BUILD A MAGLEV TRAIN MODEL

PLANNING YOUR EXPEDITION

Models constructed in this activity will be used in Expedition #16 "Model Train Competition."

In this Expedition and its follow-up, "Model Train Competition," students will build models of a transportation system to demonstrate how magnets can be used in a practical way. Combining content issues like magnetism with real-world applications brings another dimension to science in the classroom.

It is possible to build a simple levitating train using some of the principles that your students already know about magnetism. Although a true MagLev train is a very complex device, students should be able to build a mock-up of a simple train that levitates along a 1-foot (approximately) track just by using permanent magnets and common materials.

Scientific advances bring both problems and benefits, and informed citizens need to understand how these advances impact their lives. Today's citizens must make decisions regarding scientifically based social issues, i.e., genetic engineering, cloning, energy consumption, or environmental conservation. These decisions will affect not only society as a whole but students' individual lives. Using real-world applications of science in classroom instruction provides opportunities for students to analyze the impact of science and technology on society and to determine their costs and benefits. Students engage in real world situations which motivate the learning of science content.

If students come up with ideas using other materials, encourage their creativity, and make other magnets or related materials available to them if possible.

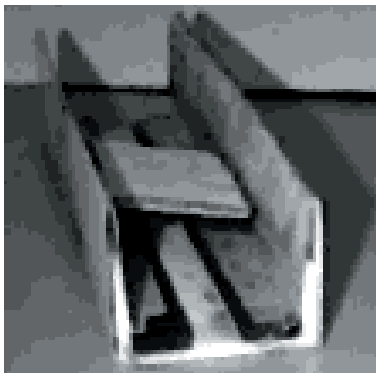
1. Students construct a base for a MagLev train from foam board, posterboard, or cardboard.

2. Using magnets, students will construct the track. As they do this, they will discover (if they did not realize this before they began) that the magnets must be aligned in a certain way for this to work. Students will also find that taping the magnets together so that like poles line up is not as easy as it first seems. It may be helpful for students to figure out which surface of each magnet represents the same pole, and mark an "X" on that surface before placing the magnets on the tape. (See graphic.)

3. Once the tracks are in place, students need to make a "train" that will float on the rails. They discover that weight and shape is important. Students need to experiment with several variables before arriving at the best design.

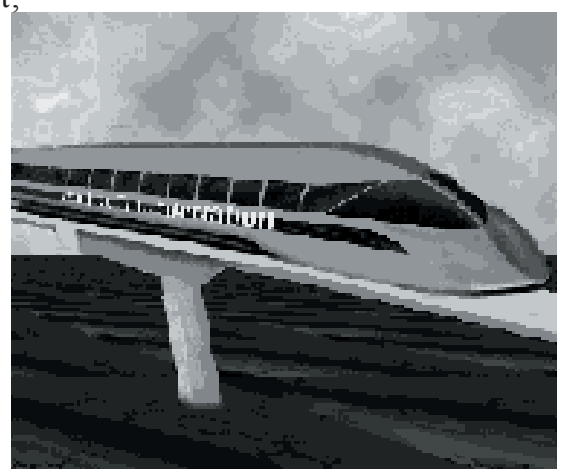
4. Encourage students to decorate their models and personalize them. They could develop a team name and logo.

5. Students will demonstrate their model for you and for other groups.



BACKGROUND INFORMATION

Fossil fuels are dwindling. They are also a source of pollution that is threatening our atmosphere. A magnetic levitation system consists of safe, quiet, nonpolluting vehicles. Worldwide there are two types of magnetic levitation trains: those that use superconducting magnets and those that use permanent magnets. Both systems can travel at very high speeds; both systems are nonpolluting. The German system relies on attraction; the Japanese system on repulsion. In both systems propulsion is similar in that the train rides on an electromagnetic wave. The German Transrapid has no wheels; electromagnets on board are attracted to a magnetic surface on top of the track. This lifts the train about 3/8 inch off the ground. The Japanese train rests on a set of wheels. When it reaches 100 mph it levitates 4 inches above the rails. Both systems rely on a lateral guidance system to keep the train in the middle of the track.



Using technology similar to that used to develop Maglev trains, scientists around the world are attempting to use this technology for other purposes. In Japan, for instance, engineers are working on a motor to propel elevators to greater heights in skyscrapers. The vertical linear motor will use the concept that magnetic forces act at a distance but will be limited, of course, as to the speed and acceleration that can be used since the elevators will contain human beings. Electromagnets have traditionally been the basis for motor design. However, permanent magnets are becoming more desirable due to the fact that they can be made smaller, stronger, and are advantageous environmentally. They need no electric current, thus no fossil fuels are used to create the electricity.

Another use, however, for this same technology is to build electromagnetic launchers to propel vehicles beyond Earth's gravity into space. These vehicles could carry, for example, parts and supplies for a space station or a

moon colony. Currently, most research that is being done in Japan and the United States is producing rail guns (also called rail launchers and coil guns).

