

Magnetism Packet

Magnets, Magnetic Fields, the Magnetosphere & Migration and More

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Some of the items you need for this unit

- 2 Bar Magnets
- 1 horseshoe (or U) magnet
- Donut Magnet (sometimes called Magnet Rings)
- Iron Filings
- Boy Scout Compass
- Very thin sewing needle

Magnet Unit Supplies



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Magnetic Fields:

We talked about magnetic fields and then did a number of hands-on activities to explore the magnetic fields generated by magnets in various positions. The kids *loved* this! Again, you will find the [Iron Filings](#) here. Be really generous when you shake the filings... it makes the magnetic fields stand out more.

Magnet Unit: Learning about Magnetic Fields!

The image displays a collection of educational materials for a magnet unit. On the left, there are two worksheets titled "Magnetic Fields". The top worksheet includes a diagram of two bar magnets with their magnetic field lines and instructions for a hands-on activity using iron filings. The bottom worksheet features a 2x2 grid of diagrams showing different magnet configurations: two bar magnets with like poles facing each other, two bar magnets with unlike poles facing each other, and a horseshoe magnet. In the center, another worksheet titled "Magnetic Fields" has a "Name" line and a "Try This" section with a diagram of a horseshoe magnet and a grid for recording observations. To the right, there are two photographs of iron filings experiments. The top photo shows two bar magnets (N-S and N-S) on a surface with iron filings forming field lines. The bottom photo shows a horseshoe magnet with iron filings forming a dense field between its poles. A small bottle of iron filings is visible in the upper right corner.

Magnetic Induction, the Magnetosphere, Making a Homemade Compass:

We went on to talk about magnetic induction & the movement of electrons. We talked about domains and how temporary domains give items temporary magnetic properties. Then we talked about the magnetosphere and Earth's magnetic fields.

The kids each made their own **floating compass**. Remember that if you do this activity you need a very thin, light sewing needle. Larger needles will sink! :)

Magnet Unit: Magnetic Induction, The Magnetosphere, Magnetic North, Creating a Compass!

Temporary Magnets

Try this: Take a magnet and single several paper clips from it. Carefully group the top paper clip and remove the magnet. What happens?

ANSWER: The paper clip becomes a temporary magnet and attracts other paper clips.

Magnetic Induction

Magnets attract other magnetic materials in a process called magnetic induction. How does this work? Scientists think it is more likely due to the effects that spinning electrons have on the nuclei of magnetic material. The spinning electrons cause an atom to have a magnetic field.

Atoms are the small particles that make up elements. Each atom is made up of different particles with charges. In the diagrams to the below you see negative - particles, positive particles +, and particles with no charge.

In the pictures to the right what color are the electrons? _____
protons? _____
neutrons? _____

Each proton has a positive charge, each electron has a negative charge. It is the spinning electrons that make magnets work. When the electrons spin, they create tiny magnets in the atoms of most materials. The electrons spin around the nucleus in pairs. Since the electrons spin in opposite directions, this cancels out any effect the electrons might have on the material.

In an atom, electrons spin around the nucleus in a series of energy levels called shells around the nucleus in pairs, but in opposite directions - one up and one down. It is the spinning movement of electrons that causes magnetism.

In permanent magnets such as a bar of iron, the atoms contain electrons that spin in the same direction.

If you have studied chemistry and have talked about Lewis or Bohr Diagrams, the picture below is helpful in visualizing this. In iron, Fe, there are two electrons that are unpaired and are a magnet. In the Lewis diagram below right.

Model if another naturally magnetic material. If you look at the Lewis Diagram below you see unpaired electrons.

Fe
Ni

This is fairly advanced chemistry, though, so if you haven't covered this yet, don't worry! Just know that scientists believe that magnetism has to do with electrons and their motion.

Scientists think that magnetic materials consist of groups of atoms called domains which act as individual magnets. All the individual spinning electrons produce a magnetic moment that forces the domains to line up along the line of magnetic force. The domains all point toward a pole. When you put a magnet near a magnetic object such as a paper clip, the magnetic field works through the paper clip. It makes the paper clip's domains line up too. This is why a paperclip can become a temporary magnet that pulls on other paper clips.

What is the Biggest Magnet? Earth!

Earth is a giant magnet. Deep inside the Earth is a core of molten iron. This creates a vast magnetic field around the planet. This magnetic field is called the magnetosphere. It extends more than 100,000 miles into space.

Before the magnetosphere was discovered, the Earth's field was thought to be symmetrical, resembling that of a large bar magnet, dipping off continuously into space. However, we now know that the solar wind shapes the outer regions of the Earth's field, and that the field is sharply bent.

