Lesson Plan: The Maglev Train
Millsmont High School

Mentors:

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Materials:

- One 2x4 board; 6.5 ft
- Poster board
- Gorilla glue (wood-based glue)
- Hot Glue Gun
- Stopwatch
- Ceramic magnets (~ 100 2-in magnets)
- Foam core
- Sandpaper
- X-Acto knife
- 50mm fans (one per car) / Small motors to attach propellers to (whichever one is easier).
- Toothpicks

Agenda:

(2 hour session)

The goal of this lesson is to introduce students to the engineering design in order to design and build a magnetic levitation train. During the design phase, the students will develop their ideas for building foam core trains and sketch plans and materials. They will test their trains and undergo the process of failure analysis and redesign based on how their train performs.

The lesson will introduce concepts of electricity and magnetism as well as alternative means of transportation.

- Introduce theory behind magnets and the trains
- Show the students a video of a mag-lev train
- Demonstrate how to build the train and test the demo train
- Have the students formulate a plan and sketch their trains
- Students build their train and test it on the track
- Analysis of test results and refinement

Introduction:

- Magnets—
  - Like poles of magnets repel, which will provide the force that keeps the trains off the track and hovering in the air
  - Normally there would be addition magnets on the sides to keep the train centered, but we will just accomplish that using poster board as side rails

- Electromagnets—
  - A flow of electric current around a coil creates a magnetic field through the magnet
  - This is used in real world application of maglev trains, the current varies throughout the track, propelling the train forward.
- NASA Engineering Design Process—
  - Process of idea development, planning, designing, prototype, testing, and refinement
- Newton's Laws—
  - Newton's Third Law in terms of the fan propelling the train forward, fan pushes air back, so air pushes fan (and attached train forward)
  - There's no normal force because the magnets make the train float; therefore, there is no friction between the train and the ground
- Center of Mass—
  - Position in an object where the mass is concentrated, needs to be precise in order to prevent the car from running into the sides and falling off the track
- Weight Distribution—
  - When designing vehicles, need to consider weight distribution and how it pertains to its functionality

Activities:

- Demonstration #1: Show the students a video of magnetic-levitation trains as a segue to talking about real world applications of magnetism and show them that this project is realistic.
- Demonstration #2: Mentors will build a foam-core train as an example, explaining the basic steps necessary for the train to work.
  1. Assemble basic materials and construct example train
     - Make the track by laying out magnets, all arranged in the same direction in terms of magnetism, and then use wood glue to attach them to the 2x4. Then use the wood glue to attach the poster board, creating a guide rail for the trains.
     - The basic design is a rectangular piece of foam core, 50mm fan, 4 magnets, one on each corner of the train, using the hot glue to assemble it all together. Toothpicks or hot glue can be used to attach the fan.
  2. List out essential steps for building the train to the students
  3. Test example train on the track to see if it is stable
- Design and Build Phase:
  1. Students in groups of 2 or 3 talk about ideas for their train
  2. Students will be given scratch paper to sketch designs for trains
  3. Based on sketch, students collect materials
  4. Students build foam-core trains based on their sketches
- Testing and Refinement Phase:
  1. Students test out trains on the track
  2. Mentors and students conduct time trials on the track

3. Students have the option to refine their design and re-test
4. Group who designed the fastest train present their design

Closing Discussion:

Review central concepts for the lesson and how they applied to the highest performing train. After discussing what the students felt they learned from the lesson, distribute short quizzes (students who complete the quiz will receive raffle tickets, an incentive program within the school).

- How are magnets used to make the trains 'float'?
- How do magnets propel real mag-lev trains forward?
- List the steps of the NASA design process
- Explain how the fan makes the train go forward in terms of Newton's Laws; how else could we propel the trains forward?
- What would happen if we used wooden sides for the track instead of poster board? (friction)

Name: _____

Mag-Lev Worksheet

How are magnets used to make the trains 'float'?

How do magnets propel real mag-lev trains forward?

List the steps of the NASA design process

Explain how the fan makes the train go forward in terms of Newton's Laws; how else could we propel the trains forward?

What would happen if we used wooden sides for the track instead of poster board? (friction)