Rather than propelling space vehicles, some electromagnetic launchers are being manufactured as modern weaponry. One such tested rail launcher is 2.23 meters long with a bore of 17.5mm x 39mm. The translation of technology from one use to another is common in science.

Other sources of information are: Richard P. Brennan (1990). Levitating Trains and Kamikaze Genes. New York: John Wiley & Sons; The Florida Department of Transportation, High Speed Program Office, Tallahassee, Florida; or, search on the worldwide web (www.hsgt.org).

EXCURSIONS

Either read or have students read a Jules Verne science fiction story. Using science fiction as a reference for science fact is a technique that is appealing to many students. When they realize that Jules Verne wrote about things in his novels that were decades away from being discovered, students gain a respect for fiction as a vehicle for understanding fact (some of the things that he imagined were submarines, space travel, television, mass transit, computers). By placing each of these novels in its historic context, students will be amazed at the foresight shown in each. In Paris in the Twentieth Century (1996, Random House, ISBN 0-679-44434-3), Verne talks about mass transportation (an issue in this activity and the one that follows).

SC.D.2.3.1-2, 3.3.5-7

LA.A.1.3.1-4, 2.3.1-8, LA.C.1.3.1-4, 2.3.1-2, LA.E.1.3.1-5, 2.3.5-8

Have students read "The Shot From the Moon" by Arthur C. Clarke (found in Science Fiction Stories chosen by Edward Blishen, Kingfisher Books, ISBN 1-85697-889-3). This science fiction story contains mention of a magnetic launcher in use on the moon. (In the 1970s, Arthur C. Clarke came up with this idea that was then heavily promoted for a short period of time.) Transporting people and goods to and from the moon if a moon colony were established is a problem that theoretically could be alleviated by using a magnetic launcher. Ask students to draw their idea of what a magnetic launcher would look like and answer the following questions: Why would a magnetic launcher be appropriate for use on the moon? [The moon's gravity is one-sixth that of Earth; it is fuel efficient; the moon has no atmosphere.] Drawings should portray the concept of opposites attracting and like poles repelling like poles.

SC.C.2.3.1-7, SC.D.2.3.1-2, SC.E.1.3.1, SC.G.2.3.3-4, SC.H.3.3.4-7

LA.A.1.3.1-4, 2.3.1-8, LA.B.1.3.1-3, LA.E.1.3.1-5

The use of fossil fuels is an issue that is discussed frequently on television news programs, newspapers, and magazines. By middle school, students should be able to identify the fossil fuels and the reasons why we should be conserving them. Have students research the use of fossil fuels using print media, videotapes,

or worldwide web sites. This information will be used in Expedition 16. Each group should identify this as an area of worldwide concern.

SC.D.2.3.1-2, SC.F.2.3.4, SC.G.2.3.1-4, SC.H.1.3.1, 3.3.4-7

LA.A.1.3.1-4,2.3.1-8,LA.B.1.3.1-3, LA.D.2.3.3-7

One of the reasons that the United States has cut back on fossil fuel use is that they pollute the atmosphere. This could be tied into increasing levels of carbon dioxide in the atmosphere. Have students research the issue and present their findings at a poster session. Students may want to invite others to participate to share their information as scientists do in actual laboratory situations.

SC.D.2.3.1-2, SC.F.2.3.4, SC.G.2.3.1-4, SC.H.1.3.1, 3.3.4-7

LA.A.1.3.1-4, 2.3.1-8, LA.B.1.3.1-3, 2.3.1-4, LA.D.2.3.3-7

FOR YOUR PLANBOOK: Build A MagLev Train Model

Suggested time: 1-3 hours

Gear: small square magnets (20-30 per group), foam board or cardboard, masking tape, grease pencil

National Science Content Standards: A, B, E, F, G

Sunshine State Standards Benchmarks: SC.B.2.3.2, SC.C.1.3.1, SC.C.2.3.1, SC.C.2.3.2, SC.C.2.3.3, SC.C.2.3.6, SC.D.2.3.1, SC.D.2.3.2, SC.G.2.3.3, SC.G.2.3.4, SC.H.1.3.1, SC.H.1.3.2, SC.H.1.3.3, SC.H.1.3.4, SC.H.1.3.5, SC.H.1.3.7, SC.H.3.3.4, SC.H.3.3.6

Sunshine State Standards Benchmarks -- Language Arts: LA.A.1.3.1-4, 2.3.1-8, LA.B.1.3.1-3, 2.3.1-4, LA.C.1.3.1, 3-4

Sunshine State Standards Benchmarks -- Social Studies: SS.A.1.3.1-3, 2.3.1-8, 4.3.1, 6.3.2, 6.3.3-5, SS.B.1.3.1-7, SS.C.1.3.2,5-6, 2.3.1-7, SS.D.2.3.1-3

Homework: This works best if assigned before completing the activity. Allow students several days to complete the assignment. Have students interview a grandparent, great-grandparent, or other adult over 50 (the older the better). The interviewer will ask two questions about changes in transportation: (1) What kinds of transportation did you use when you were middle school age? and (2) How has transportation changed since that time? Instruct students to note the name, date, and place of the interview as well as the age of the interviewee. Answers should be recorded in the Alpha Log.

