

What Are Magnets?

Chapter 14 Lesson 1

ByDesign Science, Level 6

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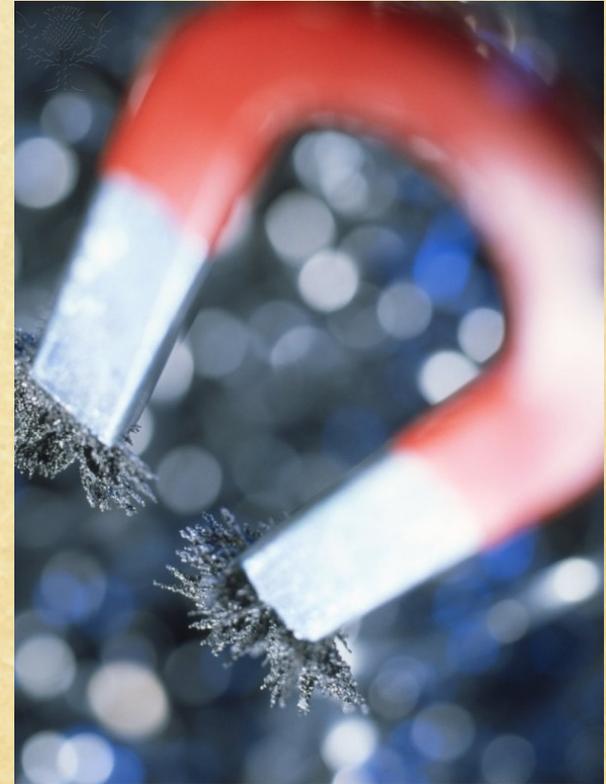
What Are Magnets?

- ◆ Lodestone is a natural magnet.
- ◆ People have used magnets for more than 2000 years.
- ◆ However, scientists did not discover the links between magnetism and electricity until the 1800s.



Magnetic Materials

- ◆ The metal most people think of when they think about magnets is iron.
- ◆ Other common metals, such as aluminum, copper, silver, and gold, are nonmagnetic.



Magnetic Materials



- ♦ Iron is not the only magnetic metal.
- ♦ Nickel and cobalt also make good magnets.
- ♦ The best magnets, however, are made of alloys, combinations of two or more metals.
- ♦ Magnets made from alloys containing iron, boron, and neodymium are the most powerful magnets.
- ♦ They are used in medical electronic devices.

Magnetic Materials

- ◆ Magnets are used in:
 - ◆ Computer hard drives
 - ◆ Audio speakers and headphones
 - ◆ Bicycle generators, for lighting
 - ◆ Motors in cordless tools
 - ◆ Flashlights that are shaken to generate electricity



Magnetic Materials

Permanent Magnets

- ◆ When magnets are put in equipment like computers, we need them to maintain their magnetic properties.
- ◆ A magnet that keeps its magnetic properties for a long time is called a permanent magnet.

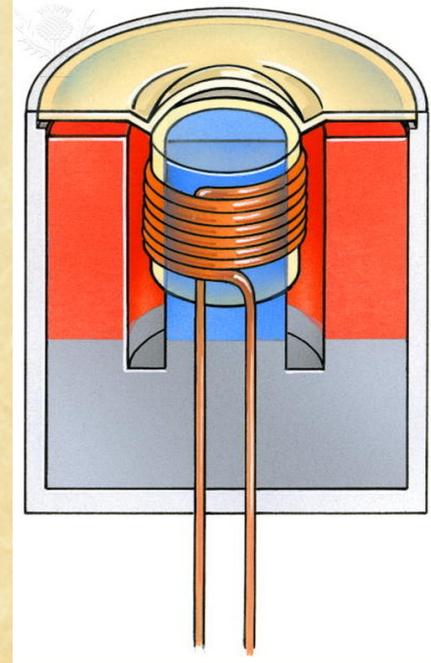
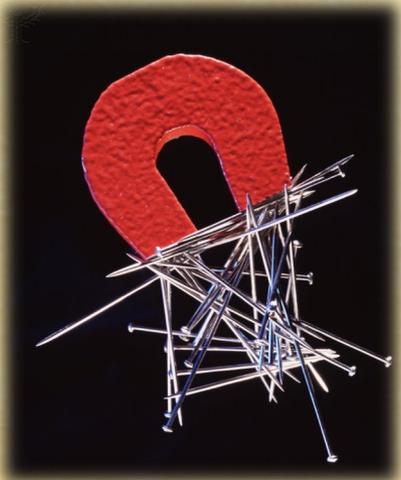


