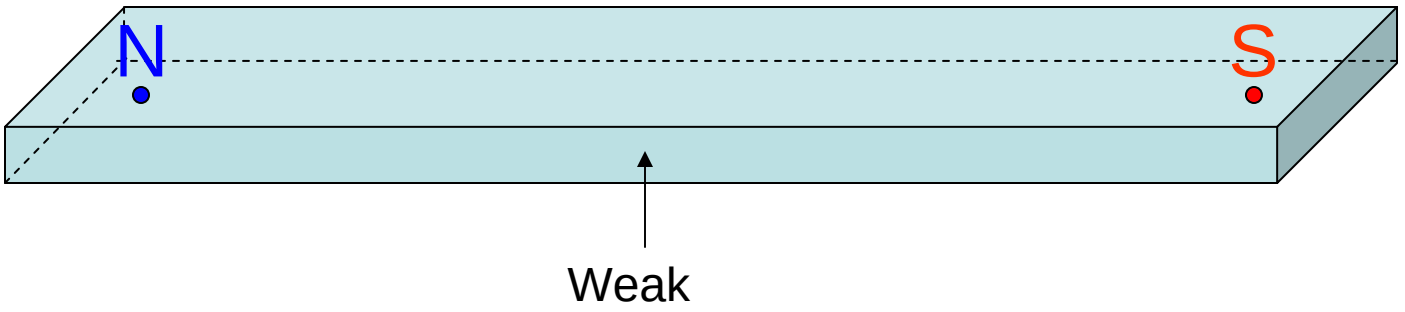
Magnets



A **magnet** is a source of magnetic interactions.

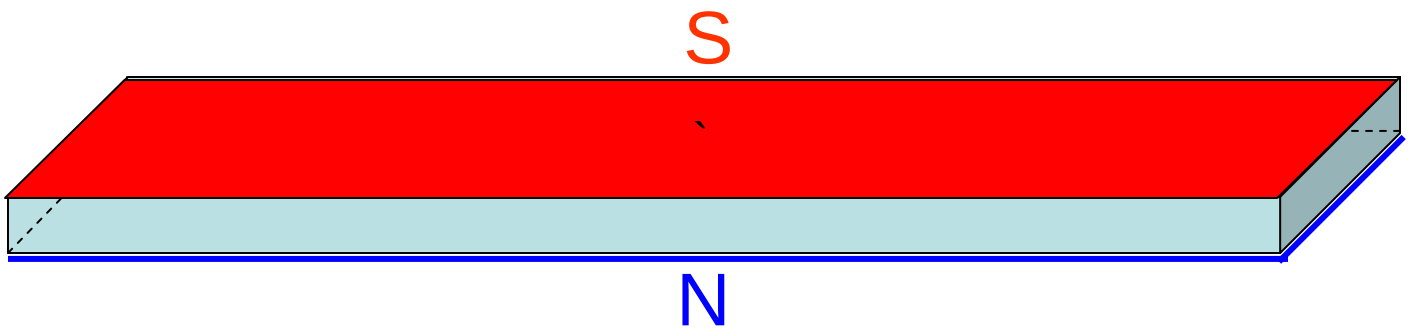
The poles of the magnet have the strongest magnetic interaction.

There are two types of poles – N pole and S pole.

Each magnet has (at least) one N pole and one S pole – it is impossible for a magnet to have only one pole.

The two poles are near the ends but inside the magnet. The magnetic interaction is very weak (or zero) at the midpoint between the two poles.

Unusual Poles

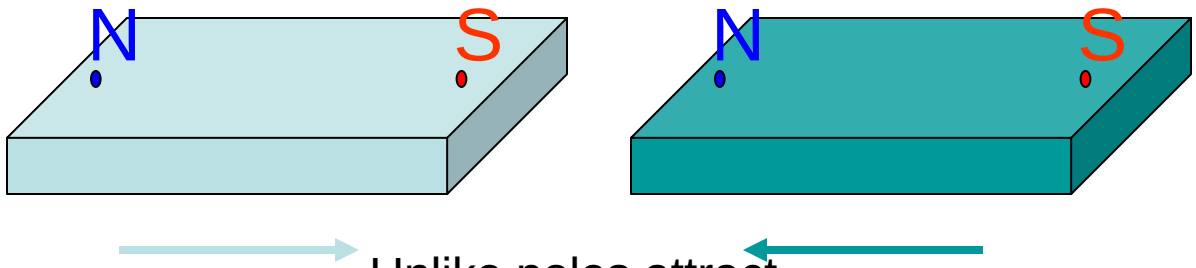


The poles do not always need to be at the long ends, as in a bar magnet. For example, in a flat refrigerator magnet, the poles are on the opposite faces. However, even in this case, the poles are on opposite “sides” of the magnet.

