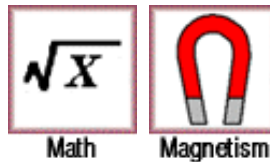




Strange Attractor

The attraction and repulsion of magnets produces entrancing, unpredictable motion.



Patterns of order can be found in apparently disordered systems. This pendulum - a magnet swinging over a small number of fixed magnets - is a very simple system that shows chaotic motion for some starting positions of the pendulum. The search for order in the chaos can be very engrossing.

materials

- ✓ A ring stand and a clamp.
- ✓ 4 to 6 ceramic magnets (available at Radio Shack).
- ✓ Paint, masking tape, or correction fluid.
- ✓ Fishing line or string.

assembly

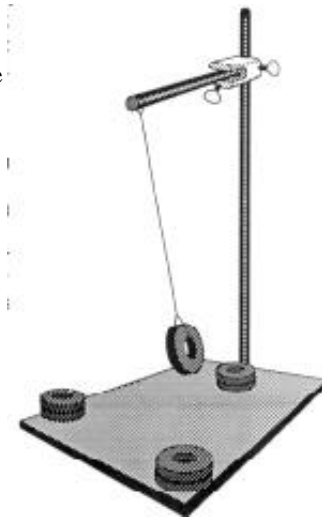
(15 minutes or less)

Put all the magnets together in a stack so that they stick together magnetically. By doing this, you are orienting the magnets so that all of the north poles point in one direction and all of the south poles point in the other direction. Mark the top of each magnet with paint, tape, or correction fluid, thus identifying all the matching poles.

Use the string or fishing line to hang one magnet from the ring stand so that it is a free-swinging pendulum. You can hang the magnet in any orientation.

Arrange the other magnets on the ring stand base in an equilateral triangle measuring a couple of inches on a side. Position the magnets so that they all have the same pole up.

Adjust the length of the pendulum so that the free-swinging magnet will come as close as possible to the magnets on the ring stand base without hitting them or the base itself. You can accomplish this either by changing the length of the string or by adjusting the position of the clamp.



to do and notice

(15 minutes or more)

Give the pendulum magnet a push, and watch!

Vary the location and poles of the magnets to develop other patterns. You can arrange the magnets so that all of them have the same pole up, or you can mix them up. Notice that a tiny change in the location of one of the fixed magnets or in the starting position of the pendulum magnet may cause the pendulum to develop a whole new pattern of swinging.

what's going on?

The force of gravity and the simple pushes and pulls of the magnets act together to influence the swinging pendulum in very complex ways. It can be very difficult to predict where the pendulum is going to go next, even though you know which magnets are attracting it and which are repelling it.

This sort of unpredictable motion is often called *chaotic motion*. Strangely enough, there can be a subtle and complex kind of order to chaos. Scientists try to describe this order with models called *strange attractors*.

etcetera

The new sciences of chaos and turbulence are unveiling hidden relationships in nature. Diverse phenomena, such as the patterns of Saturn's rings, measles outbreaks, and the onset of heart attacks all follow chaotic patterns.

Often, a system that is predictable in the long run shows chaotic variations in the short run. Although it is quite difficult to predict specific daily weather behavior in the San Francisco Bay Area, the overall long-term patterns are generally known. The individual motion of insects may be random and insignificant, yet the behavior of the population as a whole can be analyzed.

As shown in this Snack, a very slight difference in the starting position of the pendulum can grow to a tremendous difference in the pattern of motion in a short time. This is characteristic of chaotic systems. Weather scientists recognize this characteristic of chaos when they argue over the "butterfly phenomenon." That is, can a butterfly flapping its wings in China drastically alter the weather in New York?

For further reading, see: *Chaos* by James Gleick (Viking Penguin, 1988) and *The Turbulent Mirror* by John Briggs and F. David Peat (Harper Collins, 1990).



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