Illustration of microphone with moving spiral between poles of permanent magnet

Magnetic Materials

Permanent Magnets

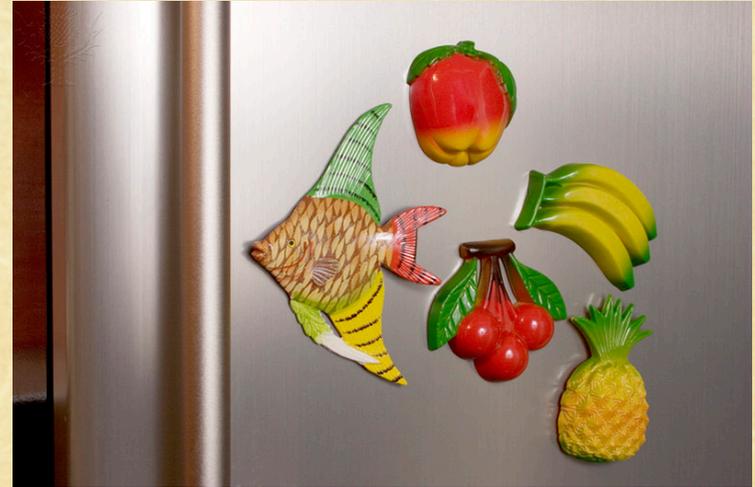


- ◆ The natural mineral magnetite, also called lodestone, is a permanent magnet.
- ◆ All other permanent magnets are made in factories.
- ◆ Most permanent magnets are made as bar magnets or U-shaped horseshoe magnets.
- ◆ These magnets are used in schools.

Magnetic Materials

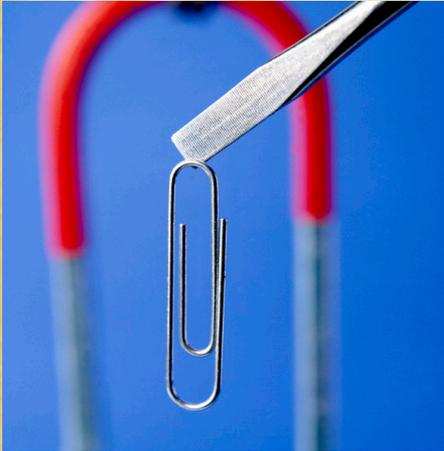
Permanent Magnets

- ◆ Flexible magnets are made by combining magnetic metals with plastics.
- ◆ Some refrigerator magnets are made this way.



Magnetic Materials

Temporary Magnets



- ◆ Metals like iron are made into temporary magnets when you put a magnet near them.
- ◆ You can make a temporary magnet by stroking a magnetic material with a permanent magnet.
- ◆ However, temporary magnets will lose all or most of their magnetism when the magnet is removed.
- ◆ Every object that is lifted, moved by, or sticks to a magnet acts as a temporary magnet.

Scripture Spotlight



*How is Jesus like a magnet? **John 12:32.***

When Jesus is lifted up, He will draw all men to Himself.

Magnetic Forces and Fields

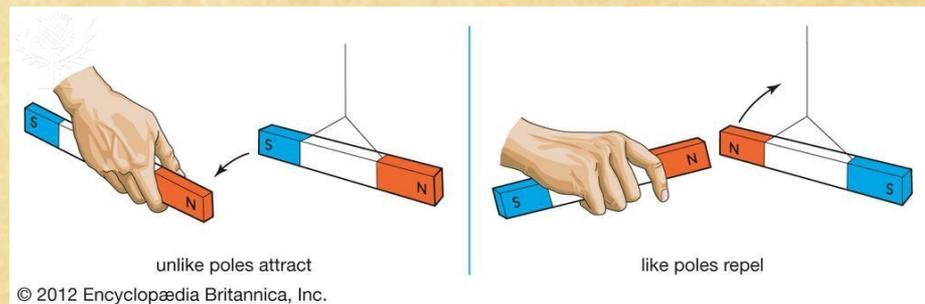
- ◆ Magnets can be made from several different types of materials in a variety of shapes.
- ◆ You have just learned that some magnets are permanent while others are temporary.
- ◆ Regardless of their shape or composition, all magnets share two characteristics.
- ◆ They all exert a magnetic force and produce a magnetic field.
- ◆ Most often magnetic forces are helpful.



