Ferrofluid

Amount of time Demo takes: 1-3 minutes

Try this in the classroom!

Lesson's Big Ideas

- This demo shows the magnetic fields created in a magnetic liquid.
- Ferrofluid is made of iron based nanoparticles (5% magnetic solids like iron, 1% surfactant, and 85% carrier solution made of oils).
- It has two states (solid and liquid-depending on the surrounding magnetic field).

Materials

- Rare Earth Magnet (1)
- Glass ferrofluid displays (2)
- Ferrofluid Lamp (Interactive Ferrofluid Lava Lamp - Inspired Designs LLC)

SAFETY!

- Rare earth magnets are extremely strong; extra care should be taken to ensure the safety of volunteers from getting fingers squished etc. Keep magnet away from other magnets. Magnet can cause issues with electronic devices including pacemakers.
- Do not allow anyone to touch the ferrofluid.

Background Information

- Ferrofluids are liquids that are magnetized when it is near a magnetic field. They consist of very tiny nanoscale magnetic particles in a fluid.
- Ferrofluids form 3D shapes when magnetic fields are near it. These 3D shapes are due to each tiny particles' magnetic fields aligning and repelling other magnetic particles; however, due to surface tension of the liquid and surfactant, these particles are held together.
- This effect wouldn't occur if the iron particles were larger or if there was no surfactant
- Magnetic sheets work same as ferrofluid, shows magnetic areas of objects when placed over

Setup Instructions

1. Set out displays and magnets. (Keep an eye on the magnets throughout the day. Students tend to walk off with them)

Instructional Procedure

1. Move magnet around the glass ferrofluid display to show the magnetic field of the magnet.
2. Allow participants to explore moving the magnet around, closer and further from the glass wall.
3. Keep people from touching and putting their hands in the ferrofluid.
4. **Keep an eye on the magnets! Students always will try to walk away with them!**
5. For magnetic sheets, place sheet over an object to observe spots of magnetism throughout the object

Tips & Tricks

- If a student moves the magnet around the ferrofluid container very rapidly, it could cause the ferrofluid to split into a bunch of pieces which will prevent the demonstration from working as well as it should. Take the magnets back for a moment and use them to bunch the ferrofluid up again (lead it all to the bottom to clump again).

Assessment Questions

- Why is the ferrofluid attracted to the magnet?
    - Since ferrofluid is made up of iron based nanoparticles, it will become magnetized when near a magnetic field (from the magnet), and therefore will want to move toward the magnet.
- Can you think of other things that are magnetic?
    - Answers may vary, but the common magnetic metals are iron, nickel, and cobalt. Steel is an alloy that contains iron and nickel, which makes it magnetic as well.

Careers & Real World Applications

- Ferrofluid is actually used in audio speakers and helps them function better.
- Nanomagnets are now being used in medicine. The magnetic particles will enter the body's system attached to medicine. Doctors can then use

magnets to keep the medicine in one place.
- Ferrofluids are used in computers, small moving parts, and one day could create mini-thrusters to take small spacecraft to space.
- Careers:
    - Materials Engineer
    - Medical Researcher
    - Physician
    - Sound Engineer

Clean Up

- Carefully package all displays and put them away so they won't be broken.

References

- http://mrsec.wisc.edu/Edetc/background/ferrofluid/index.html
- http://www.mtu.edu/news/stories/2013/august/story95326.html
- https://sciencing.com/list-metals-attracted-magnets-7501815.html
- http://particlesmatter.org/2013/06/ferrofluid-fun-and-facts/

Related Next Generation Science Standards

- K-5
    - 3-PS2 Motion and Stability: Forces and Interactions
- 6-8
    - MS-PS2 Motion and Stability: Forces and Interactions
- 9-12
    - HS-PS2 Motion and Stability: Forces and Interactions