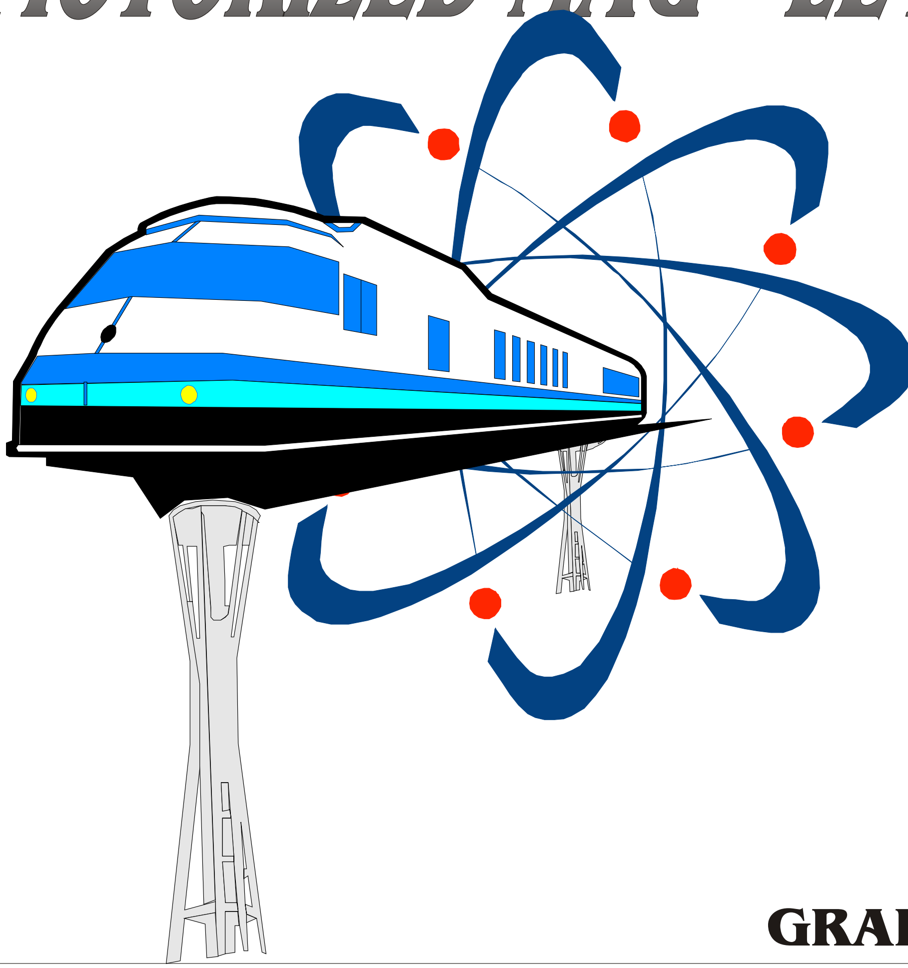
Girls in Engineering

MOTORIZED MAG - LEV



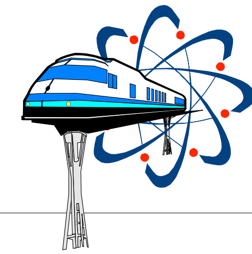
GRADE 7

BIGELOW MIDDLE SCHOOL
Newton, MA

ENGINEERING TECHNOLOGY

05-14-03

PROBLEM GUIDELINES



As we move toward the twenty first century, an analysis of our transportation needs indicates that the systems we have in place today may not be capable of supporting our transportation needs for the future. Because of the growing need for quicker and more efficient methods for moving people and goods, researchers have turned to a new technique, one using electromagnetic rails and trains. This rail system is referred to as **magnetic levitation**, or **maglev**. Maglev is a generic term for any transportation system in which vehicles are suspended and guided by magnetic forces. Instead of engines, maglev vehicles use **electromagnetism** to **levitate** (raise) and propel the vehicle. Alternating current creates a magnetic field that pushes and pulls the vehicle and keeps it above the support structure, called a **guide way**.

There are **two basic types** of maglev - **electromagnetic suspension (EMS) and electrodynamic suspension (EDS)**. **EMS** depends on **attractive force**. Electromagnets on the vehicle are drawn toward a pair of steel rails. Most of the vehicle rides above the rails but the magnets wrap beneath the rail. As the magnets pull the vehicle upward, their current is electromagnetically regulated to maintain a constant gap between the rails and the vehicle. **EDS**, on the other hand, is based on **repulsive force**. The vehicle contains superconducting magnets that induce a repulsive force in a conducting guide way as the vehicle moves along it. **Superconducting electromagnets** are much more powerful than ordinary electromagnets. West Germany and Japan have successfully tested maglev systems. The West German maglev system uses conventional electromagnets (EMS). The Japanese prototype uses superconducting electromagnets (EDS).

