

Can we measure the strength of magnets?

SUMMARY INFORMATION

Keywords

Permanent magnets, magnetic fields, Strength of magnets, tensile strength, electromagnets

Topics Covered

Physics

Target Grade(s)

6, 7, 8

Estimated Time Required

1-2 hours

LESSON

Goals and Pre Requisites

Goals

To help students understand the concept of magnetic fields.

Pre Requisites

Knowledge on properties of Magnets and principle of magnetism.

Instructional Objectives

Through this activity, students would be able to

- Apply conceptual understanding
- Demonstrate critical thinking
- Use physical & mathematical concepts
- Experience research based learning

Instructional Resources

Problem Statement

The magnetic field strength of a magnet is measured in two units of measurement, discovered by Nikola Tesla and Carl Friedrich Gauss, called Tesla and Gauss respectively. Gauss and tesla both measure how dense the magnetic field is on the surface of a magnet. This is also known as a magnet's 'magnetic induction'. The magnetic induction of a magnet is measured by a gauss-meter. A gauss meter works according to the Hall Effect, which is where electrical current flows through, and builds up to make itself equal to, a magnetic field. This build-up produces a readable voltage, which the gauss meter detects. Such special instruments can be very expensive and cost thousands of rupees.

Can we find some very simple & practical ways to measure strengths of various magnets?

Background

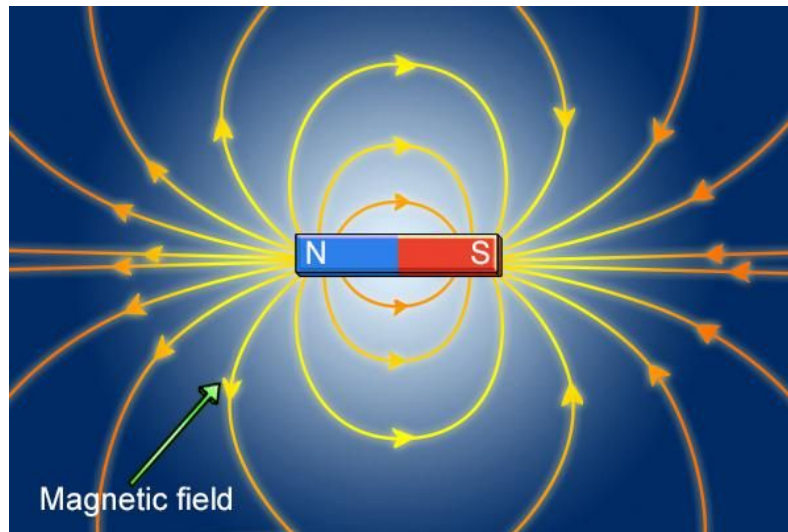
Magnets are some of the most fascinating materials for learning in a STEM classroom.

A magnet is a material or object that produces an invisible magnetic field, which allows it to attract ferromagnetic materials. A ferromagnetic material is one that is attracted by a magnetic force. To be ferromagnetic, a material must contain an element of iron, nickel, cobalt, or gadolinium.

A magnetic field is the force around a magnet which gives the magnet its ability to attract and hold ferromagnetic materials.

Did you know that Jupiter has the largest magnetic field out of the planets in our solar system? Its magnetic field strength is 1900 times greater than Earth's.

Every magnet has a two magnetic poles, a north pole and a south pole. They are often called the north and south 'seeking' poles as each will try to seek out their namesake, i.e. either the north or south magnetic poles of the earth.



There are two sets of north and south poles on the earth, the magnetic poles and the geographic poles. The north magnetic pole is currently at 80 degrees north latitude and 105 degrees longitude (north Canada). The Earth's magnetic poles are constantly moving, due to the earth's solid and liquid metal cores moving past each other very slowly.

There are two different types of magnet: permanent magnets and electromagnets.

