

Can a liquid be a magnet?

Fun with Ferrofluids

Activity 1:

- Look at the vial of ferrofluid. Move it around. Is the ferrofluid a liquid or a solid?
- Now hold a magnet up to the ferrofluid. What happens? Is it a liquid or solid?
- Now hold the magnet up to the vial of black sand. Does it act the same?

A **ferrofluid** is a unique material that acts like a magnetic solid AND like a liquid. In contrast, black sand is a regular magnetic solid. BOTH are made of magnetite, but the difference in their behavior is due to size.



CRITICAL THINKING

“What do you already know about magnets that would explain why the ferrofluid and the black sand act the way they do in the presence of the magnet?”

Ferrofluid is made up of tiny, nanometer-sized particles of coated magnetite suspended in liquid. (A nanometer is one billionth of a meter!) Particles of this size are known as **colloids**. When there is no magnet around, the ferrofluid acts

Can a liquid be a magnet?

Fun with Ferrofluids

like a liquid—the magnetite particles move freely in the fluid. BUT, when a magnet is produced, the particles are temporarily magnetized. They form structures within the fluid, causing the ferrofluid to act more like a solid. When the magnet is removed, the particles are de-magnetized and ferrofluid acts like a liquid again.

So...why is the black sand different? The answer is simple: **SIZE!** The black sand is also made of magnetite, but it does not have ferrofluid's unusual properties because the grains of sand are much larger. As a result, the grains of black sand are permanently magnetic and cannot be suspended in a liquid.

In this case, why is small better?

A material can act differently when it is nanometer sized.



Without looking back, what is the size of a nanometer?

Answer: _____

On the nanoscale, magnetite is paramagnetic, which means it is only magnetic in the presence of a magnet. This explains why ferrofluid acts like a liquid when no magnet is around, and a solid when a magnet is presented.



CHEMISTRY TIME!

The magnetic particles in the ferrofluid are called _____.

These particles are **iron oxide** (Fe_3O_4) and are coated with a surfactant to keep them from sticking to each other!

Can a liquid be a magnet?

Fun with Ferrofluids



CRITICAL THINKING

“Think about what you already know about solids and liquids. What are some similarities between solids and liquids?”

“What are some differences between solids and liquids?”

“Describe a situation where it would be more beneficial to have something be in a liquid form instead of a solid form.”

Can a liquid be a magnet?

Fun with Ferrofluids

Activity 2:

- a. Hold the magnet up to a crisp dollar bill. What happens?
- b. Is the dollar bill a liquid or a solid? _____ Is it a magnet? _____

How do you know? _____



Did you know? The ink used in printing money contains ferrofluid!

Considering what you have just learned about ferrofluid and how it reacts with magnets, can you think of some reasons why our money is printed with this special ink?



Can a liquid be a magnet?

Fun with Ferrofluids

Other applications: Aside from being used in ink, ferrofluids are used in loudspeakers to dampen vibrations, in rotary seals for computer hard drives and other rotating shaft motors, and even in medicine! Researchers now are looking at ways to use ferrofluid as a contrast agent for magnetic resonance imaging!

SUMMARY

Describe the most interesting thing you have learned during this exercise. What would you still like information on? How will you find the information you need to answer your questions?

ONE STEP FURTHER



Now that you have an understanding of ferrofluid and how it behaves as both a liquid and a solid, do you think you could create ferrofluid of your own? What would you need in order to create ferrofluid?