Curriculum topics:

- Magnetism
- Geography
- Orienteering
- Magnetic Poles
- Magnetic Fields
- Properties of Materials

Subject:

Physical Science, Earth/Space Science

Grade range: 4 – 12

Who we are:

Resource Area for Teaching (RAFT) helps educators transform the learning experience through affordable "hands-on" activities that engage students and inspire the joy and discovery of learning.

For more ideas and to see RAFT Locations

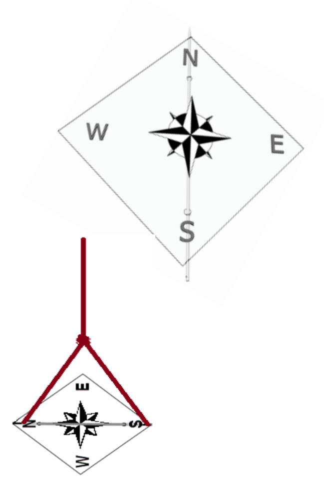
www.raft.net/visit-raft-locations

FLOATING COMPASS

Let a steel needle point the way!

The floating compass is a useful tool for detecting the magnetic fields of magnets and of the Earth. Make a simple compass with a magnetized needle that demonstrates the properties of magnetic materials and shows that magnets have north and south poles. Using the floating compass provides a visual example of how like poles repel each other.

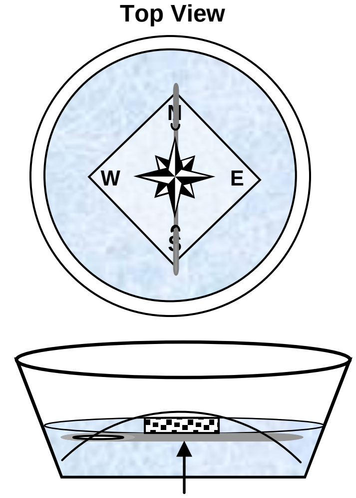
Top View



Rotated side View

Hanging Compass

Top View



Rotated side View

Water-based Compass

Materials required

Per Floating Compass unit:

- Compass rose preprinted on transparency (download a blackline master at www.raft.net/raft-idea?isid=161)
- Steel blunt tip needle
- Thread, 30-45 cm (1' - 1½') long
- Plastic portion cup, 3-4 oz.
- Optional: Foam section, EVA or "meat" tray (recommended)
- Water
- Pushpin
- Magnet
- Scissors

How to build it

> *Note: Steps 1-6 below are for the hanging version of the floating compass.*
> *Steps 9-11 are for the water-based version.*

Hanging version:

1 Cut the compass roses from the transparency. See Figure 1.

Figure 1

2 Use pushpin to poke one small hole through each of the two printed circles on each compass rose. See Figure 2.

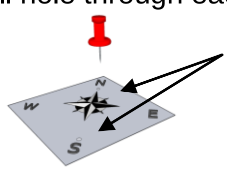
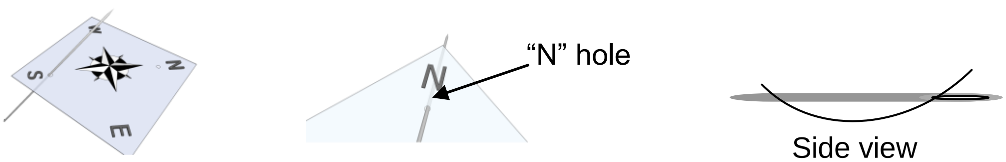


Figure 2

3 Insert the steel needle (point first) into the hole by the "S" starting from the *underside* of the transparency. Push needle across to the "N" hole and insert the needle. Center the needle on the compass rose. Transparency will have an upward curve. See Figure 3.

Figure 3



4 Make a 10 cm (4") slip knot in a 30-45 cm (1' - 1½') length of thread. See Figure 4.

Figure 4

5 Make two short slits starting at the "N" and "S" corners by cutting towards the center. Stop before reaching the letters. See Figure 5.

Figure 5

6 Place the loop of thread over the ends of the needle and hold the other end of the thread. Adjust the needle making it parallel to the floor. See Figure 6.

7 Rotate the uppermost corner (E or W) of the compass rose through the loop until the thread slips into the two slits and compass rose is parallel with floor. See Figure 7. The transparency and the needle will hang horizontally. See Figure 8.

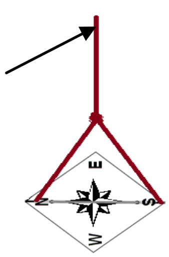
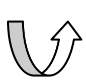


Figure 6



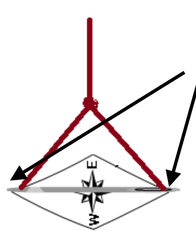


Figure 7

Figure 8

Water-based version (Use material from hanging version):

8. Insert the needle point first into the hole by the “S” starting from the *topside* of the transparency. Push the needle across to the “N” hole and insert. See Figure 9.

