Detect Solar Storms

How can you detect Solar storms from here on Earth?

Description

Build a magnetometer, an instrument that can measure slight changes in Earth's magnetic field that are caused by Solar storms.

Age Level: 13 and up

Materials

- Empty 2-liter soda bottle
- 30-cm length of thread
- Bar magnet (2 - 8 cm in length)
- Clear tape
- 3" x 5" index card
- Drinking straw
- 3-5 handfuls of sand, pebbles, or coins
- Laser pointer
- Rubber bands
- Two sheets of white paper
- Ruler
- Pencil
- Small mirror
- Scissors
- Hammer
- Small nail
- Stack of small books
- Utility knife (optional)

Small pebbles and coins can be used in place of sand. A small mirror can be obtained from a used makeup compact case.

Time

Preparation: 15 minutes
Activity: 60 minutes + data collection
Cleanup: 5 minutes

Safety

Be extremely careful never to look directly at a laser beam. Never aim a laser pointer directly at a person or pet. When reflecting the laser beam off of any reflective surface, be cautious of where the reflected beam will travel.

Step 1

Cut the soda bottle into two parts, with the cut line about ⅓ of the way from the bottle's top. You will need to use both pieces of the bottle, so be sure the cut is clean and straight.

Tip

Whether you use scissors or a sharp knife, be very careful so you don't cut yourself. Ask an adult if you need help.

Step 2

Fill the bottom portion of the bottle with sand or pebbles about 5-10 cm deep. This will stabilize the bottle so it doesn't tip over.

Tip

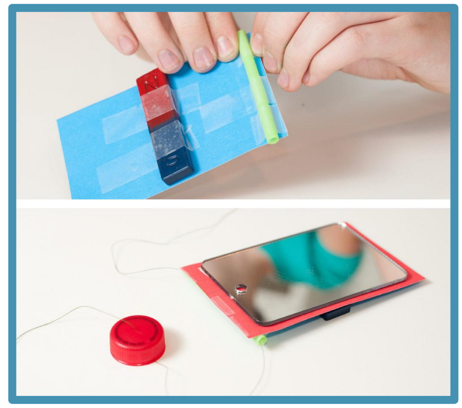
If you don't have sand, you can use pebbles or coins.

Step 3

Using the hammer and nail, poke a small hole in the center of the bottle cap. Run the thread through the hole, and tape it to the outside of the cap.

Step 4

Tape your small mirror (or reflective material) to the center of the card. Tape the bar magnet and a 5-cm length of straw to the top of the card, as seen in the photo.



Step 5

Run the end of the thread through the straw and secure it with a knot. Place the bottle top back on the bottom of the bottle. Adjust the thread through the cap so that the card-mirror-magnet apparatus hangs freely without touching the pebbles below.

Tip

Secure the thread outside the bottle with a piece of tape.

Step 6

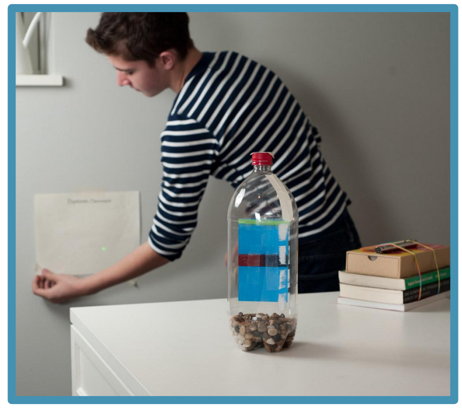
Place the laser pointer on the stack of books, so the laser beam can be aimed directly at the middle of the mirror inside the bottle. Secure the laser to the stack of books with rubber bands, so the laser will remain in place.

Tip

Any small, Solid, stackable objects can be used to raise the laser to the correct height. Be careful when reflecting laser light off of the mirror!

Step 7

Place the laser pointer and the magnetometer on a Solid table or floor, where they can be undisturbed for at least a week. Arrange the objects as shown here, where the laser is about 0.3 m away from the bottle, and a white sheet of paper (attached to either a wall or prop) is about 1 m away from the bottle. The reflected laser light should be aimed at the center of the sheet of paper.



Tip

Do not place the laser pointer on a table or counter where it will be at eye level.

Step 8

Wait about 10 minutes for the mirror in the magnetometer to stop moving. The magnet in the magnetometer will align with Earth's magnetic field, just like a compass needle. Once the magnet has settled, the bright dot from the laser beam should be stationary on the white paper.

Tip

Your magnetometer is very sensitive—try bringing another magnet towards it from afar and watch the bright laser dot deflect as you get closer.

Step 9

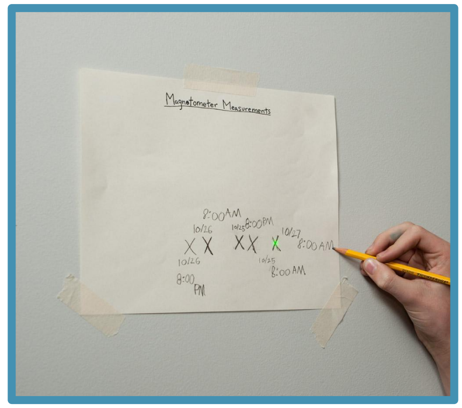
Once the bright laser dot on the paper has settled again, mark the dot's location on the paper. Record the time and date next to the dot.