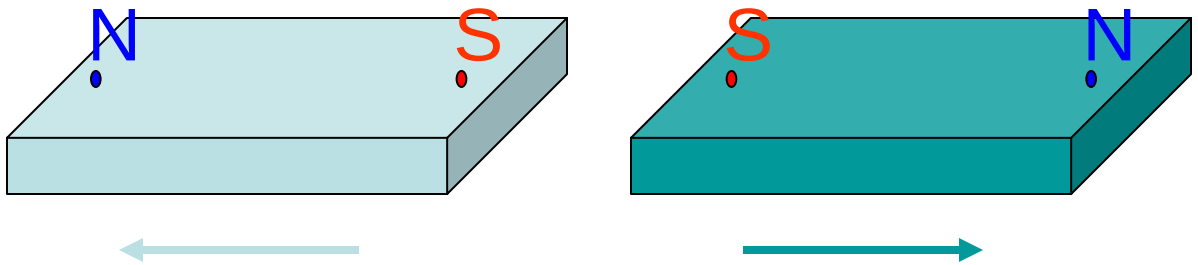
Three types of materials

1. *(Permanent)* Magnet
2. Ferromagnertic
3. Non-magnetic

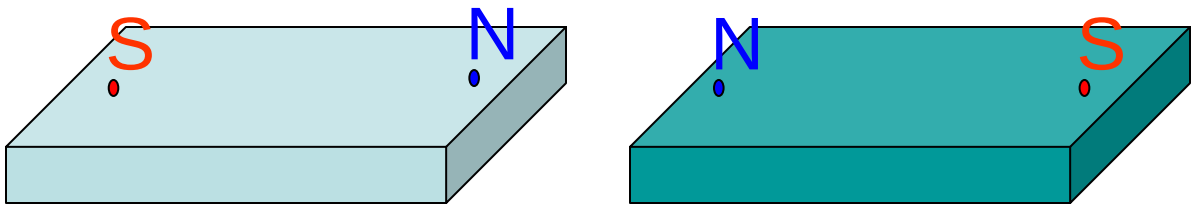
Interaction between two magnets



Unlike poles attract

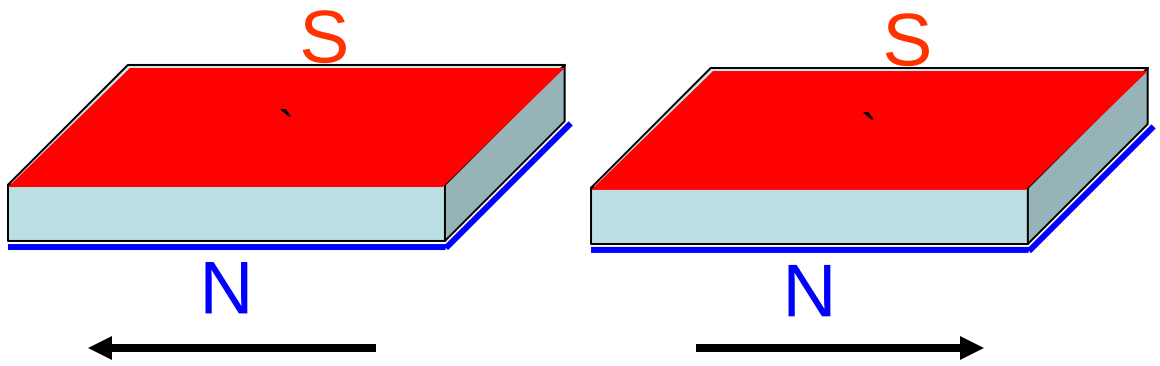


Like poles repel

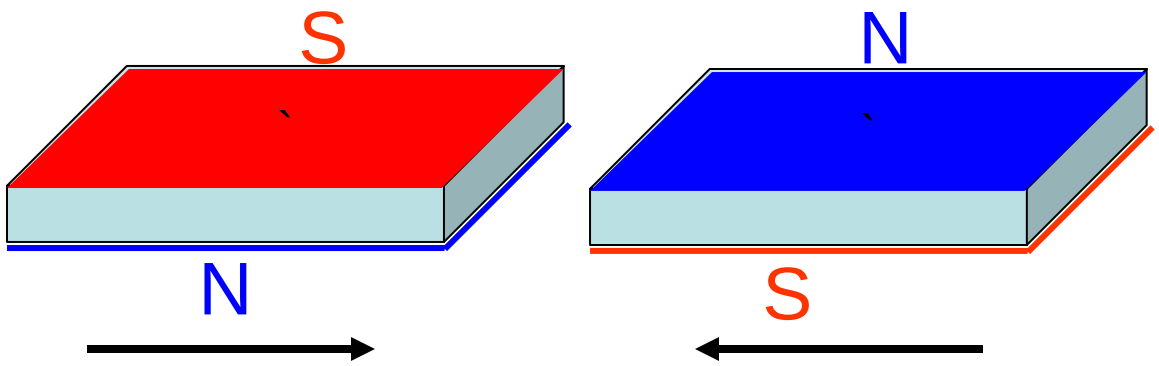


Like poles repel

Interaction between two magnets

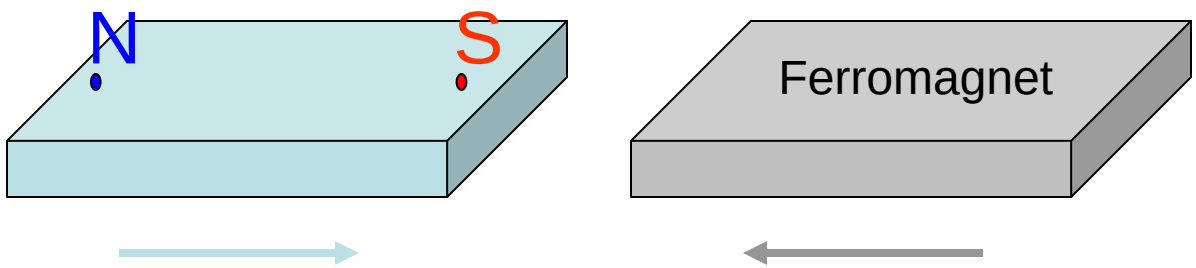


Like poles repel



Unlike poles attract

Interaction between magnet and ferromagnet

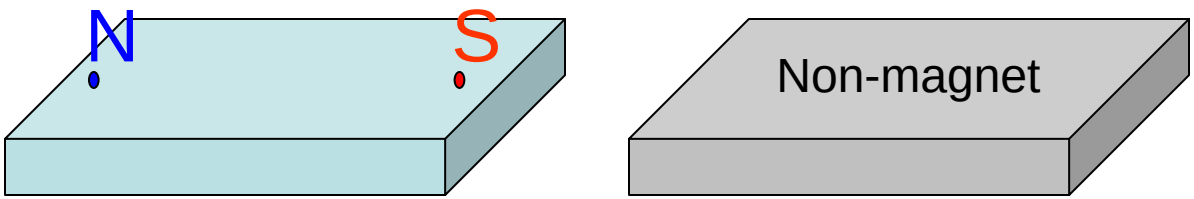


Always attract

Magnet and ferromagnet *always* attract each other.

Note: Ferromagnets do not have poles.

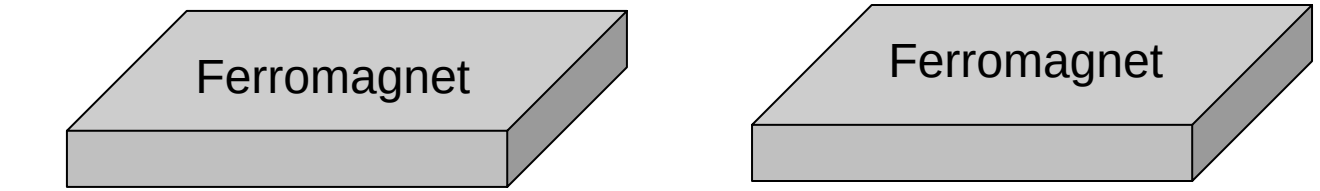
Interaction between magnet and non-magnet



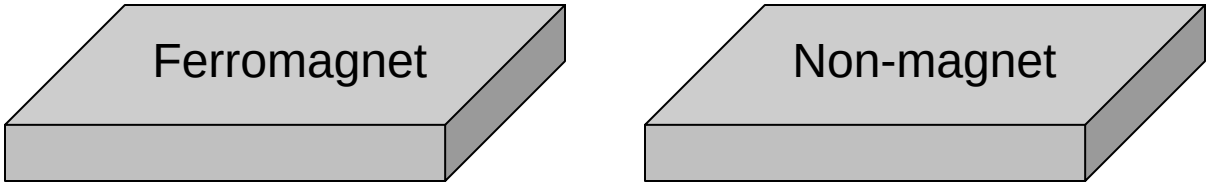
No interaction

Magnet and non-magnet *never* interact each other.

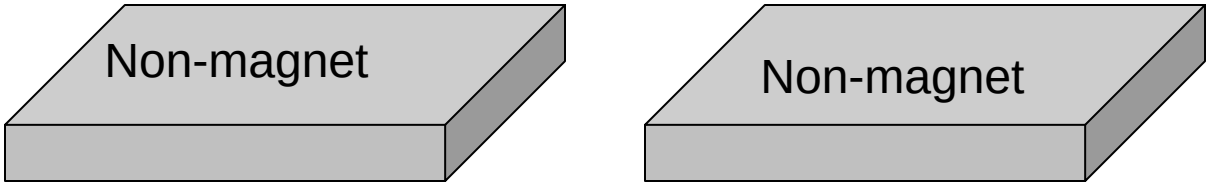
Other combinations



No interaction



No interaction



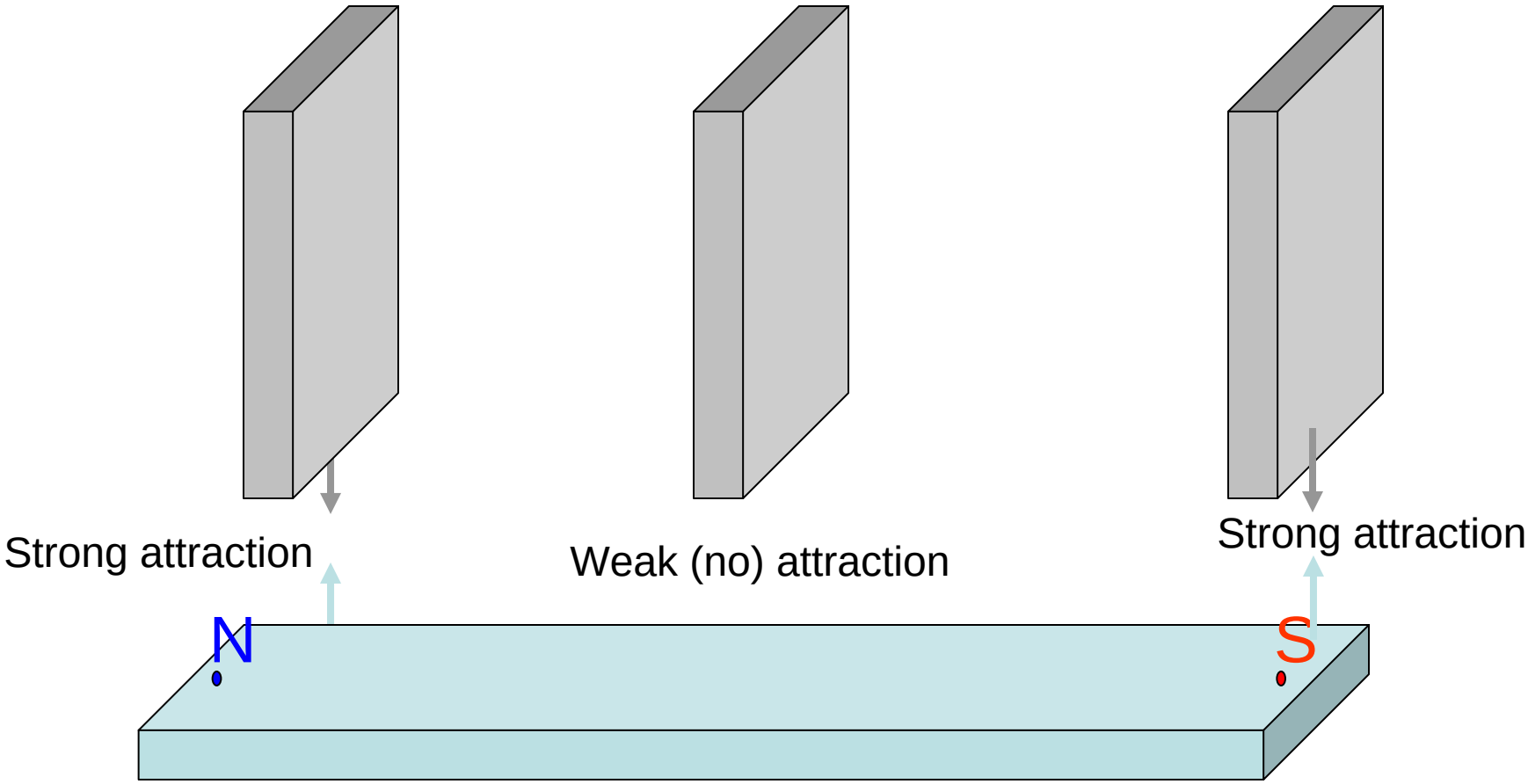
No interaction

For any interaction (attractive or repulsive), at least one of the two objects has to be a magnet.

