# *Engage* *Electric and Magnetic Forces*

Watch this video: https://www.youtube.com/watch?v=WS9ISUXBsa8

1. What do you think is causing her hair to stand on end? (Hint: Her left hand is on a steel ball. What is that thing?)

I think her hair is standing on end because…….

Watch this video: https://www.youtube.com/watch?v=BQA5VDXE7ts

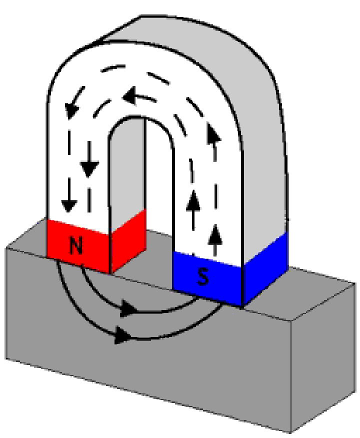
2. What do you think caused the engine to float up to the crane?

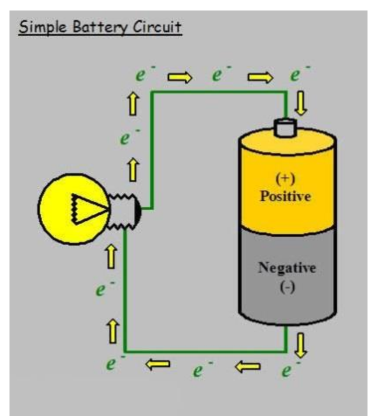
I think the engine floated up to the crane because……

3. What do you think caused the engine to drop from the crane?

I think the engine dropped from the crane because….

Both videos show something caused by what appears to be an invisible force. Just because you cannot see the force doesn't mean it's not there. Actually they are using two different types of invisible forces.




Look at the pictures above.

4. What do you notice about both pictures? What is one thing they have in common and one thing that is different?

One thing the diagrams have in common is…..

One thing the diagrams have that is different is…..

Electrical energy flows and can pass through wires or other materials which can conduct electricity.  Magnets generate fields which can be diagramed as lines.

Watch the first 30 seconds of this Myth Busters video about how Van de Graaf generators work.

http://www.youtube.com/watch?v=7qgM1A3pgkQ

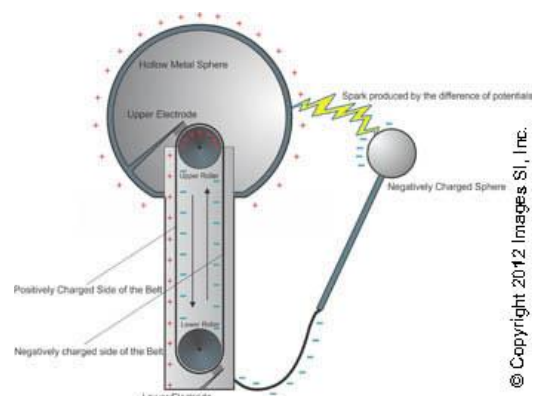
Read the following information about Van de Graaff generators:

Van De Graaff generators are a common sight in many science laboratories and for many people it is a device that looks like a large metal ball on a pedestal and can make hair stand on its end literally. However, there is more to the Van De Graff generators than just deploying static charge.

Stop and discuss

The Van De Graaff Generator is basically an electrostatic machine that can generate high voltages. A typical Van De Graaff Generator consists of an insulating belt that transports electrical charge to a terminal. The charges that are sent on the belt are generated through a high voltage DC supply. These charges are collected in the inside of the terminal and transferred to its external surface.

The first Van de Graff Generator was invented by Dr. Robert J Van De Graff in 1931 in the Unites States of America for the sole purpose of generating and using high voltages for use in nuclear physics experiments.  Dr. Van De Graff, a professor in the reputed Massachusetts Institute of Technology, designed and built the world's largest air-insulated Van de Graaff generator for use in X-ray experiments and for research in atom-smashing.




