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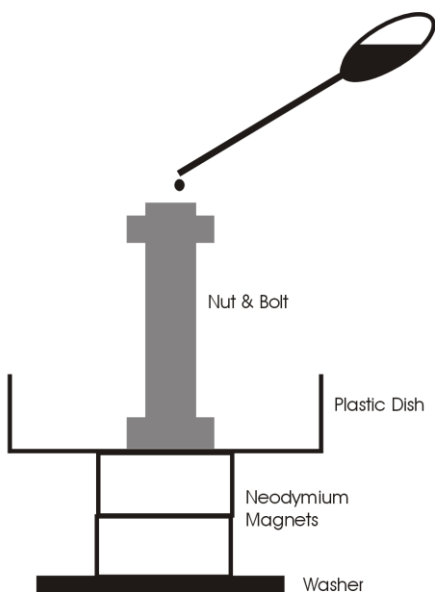
Ferrofluid Bolt Kit

FF-400

When a black liquid is slowly dropped on the top of a magnetized bolt, numerous spikes form.

Safety Precautions:

1. Neodymium magnets are extremely strong and unexpectedly can attract other magnets or pieces of ferrous metal. Often this results in pinched fingers and flying chips from the magnets.
2. Safety glasses, rubber gloves, and protective clothing must be worn whenever using neodymium magnets and ferrofluid. When neodymium magnets collide with an object, they sometimes chip and ferrofluid will permanently stain surfaces such as tabletops, clothing, skin, or eyes.
3. Do not bring a magnet close to the liquid ferrofluid, as it will cause the ferrofluid to jump to the magnet.



Instructions:

Carefully, attach the large washer to one of the flat surfaces of the two neodymium magnets. This gives the base stability.

Set the plastic dish on the top surface of the magnets and secure with the nut and bolt assembly.

Slowly drip the ferrofluid, a drop at a time, onto the TOP of the assembly, keeping the pipet well away from the magnets at all times. Numerous spikes should form. **WARNING:** if you add the ferrofluid too quickly, it may make a mess.

When finished, use the pipet to draw up the ferrofluid and return it to its bottle.

Things to Try:

Bring a magnet to within 12" of the ferrofluid on the bolt and observe the effect on the spikes. What happens when you move this magnet? What is the greatest distance a magnet can affect the spikes? Repeat with another magnet. Using the two distances and the Inverse Square Law, determine the relative strengths of the two magnets.

NGSS Correlations

Our Ferrofluid Bolt Kit and these lesson ideas will support your students' understanding of these Next Generation Science Standards (NGSS):

Elementary

Students will benefit from demonstrations using Ferrofluid. Ferrofluid can be quite messy if handled recklessly. This kit is recommended for hands-on use with students in middle school and older.

High School

HS-PS3-5

The Ferrofluid can be used to develop and model how two objects interacting through magnetic fields, illustrates the forces between objects and the changes in energy of the objects due to the interaction.

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Middle School

MS-PS1-3

Students can use Ferrofluid to gather and make sense of information during an investigation.

MS-PS2-3

Students can use the Ferrofluid in an investigation to ask questions about data to determine the factors that affect the strength of magnetic forces.

MS-PS2-5

Students can use the Ferrofluid to conduct an investigation and evaluate the experimental design to provide evidence that fields exist between objects exerting forces on each other even though the objects are not in contact.

MS-ESS2-2

Students can do an activity with the Ferrofluid with a Bar Magnet to construct an explanation based on evidence for how geoscience's processes have changed Earth's surface at varying time and spatial scales.

Suggested Science Idea(s)

MS-ESS2-2

Using a variety of magnet shapes and the Ferrofluid will allow students to observe the various shapes magnetic field can take.

When a bar magnet is used, it can model how the magnetic properties of the North and South Poles of the Earth. Students can use this information to model how, over the course of Earth's history, the magnetic field of the poles have swapped location, based on magnetic readings of the Atlantic Ocean floor. Rotate the magnet 180 degrees to model the geologic history of the Earth's magnetic field.

DCI/PS1.A

Each pure substance has characteristic physical and chemical properties that can be used to identify it.