Tip

If the dot slowly moves back and forth on the white paper, mark the center of the path that the dot travels.

Step 10

Record the position of the bright dot on the white paper at least twice a day (morning and night) for 3 days. The movement of the laser beam indicates a change in Solar activity! A large increase in Solar activity will influence Earth's magnetic field and the position of the laser dot.

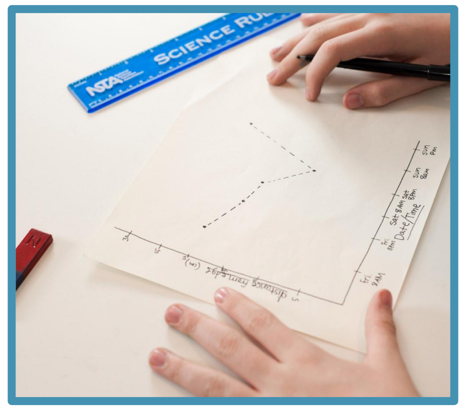


Tip

You can take measurements more frequently if you wish and for a longer length of time as well.

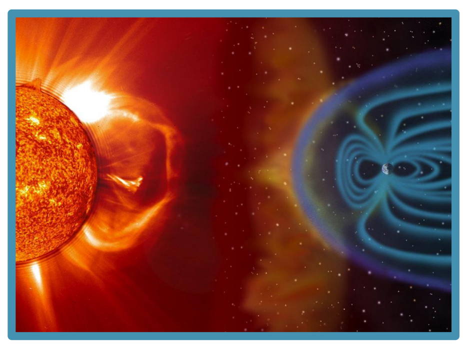
Step 11

Record the data from your white paper onto a chart, where the dot's distance from the edge of the white paper is noted on the vertical y-axis, and the time/date is noted on the horizontal x-axis. Here is a sample of what your data may look like.



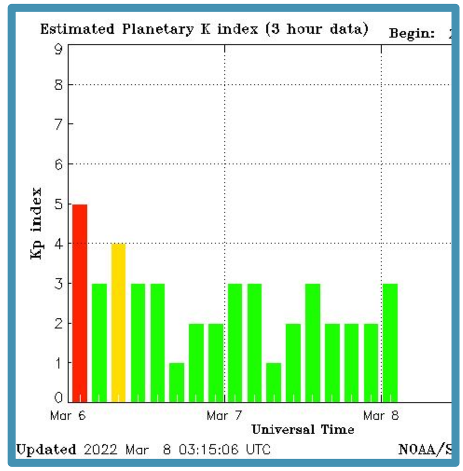
What's Going On?

The magnetometer you just made acts like a compass—the magnet rotates and aligns itself with Earth's magnetic field. Solar storms that send charged particles towards Earth can affect Earth's magnetic field, changing which way the magnetic field points at your particular location on Earth. The magnetic field usually points towards the magnetic north pole, but Solar activity can change the field's direction slightly.



Compare your data

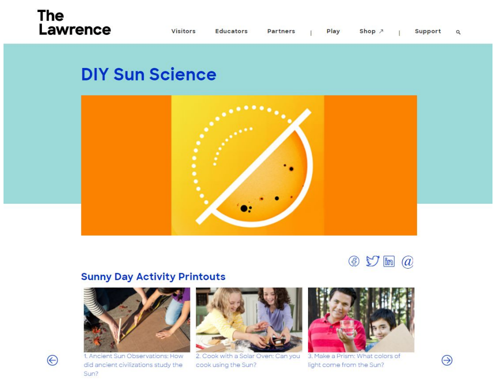
You can see if the observations from your magnetometer are similar to what scientists have measured. The graph shown here shows a measurement of how much Earth's magnetic field is disturbed due to Solar storms. The higher the number, the more disturbance there is. This value, called the Kp index, is an average strength of a magnetic storm that's felt at various locations around Earth. This information is updated from professional magnetometers every 3 hours.
http://www.swpc.noaa.gov/products/planetary-k-index



How sensitive is the device?

The magnetometer you built is very sensitive. Try bringing another magnet near it and see when the bright laser dot is deflected. You may even be able to detect when large electrical appliances turn on! Large appliances like refrigerators and clothes dryers have electric motors that contain magnets inside them. When turned on, they can change the magnetic field near your magnetometer that you may be able to detect.

Learn More



For more info and other activities, visit:

LawrenceHallofScience.org/do_science_now/diy_sun_science

Credits

The DIY Sun Science app allows families and educators to investigate and learn about the Sun at home, at school, or anywhere you go! The app provides 15 hands-on investigations, images, and videos.

Activity inspired by “Solar Storms and You!” NASA, EG-2000-03-002-GSFC. Slide 14, ESA/NASA. Slide 15, NOAA/SWPC.

This work was supported by NASA under award number NNX10AE05G and 80NSSC21M0082. Any opinions, findings, conclusions, or recommendations expressed in these programs are those of the author and do not reflect the views of NASA.