5. What is the aim/purpose of the article?
The purpose of the article is to….

6. Do your best to explain how a Van de Graaff Generator works.
A Van de Graaff generator works by….

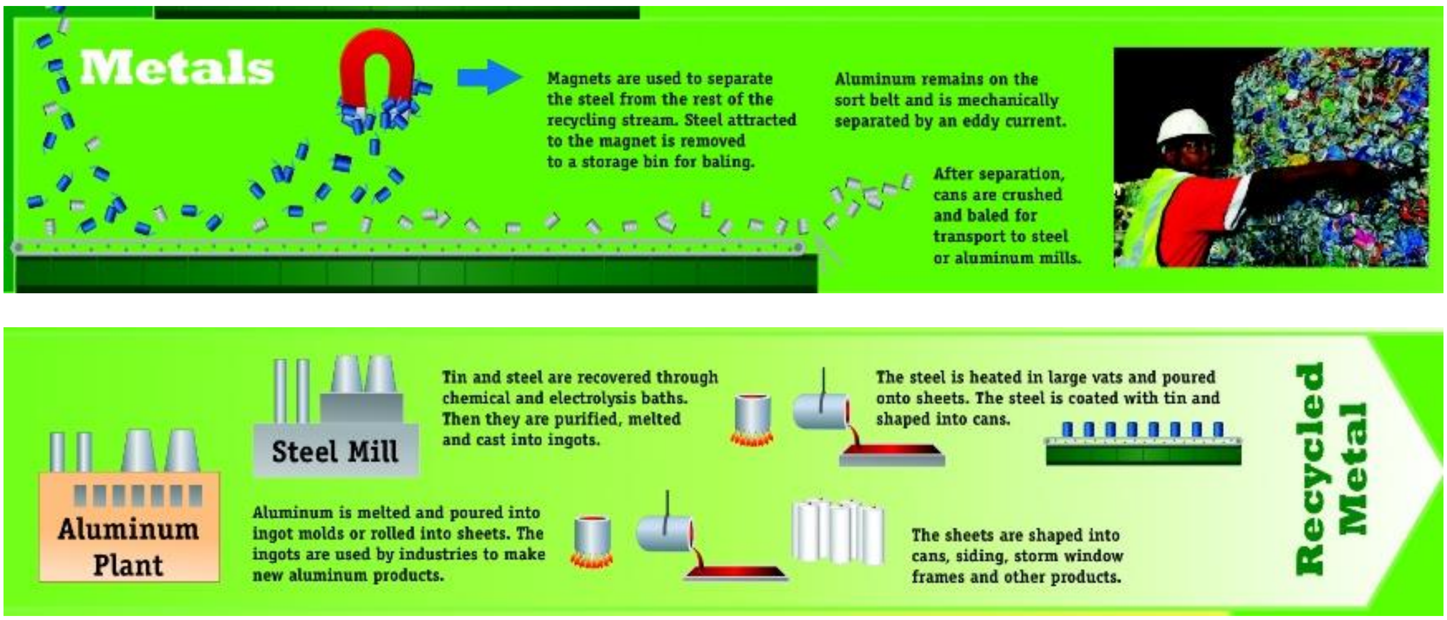
Now watch the following video showing a Van de Graaf generator in action:

http://www.youtube.com/watch?v=rNEY3Yv9kC8

7. Explain what you think generated the sparks seen from the steel sphere on top of the generator.

I think the sparks were generated from…..

Now examine the following diagram about recycling metal.




8. Explain the process of how metals are recycled by using one or two words to describe each of the four steps. For example, the first step is to remove the metals from the recycling stream. So MY first word would be "remove." YOU need to think of a different word.

1.
2.
3.
4.

9. What is the aim/purpose of the diagram?

10. Explain how electricity or magnetism is used to recycle metal in the diagram above.

Now we will explore electric and magnetic forces. You will need to go to your lab stations to perform the activities. Before you go you need to know the difference between attract and repel.