The shape of the Earth's magnetosphere is the direct result of being blasted by solar wind.

Solar wind shapes the outer regions of the Earth's magnetic field. Outside the boundary, it is dominated by the solar wind and the interplanetary magnetic field. Inside the boundary, it is dominated by the Earth's magnetic field. The magnetosphere shows many space storms like the aurora borealis.

The magnetosphere acts as a shield for Earth. In the outer layer, the magnetosphere is important to life on Earth because it blocks out most of the harmful solar radiation and hot plasma from the Sun, which would otherwise strip away the atmosphere.

Earth's magnetic field protects Earth from radiation and particles in space. It has these solar particles hit the magnetosphere, especially around the poles. There, they can create auroras. These particles break away from the field and go into Earth's atmosphere, moving towards the magnetic poles. If they combine with gases in Earth's atmosphere, they create colorful light displays in the sky. These lights are called auroras.

Compass

Earlier, we learned that the Chinese found that they could magnetize iron using a lodestone. They rubbed the iron with a rock to create the magnet. Those pieces of iron aligned themselves in the same direction - pointing to the North Pole. The needle of the compass aligns itself with the Earth's magnetic field.

Remember... the north pole of the magnet "seeks" the Earth's North Pole. We know that like poles repel each other, so the North Pole is actually the planet's south magnetic pole! Confusing, right?

Try this: Make your own compass!

- Paper, ruler and markers
- Tape
- Needle (This needle to be a very thin sewing needle! A bigger needle did not work for us!)
- Bowl of water
- A piece of string
- Magnet

1) Draw a line on the paper. Mark one end N for north and the other S for South.

2) Use a compass and align the paper so it is oriented north. Tape the paper to the floor so it doesn't move.

3) Place a needle on the north end of the magnet. Leave it there for a few minutes.

4) Stick the needle through one thing about of tissue.

5) Gently place the tissue and needle on the surface of the water.

6) Watch as the needle orients itself towards North!

Earth's Magnetic Field and Animal Migration:

The last part of our magnet unit was all about animal's ability to detect the Earth's magnetic field.

We learned about some of the experiments scientists have done to uncover how animals are able to detect the magnetic field. It ranges from animals actually having magnetite inside them, to various proteins that change in the presence of light and create magnetic cells. This is some cutting-edge science at the moment, so there's no doubt that more will be uncovered in the coming years about how animals use magnetism to migrate thousands of miles!

Below I've pictured the notebook pages, but there is a full-text set provided as well if you just want to read through this material with your kids. :)

Earth's Magnetic Field and Animal Migration Notebook Pages



Name: _____

Many Animals Can Sense the Earth's Magnetic Field

Animals like salmon, leatherback turtles, butterflies, and _____ use the Earth's magnetic field to migrate thousands of miles. Even _____ have been shown to be magnetosensitive.


Dozens of experiments have now shown that diverse animal species, ranging from bees to salamanders to sea turtles to birds, have _____ compasses. Some species use their compasses to _____ others to find better food just a few inches away.

Salmon use the Earth's magnetic field to migrate.

Each year, the Arctic Tern travels over _____ miles, migrating nearly from _____ and back again. Researchers have established that birds can sense the earth's _____ and use it to orient themselves.

Arctic Tern Migration



How did we first learn that animals could use the Earth's magnetic field?

In 1957, a Frankfurt scientist named Hans _____ noticed that the European _____ he had placed in a cage were getting restless. It was fall, and they kept on moving to the southwest part of the cage. Why were they doing this?

Robins in Germany migrate to Spain to the winter, but their behavior puzzled Fromme: these robins were in a _____ room, without the _____ or the _____ to guide them!

They could not tell that it was fall, and they could not use the position of the sun and the _____ where Spain was. He decided that they must be using the Earth's magnetic field to guide themselves _____.

Forty years ago, Prof. Dr. Wolfgang Wiltschko was the first to _____ that migrating robins use the Earth's magnetic field to direct themselves during migration. Their magnetic sensor showed them the course of the field lines of the Earth's magnetic field. Since that time a compass of this kind has been found in more than _____ species of birds, the majority of them being those seabirds that undertake annual migration.

Even more recently (Jan. 2011) researchers have been investigating the mechanism which enables robins to detect the Earth's magnetic field to help them navigate over vast distances. This ability, known as magnetoreception, has been linked to chemical reactions inside birds' _____ This occurs in _____ called cryptochromes.