Magnetic Forces and Fields

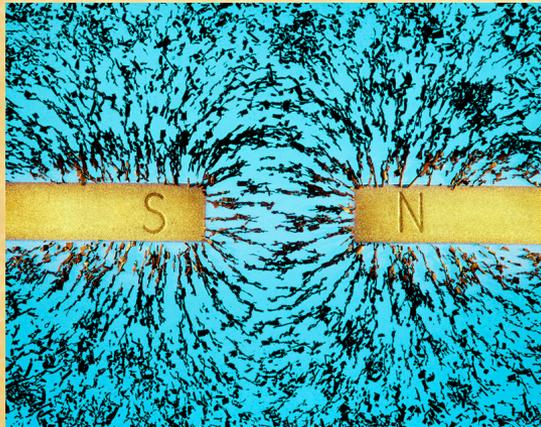
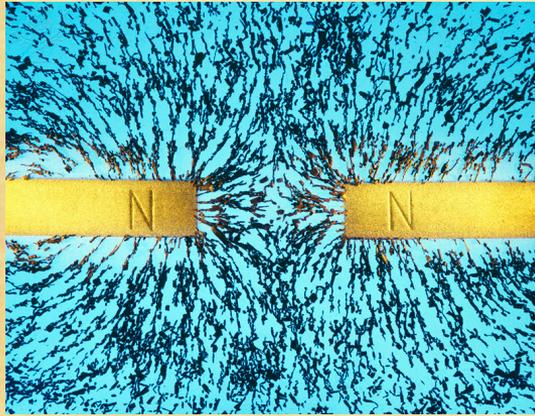
Magnetic Poles

- ◆ The places on a magnet where magnetism is the strongest are the magnetic poles.
- ◆ Each magnet has a north pole and a south pole.
- ◆ The poles on a bar magnet are at either end.
- ◆ The poles of a donut magnet are around the outside edge of the magnet.



Magnetic Forces and Fields

Magnetic Poles

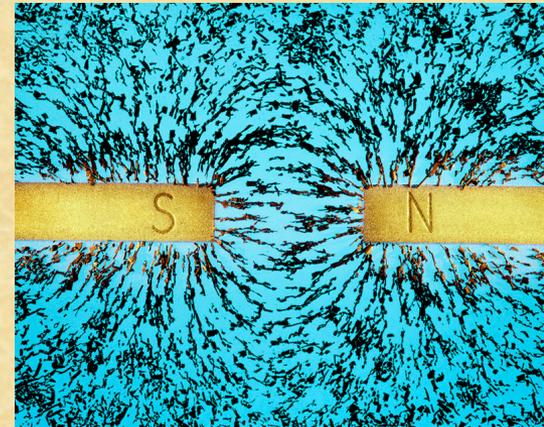
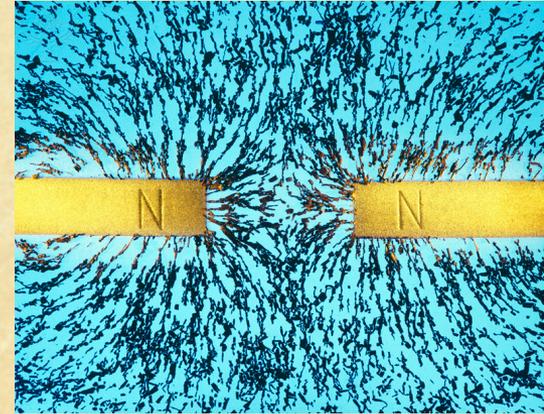


- ◆ The two poles of a magnet respond differently to the poles of a second magnet.
- ◆ The north pole of one magnet will pull on the south pole of another magnet.
- ◆ However, the north pole of the first magnet will push away the north pole of the second magnet.
- ◆ This simple experiment shows that the two poles of a magnet are different.