11. Discuss with your neighbor the difference between attract and repel. Think of an example of things that attract and things that repel.

# *Explore* *Electric and Magnetic forces*

## Make Static Electricity with Scotch Tape!

**Procedure, Part I:**

A. Fold over the end of a piece of tape 10 cm long to make a handle. Then stick this piece of tape to the top of your table.

B. Do the same thing to three more pieces of tape each 10 cm long.

C. Use a pen and write 1 on the handle of the first piece. On the other pieces, write 2, B, and T.

D. Hold the 1 handle between your right index finger and thumb. Hold the 2 handle between your left index finger and thumb. Keep your other fingers pointing upward. Now---just rip the pieces of tape off the table.

As you try the following things, your lab partners should write down the answers to the questions.

E. Hold the tapes in your hands and bring their non-sticky sides close together.

1. Do the non-sticky sides **REPEL** or **ATTRACT** each other?

F. Hold the tapes in your hands and bring their sticky sides close together.

2. Do the sticky sides **REPEL** or **ATTRACT** each other?

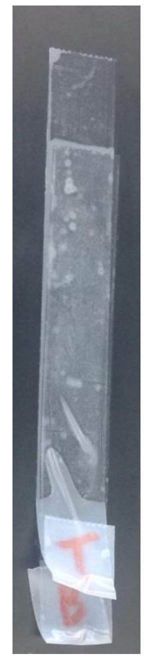
G. Hold the tapes in your hands and bring the sticky side of one close together with the non-sticky side of the other.

3. Do these sticky/non-sticky sides **REPEL** or **ATTRACT** each other?

4. Do the tapes want to **REPEL** or **ATTRACT** your hand?

Stick the tapes back onto the table. Answer the rest of the questions.

**Procedure, Part II:**




H. Place the sticky side of the tape labeled T on top of tape B. In other words, B is on the table, on the bottom, and T is on top of B.

I. Pull B off the table so that B and T remain stuck together.

J. While B and T are still stuck together, touch both B and T with your fingers many times. This will get rid of any charge that might be on them.

K. Rip B and T apart as quickly as you can. This will put a charge on both B and T.

As you try the following things, your lab partners should write down the answers to the questions.

L. Hold the tapes in your hands and bring their non-sticky sides close together.

5. Do the non-sticky sides **REPEL** or **ATTRACT** each other?

M. Hold the tapes in your hands and bring their sticky sides close together.

6. Do the sticky sides **REPEL** or **ATTRACT** each other?

N. Hold the tapes in your hands and bring the sticky side of one close together with the non-sticky side of the other.

7. Do these sticky/non-sticky sides **REPEL** or **ATTRACT** each other?

8. Do the tapes want to **REPEL** or **ATTRACT** your hand?

**Procedure, Part III:**

O. Now we are going to try to figure out what charges we have on each one of these tapes. Put tape T on top of tape B, just like before.

P. Bring 1 and B close together.

9. Do they **REPEL** or **ATTRACT**?

Q. Bring 1 and T close together.

10. Do they **REPEL** or **ATTRACT**?

11. Which two tapes have the exact same charge (repel)?

12. Which two tapes have the opposite charge (attract)?

# Balloon Static

Take the balloon and rub it on your shirt for 10-15 seconds. Now see if the balloon attracts or repels the following things:

| **Object** | **Attract/Repel** |
|---|---|
| hair | |
| tiny pieces of tissue | |
| cloth | |
| pieces of thread | |
| pepper | |
| iron powder | |
| pencil shavings | |

12. How many objects were attracted to the balloon?

13. Guess why the objects were attracted.

14. How many objects were repelled by the balloon?

15. Guess why the objects were repelled.

# Magnetic Force

Use the magnet to see what objects are attracted, repelled, or nothing happens.

| Object | attract/repel/nothing |
|---|---|
| coin 1: | |
| coin 2: | |
| metal cube | |
| magnet | |
| paper clip | |
| cloth | |
| pieces of thread | |
| pepper | |
| pencil shavings | |