Permanent magnets produce their own magnetic field and can last indefinitely. Electromagnets, on the other hand, need electricity to work. This guide focuses on the different types of permanent magnets, including weld clamp magnets and pot magnets.

How is magnetism measured?

The strength of a magnet is most commonly measured using a magnetometer, also known as a gauss meter, which are used to measure everything from the Earth's magnetic field to small magnets. A magnetometer consists of a small conductor or semiconductor at the tip of a probe through which an electrical current is passed. The effect of the magnetic field on the electrons in the conductive material can then be measured. The International System unit for measuring magnetism is tesla which measures something called the magnetic flux density, but tesla is only useful for measuring very large magnetic fields.

A more suitable way to measure smaller magnetic fields is to use the unit gauss. One tesla equals 10,000 gauss. The Earth's magnetic field is about half a gauss, a fridge magnet about 100 gauss and a large electromagnet like that in a MRI could be up to 1,500 gauss. There are several factors that will affect the results of any measurement such as the distance from the magnet the reading is taken, the magnet's size and whether or not the magnet is

attached to anything. A more practical measure of a magnet's strength is to measure how much weight it can lift.

Procedure

1. Introduce the **Problem Statement** to students.
2. Form students into groups of four.
3. Allow them to brainstorm with their groups, on the given **Problem Statement**.
4. Each group must come up with their unique solution(s) to the given problem.
5. Each group can compare their solutions with fellow groups and with their teacher to check on the feasibility of their solution.
 - In order to check on feasibility, instruct students to discuss with their team mates and have a rough sketch of their plan before constructing it. Students must be able to provide justification for their choice of materials.
6. Ask students to build a timeline (within the estimated amount of time provided under summary information) and ensure that all members of each group are involved in planning the project in terms of availability and cost of materials.
7. Students must make sure that the design incorporated in their process would address the existing problem.
8. Each group can present their solution and evaluate feasibility with peer groups and the teacher.

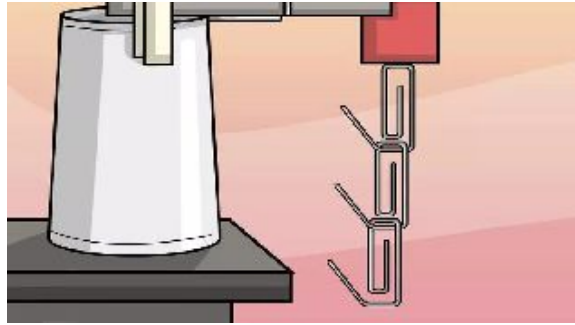
Sample Methodology

Note: The following is an example of how the given **Problem Statement** might be addressed. **For Teacher Reference only.**

Put these below materials out and encourage students to PLAY. Tell them to try all sorts of things and praise failure! We must fail if we are ever to succeed.

1. Paper cups, paper clips, A permanent magnet

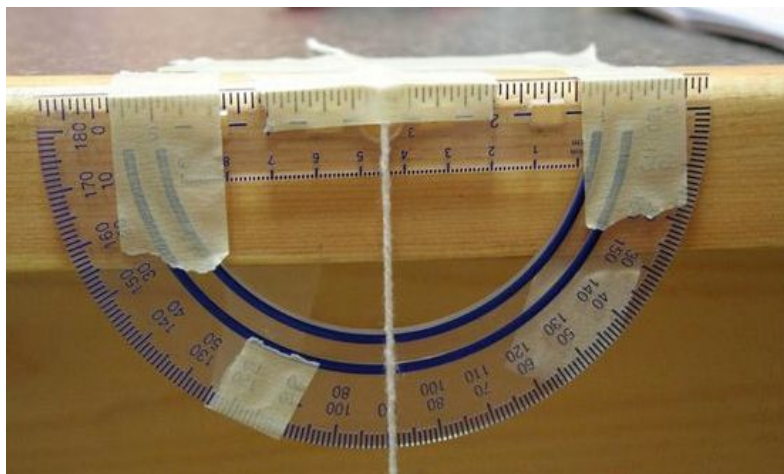
Hint: Pics



Create the apparatus shown in the picture and test the strength of the magnet by hanging paper clips till they fall off. Note down the number of clips used for each magnet and compare.