Homework Assessment: Encourage students to consider all types of transportation when conducting their interviews, for example, not just cars or planes, but scooters, roller skates, skis, walking as a mode of transportation, horseback riding, or tractor. Interviewing is another way of gathering data. If students come to class with answers to the two questions as well as the name, date, and place of the interview, they have successfully completed the assignment.

Assessment: Use data gathered from interview questions assigned for homework to conduct a class discussion. From this discussion, students generate a list of modes of transportation and then add to it how each has

changed over a time. Students develop an understanding of the historical place of science in society. This would be a good place to distinguish between innovation and invention.

Have students create a Venn diagram (three concentric circles) based on the information from interviews and follow-up discussions. One circle could represent transportation in the past; another, transportation in the future; and the third, transportation at present. The intersection of the three would be a place to list those modes of transportation are common to all three.

Instead of the Venn diagram (above), have students create a concept map based on the same information. It serves the same purpose: students view science as a human endeavor with lasting influence upon society. A concept map is a way for students to present, in visual form, their conception of certain information. To create a concept map, students first clarify how new knowledge is related to other ideas that they have encountered. Concept maps present interrelated knowledge rather than isolated facts.

Models created should indicate that students understand enough of the technology to know that the MagLev trains are created by magnets that repel and attract, that all magnets must be placed in a certain configuration in order for these forces to work, and that the nature of science is such that trial and error create opportunities for new development.

Check Alpha Logs for record-keeping. Students realize quickly the need for accurate and detailed records. In this activity, particularly, it will be to the students' advantage to write down each time they have a problem and how they solve it. If Logs contain this type of information, students have been successful in their record keeping. Remind students that replication is important in science. Other scientists have to be able to reproduce what another scientist has done in order to validate the results.

BUILD A MAGLEV TRAIN MODEL

Itinerary

It is possible to build a simple levitating train using some of the principles that you have learned about magnets. Although a MagLev train is a very complex device, you should be able to build a mock-up of a simple train that levitates along a 1-foot (approximately) track using permanent magnets and common materials.

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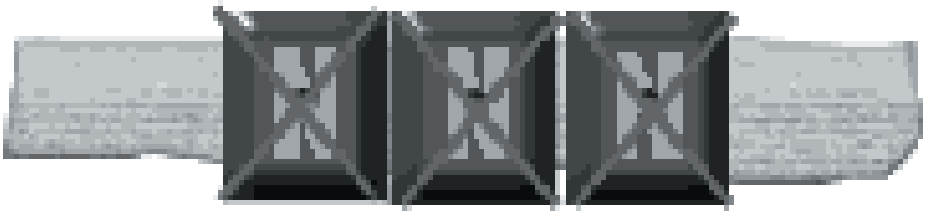
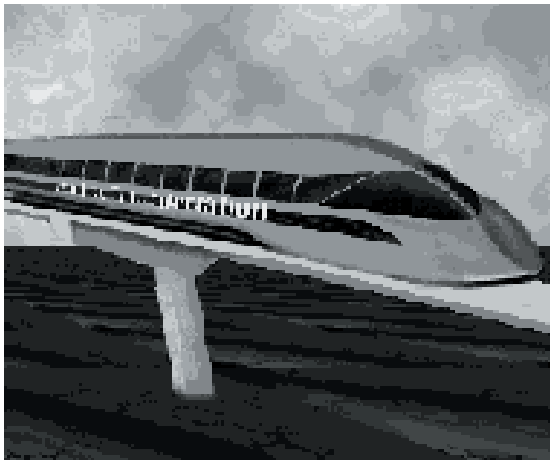
1. The Materials Manager should collect all necessary materials: foamboard, poster board, or cardboard, a marker, 20-30 square magnets, and masking tape. Be creative. If there is other material that you believe you need, ask your teacher .
2. Construct a track for your MagLev train. This is a little more complicated than it seems at first, so be patient. Keep a record in your Alpha Log of any problems you may have .
3. If you get to a point in your design or construction stage where you cannot overcome difficulties that you are having, consult another group, or your teacher.



4. Once your track is in place, make a "train" that will float above the rails. Weight and shape are important; try several different designs before deciding on the final one.
5. In your Alpha Log, draw a plan of the train, listing materials and directions. Remember, other scientists will need to replicate (repeat exactly) your work.
6. Decorate your model. Design a logo based on a team name or nickname.
7. Demonstrate your model for the other groups.
8. In your Log, list some ways that you could improve your design.