Magnetic Forces and Fields

Magnetic Poles

- ◆ The north poles of two magnets push each other away or repel each other.
- ◆ The same thing happens with the south poles of two magnets.
- ◆ They act like two positive or two negative electric charges.
- ◆ To summarize, like poles repel.
- ◆ Unlike poles attract.



Magnetic Forces and Fields

Magnetic Poles

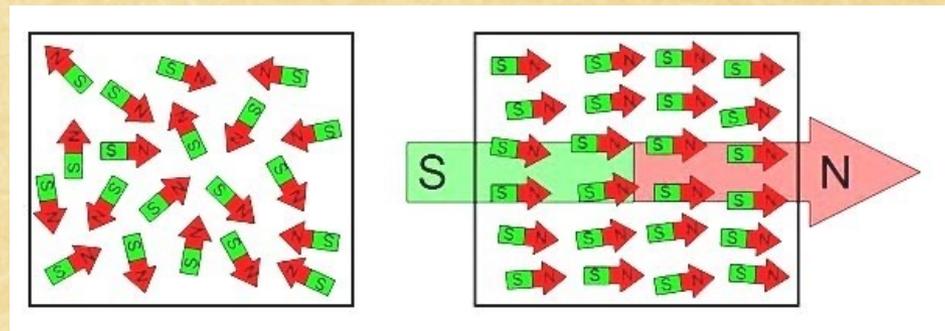


- ♦ What happens if you cut a bar magnet in half?
- ♦ Each smaller magnet has both a north pole and a south pole.
- ♦ Cutting each small magnet in half produces four smaller magnets.
- ♦ Each magnet still has a north pole and a south pole.
- ♦ You could continue this process until the magnets are very tiny.

Magnetic Forces and Fields

Magnetic Domains

- ◆ The domain model explains properties of a magnet.
- ◆ In this model, a magnet is made up of a collection of tiny magnetic domains.
- ◆ Each domain acts like a tiny magnet.
- ◆ In a magnet, the domains are all lined up so that their north poles all point in the same direction.



Magnetic Forces and Fields

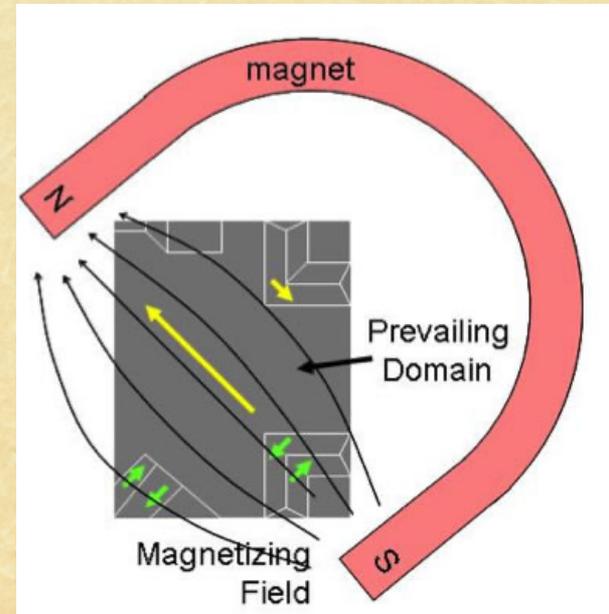
Magnetic Domains

- ◆ Nonmagnetic materials are also made of magnetic domains.
- ◆ Their domains are mixed up in all different directions, so these materials do not act as a magnet.

