Description: Learners model the process of solar wind interacting with Earth's magnetosphere by using a magnet to represent the Earth's magnetosphere and moving iron powder to represent the solar wind.

Background: The National Science Standards call for learners to understand how magnets affect other materials. In this activity, participants will place a round magnet under a piece of paper and use a straw to blow iron powder across the top of the paper. Learners will discover that the magnet affects the powder even though it is under the paper.

Similarly, the Earth is a huge electromagnet that generates a very large magnetic field extending well into space. It is this magnetic field that provides us protection from the solar wind plasma *(ultra-hot gases emitted by the Sun; contains super-charged particles that can conduct electricity*). It is also the interaction of the Earth's magnetic field with the solar wind that makes it necessary for the Genesis mission to go outside the Earth's magnetosphere (*the region surrounding a planet where the behavior of electrically charged particles is determined by the planet's magnetic field*) to obtain a "clean" sample of the solar wind. More information about solar wind plasma and planetary magnetospheres is available in the following instructional materials from the Genesis science module *Cosmic Chemistry: Planetary Diversity:*

- Teacher Guide http://genesismission.jpl.nasa.gov/educate/scimodule/PlanetaryDiversity/plandiv_pdf/PlasmaWarsTG.pdf
- Student Text http://genesismission.jpl.nasa.gov/educate/scimodule/PlanetaryDiversity/plandiv_pdf/Plasma%20WarsST.pdf

National Science Standards[1]

3-5 Nature of Science

Understands the nature of scientific inquiry

Plans and conducts simple investigations

3-5 Physical Sciences

Understands forces and motion

Knows that magnets attract and repel each other and attract certain kinds of other materials

K-2 Physical Sciences

Understands forces and motion

Knows that magnets can be used to make some things move without being touched

[1]Kendall, J.S. & Marzano, R.J. (2000). *Content Knowledge: A Compendium of Standards and Benchmarks for K-12 Education.* (3rd ed.). Alexandria, VA: Association for Supervision and Curriculum Development.

Materials (For the Class)

For each group:

- One sheet of white paper (preferably legal-sized)
- One round magnet (between 1 and 1.5 cm in diameter), available locally at craft shops
- Iron powder (dime-sized amount—approximately 5 g)
- Two strips of masking tape

Caution!!!

If you are planning to use this activity with more than one class each day, fresh iron powder samples should be used for each group of students. Once the iron powder is magnetized, it should not be used again for this activity until the granules are completely demagnetized. Heating the powder between uses will enhance the demagnetization process.

For each student:

- Straw
- Write-On Sheet, "Plasma Wars"
- Safety goggles

Safety Note

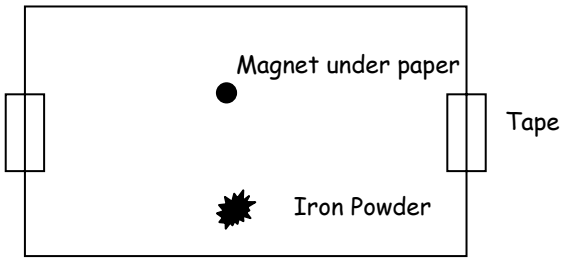
Safety goggles should be worn according to local regulations.

Procedure:

1. Ask learners to describe what they know about magnets. Ask them what some uses are for magnets (some participants may have played with magnets or used them to pick up paperclips or play games). Explain to learners that they will conduct an experiment that shows how the Earth acts like a giant magnet.

2. Divide the class into teams of two participants each. Distribute materials and the Write-On Sheet, "Plasma Wars" to each team.

3. Instruct students to place a circular magnet underneath a piece of white paper about 2 cm from the edge of the paper. Then secure the paper by taping the two ends to the table or desktop. Place a dime-size pile of iron powder across from the magnet. (see illustration below).



4. One at a time, participants will use a straw to gently blow the iron powder toward the magnet. The straw should be held in the same plane as the table and pointed directly toward the iron powder. Caution participants to avoid facing or standing too close to the blowing powder. They should sketch their observation after the first puff. Tell

them to repeat this process until all the powder is distributed from the pile, making a separate sketch of their observations after each puff.

5. Once participants have made several observations, ask them to imagine that the magnet represents the Earth, and the iron powder represents solar wind plasma or invisible, gaseous particles moving away from the Sun at great speeds. Ask learners to describe how the Earth affects the solar wind. (Learners might suggest that some of the solar wind is deflected by the Earth.)

6. Ask learners to imagine that there are many different types of particles in solar wind plasma. If they wanted to collect a sample of this solar wind, why would collecting it on Earth be a problem? (Learners may suggest that some of the particles never make it to Earth.) Ask them where they could get a good sample. (Learners may suggest that a spacecraft outside of the area around the Earth would be best.) Explain to the learners that the Genesis spacecraft collected solar wind about one million miles from the Earth.

Alternate Strategy Tip

Allow learners to repeat this investigation using different sizes or shapes of magnets. Ask learners how this might model what happens in space. (Learners may suggest that other planets may have magnetic fields that are either larger or smaller than Earth's.)

This activity was adapted for Community Quest from an activity in the Genesis education module *Cosmic Chemistry: Planetary Diversity* found at: http://www.genesismission.org/educate/scimodule/PlanetaryDiversity/index.html

Resources for Extension and Enrichment Activities

http://dynamicsun.gsfc.nasa.gov/img/star_english.pdf
NASA offers "Our Very Own Star: The Sun" a coloring book with kid-friendly text that mentions solar wind and solar flares.

http://image.gsfc.nasa.gov/poetry/
This NASA site offers images and lots of information about auroras – the visible effects of solar wind that enters Earth's atmosphere.

http://set.lanl.gov/programs/LASSO/ACE/ACETchr/Albee/plasmalesson.html
Los Alamos National Laboratory's Space Science Outreach offers a hands-on activity that explores plasma as a state of matter.

http://set.lanl.gov/programs/lasso/ace/ACETchr/Price/molecules.html
Learners create a model of an atom and then simulate what happens to charged particles in solar wind plasma.