Figure 9

9. Center the needle on the compass rose. Transparency will have a *downward* curve with the needle below the compass rose. See Figure 10.

Figure 10

10. Optional: Wedge a flat piece of foam between the needle and compass rose to aid in flotation.

> *Tip: Make a compass to check the polarity of the magnets used before doing this activity with students. If the north pole of the magnet is not labeled with an “N” or red mark, hang the magnet so that it can freely pivot. Note which end points north and mark that end.*

To do and notice

1. Magnetize the needle by briefly touching the south pole of a strong magnet to the pointed end of the needle, and then touch the north pole of the magnet to the “eye” end of the needle. The magnet used must have only one pair of north and south poles.

2. **Hanging version**: Suspend the compass by holding the end of the thread. Note the direction in which the “N” corner of the compass rose points. If the “N” corner is not pointing north, re-magnetize the needle making sure the south pole of the magnet touches the pointed end of the needle.

3. **Water version**: Fill a portion cup with enough water so the compass rose will freely float. Place magnetized compass rose in the water. If the compass sinks, dry it off and try it again. Note the direction in which the “N” corner of the compass rose points. If the compass touches a side of the portion cup, lightly tap the cup or reposition the compass so that it is free and centered in the cup. If the “N” corner of the compass rose is not pointing north, re-magnetize the needle making sure the south pole of the magnet touches the pointed end of the needle.

4. Predict how the compass will react when a magnet’s north or south pole is facing the compass.

5. Can the needle be made to spin? Try it!

The science behind the activity

Key content

Everything is made up of extremely tiny parts (electrons, protons, etc.) that have an electrical charge. When charged particles move about they create magnetic fields. In most cases, these fields cancel each other out at the sub-atomic level. In magnetic materials, like iron, these fields do not cancel out (due to the structure of the atoms). In these materials, groups of atoms can be thought of as tiny bar magnets, which are usually oriented in different directions, canceling any net magnetic field.

Curriculum Standards:

Electric or magnetic interactions between objects not in contact with each other (Next Generation Science Standards: Grade 3, Physical Science, 2-3; Middle School, Physical Science, 2-5)

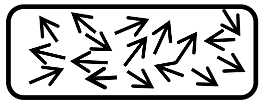
Strength of magnetic forces (Next Generation Science Standards: Middle School, Physical Science, 2-3)

Science and Engineering Practices (Next Generation Science Standards Grades 4 – 12)

Additional standards at: http://www.raft.net/raft-idea?isid=161

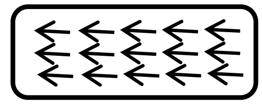
The science behind the activity (continued)

Touching the steel needle (made from iron) to a magnet causes most of the groups (domains) of iron atoms to align, magnetically, in the same direction. The magnetic fields combine, “pushing and pulling the same way”; into a strong enough force to create a temporary magnet from the steel needle!



Magnetic material (not magnet)

N
(north pole)



S
(south pole)

Magnetized magnetic material (magnet)

The north pole will point northward while the south pole 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? Well the answer is that magnets were labeled before people knew why they pointed north or had a “north seeking” pole. The Earth’s North Pole is a geographic north pole, not a magnetic north pole. The Earth acts as if it had 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. The Earth’s magnetic poles have (and will) moved about and have even switched places over time!

Learn more

- Magnetize needle with magnets of various strengths and observe differences in compass motion.
- Create a large compass to test the effect of size on the ability to magnetize the needle.

Extend this activity with the following suggestions:

- Use either the water-based or thread version of the compass in a simple orienteering exercise.
- Brainstorm and design a game that uses the compass to find hidden items inside or outdoors.

Related activities: See RAFT Idea Sheets:

Amazing Magnetic Worms –
http://www.raft.net/ideas/Amazing Magnetic Worms.pdf
Floating Garden of Magnets –
http://www.raft.net/ideas/Floating Garden of Magnets.pdf
Magnet Painting –
http://www.raft.net/ideas/Magnet Painting.pdf
Magnetic Field Line Viewer –
http://www.raft.net/ideas/Magnetic Field Line Viewer.pdf
Mini Magnet Wands –
http://www.raft.net/ideas/Mini Magnet Wands.pdf
Where is the Magnet? –
http://www.raft.net/ideas/Where is the Magnet.pdf

Resources

Visit www.raft.net/raft-idea?isid=161 for “how-to” video demos & more ideas!
See these websites for more information on the following topics:

- **Compass rose history** –
  http://www.compassrosegeocoin.com/crhistory.php
- **Navigation with compass** –
  http://www.backcountryattitude.com/navigation_map_compass.html
- **Videos on Electricity and Magnetism from the Khan Academy –**
  https://www.khanacademy.org/science/physics/electricity-and-magnetism