16. What is a common characteristic of objects which were attracted?

17. Guess why the objects were attracted.

18. What is a common characteristic of objects which were repelled?

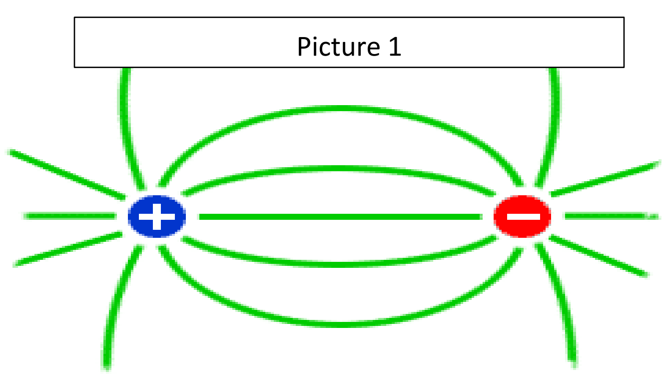
19. Guess why the objects were repelled.

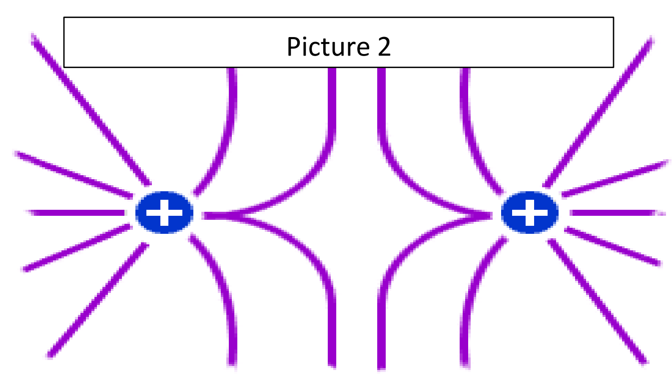
20. What is a common characteristic of objects which nothing happened to?

21. Guess why nothing happened.

## ***Explain*** **Electric and Magnetic forces**

You have seen both electric and magnetic forces attract and repel under different circumstances. Whether the forces attract or repel is determined by their charges.




22. Look at picture 1. Will the charges repel or will they attract?

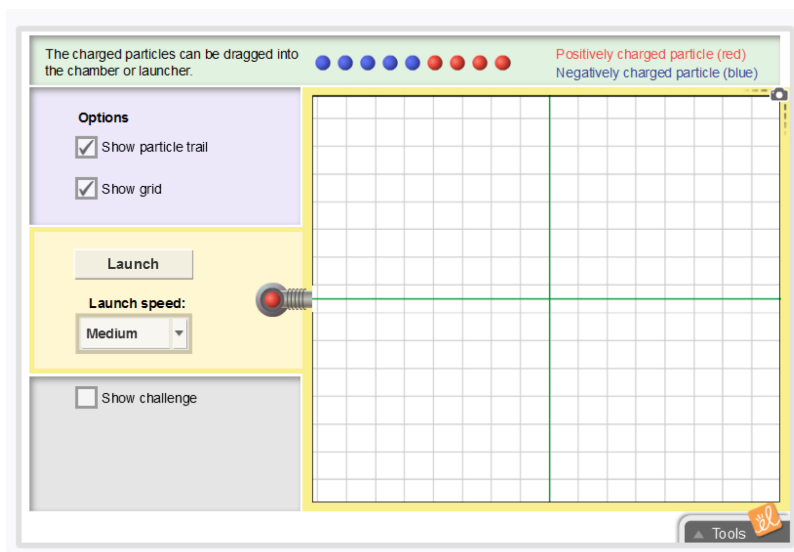
23. Look at picture 2. Will the charges repel or will they attract?

24. There are lines in both pictures.  What is the difference between the lines in picture 1 and the lines in picture 2?  (I'm not asking about the color.)

