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Physics II: H1

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Magnetic Levitation

This project observes the effects of materials with magnetic and diamagnetic properties through the construction of a device that levitates a small magnet. The material below outlines the construction of the device as well as the physics behind the device.

The construction of the device began with making the bismuth plates. Bismuth is in the core of bird shot, which is most commonly used in the ammunition of a shot gun. In order to extract bismuth from the core of the bird shot, the bird shot was placed in a large spoon over a flame that was produced by alcohol. Since alcohol burns both slowly and at a high temperature, the bird shot was able to become hot enough to turn into its liquid state. Once the bird shot was liquefied, a toothpick was used to push the slag to the side. The next step was to find a suitable mold to hold the liquid bismuth until it cooled. An aluminum can was chosen because its melting point is higher than that of bismuth, and the bottom of the can has a dome shape. Once the bismuth was cool enough, it was pried out of the bottom of the can and smoothed out using a metal file. This process was repeated twice in order to make the upper and lower plate for the device.

The next part of the construction was fabricating the main structure and altering speaker magnets. The main structure of the device was made with three pieces of wood that were cut using a table saw. The three pieces of wood were assembled using a biscuit joiner and

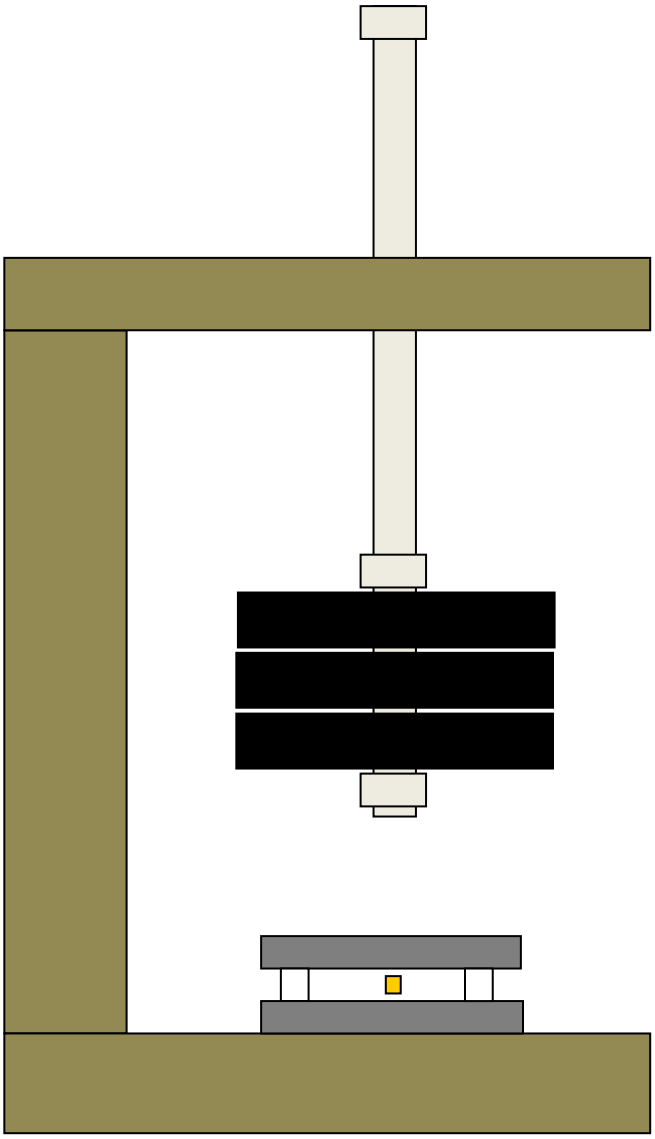
wood glue. This was chosen over using nails because it provides more strength for the type of stress that the structure will endure. After the wooden structure was completed, a quarter-inch hole was drilled into the top wooden piece. A threaded prong was then placed in the top for the threaded rod. The quarter-inch threaded rod was then placed into the prong with three nuts. The next part of the project required circular magnets to be used for the top magnets. Two of the three magnets were obtained by destroying two Bose speakers. The third magnet was taken from a construction tool. The third magnet had a five-eighth inch hole in the center, but the magnets from the speakers did not. A handheld drill was then used to make a hole slightly larger than a quarter-inch. Due to time convenience purposes, a drill press was used instead to drill the hole in the second speaker magnet.

The last part of the construction was assembling the device. Five-minute epoxy was used to attach the lower bismuth plate to the wooden structure and to assemble the three spacers in between the bismuth plates. There are three spacers and each contains three nylon washers and part of a toothpick. After the epoxy dried, the threaded rod was inserted into the prong and through the center of each of the three magnets. The three spacers were then setup in an equilateral triangle on the lower plate to provide a support structure for the upper bismuth plate. After setting up the plates, a one cubic-millimeter neodymium-iron-boron magnet was inserted in between the bismuth plates, which is where physics plays the main role.

The heart of this project is based on the diamagnetic properties of the bismuth plates. First of all, what does it mean to say something is diamagnetic? Diamagnetism is based on the

magnetic response of a material. When the material creates a magnetic field opposite of the applied external field, it is diamagnetic. In more simple terms, a diamagnetic material repels a magnet regardless of which magnetic pole it is facing. Diamagnetic properties are found in every material, but the effects are too small to observe in every-day life. Bismuth has the strongest diamagnetism out of any metal, which is why it was used for this project. In the project, a particularly strong magnet is placed between the bismuth plates. The rod is then lowered or raised until the force by the top magnets counteracts the gravitational force on the small magnet. When this point is found, the top magnets counteract the gravity and the bismuth plates repel the small magnet enough that it levitates. If the bismuth plates were not there, the magnet would jump up to the top magnets. The point where the top magnets counteract gravity is easier to find when the top magnets are stronger, because this creates a broader field. As a result, it is easier to make the small magnet levitate, which is why three top magnets were used instead of one.

Through constant adjustment of the rod, a point at which the magnet levitates was found. This project observed the effects of diamagnetism through the construction of a device that levitates a magnet.



Key:

Three top magnets – black

Wooden structure – brown

Cubic neodymium iron boron magnet – gold

Threaded rod and nuts – silver

Spacers – white

Bismuth plates – dark gray

References

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