RAFT IDEAS

Topics: Magnetism, Geography, Orienteering

Materials List
(For each compass)

- ✓ Compass rose (see last page), either preprinted on a transparency (best) or paper or a drawn pattern
- ✓ Steel needle (a blunt tip needle is recommended)
- ✓ Plastic cap from a beverage bottle, with a diameter smaller than the diagonal of the compass rose
- ✓ Plastic margarine container (tub) or other container that has a bottom with a raised central area
- ✓ Marbles
- ✓ Water, tap or (better) distilled

Tools needed:

- ✓ Pushpin
- ✓ Scissors
- ✓ Hot glue gun/glue
- ✓ Magnet

This activity can be used to teach:

- Properties of magnets and magnetism (CA Science Standards: Grade 4, 1.b and 1.f)

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1355 Ridder Park Drive San Jose, CA 95131
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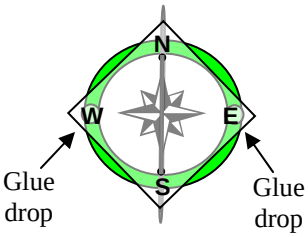
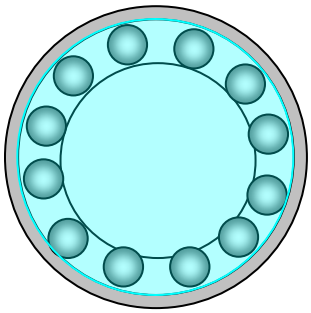
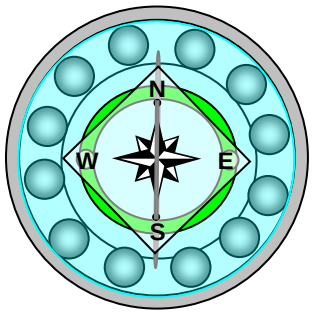
Compass in a Tub

A smoothly pivoting floating compass



Compass rose and needle glued to a cap



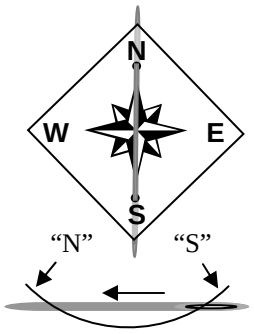


Container with marbles and water

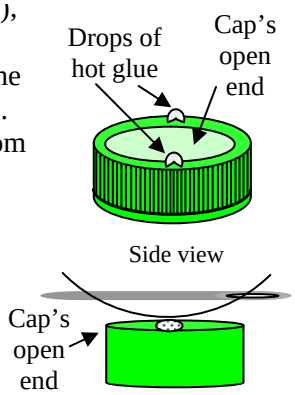
Corral a compass rose and allow a needle to rotate smoothly by using marbles!

Assembly

1. Cut a compass rose from a printed copy (transparency or paper) or a pattern drawn on thin cardboard or stiff paper.
2. Use a pushpin to poke a hole through each of the two printed circles on the compass rose or just below the "N" and above the "S" on a drawn pattern. (This can be done to an aligned stack of 3-4 compass roses to speed construction)
3. Insert the needle into the holes in the compass rose starting from under the "S" as shown in the illustration to the right.
4. Put drops of hot glue on opposite sides of the cap as shown.
5. Center the compass rose over the upturned cap (open end upward), with the W-E diagonal aligned with the glue drops, see top left illustration. Push the "W" and "E" areas into the glue to secure the compass rose to the cap. Remove any "threads" of glue from cap.
6. Place enough marbles in the container to create a ring in the bottom as shown at the top of the page.
7. Add water to cover the marbles.
8. Place the cap and compass rose in the center of the container. Add more water until the cap floats freely but will still bump into the marbles when rotating. The marbles prevent the floating compass from touching the container.



Rotated side view



To Do and Notice

To create a functioning compass the needle must be magnetized. (Students should perform this step **themselves** to better understand how to make a compass. Please see the note on the next page regarding the type and markings of the magnet to be used.)