Detecting the Magnetic Fields:

Since Fromme's time, many experiments on animal behavior have determined that organisms as diverse as bacteria and hamsters can detect the _____ of the Earth's magnetic field and the _____ at which it intersects with the Earth.

Marine biologists report that loggerhead sea turtles detect different magnetic fields and use them as boundaries while migrating. They use these fields to help them to stay on course.

Here is how they determined this:

Young loggerhead sea turtles (Caretta caretta) from eastern Florida undertake a transoceanic migration in which they gradually circle the north Atlantic Ocean before returning to the North American coast.

Scientists exposed hatching loggerhead turtles to magnetic fields replicating those found in various ocean regions. The hatchlings responded by swimming in directions that would keep them within certain ocean currents. This facilitated their movement along the migratory pathway.

These results implied that the young turtles have a _____ system that reacts to regional magnetic fields. With this _____ system, they will change swimming direction at crucial geographic boundaries.

How do animals detect Earth's magnetic field?


There is still a lot of research being conducted to determine this, but some animals contain small quantities of _____ while others have certain _____ which have molecules that can spin in certain ways depending on the Earth's magnetic field.

Magnetotactic bacteria orient themselves along the magnetic field lines of Earth's magnetic field. These bacteria have organelles called magnetosomes that contain _____ crystals.

Scientists called neuromatologists have identified an area of the mammalian _____ that apparently processes magnetic field information.

Research has discovered that many species contain small quantities of magnetite!

In 2012, researchers discovered that rainbow trout have some cells in their olfactory system (used for _____) that contain small quantities of magnetite!





Similarly, several species of _____ are known to incorporate magnetite crystals in the upper _____ for magnetoreception, which (in conjunction with cryptochromes in the retina) gives them the ability to sense the _____, polarity, and magnitude of the ambient magnetic field.

The bodies of animals such as birds and the fruit fly contain proteins called cryptochromes. When these proteins are exposed to blue light, they form molecules with _____ depending on the earth's magnetic field.

Scientists think that these cryptochromes could help some animals navigate.

In a study of monarch butterflies, researchers from the University of Massachusetts Medical School found that migrating monarchs orient themselves to the _____ - even in the absence of the sun. This means that even when it's _____, butterflies can continue moving to their winter home.

Tests and experiments showed that the monarch's _____ compass, and thus directional dependent on exposure to light wavelengths found in the ultraviolet A blue light spectral range, become cloud.

Magnets, Magnet Fields & the Magnetosphere Interactive Notebook Activity:

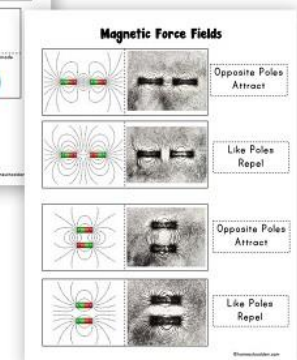
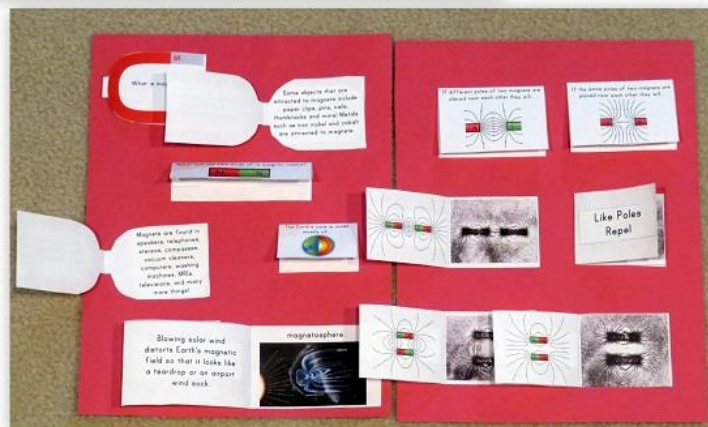
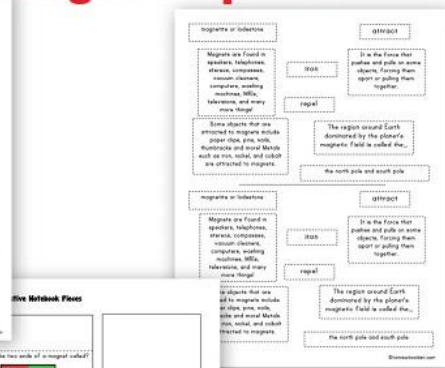
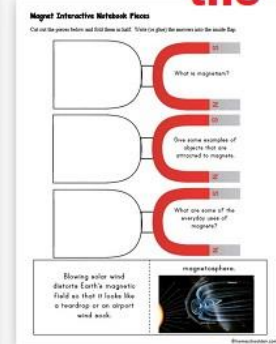
Our last activity was to create some interactive notebook pages that the kids added to their science notebook. Students can either glue the pieces onto paper (as we did below), directly into a notebook or they can create a lapbook with the materials provided.

