Magnetic Levitation

University Physics II Honors Project

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Lab Section: L1

The use of magnets in the infrastructure of everyday life is nothing foreign; in actuality, magnets are everywhere around us, whether we know it or not. In fact, the stipulations of the paper would make it difficult to write if not for the use of magnetic materials, whether on a computer or a typewriter. (Daniel, Mee and Clark 1999) But that is neither here nor there. What is though is perhaps the most interesting, up and coming use of magnets in both the technological as well as industrial realms. Whereas the use of fossil fuels, wind, and manpower for propulsion have been used for centuries, and in some cases millennia, the use of magnets as propulsion is a relatively new concept. Although patents for such a thing were developed in the early twentieth century (Zehden 1905), the first successful implementation of a system for magnetic levitation that inevitably came to fruition was centered in Hamburg, Germany. Even after this successful implementation, the use of magnetic levitation, known colloquially as MAGLEV, has been minimal at best – neither the United States, nor Europe, have operational MAGLEV facilities and tracks that are usable by the public. (Vantuon 1994) The purpose of this paper is to describe our attempts to create a model magnetic levitation system, the reasons that led to its success, and the troubles we encountered in the preparation of our project.

The primary purpose of our project was to use a small track to demonstrate the amazing ability of magnets to levitate and propel objects along by use of their exhibited fields and the forces manifested from these. To do this, we first purchased two long, narrow strips of woods to act as either side of a track. Then, we purchased two different types of magnets. The first type, used to line the track on either side, measured approximately ½ inch by 1/16 inch, in the shape of a width-dominant cylinder. The second, in the shape of a cube, measured approximately ¼ inch on each side. We also purchased a block of Styrofoam for use as a model. We laid each board down, and used lined seventeen magnets along each side of each board with opposite facing poles, these magnets held down by a liberal amount of tape. Then, we placed these on another board, whose purpose was primarily stability, following which we placed two equal length boards vertical along the track. The purpose of these boards was to prevent the Styrofoam model from drifting too far to either side, and thus falling off the track. To minimize friction as best as possible, we covered each of these vertical boards with tape.

Once we had our track system in place, our main efforts were diverted into design and construction of the model. We came to the conclusion that Styrofoam would ultimately be the best method of creating a model. On each end of a cut of rectangular Styrofoam, the width of which was just smaller than the width between our two vertical boards, we placed a brick of five cubed magnets, aligning them so as to repel the oppositely placed track magnets. We then wrapped the model completely in tape, both to hold the magnets in place as well as to act as another measure to decrease friction between the model and the boards. Another design of model, placing the magnets vertically in the model to directly oppose the track magnets was tried, and while it produced a greater vertical stability, its lateral stability was greatly hindered. Ultimately, when put together, our original model fit well in the track, and with a light push, moved with relative ease from one side of the track to the other to create a successful model MAGLEV simulation.

Once we successfully completed the track and model system, we a test to determine the most important fact about our system. Using quarters as a simulated weight system, we discovered that our model could safely hold up to eighteen quarters a cumulative weight of approximately 147 grams (.147 kg) (assuming each quarter is approximately 6.25 grams), as the approximate wait of the model is 34 grams, before the weight of the quarters overcame the lifting force of the system. The significance of this is great, as this weight represents a multiplier of approximately 3.3 relative to the weight of the cart itself.

Our primary difficulty in the construction of the system lay in the use of permanent magnets. Because permanent magnets exhibit permanent fields, and because of the relatively high-strength of the magnets we used, simply placing the magnets in a line was inevitably a very difficult task. Furthermore, as our track magnets were very thin as well as very strong, when uncontrollably released toward another magnet, they displayed a tendency to break upon impact very easily, rendering each useless.

Another attempt in our project was to create a way by which the model was propelled through the use of electromagnetism. Our first attempt was to use a large nail, composed in part by iron, wrapped in loops of copper wire, to act as a solenoid-based induced magnet system, by which when a direct current of approximately seventeen amperes was introduced, the large change in magnetic field would propel the model along the track, and due to the overall low friction of the system, the force would be enough to keep sufficient velocity for the model to exit the system. Unfortunately, though, the attraction between the induced ferromagnetic rod and our model was too much for the created magnetic force to overcome. Our second attempt to create electromagnetic propulsion centered on using magnets, instead of a ferromagnetic rod, wrapped in a solenoid. This though, was equally as unsuccessful.

Ultimately, one would have to say that our project was successful. Using ordinary materials coupled with relatively strong magnets, we were able to provide sufficient lift to simulate the conditions of a MAGLEV train.

Figure 1. Diagram From above

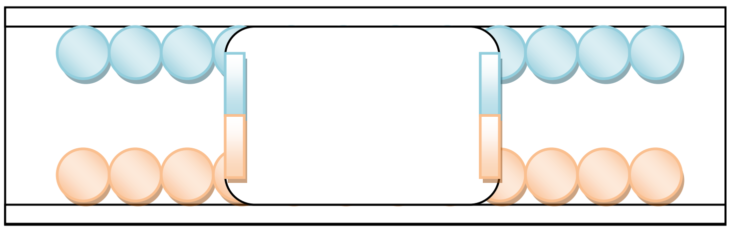
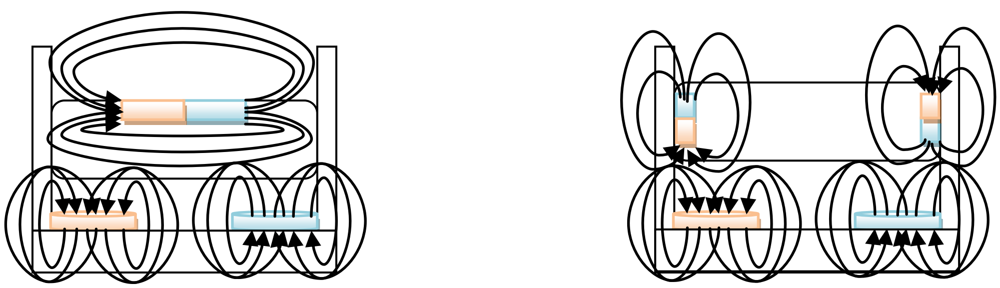


Figure 2. Cross Sectional Diagram of Both Cart Designs with Magnetic Field Lines



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