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Neodymium Magnets

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BACKGROUND:

The magnets in your possession are some of the most powerful magnets in the world. They are made out of a neodymium-iron-boron material, or $Nd_2Fe_{14}B$, of which iron is the main component. Their field strength has been measured at 12.5 kiloGauss, or 1.25 Tesla (tens of thousands of times stronger than the earth's magnetic field). Their incredible strength makes them a constant source of wonder as well as ideal demonstrators of the force of magnetism in traditional, and some not so traditional, experiments. As you may already know, these are not ordinary magnets and cannot be handled as such - please read the cautionary notes below.

PRECAUTIONS:

- Never allow the two magnets to come together abruptly! The attraction is so strong that the magnets may chip or break, launching tiny chips into the air!
- Take care that your finger or a sensitive fold of skin does not get caught between this magnet and another. A blood blister or minor abrasion could result.
- Never allow the magnets near computer disks, recording tapes of any kind, credit cards, bank cards, or any other device which uses magnetic material to record information.
- It is very difficult to separate the two magnets by hand. Separate them by sliding them apart rather than by a direct pull.
- Storage is not a problem (no keeper is needed), but do not store near magnetically sensitive materials.
- Do not heat the magnets over 150oC. They will lose some of their magnetism permanently.

ACTIVITIES:

Place one of the magnets on the back of your hand and the other on your palm. The attraction is strong enough to prevent either magnet from falling. Turn your hand palm-side downward and turn over the lower magnet. Reversing field will repel the upper magnet, making it turn over as well. Take care that the two magnets do not seek each other out around the edge of your hand!

1. Test the magnet on substances you “know” are not magnetic-pencils, crayons, aluminum foil, bits of clay, paper, and anything else you can think of. See what happens when one of the magnets is brought close to a dollar bill. Can you think of a way to determine whether the attraction is from the printing ink or the paper itself? Could you if it weren’t your dollar?

2. Obtain a straight copper tube 3/4 inch in diameter and about 2-3 feet in length. Holding the tube vertically, observe the magnet drop through the tube. Then try it with 2 joined magnets. Can you explain the resulting phenomenon? (Hint: remember Hans Oersted’s discovery of 1820 and what Joseph Henry and Michael Faraday independently demonstrated in 1832. Lenz’s law is most often referred to in context of this experiment.)

3. Gently roll a magnet across a wooden table. It should align itself with the earth’s magnetic field.

4. Test the “lead” (graphite) of a mechanical pencil for magnetism. Balance the graphite on a nonmagnetic item and observe whether the graphite is attracted or repelled by the magnet.

5. Move the magnet across a plate of aluminum. Vary the speed and force you apply to the magnet. The opposing force will amaze everyone. Next, try rolling the magnet down the plate at an incline. What happens when it reaches the edge?

6. Set up a rotating balance apparatus. A pin mounted on the center of a wire (try a section of coat hanger) works well. Then balance the point of the pin on top of an upside down cup so that the “arms” (the wire) can rotate around the pivot. Pull the ends of the wire down below the pivot point so that the center of gravity makes it easier to balance. Test for “diamagnetism” in food. Stick a grape on each end of the wire (more balancing may be required). Use both magnets stacked to repel the grapes (the balance will rotate.) Notice that both poles repel the grapes.