Magnetic Forces and Fields

Magnetic Domains

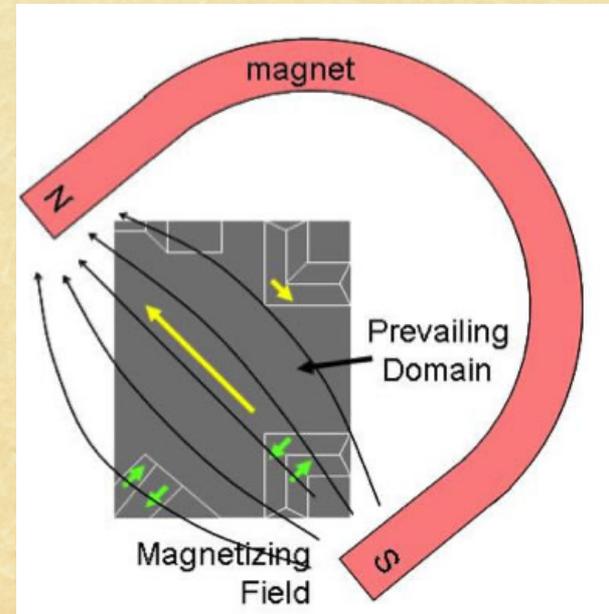
- ◆ Some materials will have their domains lined up temporarily if they are near a stroked magnet.
- ◆ These materials become temporary magnets when stroked many times with a magnet.
- ◆ Each stroke aligns the magnetic domains in the material.
- ◆ Temporary magnets are made just by touching a permanent magnet.



Magnetic Forces and Fields

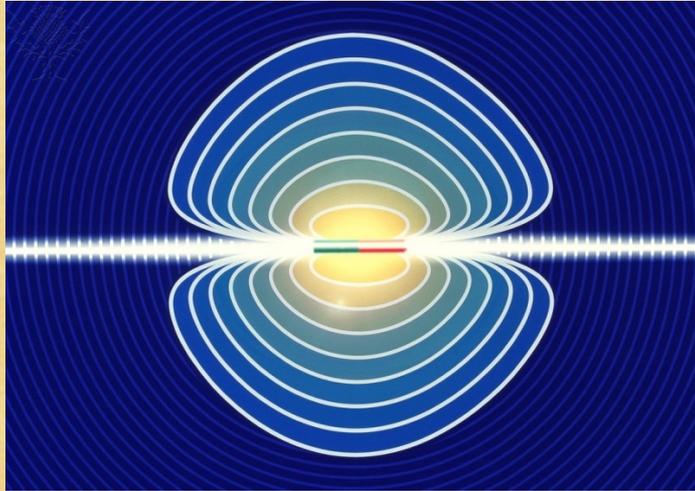
Magnetic Domains

- ◆ Temporary magnets can also be made by running an electrical current through or around some metal objects.
- ◆ Heating or pounding can destroy the magnetic properties of a magnet by moving the domains out of order.



Magnetic Forces and Fields

Magnetic Fields



- ◆ A magnet creates an invisible area of magnetism all around it called a magnetic field.
- ◆ If you slowly push a magnet toward a nail, at some point that nail will jump and stick to the magnet.
- ◆ The magnetic field acted on the nail.

Magnetic Forces and Fields

Magnetic Fields

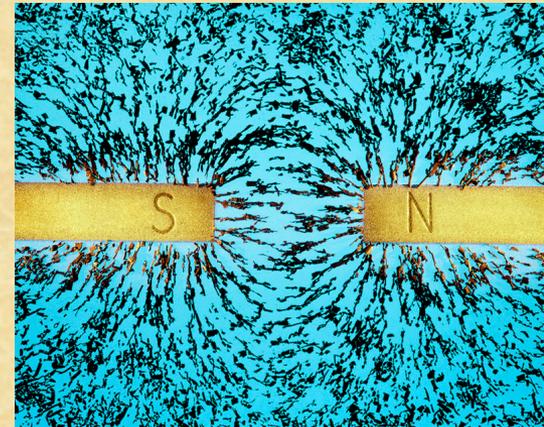
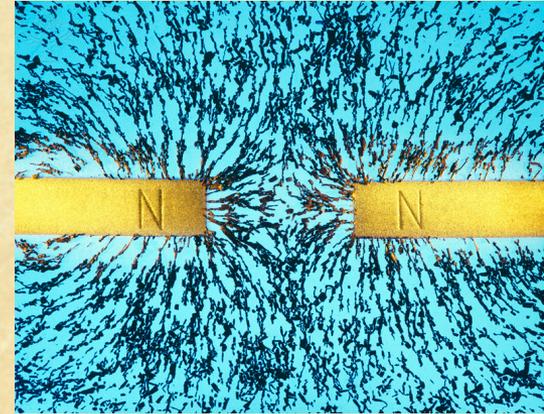
- ♦ Iron filings can show the direction of the magnetic field of a magnet.
- ♦ The filings are closest together where the magnetic field is strongest at the poles and farther apart where the magnetic field is weaker.