Summary

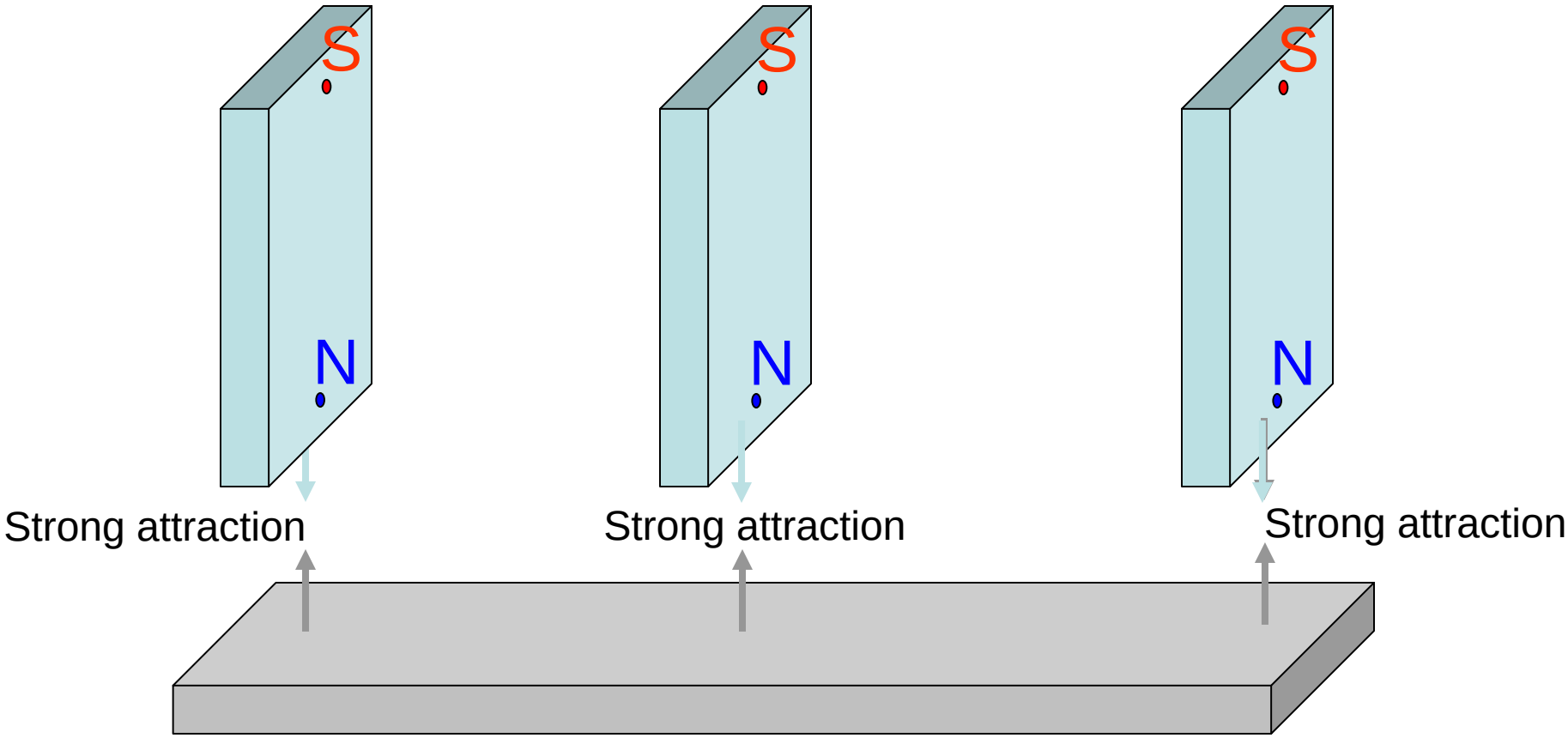
Object 1 / Object 2	Magnet	Ferromagnet	Non-magnet
Magnet	Attractive or repulsive	Attractive	No interaction
Ferromagnet	Attractive	No interaction	No interaction
Non-magnet	No interaction	No interaction	No interaction

Interaction between magnet and ferromagnet

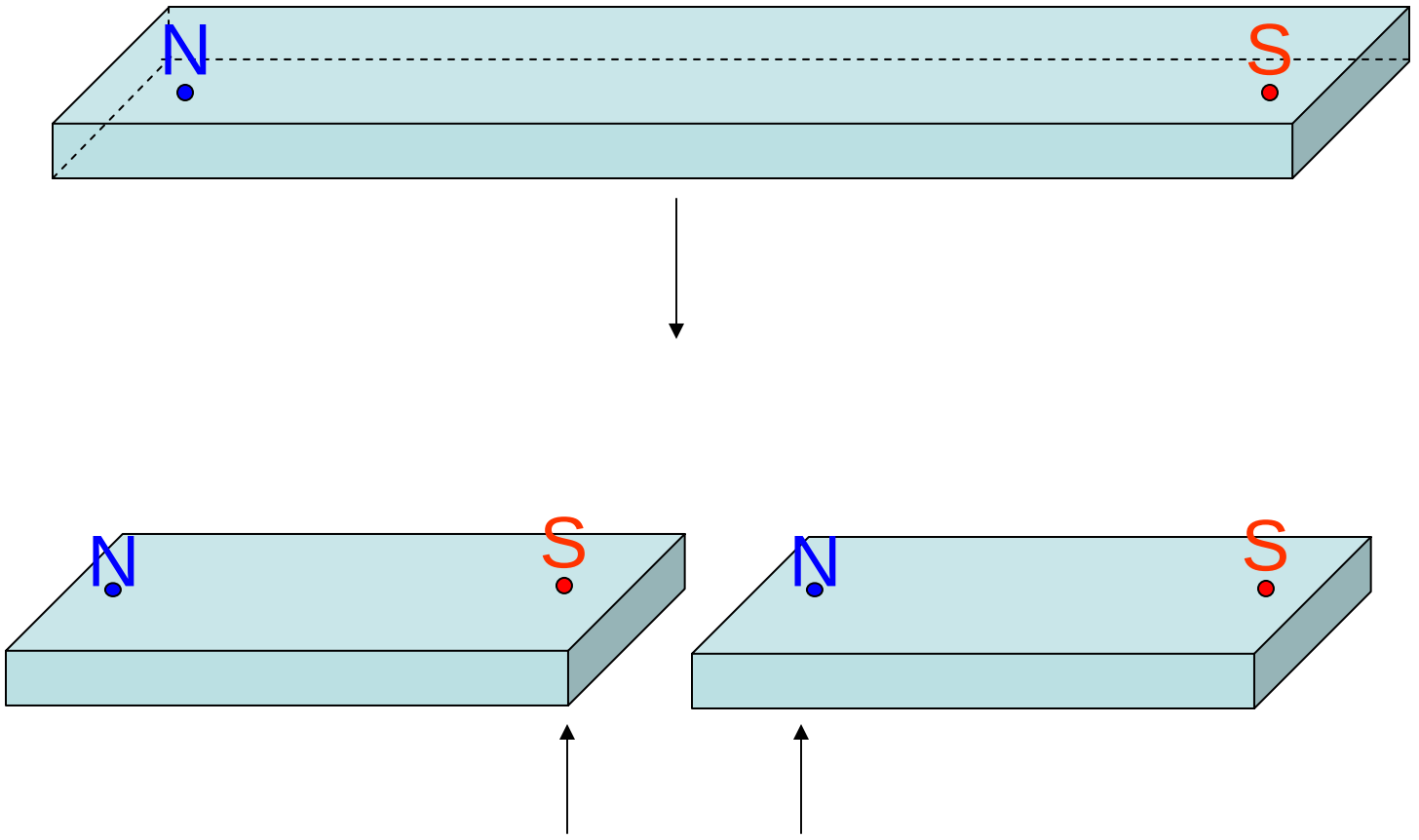


Magnetic strength is the strongest near the two ends (poles) of a bar magnet and it is weakest at the midpoint between the two poles.

Interaction between magnet and ferromagnet

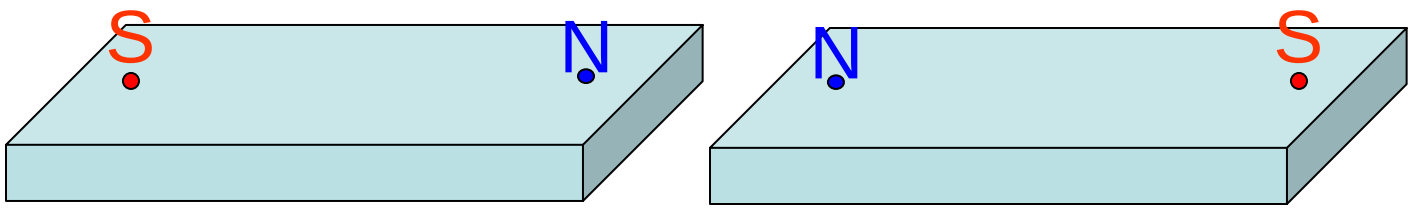


Breaking a magnet

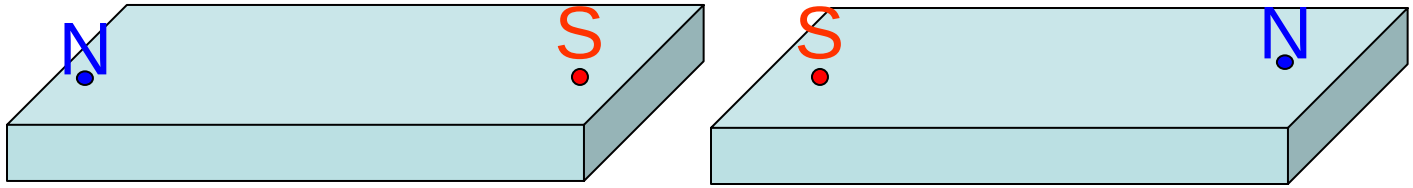


Poles are created in pairs so that each piece still has both an N-pole and a S-pole.

