# Student Worksheet or Guide

## What does Magnetism have to do with Nanotechnology? – A Ferrofluid Activity

**Essential Questions:**

1. What does magnetism have to do with nanotechnology?
2. Can liquids be magnetic? Have you ever seen a liquid that is magnetic?
3. How could you keep a liquid in place in outer space where there is no gravity?

**Objectives: By the end of this activity you should be able to:**

1. Review magnetic characteristics.
2. Discuss the difference in the behavior of liquids that have different size magnetic particles.
3. Discuss what ferrofluid is and some of its uses.

**Procedure:**

Teacher Demo: Write in the space below what you observed and what you think is happening.

_____
_____
_____
_____

**Activity 1:** Take a few minutes to discuss with your group the answers to the following questions.

1. A student holds a bar magnet in each hand. If both hands are brought close together, will the force be attractive or repulsive if the magnets are held so that (a) the two N-poles are brought close together and (b) an N-pole and an S-pole are brought together?
   _____
   _____

2. The figure to the right shows five disk magnets floating above each other. The N-pole of the top most disk faces up. Which poles are on the top-side of the other magnets?

   _____
   _____
   _____



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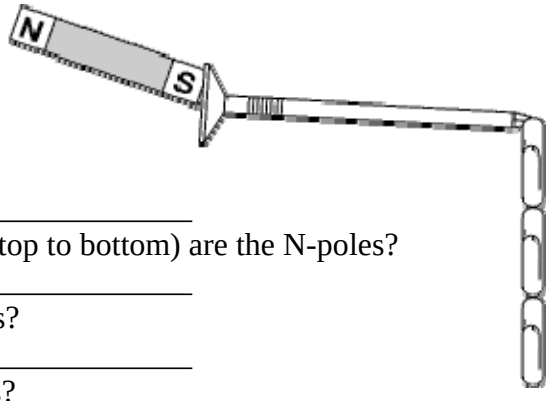
3. The figure to the right shows a magnet attracting a nail to it which, in turn, has attracted many paper clips that are attached to the nail.




   a. Which end of the nail is the N-pole?

      _____

   b. Which ends of the three paper clips (from top to bottom) are the N-poles?

      _____

   c. Which of the items are permanent magnets?

      _____

   d. Which of the items are temporary magnets?

      _____

**Activity 2:**

1. Along with your group, write down two observations about the vial of iron filings that you have been given.

2. On the diagram of the magnets below draw lines that would represent the attractive or repulsive force between the two magnets


3. Do the force lines have a specific direction?

4. Take the magnet you have been given and move it around the vial of iron filings, Write one observation about what is happening.

5. Would iron filings be classified as a paramagnetic solid (temporary magnet) or a ferromagnetic solid (permanent magnet)?

**Activity 3:**

1. Along with your group make two observations about the vial of iron filings and water that has been given to you. _____

_____

_____

_____

2, Take the magnet and move it around the vial. Write your observations. _____

_____

_____

_____

_____



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3. Would you say the iron filings are magnetic? Would you say that the water is magnetic?

4. When the magnet is removed from around the vial, what happens to the iron filings? Why?

5. What are the similarities and differences between the vial with just iron filings and the vial with the iron filings and water? _____

**Activity 4:**

Caution: Be careful when working with ferrofluid since it will cause stains. In addition, it is difficult to remove ferrofluid when it comes in contact with a magnet. DO NOT OPEN VIAL.

1. Carefully pick up the vial of ferrofluid. Be careful to not shake or tilt vial since ferrofluid tends to stick to the sides of the vial. Along with your group write two observations about this vial. _____

2. Carefully lay the vial over on its side above the table top. Place the magnet you have been given under the vial. Describe below what happens. _____

3. Move the magnet around the vial. Describe what happens. _____

4. What are the similarities and differences between the vial of iron filings and water and the vial with the ferrofluid? _____

5. What are the similarities and differences between a solution and a mixture? _____



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**Activity 5:**

Caution: Be careful not to shake the vial around.

1. Inside the container is ferrofluid and a bead. Which do you think is more dense? Why?

_____

_____

_____

2. Put the magnet under the vial and observe what is happening with the bead.

3. Is there a difference in the behavior of the ferrofluid when the magnet is present? _____

_____

**Conclusion:**

Answer the following questions.

1. Is a ferrofluid a solid or a liquid? _____

_____

2. Does the solid in the ferrofluid behave the same as the iron filings in the vial of water?

_____

_____

3. How was the penny able to float? _____

_____

_____

4. What is considered to be "nano" about ferrofluid? _____

_____

_____

_____



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