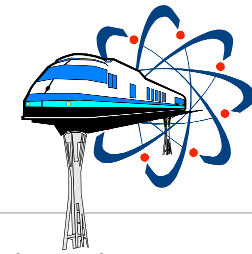
Friction exists in all transportation systems. Friction causes energy loss, generates heat and mechanical wear on the parts of the system. The lower the friction between two surfaces, the less force is required to move the vehicle. Therefore, friction must be reduced as much as possible to make the system more **efficient**. The reduction of friction in a maglev system provides a **comfortable**, **smooth ride**, **eliminates noise**, and can **lower maintenance costs**. Most important of all, the lack of friction allows maglev vehicles to travel at **speeds over 300 miles per hour**.

Maglev systems have many safety and health impacts. Maglev systems are predicted to be **very safe** compared to similar systems of mass transit. The vehicles **cannot derail** due to the track design. The vehicle is "locked" onto the guide way. They also **do not carry on-board fuel**, therefore, it should be safer in the event of a crash. Because the vehicle does not touch the guide way, accidents related to weather and wear will be minimized. A **health concern** is that people must be shielded from the **magnetic field radiation**.

Maglev also has a variety of **environmental impacts**. A maglev guide way doesn't require a very wide thoroughfare therefore **consuming less land**. The guide way could even be built on existing interstate highway rights of way. Because the guide ways are elevated, they have **useable land underneath**. Maglev also **consumes less natural resources**. While we are growing more and more dependent on petroleum in an unstable oil market, maglev is only 30% dependent of petroleum. Maglev vehicles use only one-fourth to one-half as much energy as jets and automobiles.

Pioneering maglev research was done in the U.S. from the late 1960's until 1975 when all federally funded work was canceled. In 1988 the maglev effort was revived and for now is still alive. High speed maglev is now at the point railroads were at in the 1820's - plans are being made and groundbreaking appears likely. Two plans are now in the works: a 250 mile route from the outskirts of Los Angeles to Las Vegas and a 13 mile airport connector in Orlando, Florida. The technology is available, the problem is financing. The initial cost of setting up a maglev system is great. Industry lacks incentive to make major financial commitments to maglev because of the long-term nature of the investment. Help must come from the federal government. This activity will allow you the opportunity to design, build, and test a magnetic levitation transportation system.

PROBLEM GUIDELINES



A local transit company is planning to construct a transportation system based on magnetically levitated vehicles. The new system will provide commuters with fast, economical, and safe transportation to and from work. As a member of the design team, your responsibility is to design and construct a maglev model that will travel the eight foot length of the magnetic guide way in the lab, as fast as possible. Variables such as weight, shape, distribution of the load, resistance with the track, guidance, height of levitation, number of magnets, and aerodynamics should be considered.

THE DESIGN PROCESS

1. Identify the need or the problem by reading the Introduction hand-out
2. Research the need or the problem
3. Develop possible solutions to the need or the problem (thumbnail sketches)
4. Select the best possible solution (final design)
5. Construct a prototype of your solution (build your racer)
6. Test and evaluate the solution (make many tests to your racer on the track)
7. Communicate the solution (demonstrate your racer to the other teams and race)
8. Redesign and / or rebuild
9. Evaluation

LIMITATIONS & SPECIFICATIONS

1. You may use up to six ceramic magnets supplied by the teacher.
2. Your vehicle can only be propelled by a motor and propeller.
3. The rails of the track are 3 inches apart so the base of your racer should be slightly smaller.
4. The vehicle should be no longer than six inches in length.

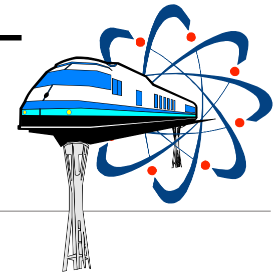
HINTS:

1. Guidance is best achieved if the magnets, not the vehicle body, rub against the track rails. The body can be much narrower than the track if the magnets stick out on each side for guidance.
2. Usually, the higher the vehicle levitates off the track, the better it performs.
3. The load (weight) should be distributed evenly. Vehicles that ride level do very well.
4. The electrical contacts from your racer to the track are critical. Develop a design so the wires stay in contact with the rails at all times. If the racer loses contact, it will lose power!
5. Decorations can and should be added to your vehicle. Most spray paints will dissolve styrofoam but you can use permanent marker, acrylic paint, or stickers.

Tools and materials

styrofoam	**wire cutters**	**band saws**
wooden sticks	**wire strippers**	**hand tools**
wire	**motors**	**rulers**
glue guns	**propellers**	**scissors**
soldering irons	**magnets**	**tape**

Team Members: ____



RESEARCH WORKSHEET

Step 2 Research the need or problem

How does Magnetic Levitation work?____.
____.
____.

How is Magnetic Levitation used for transportation?___________________________.
____.
____.

List two advantages that Mag Lev trains have over traditional fuel-burning trains?__________.
____.
____.

If a person wanted to ride on a Mag Lev train, where could he/she go (what city?)?_________.
____.