25. Why are the lines connected between the positive and negative charges in picture 1?  Guess what this might represent.

26. Why are the lines not connected between the two positive charges in picture 2? Guess what this might represent.

Now you will use the Gizmo called "Charge Launcher."  Load the Gizmo.  Try to accomplish each of the following tasks by moving the positive (red) and negative (blue) particles.  When you are successful take a screenshot and paste the picture into the lesson.




Keep the settings the same as in the picture.

27. Have the positively charged particle (red) exit quadrant one (I). Don't forget to paste the screenshot!

28. Have the positively charged particle (red) exit quadrant two (II).

29. Have the positively charged particle (red) exit quadrant three (III).

30. Have the positively charged particle (red) exit quadrant four (IV).

31. CHALLENGE – Have the positively charged particle (red) pass through each quadrant before exiting.


32. Have you ever lost a sock when doing laundry?

33. Which two of the demonstrations above (tape, balloon, or magnet) work for the same reason as a sock stuck to a shirt? Explain your thinking.

34. What types of charges do the sock and shirt have to cause the attraction?

35. Which of the demonstrations above (tape, balloon, or magnet) works for the same reason as the spinning top? Explain your thinking.

36. Look the magnetic top floating above the person's hand. Below the hand is blue magnet. What types of charges do the top and magnet have to cause the repulsion?

## *Elaborate* Electric and Magnetic forces

Pretend it is 9 am and you have just been dropped off in a forest you have never been in before. You need to find the ranger station which is exactly 2 miles north of the drop-off point. You have no electronic devices with you.

37. How would you know which way to walk?

Before the age of technology people found their way around all the time with one very important tool.

Magellan used it to circumnavigate the globe.

Lewis and Clark paid $2.50 for one in 1803 and used it to traverse the United States.

Boy Scouts use them all the time when hiking.

The incredible device was first used by the Chinese over 3000 years ago.

The object is a compass.  The needle is actually a _______________.

Magnets create fields around them.  These fields are not visible by themselves, but with the help of some iron filings, the fields can be observed.

38. Take a picture of the magnetic field model your teacher shows you and import the picture to the space below.

39. Label the magnet lying on its side “A” and the magnet up on its end “B”.

39. Describe the field generated by magnet A (lying on its side).

40. Describe the field generated by magnet B (up on its end).

41. Describe the main difference between the fields generated by magnet A and magnet B.

42. Guess what you think causes the main difference.

43. You will observe some more fields generated by other magnets. Make some predictions with your neighbor before the outcome is revealed.

Now you will be using the GIZMO: Magnetism. Load the gizmo and follow the steps.

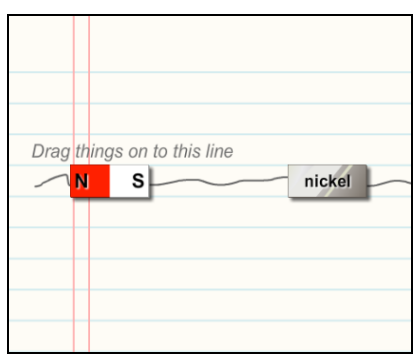
**Prior Knowledge Questions** (Do these BEFORE using the Gizmo.)

44. What happens when you place two magnets close together?

45. What objects do magnets stick to? Make a list.

46. What do these objects have in common?

**Gizmo Warm-up: What is attracted to magnets?**



A **bar magnet** is a simple rectangular magnet. If you hang a bar magnet by a string, the **north pole** (N) of the magnet will tend to point north while the **south pole** (S) of the magnet points south.

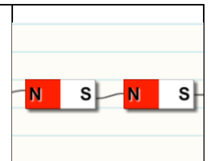
47. Look at the materials at the bottom of the Gizmo™. Which ones do you think will stick to a bar magnet?

**48. Ferromagnetic** materials are strongly attracted to magnets. Drag a bar magnet and the piece of **nickel** onto the scribbled line. Press **Play** (▶).

