Magnetic Atmosphere Model

Don't be the low man on the totem pole!

Introduction

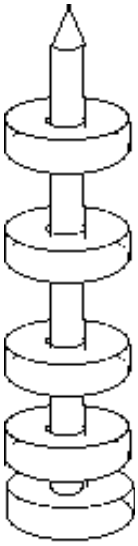
Thread two donut magnets onto a pencil so that they repel. Hold the pencil vertically and one magnet floats above the other. Add more magnets to the pencil and make a model of the earth's atmosphere.

Material

- Five donut magnets, a.k.a. refrigerator magnets, make sure the center hole is large enough to fit over a pencil.(available from Radio shack in 5 packs.)
- A pencil

Assembly

Slide one magnet onto the pencil. Slide a second magnet onto the pencil so that it repels the first one. (There are two orientations in which the second magnet can be slid onto the pencil, in one orientation it will attract the first magnet, in the other it will repel.)



To Do and Notice

Hold The pencil horizontal and notice the spacing between the magnets. Push one magnet toward the other and notice that the magnetic

repulsion pushes it away. Notice that the closer the magnets are pushed the larger the force. It is as if there were an invisible magnetic spring between the two magnets. Hold the pencil vertical and notice that one magnet floats above the other.

Add a third magnet so that it too floats. Add fourth and a fifth magnet so that they too float. What do you see?

Notice that the spacing between the magnets is smallest between the bottom two magnets and largest between the top two?

Lift the top magnet and notice how the spacing between the other magnets gets larger, add the top magnet back and watch the spacing decrease. The magnetic springs between the other magnets have to compress to hold up the extra weight of the top magnet.

What's Going On?

The lower magnet has a magnetic pole facing upward, the north pole say. If the magnet above it has its north pole down, the like poles will repel and it will float above the lower magnet. The pencil keeps it from falling off to one side. The second magnet has its south pole facing up. So the magnet above it must have which pole facing down in order to be repelled?

The third magnet must have its south pole down. The magnets in the stack alternate north and south poles facing up through the stack.

This is a model for the earth's atmosphere.

Air is also a spring, as you can feel when you squeeze a balloon.

The air near the surface of the earth must support the weight of all the air above it. It is thus compressed to a higher density. The air molecules near the bottom of the atmosphere are closer together just as the magnets are closer together at the bottom of the stack. The higher you go in the atmosphere the less air there is above so the air molecules support less weight, and are less compressed.

Don't carry the analogy too far, the spacing between air molecules decreases as an exponential function of height. The spacing between the magnets decreases with height but not exponentially.

So What?

Mountain climbers notice the lower density air as they climb. Near the surface the pressure of the atmosphere decreases by about 1% every 100m (3% or 1 inch of mercury every 1000 feet) At an altitude of 5.6 km, 18000 feet, above sea level you are above half of the atmosphere. (I like to say it feels as if someone ripped out one of your lungs.) At 8.4 km, or 27,000 feet you are above 2/3 of the atmosphere and well on your way to the summit of Mt. Everest. Above 6 km, 19,600 feet, you enter "the death zone." Your body is slowly dying above this altitude.

Etc.

The spacing between the magnets also provides a model for the repulsion of atoms and molecules. When you stand on the floor the weight of your body compresses the atoms in the floor. The atoms in the floor move closer together just like the magnets on the pencil when you push down on the top magnet.

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