List at least three concerns that would arise in order to build a Mag Lev train here in Boston.
____.
____.
____.

List at least two <u>positive</u> outcomes of building a Mag Lev train in Boston?______________.
____.
____.

What is an Electrical Circuit?____.
____.

What type of electricity is produced from a battery? (circle one) **AC** or **DC**

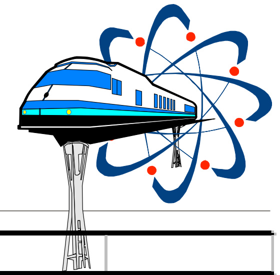
What do the letters "DC" stand for?____.

What do the letters "AC" stand for?____.

Draw a picture of a simple **parallel** circuit below

Draw a picture of a simple **series** circuit below

NAME: ______________________ **CLASS:** ____________.



DESIGN SHEET

Team Members:

Step 1 Identify the need or the problem

What do we have to do?

Standards we must meet:

Step 2 Research the need or problem

Use the back side of this worksheet to do your research

Step 3 Develop possible solutions

Draw at least 4 possible solutions (thumbnail drawings)

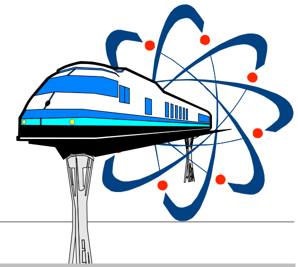
sketch 1

sketch 2

sketch 3

sketch 4

NAME: ______________________________ CLASS: ____________.



FINAL DESIGN

Step 4 Select the best possible solution

Include dimensions and the materials you plan to use.

final design

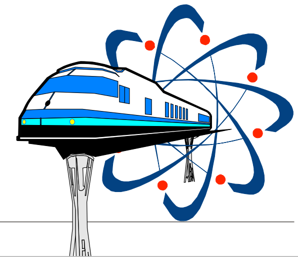
Step 5 Construct a prototype of your solution

List the parts of your racer:	List materials you propose to use:

Step 6 Test and Evaluate the solution *(make many test runs on the race track)*

Record any problems you find when testing	List solutions to the problems

NAME: ________________________________ CLASS: ____________.



RE-DESIGN & EVALUATE

Step 7 Communicate the solution (Race your vehicle and record initial times)

Demonstrate your solution to other teams

Time for Race #1 ____________ Time for Race #2 ____________

Observations | Improvements

________________________________ ________________________________
________________________________ ________________________________
________________________________ ________________________________
________________________________ ________________________________
________________________________ ________________________________

Step 8 Redesign and / or rebuild

Necessary changes to be made

____
____
____
____
____

Step 9 Evaluation

What modifications were needed?

____
____

What improvements could be made?

____
____

How could your team have performed better?

____
____

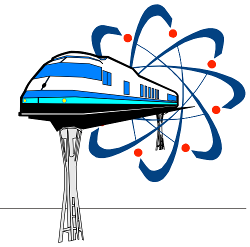
What changes would you make for next time?

____
____

Were you happy with your team's results? Why or why not?

____
____

Connection to Frameworks



Upon completion of this TLA students will have learned and / or demonstrated the following Frameworks Standards:

1 Materials, Tools, and Machines

1.1 Given a design task, identify appropriate materials (e.g., wood, paper, plastic, aggregates, ceramics, metals, solvents, adhesives) based on specific properties and characteristics (e.g., weight, strength, hardness, and flexibility).

1.2 Identify and explain appropriate measuring tools, hand tools, and power tools used to hold, lift, carry, fasten, and separate, and explain their safe and proper use.

1.3 Identify and explain the safe and proper use of measuring tools, hand tools, and machines (e.g., band saw, drill press, sanders, hammer, screwdriver, pliers, tape measure, screws, nails, and other mechanical fasteners) needed to construct a prototype of an engineering design.

2 Engineering Design

2.1 Identify and explain the steps of the engineering design process, i.e., identify the need or problem, research the problem, develop possible solutions, select the best possible solution(s), construct a prototype, test and evaluate, communicate the solution(s), and redesign.

2.2 Demonstrate methods of representing solutions to a design problem, e.g., sketches, orthographic projections, multi-view drawings.

2.3 Describe and explain the purpose of a given prototype.

2.4 Identify appropriate materials, tools, and machines needed to construct a prototype of a given engineering design.

2.5 Explain how such design features as size, shape, weight, function, and cost limitations would affect the construction of a given prototype.

2.6 Identify the five elements of a universal systems model: goal, inputs, processes, outputs, and feedback.

6 Transportation Technologies

6.1 Identify and compare examples of transportation systems and devices that operate on each of the following: land, air, water, and space. 6.2 Given a transportation problem, explain a possible solution using the universal systems model.

6.2 Identify and describe three subsystems of a transportation vehicle or device, i.e., structural, propulsion, guidance, suspension, control, and support.

6.3 Identify and explain lift, drag, friction, thrust, and gravity in a vehicle or device, e.g., cars, boats, airplanes, rockets.