Magnetic Forces and Fields

Magnetic Fields

- ◆ Magnetism is sometimes described as a force that “acts at a distance.”
- ◆ This means that a magnetic field can cause a pulling or pushing force on an object without touching it.
- ◆ Push the north pole of a bar magnet toward the south pole of a second magnet.
- ◆ What will happen?



Scripture Spotlight



Think of a Christian as a magnet with an invisible magnetic field around him or her that helps attract others to Jesus. What might that spiritual magnetic field be made of? See **John 13:35** and **Matthew 5:16**.

John 13:35 – love

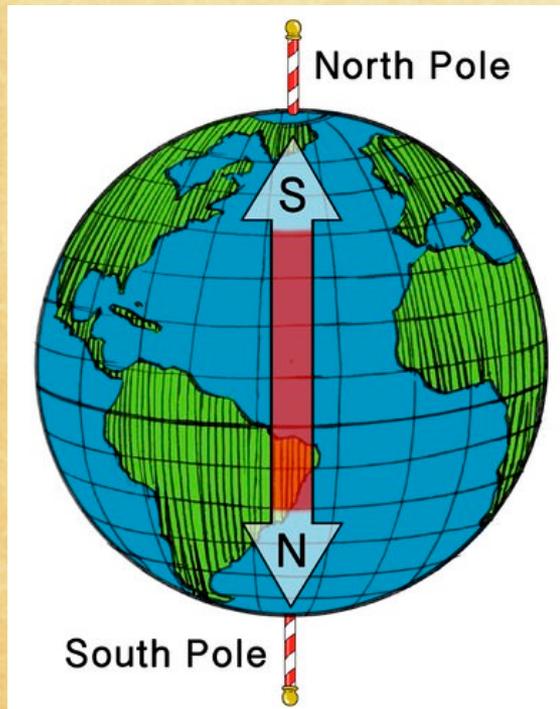
Matthew 5:16 – good works

Fun with Magnets



Earth as a Magnet

- ◆ You have likely heard of the North and South Poles on Earth.



- ◆ We call these two locations poles because Earth acts like a magnet.
- ◆ Earth's liquid core rotates, producing a magnetic field.
- ◆ This magnetic field is almost the same as the one produced by a bar magnet.

Earth as a Magnet

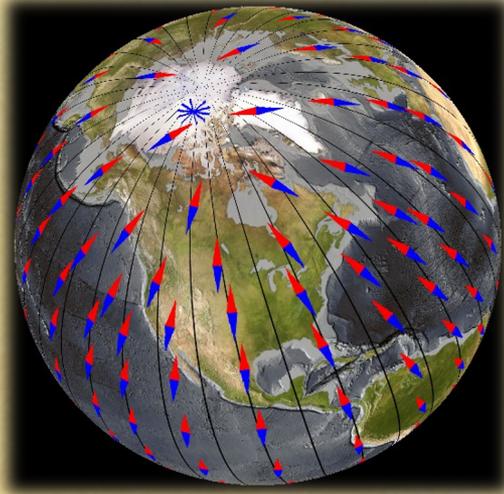
Compasses

- ◆ For at least 1000 years, people have used Earth's magnetic field to find direction.
- ◆ People in China discovered that lodestone always pointed in the same direction when it could swing freely.
- ◆ Later they discovered that a floating, magnetized needle also always points in the same direction.
- ◆ The invention of the *magnetic compass* was based on this discovery.
- ◆ At first, compasses were used exclusively on land.



Earth as a Magnet

Compasses



- ◆ The north-seeking pole of a compass points toward Earth's north magnetic pole.
- ◆ The south-seeking pole of a compass points toward Earth's south magnetic pole.
- ◆ The compass made long-distance ocean travel possible without getting lost.

Earth as a Magnet

Compasses

- ◆ Zheng He was a Chinese admiral.
- ◆ Zheng He was the first recorded person to use a compass to navigate.
- ◆ He made seven ocean voyages between 1405 and 1433.
- ◆ Later, European explorers used magnetic compasses to travel across the Atlantic Ocean.