Joining magnets

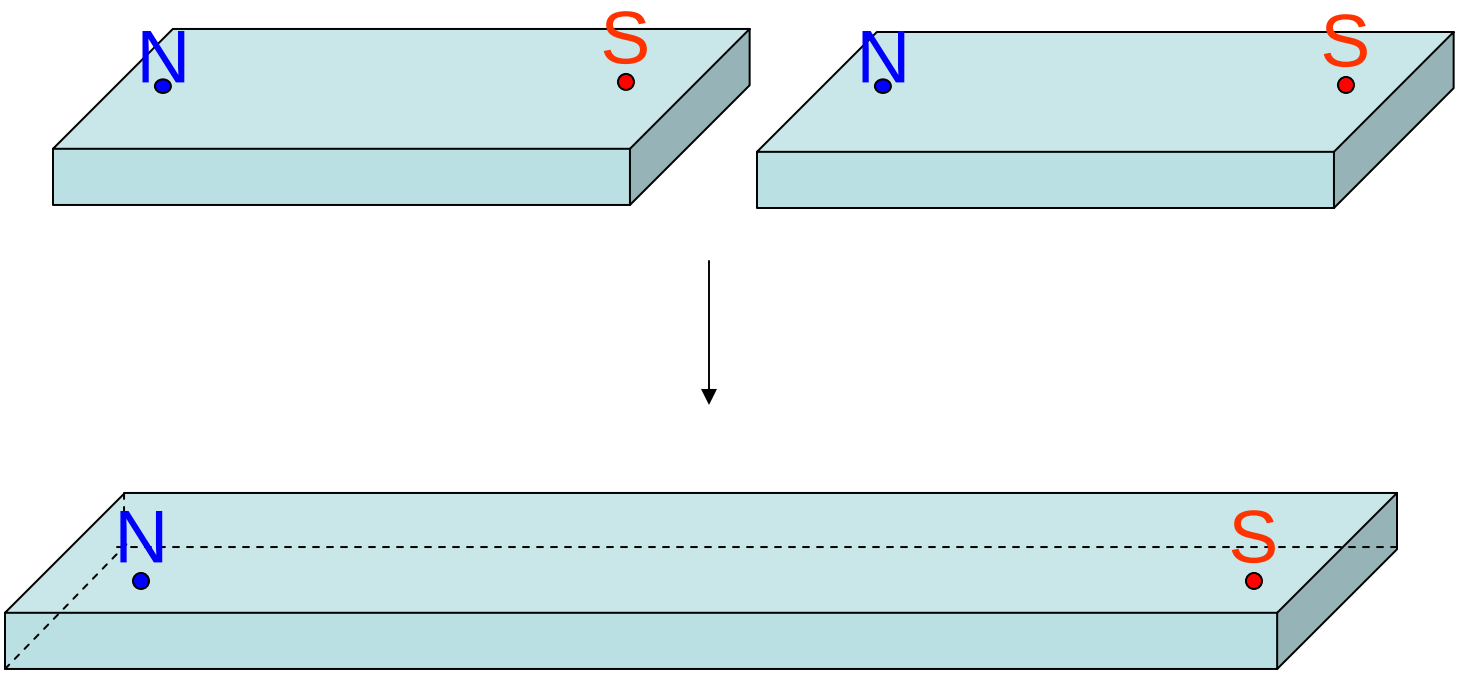


OR



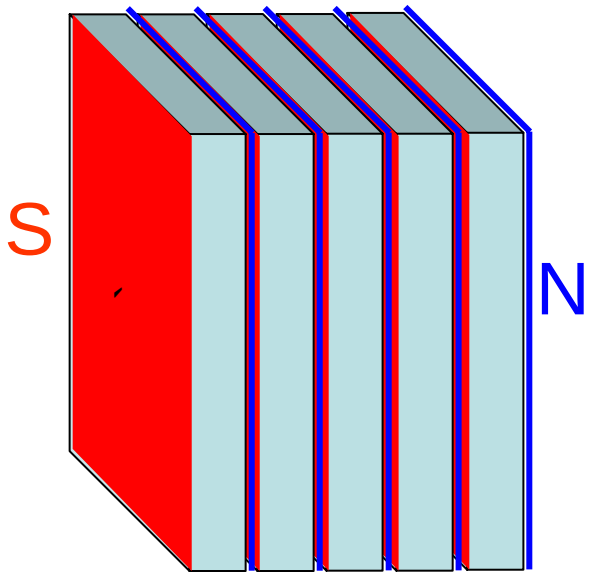
Cannot be done because they repel each other!

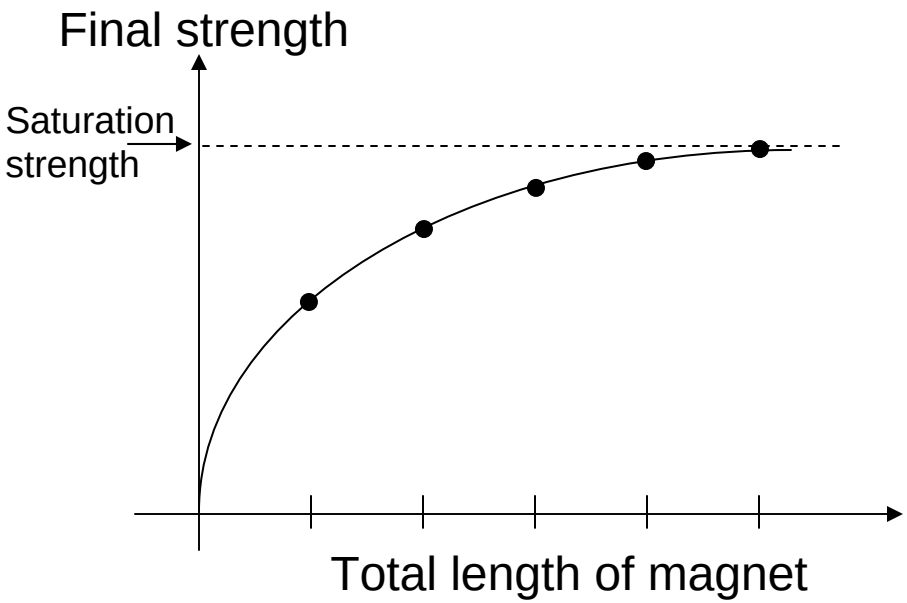
Joining magnets



These pieces attract each other and therefore will stay together.
The new composite magnet has one N-pole and one S-pole;
the old poles in the center "*cancel*" each other out.