DCI-HS/PS2.B

Investigations using Ferrofluid and magnets will demonstrate the attraction and repulsion between electric charges at the atomic scale explain the structure, properties, and transformations of matter, as well as the contact forces between material objects. Use the Ferromagnetic Liquid to show the magnetic field.

S&E

Students can use the Ferrofluid to develop a model to describe a phenomenon. The students will be engaged in learning as they visualize various magnetic fields.



MATERIAL SAFETY DATA SHEET

January 1999

Display Cell consists of 2 components: a clear liquid containing alcohol and water, and a small amount of black/brownish color liquid called ferrofluid. This MSDS pertains to the ferrofluid in the Display Cell. For the clear liquid there is a separate MSDS.

SECTION I: PRODUCT IDENTIFICATION

MANUFACTURER'S NAME:	Ferrofluidics Corporation	CHEMICAL NAME:	Proprietary Product
ADDRESS:	40 Simon Street Nashua, N.H. 03061	TRADE NAME & SYNONYMS:	DISPLAY CELL-FERROFLUID
EMERGENCY TELEPHONE:	(603) 883-9800 (X-212)	CHEMICAL FAMILY:	Colloidal Dispersion
		FORMULA:	Mixture

SECTION II: COMPONENTS

The precise composition of this ferrofluid is proprietary information. This material has low toxicity. It is NOT recommended for human consumption. A more complete disclosure will be provided to a physician or nurse in the event of a medical emergency.

Magnetic:	5-6 % by volume	Fluorocarbon Carrier:	75-80 % by volume
Oil Soluble Dispersant:	15-19 % by volume	PS=The volume of magnetic fluid in the Cell is 6-8%	

SECTION III: CHEMICAL AND PHYSICAL PROPERTIES

Boiling Point (°F):	194-225	Vapor Density (AIR = 1):	14
Specific Gravity:	~2.1	Solubility in Water:	None
Vapor Pressure (mm Hg):	42 at 20°C	Evaporation Rate at:	>1 (Butyl Acetate=1) [4.3x10 ⁻⁶ g/m ² ·sec at 22°C]
Percent Volatile by Volume:	75-80 %	Appearance & Odor:	Black, odorless liquid

SECTION IV: FIRE AND EXPLOSION HAZARD AREA

Flash Point (°F):	None	Flammable Limits:	uel: Nonflammable lcl: Nonflammable
Method:	Not Applicable	Extinguishing Media:	Nonflammable

Special Fire Fighting Procedure: When fire-fighting conditions are severe and total thermal decomposition of the product is possible, wear full protective clothing, including helmet, self-contained, positive pressure or pressure demand breathing apparatus, bunker coat and pants, bands around arms, waist and legs, face mask, and protective covering for exposed areas of the head. No unusual effects are anticipated during fire extinguishing operations. Avoid breathing the products and substances that may result from the thermal decomposition of the product or the other substances in the fire zone. Keep containers cool with water spray when exposed to fire to avoid rupture.

Unusual Fire and Explosion Hazard:	Exposure to extreme heat can give rise to thermal decomposition.
Unusual reaction hazard:	None
	NFPA Hazard Codes:
	Health - 1
	Fire - 0
	Reactivity - 0

SECTION V: HEALTH HAZARD AREA

Threshold Limit Value: Not determined. 5mg/m³ for oil mist in air (OSHA Regulations 29 CFR 1910-1000).

Emergency and First Aid Procedures:

Skin Contact: Wash affected area with soap and water.

Eyes: Immediately flush eyes with large amounts of water. Get immediate medical attention.

Inhalation of Smoke or Mist: If signs/symptoms occur, remove person to fresh air. If signs/symptoms continue, call a physician.

If Swallowed: Get immediate medical attention.

Other First Aid: This product is not expected to be irritating to the eyes, skin or respiratory system at room temperature conditions. This assessment does not account for contaminants from product use. The suggested first aid measures are basic first aid measures for removal of foreign materials from the skin and/or eyes.

MSDS: DISPLAY CELL - FERROFLUID

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SECTION VI: REACTIVITY DATA

Stability: Unstable [] Conditions to Avoid: Polysyllable [X]

Incompatibility (materials to avoid): Strong oxidizing materials, heat, and flame. Finely divided active metals, Alkali and alkaline earth metals.