We used this as our final wrap up and review, but it can be used to introduce students to the materials as well. Students can either cut out the suggested answers or they can write their own answers into the insides of the pieces. Some of the questions it covers include:

- What is magnetism?
- Give some examples of objects that are attracted to magnets.
- What are some of the everyday uses of magnets?
- The region around Earth dominated by the planet's magnetic field is called the... magnetosphere
- What are the two ends of a magnet called?
- The second page is mostly about magnetic fields



Magnets, Magnetic Fields & the Magnetosphere



What ages is this packet for? I would say this packet is suitable for **3rd - 7th grades** or so (ages 8-13 or so) - of course younger kids will love doing all the hands-on activities, so it is adaptable for homeschool families. My girls are 10 and just turned 13. They both enjoyed this unit a lot. I also had my high school aged (15-year old) son review some of the material with us and as I said above, we all really enjoyed playing around with the magnets and iron filings! :)

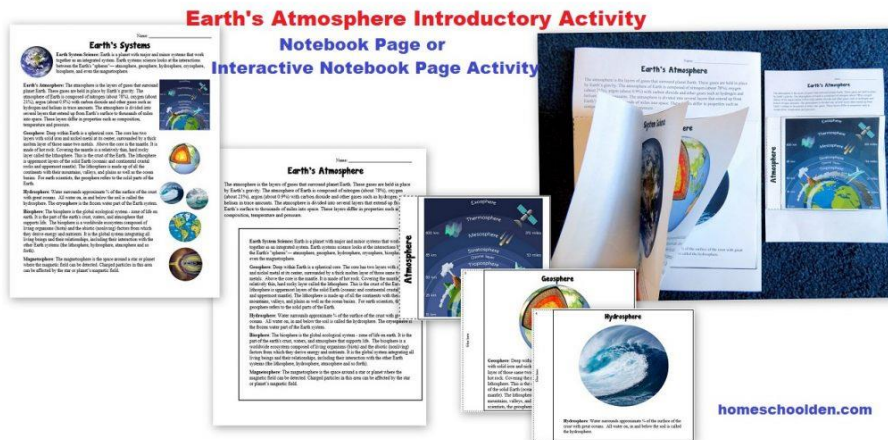
Is any background needed? My kids have a pretty good understanding of atoms (electrons, protons and neutrons). It is not necessary, but there is some discussion of electron orbitals that you may have to gloss over. (We did a [Chemistry Unit](#) last spring and went into a lot of detail about the periodic table, Bohr and Lewis Diagrams, etc.) Also, let me share what we were doing just before we jumped into this our Magnet Unit:

Just so you know, earlier this semester, my daughter (age 10) did the [Where I Live Activity Packet](#) (My galaxy, solar system, planet, continent, country, state, town, and home!). Then we moved on to the [Layers of the Atmosphere Packet](#). We had just finished the introductory activity (below) when I decided to take this detour and talk about the magnetosphere and magnetic fields in more depth.



Earth's Systems: Geosphere, Hydrosphere, Magnetosphere, Biosphere, Atmosphere

This activity reviews all of Earth's Systems: geosphere, hydrosphere, biosphere, magnetosphere, atmosphere



Again, neither of those units are necessary to do before this one, but I wanted you to know what we were up to! :) The Earth's Systems activity (above) is in the [Layers of the Atmosphere Packet](#) **not** in the Magnet Packet below.

The Magnetism Packet is 25+ pages.

Let me know if you have any questions! ~Liesl Liesl@homeschoolden.com

The collage features several pages from the Magnetism Packet. On the left, there's a page titled 'Magnets' with a 'How does magnetism work?' section. In the center, a 'Magnetism Definition' page explains the force between objects. To the right, 'What is the Magnet Magnet Earth?' discusses Earth's magnetic field. Below these are pages on 'Magnetic Fields' and 'Magnetism and Migration'. A large diagram in the center shows magnetic field lines between two poles. On the right side, there are 'Magnet Interactive Notebook Pages' with various diagrams and text boxes. At the bottom right, a red notebook page is visible with sections for 'Opposite Poles Attract' and 'Like Poles Repel'. Photos of hands holding magnets and a stack of colorful rings are also included.

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