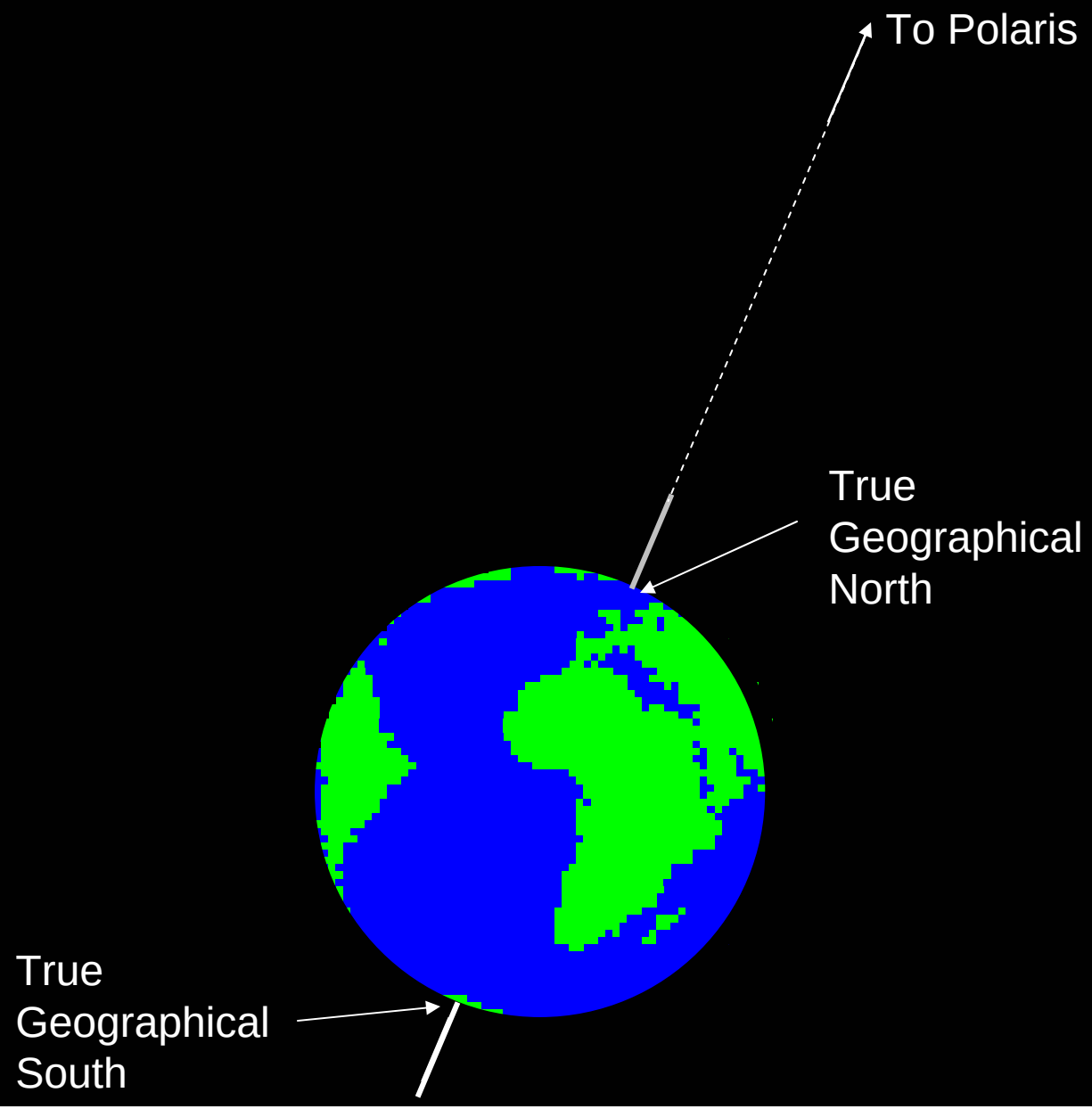
Joining magnets can increase strength



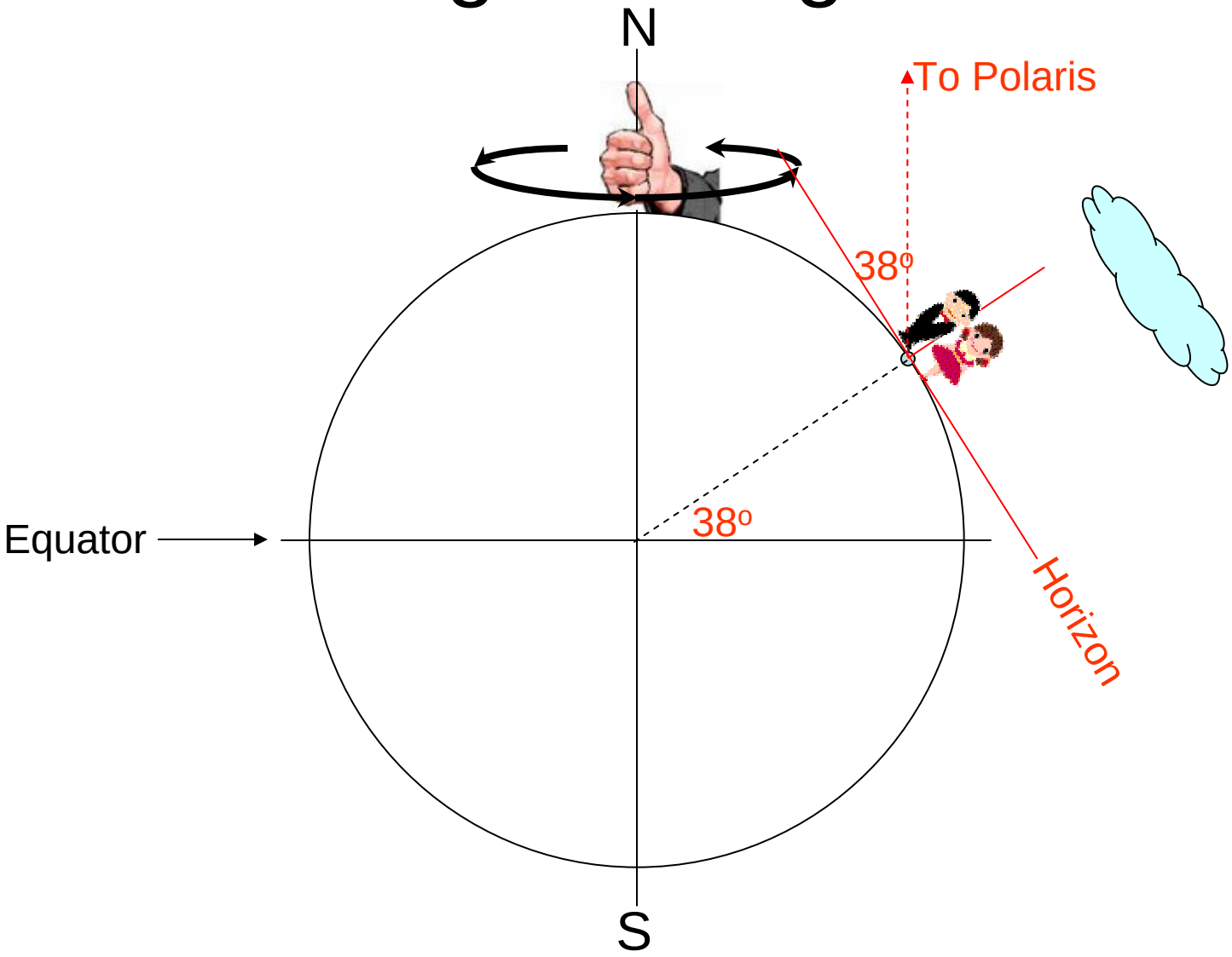


Joining magnets together can increase the overall strength, but only up to a certain length. This method does not work well for bar magnets, because the bar magnet is quite long already.