Hazardous Decomposition Products: If the product is exposed to extreme condition of heat from misuse or equipment failure, toxic decomposition products that include hydrogen fluoride and perfluorobutylene can occur.

Hydrogen fluoride has an ACGIH threshold limit value of 3 parts per million parts of air, ppm, of fluoride as a ceiling limit and an OSHA-PEL of 3 ppm of fluoride as an eight hour time-weighted average and 6 ppm of fluoride as a Short Term Exposure Limit.

Perfluorobutylene has an ACGIH threshold limit value of 0.01 parts per million parts of air as a ceiling limit or 0.082 milligrams per cubic meter as a ceiling limit.

SECTION VII: SPILL OR LEAK PROCEDURES

Steps to be taken in case material is released or spilled: Remove free liquid. Add absorbent (sand, earth, sawdust, paper/towel) to spill area. After removing absorbent, wash surface with soap and water to reduce possible slipping hazard.

Waste Disposal Method: As a disposal alternative, incinerate in the presence of a combustible material in an industrial or commercial facility capable of handling halogenated waste. Reclaim if feasible. Small amounts may be left to evaporate off in a fume hood at room temperature.

SECTION VIII: SPECIAL PROTECTION INFORMATION

Respiratory Protection (Specify Type): None required unless smoke, mists, or vapors are produced.

Ventilation: No special ventilation required.

Protective Gloves: If required to prevent prolonged or repeated skin contact.

Eye Protection: Safety glasses, if splash is possible.

Other Protective Equipment: Not needed.

SECTION IX: SPECIAL PRECAUTIONS

Precautions to be taken in handling and storage: Ordinary care in handling chemicals. Wash hands after handling.

Other Precautions: Avoid contamination of tobacco products. Users should be aware that a very small percentage of the population may display unexpected allergic skin reactions to otherwise innocuous industrial chemicals and raw material.

SECTION X: COMMENTS

- * This product DOES NOT contain any materials considered to be carcinogenic by any recognized sources.
- ** This material is not sold for use in products for which prolonged contact with skin or implantation in the human body is intended. Ferrofluidics Corporation does not recommend this material as safe and effective for such uses and assumes no liability for any such use.
- *** This product does not contain any chemical subject to the reporting requirements of Section 313 of Title III of the Superfund Amendment and Reauthorization Act of 1986 and 40 CFR Part 372.

MSDS: DISPLAY CELL - FERROFLUID

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Take Your Lesson Further

As science teachers ourselves, we know how much effort goes into preparing lessons. For us, “*Teachers Serving Teachers*” isn’t just a slogan—it’s our promise to you!

Please visit our website
for more lesson ideas:

TeacherSource.com/lessons

Check our blog for classroom-tested
teaching plans on dozens of topics:

<http://blog.TeacherSource.com>

To extend your lesson, consider these Educational Innovations products:

Ferrofluid Preform Display Cell (FF-200)

This Ferrofluid Display Cell is a fantastic way to demonstrate Ferrofluid with students of any age. A ferrofluid is a liquid that becomes strongly magnetized in the presence of a magnetic field. The strong 5.5" plastic display cell is completely sealed and resistant to breakage. Use the cell with any strong magnet to demonstrate the incredible properties of this amazing liquid. Demonstrate lines of force or show how charged particles stream into a star. Educational Innovations created these cells cooperatively with Ferrofluidics Corporation and is your sole source for them.



The Ferrofluidic Adventure Science Kit (FF-100)

Demonstrate magnetic fields in an incredible way! The Ferrofluidic Adventure Science Kit contains everything necessary (including magnets and a 17-page instruction booklet) to conduct fascinating experiments with Ferrofluid - the only known ferrous liquid. We're sure this kit will totally amaze you and your students. If you are teaching magnets or working with magnetic fields then this kit will integrate perfectly into your lesson and make a super demonstration or hands-on activity.



Neodymium Magnet Experimenter's Set (ED-175)

This set includes a fantastic assortment of our most popular neodymium magnets which work well with all of our Super-Large Eddy Current Tubes. Each has different characteristics along with slightly different fall times. A must for every teacher or student experimenting with eddy current tubes!