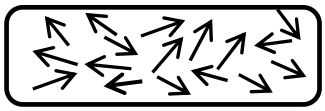
1. Move the container around and observe how the compass needle reacts.
2. Remove the cap and the compass needle from the water.
3. Magnetize the needle by touching the south pole of a magnet to the pointed end of the needle and then touching the north pole of the magnet to the other, "eye", end of the needle. Place the cap and compass needle back in the container.
4. Repeat step 1 and note how the compass needle moves. (Note that any nearby items that contain iron, such as the legs, bracing, or metal top of a table or desk, can affect the compass needle's movement. If needed, the compass should be moved away from such magnetic items until the needle is able to point North.)

Designed and written by Michael Pollock (RAFT)

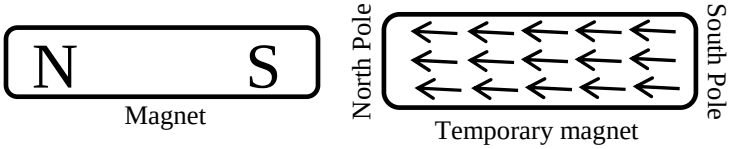
Note the magnet to be used for magnetizing the compass needle must meet the follow 3 requirements:
A magnet must be strong enough to cause the iron in the needle to become a temporary magnet. The magnet must have only one north/south pair of magnetic poles. Thin, flexible advertisement and calendar magnets have many pairs of poles and **cannot** be used to magnetize the needle. The magnet must have the north pole correctly labeled (letter "N" or a red mark). To check for correct marking, or to add a mark if none present, first use a metal paperclip on a thread leash to find the poles. Next, suspend the magnet from a point between the poles so the magnet can pivot freely. Note which pole points north and, if needed, mark that end. Make a sample compass to double check.

The Science Behind the Activity

Everything is made up of extremely tiny parts (for example electrons and protons) that have an electrical charge. Whenever a charged particle moves a magnetic field is created. In most cases, the random orientations of the many different particles' magnetic fields cancel each other out, at the sub-atomic level. In magnetic materials, like iron, these fields do not cancel out. Each group of atoms in a magnetic material (called domains) can be thought of as tiny bar magnets. The orientations of the different groups' magnetic fields will point in different directions so there is, effectively, no overall (net) magnetic field. Bringing together a magnet to a steel needle, which contains iron, causes most of the groups of iron atoms to magnetically align in the same direction. The magnetic fields "pushing and pulling in the same direction" result in a strong enough force to create a temporary magnet from the steel needle!



Magnetic material (not a magnet)



The magnetic material has been magnetized by the permanent magnet on the right

Most magnets have two magnetic poles (areas) where the magnetic attraction is the strongest. We call one area the "north pole" and the other the "south pole". A magnet that can pivot freely will turn and become aligned with the Earth's magnetic field. The north pole of the magnet will point northward while the south pole of the magnet points southward. This can be a source of confusion when students learn that like poles repel each other. Why does the north pole of a compass needle point toward the Earth's North Pole? The answer is that magnets were labeled before people knew why they pointed north (had a "north seeking" pole). The Earth's North Pole is a **geographic** North Pole, not a magnetic north pole. The Earth's magnetic field has **a south magnetic pole in the North Polar Region** (near but not at the pole) and **a north magnetic pole in the South Polar Region**. This convention forms the basis for the other scientific rules linking magnetism and electricity (right and left hand rules).
The Earth's magnetic poles have moved and even switched places! Over time the poles have switched places many times, but not in the last 100,000 years or so. The Earth's south magnetic pole should remain in the North Polar Region for the next several thousand years, at least. Until then, the north end of a compasses needle will point north.
Note: The cap and marbles in an uncovered container may become coated with mineral deposits from the evaporating water, which is less likely if distilled water is used, and/or from dust that settles on the water's surface. Such deposits will cause the cap to not rotate as freely or not rotate at all due to the affects of friction and surface tension. Covering the container with clear plastic wrap will reduce or eliminate the need for periodic cleaning or replacing, of the cap, marbles, and water.

Web Resources (Visit www.raft.net/more for how-to videos and more ideas!)
Magnet Mini Wand idea sheet at http://raft.net/ideas/Mini%20Magnet%20Wands.pdf