The Theatrics of Diamagnetism: Unveiling the Phenomena of Repulsion

Statement of the Problem

This project explores diamagnetism by demonstrating how water exhibits weak repulsive forces when it comes near a magnet.

Specifically, it investigates the following questions:

1. How does water show magnetic repulsion when placed near a magnet?
2. How can floating objects on water help reveal this repulsive effect?
3. Do fruits with high water content—such as cucumber, apple, and watermelon—also display repulsion when placed close to a magnet?

Background Research

- Michael Faraday discovered diamagnetism in 1845 while studying bismuth, identifying it as a property where materials repel magnets (Jackson, 2014).
- Diamagnetism occurs because electrons create tiny opposing magnetic fields when exposed to an external magnet, causing a weak repulsive force (Buschow & de Boer, 2003).
- Water is a common diamagnetic substance, and although its repulsion is very weak, it can be observed using strong magnets (Chen, 2010).
- Fruits with high water content, like cucumbers and apples, also show magnetic repulsion because they contain large amounts of diamagnetic water.
- Diamagnetism has practical applications, including maglev trains, superconductors, and MRI technology in medicine (Gaeta et al., 2021).

Hypothesis

If I place a strong magnet near water or fruits with high water content then, the water and floating objects will shift slightly away from the magnet because water is diamagnetic and produces weak repulsive forces.

Variables

INDEPENDENT
Position of magnet near the water or fruit

DEPENDENT
Repulsion shown by movement of floating objects or fruit pieces

CONTROL
Amount of water, container, type of magnet, type/size of objects, room conditions

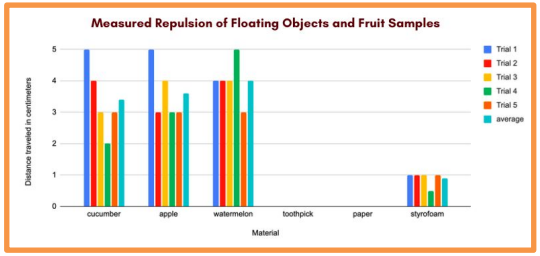
Materials

-Neodymium magnet (strong)
-clear plastic/glass container
-improvised container (made of styrofoam, straw, and tape)
-water
-floating objects (paper, toothpick, styrofoam)
-fruits (cucumber, apple, and watermelon)
-tweezers, ruler, notebook, pen
-magnifying lens
-laser pointer/flashlight

Procedures

1. Prepare the setup. Place the clear container on a flat table and pour 250 mL of water into it until it is about halfway full.
2. Add floating objects. Gently place small floating objects (like a toothpick, thin styrofoam, or paper piece) onto improvised container that is floating on the water.
3. Test the magnet with water. Slowly bring the neodymium magnet close to the side of object without touching the water.
4. Use a ruler to measure the distance.
5. Replace the floating objects with small fruit slices (such as cucumber, apple, and watermelon).
6. Repeat the experiment 5 times to observe accuracy in the measurements.
7. Analyze the results and make conclusions.

Results



Discussion

Using a stronger neodymium magnet and an improved setup, five trials were conducted for each sample within a 10-second observation window. The fruits—cucumber, apple, and watermelon—consistently moved away from the magnet, with average displacements of 3.4 cm, 3.6 cm, and 4 cm, confirming measurable diamagnetic repulsion in high-water-content materials. In contrast, floating objects such as a toothpick and paper showed no movement, and styrofoam displayed only minimal displacement (0.9 cm), likely due to friction on the water's surface. Overall, the results show that fruits with high water content exhibit weak but detectable diamagnetic repulsion when exposed to a stronger magnetic field.

Conclusion

The results of this experiment show that placing a strong magnet near water did not cause floating objects on the water to shift away, indicating that pure water's diamagnetic repulsion was too weak to observe with this setup. However, fruits with high water content—such as cucumber, apple, and watermelon—did move slightly away from the magnet, demonstrating measurable diamagnetic repulsion. These findings partially support the hypothesis: while floating objects on water did not show movement, fruits containing large amounts of water did respond to the magnetic field. This suggests that diamagnetic repulsion is present but can only be observed when the material has enough water content and when a sufficiently strong magnet is used.

Sources

- Buschow, K. H. J., & de Boer, F. R. (2003). *Physics of Magnetism and Magnetic Materials*. New York: Springer. pp. 59–61.
- Chen, Z. (2010). *Diamagnetic Properties of Water*. University of Minnesota, Conservancy.
- Gaeta, M., Cavallaro, M., Vinci, S. L., et al. (2021). *Magnetism of Materials: Theory and Practice in Magnetic Resonance Imaging. Insights into Imaging, 12*, 179. SpringerOpen.
- Jackson, J. (2014). *Michael Faraday's Discovery of Diamagnetism. Proceedings of the Royal Institution.*