NSF GK-12 Graduate Fellows Program
Award # DGE-0139171
University of North Carolina at Wilmington

MagLev Train System Activity

Activity Instructions

by
Michael Salter, Department of Chemistry

The Maglev Train: Using Natural Forces to Enhance Technology

Objective: To investigate the principles and structure of the *Maglev Train System*.

Goals addressed:

- 2.04: Analyze practices that affect the use, availability, and management of natural resources.
- 4.04: Show that the force of friction retards motion
- 4.07: Investigate electricity and magnetism as universal forces and technological applications.

Scientific Background

Goal 4.07

It is known that "like" poles of a magnet repel one another and that "opposite" poles attract one another. This is the basic principle behind the *Maglev system*. It uses the repelling of two "like" poles of magnets to levitate a train, allowing it to glide frictionless along a magnetic track. Electromagnets in the tract are used to propel the train down the track.

Goal 2.04

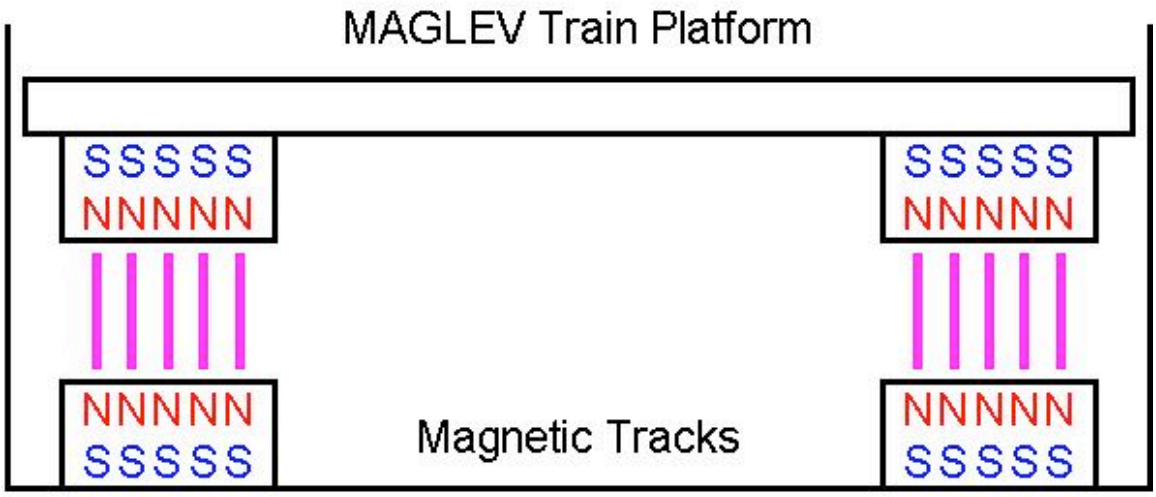
The *Maglev train system* uses no combustion reaction, which can pollute the environment, hence no detriment to the environment. In addition, the *Maglev train* uses less energy (25% of an aircraft, and 50% of a car). This makes the train a more efficient mode of transportation. Finally, the train makes almost no noise.

Goal 4.04

Since the train is levitating above the track, the train is able to achieve much higher speeds due to the lack of mechanical friction. On a straight line of track, the train can reach speeds of up to 550 km/hr or 344 mph! If friction were involved, the train would not be able to travel nearly as fast.

There are three basic elements of the *Maglev* technology:

- Levitation
- Propulsion
- Guidance



Repulsive Force

The Problem

You are the C.E.O. of World Transportation Inc., a construction company that develops and manufactures various transportation used by major cities all over the world. In addition, you hold a Ph.D. degree in structural engineering and physics from M.I.T. The President of France has asked you to develop a mode of transportation that will transport a large number of passengers using limited resources and energy. He has asked you to develop a working model of this transportation system to show him. He will be willing to pay your company $50 million dollars for this project.

But, the President of France has some requirements. The President loves magnets and loves the application of magnets to better the life of the people of France. He wants the design of the system to include the use of magnets. Also, the President is worried about increasing levels of pollution to the environment, so he wants his system to be good for the environment (no combustion or gases given off). Lastly, the people of France become annoyed at transportation that is loud and noisy. So, the President requests that the system be as quiet as possible.

If all of these guidelines are met, the President of France will pay your company the $50 million dollars in the contract. This works out to be about $15 million just for you! All you have to do know is design and build a transportation system.

From the Research and Development Department of your company, a groundbreaking new technology has just been released called the *Maglev System*. The theory behind the *Maglev System* is that it uses magnets to levitate a train above a set of rails and uses various systems to propel the train. In order to use magnets in the design of a train system, there are three principles that must be accounted for.

1) Levitation
2) Guidance
3) Propulsion

You have to use these principles to develop your system.

Procedure

1. The students will be separated into 7 groups, each at a workstation.
2. At each workstation, there is material for creating a magnetic train system (magnets, fasteners, one car, and one track).
3. Using your knowledge that like poles of a magnet repel and opposite poles attract, devise a rail system that will levitate the train and keep it on the track.
4. Record any ideas, results, and observations.
5. Place 12 magnets in the track, all with the same face up.
6. Now, place 4 magnets on the car with the same face down.
7. Once you have successfully floated a train on the rail system, the next step is to propel the train down the track.
8. Working with the other members of your group, come up with a propulsion system that will propel the car down the 4 ft. track.
9. Record any ideas, results, and observations.
10. Once each group has found a system that works, each group is going to race their trains on a track provided by the teacher.
11. The velocity of your car will be calculated using the following equation:

    Velocity = Distance/Time

12. Since you know the length of the track (4 ft.) and the time it takes to travel the track, you can find the velocity.
13. Compare your time to other groups and decide which propulsion system works the best.
14. Depending on time, you may only be able to do one run.

Ideas, Results, Observations:

Run	Time (sec.)	Velocity (ft/sec)
1		
2		
3		

Questions:

1. What forces were keeping the train off of the track?

2. What would happen if the train road on the track?

3. What natural resources were used in the building of the train system?

4. List some advantages and disadvantages about this kind of technology.

5. Do you think that this mode of transportation is possible?

6. Would this train system work anywhere in the world? Why?

Notes for Fellows

- There are 21 cars for each school, based on 7 groups in each of the 3 classes. If more cars are needed, there are extra available. The cars are on my shelf.
- Each school needs 124 magnets, 16 (12 for the track and 4 for the car) magnets for the 7 groups and a 12 additional to fill up the 4 ft. track. The magnets should be on your shelf.
- Each school needs at least 28 of the metal fasteners to hold the magnets to the car.
- When placing the magnets on the car, the students should fasten the magnets on the red line.
- In keeping track of the "north" and "south" faces of the magnets, it would be helpful to mark one side with an "X" to keep them straight.
- You can use the story or not, it's up to you.
- The magnets on the cars must be reused between classes.
- The students are to come up with the propulsion system. If they become stumped, you can advise either using a balloon, rubber bands or a sail of some kind.
- Again, take all of the magnets out of the 6" tracks and put them in the 4 ft. track.
- You may want to remove the wood screw from the tracks. I don't think that they are really needed. The nuts and bolts hold the ends on just fine.