Earth as a Magnet

Compasses

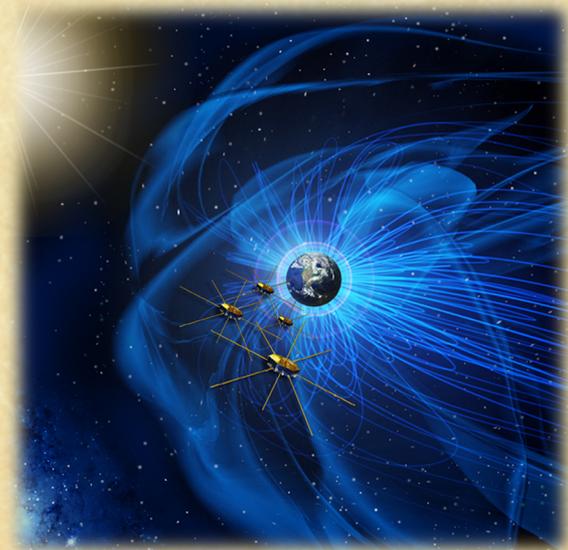


- ◆ Early navigational compasses were often suspended in water or hung from a silk cord.
- ◆ On land, the compass also was a valuable tool for early explorers.

Earth as a Magnet

Magnetosphere

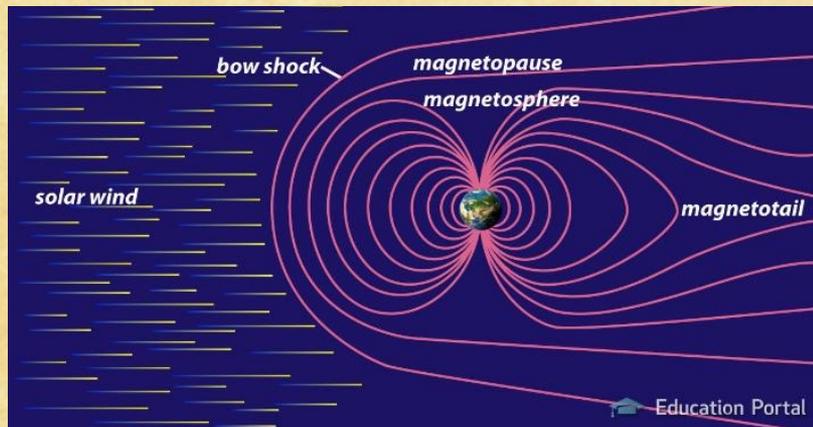
- ◆ The Sun ejects millions of charged particles into space.
- ◆ These particles, which are harmful to us, make up the solar wind.
- ◆ Fortunately, these dangerous particles encounter the magnetosphere.
- ◆ The magnetosphere is a region of Earth's magnetic field that extends about 36,000 miles into space.



Earth as a Magnet

Magnetosphere

- ◆ The magnetosphere deflects high-speed, charged particles in the solar wind and keeps them from entering Earth's atmosphere and striking Earth's surface.



- ◆ This protective feature is another demonstration of God's design to protect us from harm.

Earth as a Magnet

Auroras



- ◆ When charged particles of the solar wind reach the magnetosphere, they travel along magnetic field lines.
- ◆ The particles travel to the strongest part of Earth's magnetic field – the North and South Poles.
- ◆ At the poles, the particles travel down into Earth's upper atmosphere.
- ◆ There they collide with molecules of oxygen and nitrogen in the air.

Earth as a Magnet

Auroras

- ◆ Energy is transferred from the charged particles to the oxygen and nitrogen molecules.
- ◆ As these molecules return to a natural state, they give off their extra energy.
- ◆ Oxygen molecules give off green light or red light at different heights.
- ◆ Nitrogen molecules give off blue or purple/violet light.



Earth as a Magnet

Auroras



- ◆ These different colors of light, which produce glowing “streamers” or “curtains” of light in the night sky, are called auroras.
- ◆ In the northern hemisphere, they are called the Aurora Borealis.
- ◆ In the southern hemisphere, they are called the Aurora Australis.