A. Is nickel ferromagnetic?

B. How do you know?

49. Test copper, wood, glass, and iron. Which ones are ferromagnetic?

| | | |
|---|---|---|
| **Activity A:**<br><br>**Attract or repel?** | <u>Get the Gizmo ready</u>:<br>• Check that the MAGNETIC FORCES tab is selected.<br>• Click **Reset** (⟲). |   |

**Question: How do magnets interact?**

50. <u>Observe</u>: Drag two bar magnets onto the paper and press **Play**. Then click **Reset**. Change *one* of the magnets (either from **N-S** to **S-N**, or vice-versa). Click **Play** again.

A. What happened the first time?

B. What happened the second time?

51. <u>Form hypothesis</u>: Magnets are either pulled together (**attracted**) or pushed apart (**repelled**). Based on what you have seen, when are magnets attracted and when are they repelled?

52. Predict: Based on your hypothesis, which pairs of magnets will be attracted to each other? Which will be repelled? Record your predictions below. (Leave the result blank for now.)

| **Left magnet** | **Right magnet** | **Prediction**<br><br>**(Attract or repel?)** | **Result**<br><br>**(Attract or repel?)** |
|---|---|---|---|
| N S | N S | | |
| N S | S N | | |
| S N | S N | | |
| S N | N S | | |

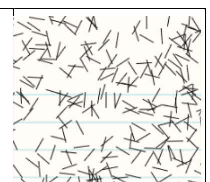
53. Run Gizmo: Test your predictions using the Gizmo. Record your results in the table.

54. Draw conclusions: Fill in each blank below with the correct word.

C. The south pole of a magnet is attracted to the ___________ pole of another magnet.

D. The south pole of a magnet is repelled by the ___________ pole of another magnet.

E. The north pole of a magnet and the north pole of another magnet will ____________ each other.

| | | |
|---|---|---|
| **Activity B:**<br><br>**Magnetic field lines** | Get the Gizmo ready:<br><br>• Click **Reset** and drag all objects off the paper.<br>• Select the MAGNETIC FIELD LINES tab. |  |

**Question: If you scatter iron filings (little slivers of iron) around a magnet, you will see a pattern of magnetic field lines. What do these lines show you?**

55. Observe: Drag *one* magnet onto the paper. Click **Sprinkle filings** and then **Tap table** five or six times. Sketch the pattern you see in the box:

What do you notice about the iron filings?

56. Observe: Drag a second magnet next to the first. Click **Sprinkle filings** and then click **Tap table** several times. Sketch what you see.

Will these magnets be attracted or repelled?

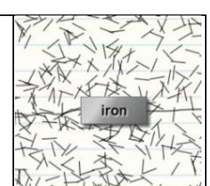
57. Observe: Now switch one of the magnets. Click **Sprinkle filings** and then click **Tap table** several times. Sketch what you see.

Will these magnets be attracted or repelled?

58. Draw conclusions: Compare the magnetic field lines you have sketched. How can you use the field lines to tell if magnets will be attracted or repelled?

59. Extend your thinking: Observe the magnetic field lines produced by an **N-S** magnet and the **mystery** magnet. Will these magnets attract or repel each other? First, make a prediction below. Then, check your answer on the MAGNETIC FORCES tab.

Prediction: _________________________ Actual result: _________________________

| | | |
|---|---|---|
| **Extension:**<br><br>**Magnetic materials** | Get the Gizmo ready:<br>• Select the MAGNETIC FIELD LINES tab.<br>• Drag an **S-N** magnet and the **copper** bar onto the paper. |  |

**Question: Why do magnets attract certain materials?**

60. Observe: Click **Sprinkle filings** and then click **Tap table** several times. Look closely at the filings near the **copper** bar. Does copper have any effect on the filings?

61. Observe: Repeat the experiment with **iron**. What effect does iron have on the filings?

62. Analyze: Which of these materials is ferromagnetic?

63. Draw conclusions: How can you tell if an object is ferromagnetic by looking at its field lines? Discuss your answer with your teacher and classmates.