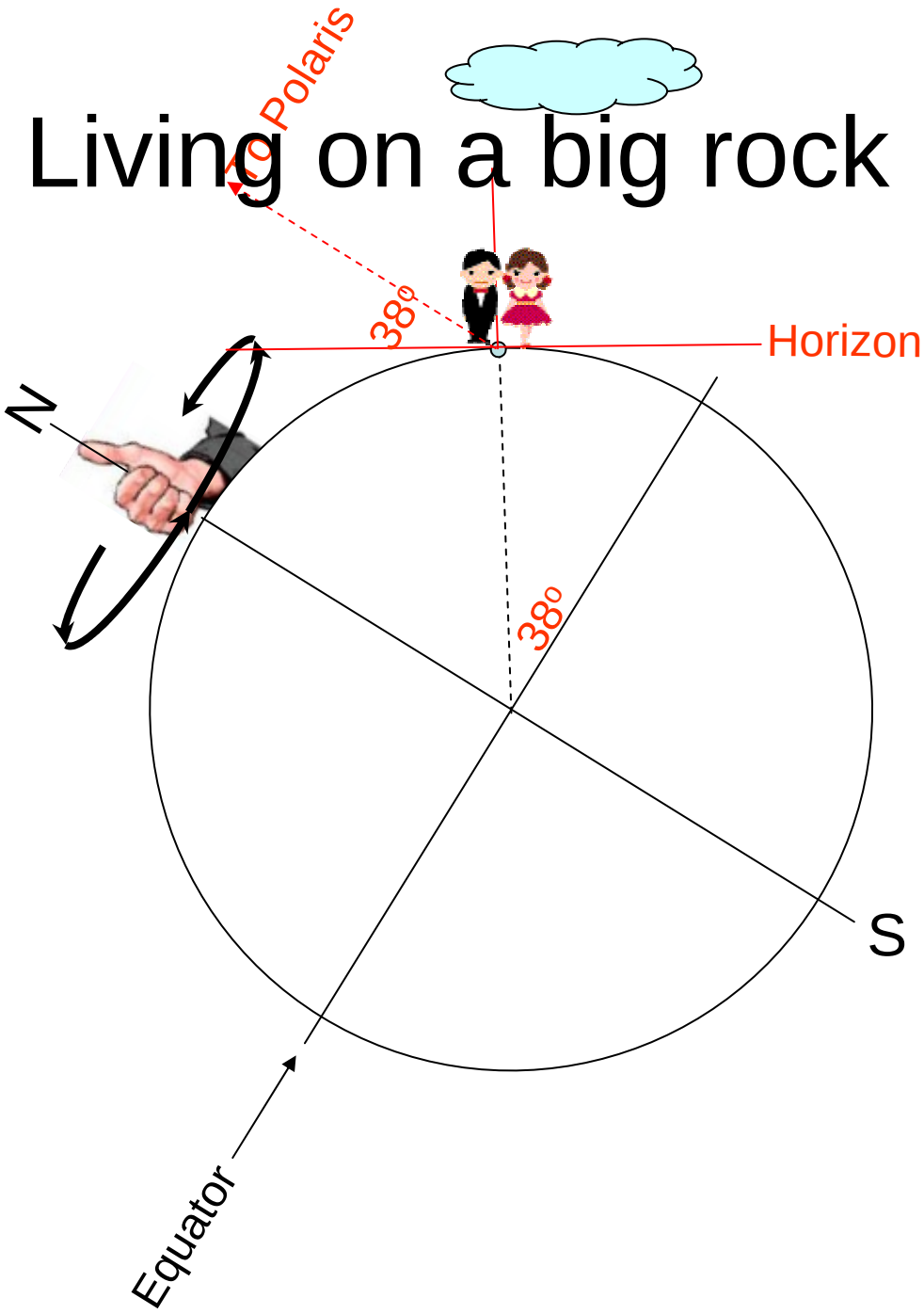
Geographical North and South



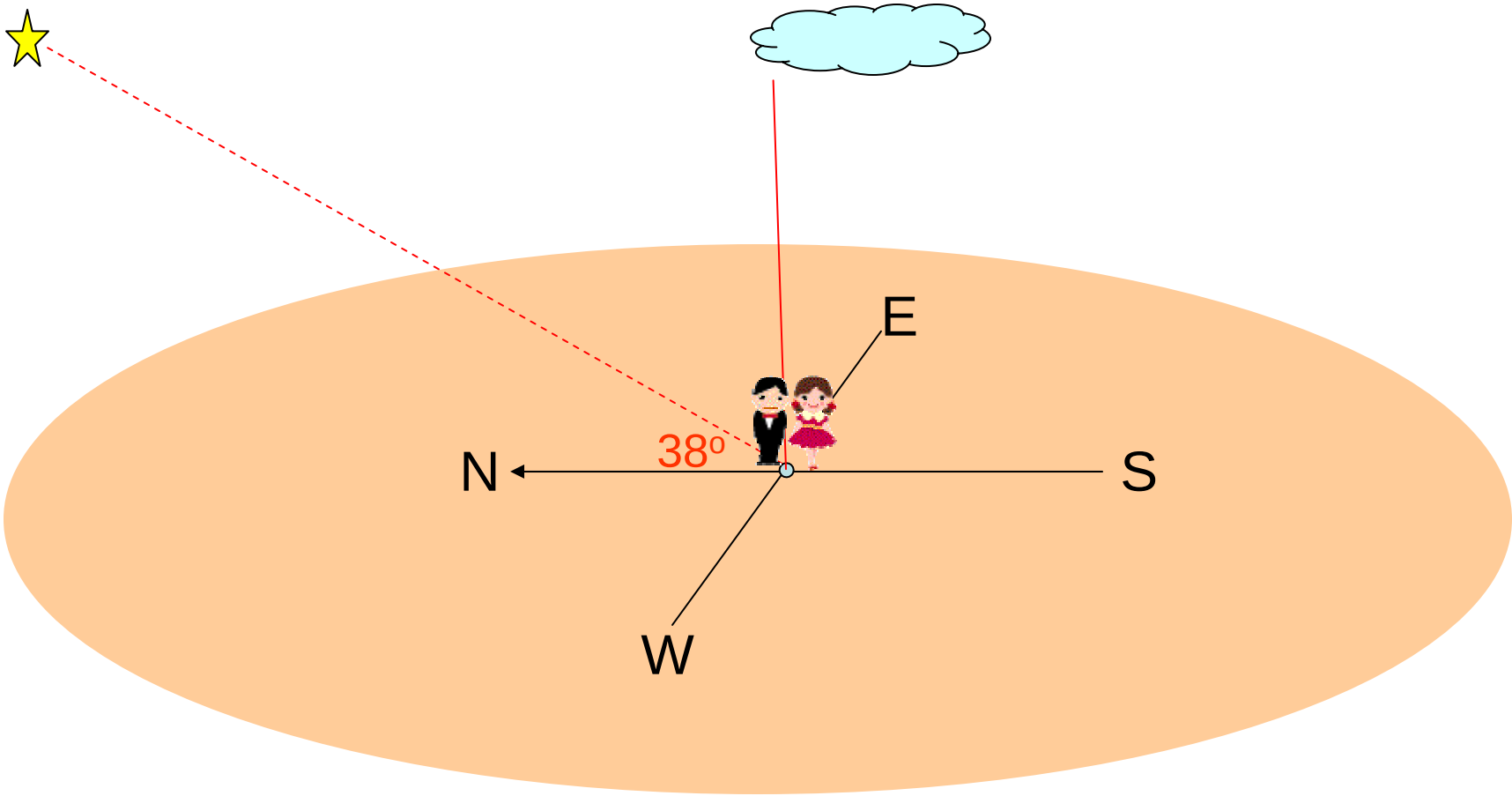
Living on a big rock



Living on a big rock



Living on a big rock



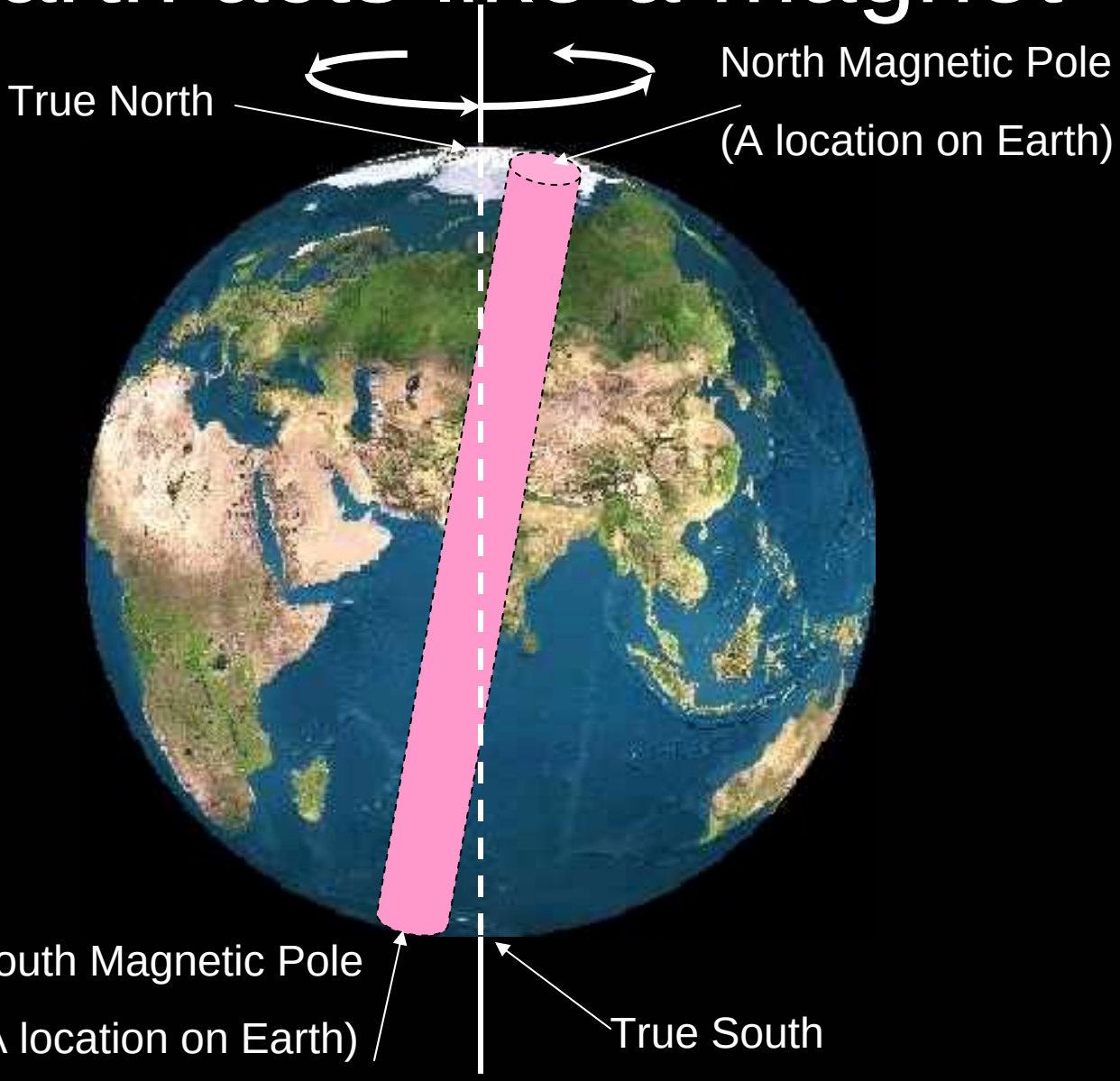
Locating the Polaris

Polaris is stationary in sky

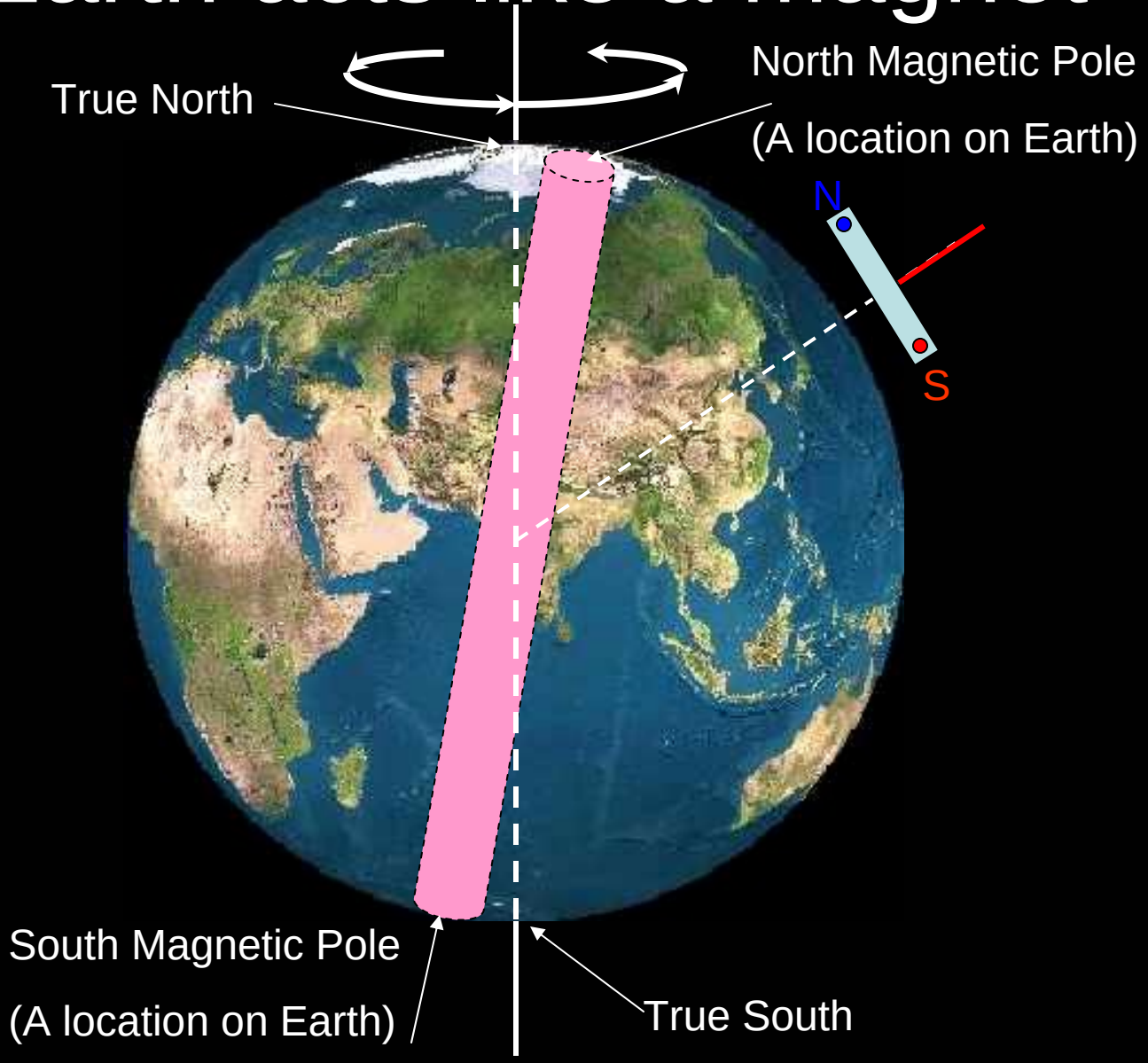
20 minutes. Mono Lake, CA.

3.5 hrs. Mt. Kilimanjaro

Earth acts like a magnet



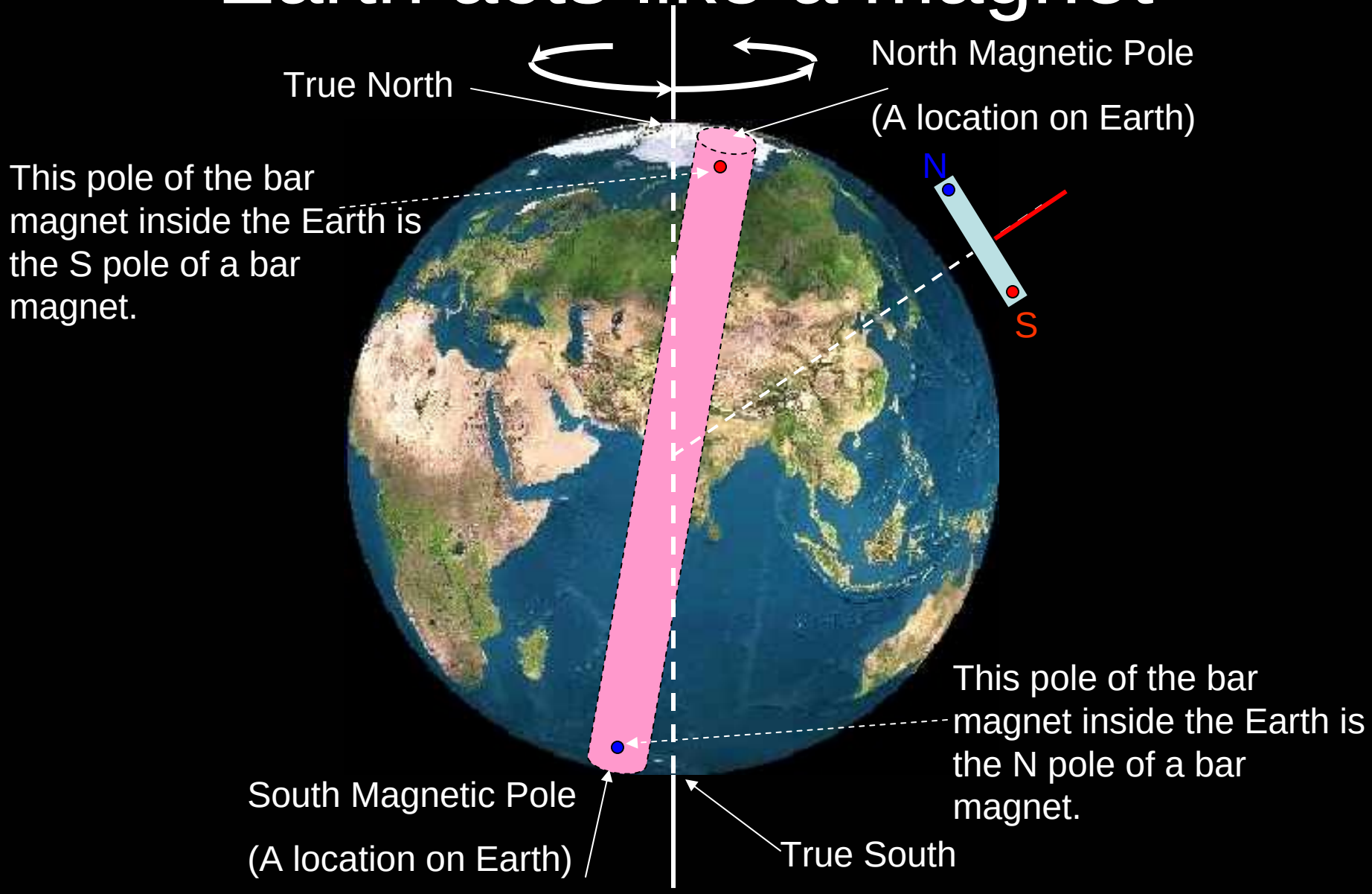