Earth as a Magnet

Auroras

- ◆ Because the light given off is much dimmer than sunlight, the auroras cannot be seen during the daytime.
- ◆ Auroras occur at both poles at the same time.
- ◆ They most often occur in ring-shaped areas around Earth's magnetic poles.
- ◆ However, the complete rings can only be seen and photographed from space.



Earth as a Magnet

Auroras



Image Citation

- ◆ **Slide #2 Lodestone:** *Lodestone*. [Photograph]. Retrieved from Encyclopædia Britannica ImageQuest. https://quest.eb.com/search/132_1345159/1/132_1345159/cite
- ◆ **Slide #3 Horseshoe Magnet:** *Horseshoe magnet attracting iron filings*. [Photograph]. Retrieved from Encyclopædia Britannica ImageQuest. https://quest.eb.com/search/132_1191012/1/132_1191012/cite
- ◆ **Slide #4 Electrum Alloy Deposit:** *Electrum alloy deposit*. [Photograph]. Retrieved from Encyclopædia Britannica ImageQuest. https://quest.eb.com/search/132_1359775/1/132_1359775/cite
- ◆ **Slide #5 Flashlight:** *NIGHTSTAR FLASHLIGHT WORKS ON FARADAY'S LAW Electricity Generated By Induction, On shaking the flashlight*. [Photography]. Retrieved from Encyclopædia Britannica ImageQuest. https://quest.eb.com/search/157_2928450/1/157_2928450/cite
- ◆ **Slide #6 Microphone with Permanent Magnets:** *Illustration of microphone with moving spiral between poles of permanent magnet*. [Photograph]. Retrieved from Encyclopædia Britannica ImageQuest. https://quest.eb.com/search/118_827965/1/118_827965/cite
- ◆ **Slide #7 Horseshoe Magnet:** *Horseshoe magnet*. [Photograph]. Retrieved from Encyclopædia Britannica ImageQuest. https://quest.eb.com/search/132_1193416/1/132_1193416/cite
- ◆ **Slide #8 Refrigerator Magnet:** *REFRIGERATOR MAGNETS Fruit and One Fish Magnets On A Refrigerator*, . [Photography]. Retrieved from Encyclopædia Britannica ImageQuest. https://quest.eb.com/search/157_2916767/1/157_2916767/cite

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- ♦ **Slide #9 Temporary Magnets:** TEMPORARY MAGNET, FERROMAGNETISM Magnetized nail suspends paper clip. [Photography]. Retrieved from Encyclopædia Britannica ImageQuest. https://quest.eb.com/search/157_2918457/1/157_2918457/cite
- ♦ **Slide #11 Magnet Fields:** Magnetic fields. [Photograph]. Retrieved from Encyclopædia Britannica ImageQuest. https://quest.eb.com/search/132_1188082/1/132_1188082/cite
- ♦ **Slide #12 Magnet Poles:** Magnetic poles. [Photograph]. Retrieved from Encyclopædia Britannica ImageQuest. https://quest.eb.com/search/309_1156135/1/309_1156135/cite
- ♦ **Slide #13 & 14 Poles Repel:** BAR MAGNET FIELDS, LIKE POLES REPEL Iron Filings Trace Magnetic Field Showing repulsion between like poles of bar magnets. [Photography]. Retrieved from Encyclopædia Britannica ImageQuest. https://quest.eb.com/search/157_2926919/1/157_2926919/cite
- ♦ **Slide #13 & 14 Poles Attract:** BAR MAGNET FIELDS, OPPOSITE POLES ATTRACT Iron Filings Trace Magnetic Field Showing attraction between north & south poles of bar magnets. [Photography]. Retrieved from Encyclopædia Britannica ImageQuest. https://quest.eb.com/search/157_2928121/1/157_2928121/cite
- ♦ **Slide #15 Magnet Field:** Magnetic field, artwork. [Photograph]. Retrieved from Encyclopædia Britannica ImageQuest. https://quest.eb.com/search/132_1447086/1/132_1447086/cite
- ♦ **Slide #20 Magnet Field:** Magnetic field. [Photograph]. Retrieved from Encyclopædia Britannica ImageQuest. https://quest.eb.com/search/132_1189973/1/132_1189973/cite

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