64. Apply: Select the MAGNETIC FORCES tab and experiment with the Gizmo. Try to answer the questions below. Share your findings with your classmates and teacher.

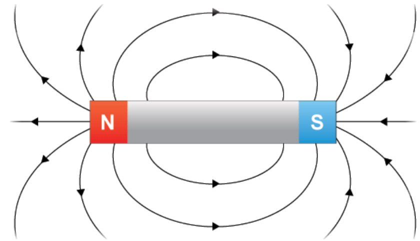
A. Can a magnet ever *repel* a ferromagnetic material?

B. In the Gizmo, does one ferromagnetic material attract another?

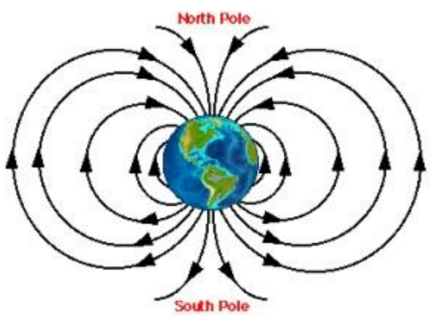
65. Experiment (optional): When a ferromagnetic material like iron is placed near a magnet, it becomes **magnetized**—it actually becomes a magnet! (Look at the field lines when iron is near a magnet.) Even after the magnet is removed, iron can stay magnetized for a while.

In "real life" (not in the Gizmo), rub a metal paper clip with a magnet. What happens when you touch another paper clip with your magnetized paper clip?

Magnets are dipolar. The picture to the right shows a dipolar magnet.

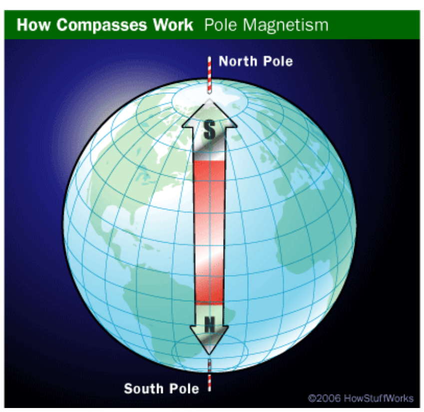



7. Describe what dipolar means.




The earth also has a magnetic field.

Now let's apply what we have learned to describe how a compass works.




8. The needle of a compass has two ends. Which end of the needle points to the North Pole? Why?

Magnets are simple examples of natural magnetic fields. But guess what? Because the core of our planet is filled with molten iron (Fe), the earth has a huge magnetic field. This creates a large field that protects the Earth from space radiation and particles such as the **solar wind**.

When you look at tiny magnets, it works in a similar way. It has a field around it.

Watch the following video which describes the earth's magnetic field and solar radiation from the sun.

http://www.youtube.com/watch?v=URN-XyZD2vQ

9. How does the earth's magnetic field protect us?

10. What would be a negative impact if none of the sun's radiation were blocked by the earth's magnetic field?

11. Draw a picture of how the earth's magnetic field would look if there were no solar radiation.

12. Draw a picture of the earth's magnetic field being hit by solar radiation.

13. Read the article "Earth's Magnetic Field Is Fading."

# Earth's Magnetic Field Is Fading

John Roach
for National Geographic News

September 9, 2004

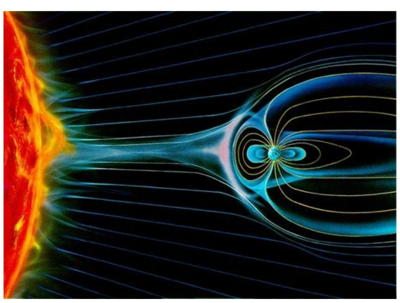
Earth's magnetic field is fading. Today it is about 10 percent weaker than it was when German mathematician Carl Friedrich Gauss started keeping tabs on it in 1845, scientists say.

