Lab: Ferromagnetic Fluid

FOR THE TEACHER

Summary
In this lab students will investigate the properties of ferromagnetic fluid and magnetism. Students will also have the opportunity to complete research about magnetic properties to help answer analysis questions.

Grade Level
Elementary School

Objectives
By the end of this lab, students should be able to
- Identify magnetism as a physical property.
- Record and analyze data based on their observations.

Chemistry Topics
This lab supports students' understanding of
- Physical Properties
- Observations
- Solutions
- Mixtures

Teacher Preparation: 30 minutes
Lesson: 1 hour

Materials
- 1 Glass jar per group/pair of students (quantity depends on how many samples you will make)
- 1 Strong magnet per group/pair of students
- About 1 tablespoon light olive oil or lubricating machine oil (any oil will do)
- Water
- Mineral oil (1 tablespoon yields enough for 2-3 samples of ferromagnetic fluid)
- 1 tablespoon of Black Iron Oxide - Fe₃O₄ (1 tablespoon yields enough for 2-3 samples of ferromagnetic fluid)
- 1 Metal or glass mixing tray
- 1 Stir stick or spoon
- Books about magnetism (optional)
- Internet access for research
- Plastic gloves (this can get messy)

Safety
- Always wear safety goggles when handling chemicals in the lab.
- Students should wash their hands thoroughly before leaving the lab.
- When students complete the lab, instruct them how to clean up their materials and dispose of any chemicals.
- Do not consume lab solutions, even if they're otherwise edible products.
- Food in the lab should be considered a chemical not for consumption.

Teacher Notes
- Here are a few possible websites for students to use for research:
- Magnet Facts
- Magnetic Properties

- You can either make the ferromagnetic fluid in advance or let the students watch you as you make it as a demonstration, but I would strongly advise that you experiment with the measurements in advance because the ratios tend to change slightly with different oils.
- If you do decide to create it in front of the students you should explain and identify each of the ingredients as you add them.
- Depending what medium you add to the oxide powder it will react differently; a low viscosity medium like water will allow you to play with magnetic fields with immediate feedback, a higher viscosity medium like mineral oil will suspend the oxide particles and create beautiful sculptures of magnetic fields.
- Procedure (this will make enough for 2-3 jars):
  1. Mix one tablespoon of oil and one tablespoon of black iron oxide powder. Tip: If you use too much ink you will end up with something too viscous to flow. Too little ink and the mixture will not be magnetic enough. Mix them in roughly equal parts for the best results.
  2. Use a stir stick or spoon to ensure that the oil and ink are well mixed.
  3. Place a small scoop of the ferrofluid in a jar. (If you add too much it tends to stick together).
  4. Fill the jar with water.
  5. Secure a lid on the jar.
  6. Now experiment with a strong magnetic outside of the jar.

- Introduce the jars of ferromagnetic fluid and magnets to the students by showing them how the magnet attracts to the fluid.
- Allow the students a little time to explore with the ferromagnetic fluid jars. It’s helpful to have a number of jars created in order to share among students.
FOR THE STUDENT
Lesson

Ferromagnetic Fluid

Background
A ferromagnetic fluid is a liquid that has really tiny magnetic particles in it. There are molecules called iron oxide in the fluid, which are magnetic and give it magnetic properties.

Pre-lab Questions

1. Define the following terms:
   a. Mixture:
   b. Magnet:

2. Why does the magnet attract to the liquid?

Safety
• Always wear safety goggles when handling chemicals in the lab.
• Wash your hands thoroughly before leaving the lab.
• Follow the teacher’s instructions for cleanup of materials and disposal of chemicals.

Procedure
1. Using a magnet investigate what happens when you touch the magnet to the glass jar.
2. Move the magnet away from the glass.
3. Place the magnet near the glass, but do not touch it.
4. Record all of your observations during your interactions below.

Observations

<table>
<thead>
<tr>
<th>Action</th>
<th>Result</th>
</tr>
</thead>
<tbody>
<tr>
<td>Magnet touching glass jar</td>
<td></td>
</tr>
<tr>
<td>Magnet away from glass jar</td>
<td></td>
</tr>
<tr>
<td>Magnet near glass jar, but not touching</td>
<td></td>
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</tbody>
</table>

Analysis
1. What happened to the ferromagnetic fluid inside the jar when the magnet was
applied to the glass? Why do you think this happened?

2. What happened to the ferromagnetic fluid when the magnet was near the glass jar, but not touching it? Use the term magnetic field in your answer (you may need to do some research to help answer this question).

3. Do you think if you used a different magnet, you might have had different results? Why or why not?

4. Identify a few ways (at least 2) that magnets are used every day to make our lives easier. Again, researching might help you better answer this question, and discover a use of magnets that you didn’t know about already!