Earth acts like a magnet



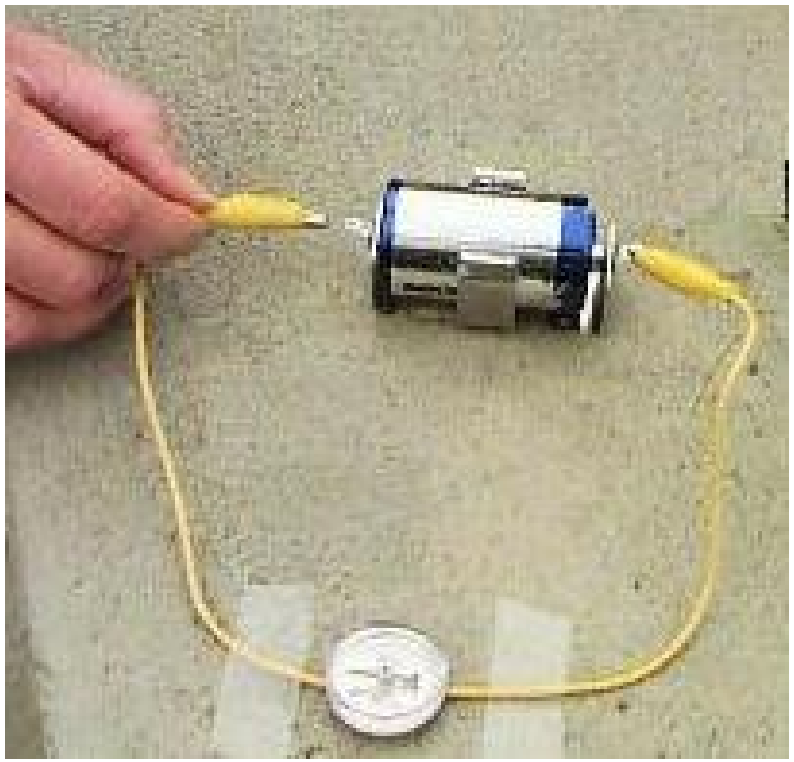
Compass

- If a bar magnet is hung freely by a string, it always rest along the south-north direction (because the Earth itself acts like a bar magnet).
- The end of the bar magnet pointing towards North is called the north (N) pole of the bar magnet. The end of the bar magnet pointing towards South is called the south (S) pole of the bar magnet.