If the trend continues, the field may collapse altogether and then reverse. Compasses would point south instead of north.

Not surprisingly, Hollywood has already seized on this new twist in the natural-disaster genre. Last year Tinseltown released *The Core,* a film in which the collapse of Earth's magnetic field leads to massive electrical storms, blasts of solar radiation, and birds incapable of navigation.

Entertainment value aside, the portrayal wasn't accurate, according to scientists who say the phenomenon of Earth's fading magnetic field is no cause to worry.

"The field has reversed many times in the past, and life didn't stop," said Gary Glatzmaier, an earth scientist and magnetic field expert at the University of California, Santa Cruz.



Glatzmaier is keeping an eye on our planet's weakening magnetic field as he tries to learn more about how Earth's geodynamo works. The geodynamo is the mechanism that creates our planet's magnetic field, maintains it, and causes it to reverse.

**Magnetic Shield**

Earth's geodynamo creates a magnetic field that shields most of the habited parts of our planet from charged particles that come mostly from the sun. The field deflects the speeding particles toward Earth's Poles.

Without our planet's magnetic field, Earth would be subjected to more cosmic radiation. The increase could knock out power grids, scramble the communications systems on spacecraft, temporarily widen atmospheric ozone holes, and generate more aurora activity.

A number of Earth's creatures, including some birds, turtles, and bees, rely on Earth's magnetic field to navigate. The field is in constant flux, scientists say. But even without it, life on Earth will continue, researchers say.

"There are small fluctuations, which lead to nothing, and large ones, which we know from the geologic record are associated with reversals," said Peter Olson, a geophysicist at Johns Hopkins University in Baltimore, Maryland.

According to Earth's geologic record, our planet's magnetic field flips, on average, about once every 200,000 years. The time between reversals varies widely, however. The last time Earth's magnetic field flipped was about 780,000 years ago.

"We hear the magnetic field today looks like it is decreasing and might reverse. What we don't hear is it is on a time scale of thousands of years," Glatzmaier said. "It's nothing we'll experience in our lifetime."

But several generations from now, humans just may witness a reversal. By then, Glatzmaier said, scientists will better understand the process and be prepared to cope with the effects.

14. Write an expository summary using the frame below about the article "Earth's Magnetic Field Is Fading" in your notebook.

## ***Expository*** **Summary**

writing frame

| Sentence 1: Who/what/main idea of text |
|---|

In the ___________________," ________________________________," by ________________,
(genre- column A) (title) (author)

the author _____________________ that __________________________________________.
( verb from column B) (article main idea)

| Sentence 2: author's purpose and text structure |
|---|

______________________ uses a _______________________________ structure in order to
(author's last name) (text structure from column C)

______________________ _____________________________________________________.
(verb from column D) (author's purpose)

| Sentence 3: author's intended audience |
|---|

This ____________________________ is intended for __________________________________.
(column E) (describe the author's audience)

The article mentions _______________________________________________________________.
(Write a sentence about whether the earth's fading magnetic field is something to worry about.)

The earth's magnetic field __________________________________________________________.
(Write a sentence about what creates the earth's magnetic field.)

If the earth had no magnetic field ____________________________________________________.
(Write a sentence about what would happen if there were no magnetic field around Earth.)

Over time the earth's magnetic field __________________________________________________.
(Write a sentence about the flipping of the magnetic field.)

In conclusion, the ______________ ___________________ ____________________________.
(genre- column A) (verb from column D) (restate main idea)

| A | B | C | D | E |
|---|---|---|---|---|
| essay | states | descriptive | demand | campaign |
| article | believes | definition | persuade | promotion |
| editorial | asserts | sequential | promote | argument |
| cartoon | denies | comparison | agree | recommendation |
| advertisement | explains | contrasting | disagree | report |
| speech | argues | cause and effect | show | letter |
| campaign | recommends | problem/solution | illustrate | document |
| letter | | question/answer | demonstrate | text |
| | | | describe | communication |
| | | | stress | |