Substitutes: Instead of paper clips, use Iron nails of different sizes & weights from 1 cm to 10 cms.

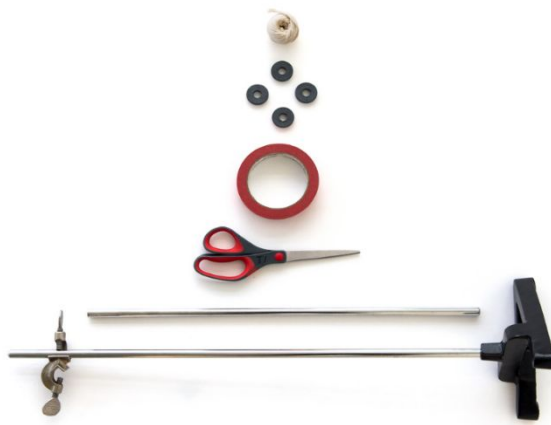
2. A protractor, tape, ruler, string, Nut, Magnets of different strengths



The Nut could be hung tied to one end of the string while the other end is taped to the edge of a table. The maximum distance moved by the string from rest could be measured when the magnet is brought near the nut, before it falls off.

3. A scissor, Stand and clamp, large size magnets, delicate strings of different tensile strength, electrical tape, nut

Hint: Pics



Try to observe at which tensile strength the string breaks when the same nut is tied to delicate strings of different tensile strengths, and the magnet is attached to it.

4. A ruler, Magnets of different strengths, Flat metal ring



Keep the magnet at "0" point on the ruler and keep the flat ring at a distance of 4 cm. Try and tap the flat ring slowly towards the magnet. The distance at which the flat ring gets pulled and sticks to magnet should be noted for different magnets. Longer this distance the stronger is the magnetic field strength of the magnet.

Conclusion

A practical and simple way to measure differing strengths of magnetic fields

Extension

Magnets are commonly found in motors, dynamos, refrigerators, credit and debit cards, and electronic equipment, such as electric guitar pickups, stereo speakers, and computer hard drives. They can be either permanent magnets, made of naturally magnetic forms of iron or alloys, or electromagnets. Electromagnets create a magnetic field when an electric current is run through a coil of wire wrapped around an iron core.

A simple electromagnet can be made by wrapping a coil of wire around a nail and attaching its ends to a 1.5-volt battery. The more coil turns per length of the core, the greater the magnetic field strength. Can we use a variation of the above methods to test this magnetic field of electromagnets?

Assessment and Rubric

Define the need or problem – Did students identify the need to resolve this problem? Were they able to relate the problem to their own environment?

Come up with ideas - Did students weigh various possibilities brainstorm on various ideas before arriving at a solution? Did each group collaborate effectively to (1) work within the time given (2) give equal opportunity for participation (3) consolidate relevant information (4) provide rationale for their decisions and choices.

Select the most promising idea or design - Were students able to evaluate the feasibility of their solution to the given problem statement? On what basis was the feasibility of the solution determined?

Communicate and plan the project – Were groups able to provide justification for their choice of materials? Were students able to see completion of the activity within the estimated time?

Create/Build and test a design –Were all members of the team participative during the course of the activity?

Evaluate and revise the design – Were student groups able to present their solutions in a clear and distinct manner with other groups? Were they keen on improving their model further?

Credits

- <http://www.wikihow.com/Determine-the-Strength-of-Magnets>
- http://www.magnetsales.com/design/faqs_frames/faqs_2.htm
- <http://www.wonkeedonkeetools.co.uk/magnets/what-is-a-magnet>
- <https://www.howitworksdaily.com/question-of-the-day-how-is-magnetism-measured/>