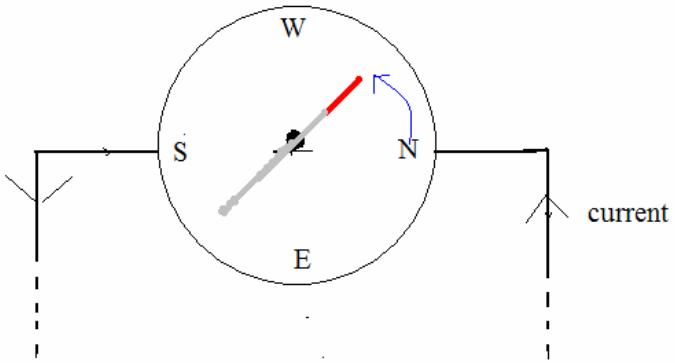
Earth acts like a magnet



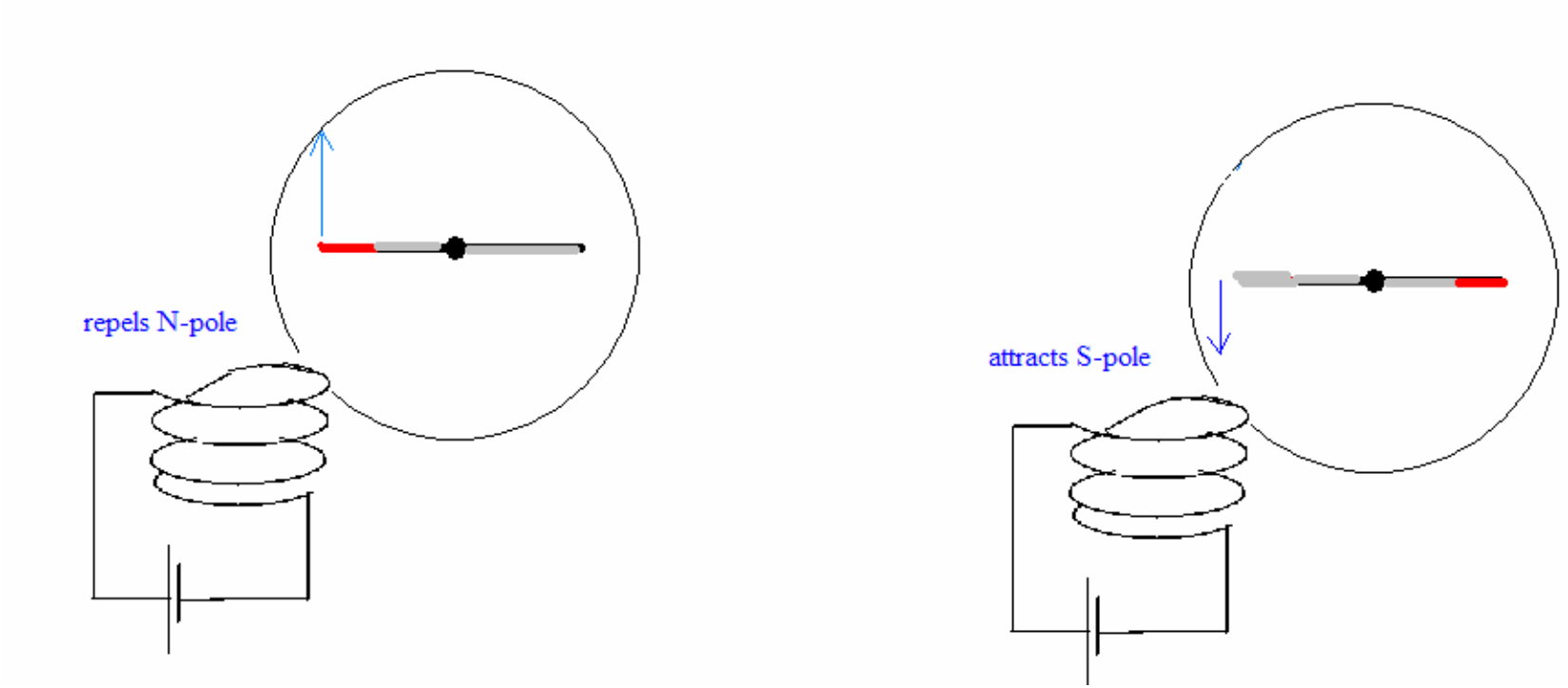
Electric Currents Affect Magnets



An electric current also interacts with a magnet. For example, if a compass is placed near a current carrying wire, the compass needle is deflected. The force is perpendicular to the direction of the current, so if the current is strong enough, it can make the compass point east or west.



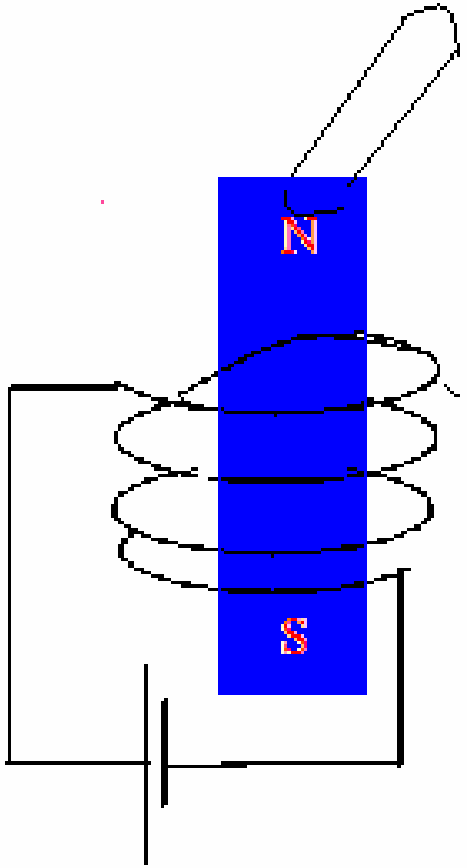
Current Carrying Coils Act Just Like Bar Magnets!



If you wrap the wire into a coil, the coil will act like a bar magnet: one side will attract the N-pole of a magnet and repel the S-pole (and the other side will do the opposite).

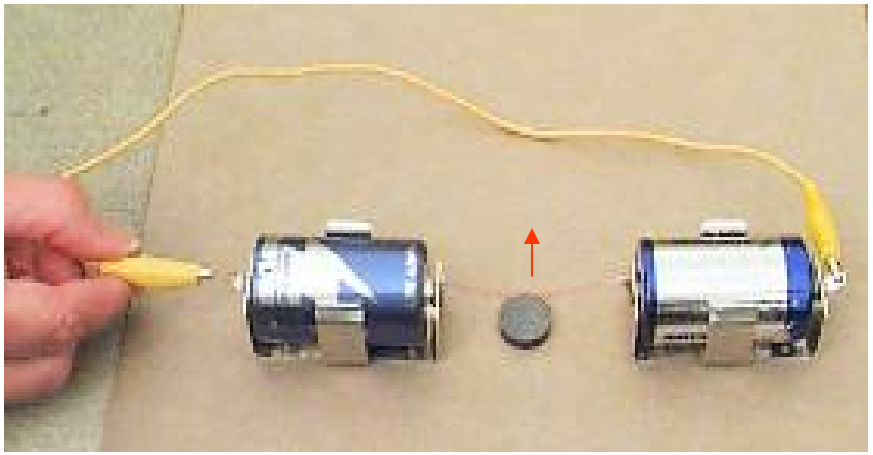
Electromagnet:

A ferromagnetic object inside a coil



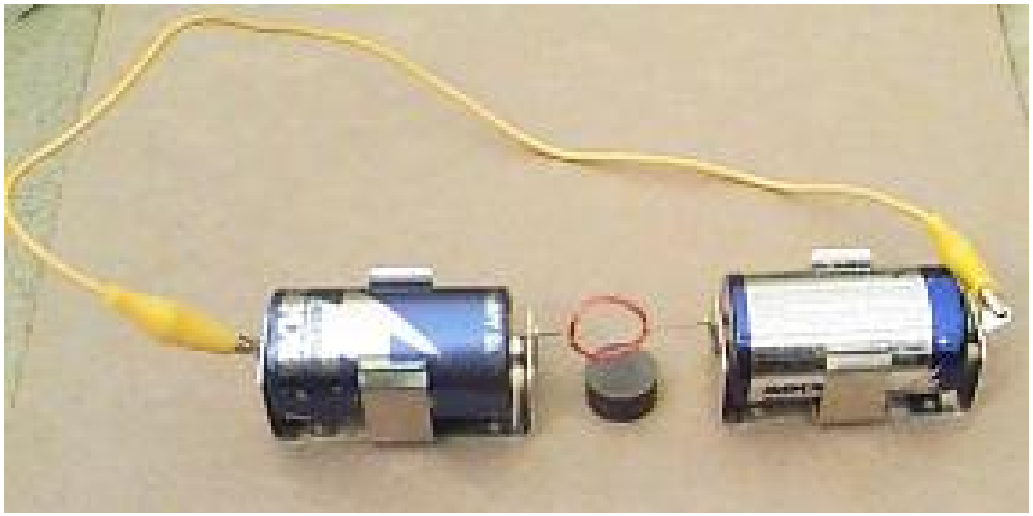
If you put a ferromagnetic cylinder inside the coil, you can make the affect much stronger, essentially making the ferromagnet act like a magnet, so that it can attract other ferromagnetic objects.

Magnets Affect Current Carrying Wires



A magnet also has a force on a wire carrying a current. A straight wire near a magnet is pushed to the side, perpendicular to the current. This is the basis of the electric motor.

Electric Motor



If you put a *coil carrying current* near a magnet, it will come to equilibrium with its plane parallel to the magnet. However, if you start it turning, and open and close the circuit at the right times, the “inertia” of the coil can carry it right past this equilibrium position, so it has to flip over again. Then the whole process repeats over and over and

you’ve made a motor!!!