Table of Contents

QuickView

Students calculate the acceleration of a maglev car traveling down a maglev track at various inclines. Students compare the actual accelerations to the theoretical accelerations.

Standards Addressed

NSTA 5-8

Students develop abilities necessary to do scientific inquiry.

- Students use appropriate tools and techniques to gather, analyze, and interpret data.
- Students think critically and logically to make the relationships between evidence and explanations.
- Students recognize and analyze alternative explanations and predictions.
- Students use mathematics in all aspects of scientific inquiry.
- Students understand mathematics is important in all aspects of scientific inquiry.

Students develop an understanding of motions and forces.

- Students understand an object that is not being subjected to a force will continue to move at a constant speed and in a straight line.
- Students understand if more than one force acts on an object along a straight line, then the forces will reinforce or cancel one another, depending on their direction and magnitude; unbalanced forces will cause changes in the speed or direction of an object's motion.

NCTM 6-8

Students compute fluently and make reasonable estimates.

- Students select appropriate methods and tools for computing with fractions and decimals from among mental computation, estimation, calculators or computers, and paper and pencil, depending on the situation, and apply the selected methods.

Students represent and analyze mathematical situations and structures using algebraic symbols.

- Students use symbolic algebra to represent situations and to solve problems, especially those that involve linear relationships.

Students use mathematical models to represent and understand quantitative relationships.

- Students model and solve contextualized problems using various representations, such as graphs, tables, and equations.

Students apply appropriate techniques, tools, and formulas to determine measurements.

- Students solve problems involving scale factors, using ratio and proportion.
- Students solve simple problems involving rates and derived measurements for such attributes as velocity and density.

Students build new mathematical knowledge through problem solving.

Students solve problems that arise in mathematics and in other contexts.

Students apply and adapt a variety of appropriate strategies to solve problems.

ITEA 6-9
Students develop an understanding of the role of troubleshooting, research and development, invention and innovation and experimentation in problem solving.

- Some technological problems are best solved through experimentation.

Students develop the abilities to apply the design process.

- Make a product or system and document the solution.

Students develop the abilities to use and maintain technological products and systems.

- Use computers and calculators in various applications.

Students develop the abilities to assess the impact of products and systems.

- Design and use instruments to gather data.

Time Required

45 minutes (will vary with class size)

Content Areas

Primary: Science
Secondary: Technology, language arts

Vocabulary

- acceleration
- descent
- distance
- elevation
- friction
- magnet
- magnetic field
- magnetic levitation
- theoretical
- velocity

Materials

- Maglev car kit
- Maglev Track
- Metric tape measure or meterstick
- Blocks or books for elevating track
- “Acceleration” resource page
- “Calculating Acceleration I Data Sheet”
- Timer or stopwatch
- Pencil

Procedure

1 Assemble a maglev car base. Assemble only the base; do not connect the body.

Students can use the instructions that come with the maglev car kit or the Construction QuickView instructions.

2 Locate the Maglev Track. Place the track on a flat surface. Elevate one end of the track to a height of 15 centimeters. Place blocks or books under one end of the track to elevate that end of the track. The bottom of the elevated end should be raised to 15 centimeters above the surface.

The students can adjust the position of the books to change the height. Moving the books closer to the center of the track causes the elevated end to rise.

3 Measure and mark a point 100 centimeters from the bottom end of the track.

The Pitsco track is 120 centimeters long. If using this track, students can measure 20 centimeters from the top of the track to find the 100-centimeter point.

4 Locate the timer or stopwatch. Place the front end of the car at the 100-centimeter point on the track. Release the car and time its descent down the track. This is trial one for this track elevation.

It is best to use a timer or stopwatch that measures to hundredths of a second.

5 In the Descent Table on the "Calculating Acceleration I Data Sheet," record the time of descent for the first trial in the appropriate column. Repeat two additional trials. Record the time for each trial. If the maglev car malfunctions or becomes stuck during any trial, repeat the trial without recording the time.

Make sure the students release the vehicles and do not push the maglev vehicles down the track.

6 Adjust the height of the track to 30 centimeters. Place blocks or books under one end of the track to elevate that end of the track. The bottom of the elevated end should be raised to 30 centimeters above the surface.

The students can adjust the position of the books to change the height. Moving the books closer to the center of the track causes the elevated end to rise.

7 Place the front end of the car at the 100-centimeter point on the track. Release the car and time its descent down the track three times, recording each trial in the appropriate location on the "Calculating Acceleration I Data Sheet."

It is best to use a timer or stopwatch that measures to hundredths of a second.

8 Adjust the height of the track to 60 centimeters. Place blocks or books under one end of the track to elevate that end of the track. The bottom of the elevated end should be raised to 60 centimeters above the surface.

The students can adjust the position of the books to change the height. Moving the books closer to the center of the track causes the elevated end to rise.

9 Place the front end of the car at the 100-centimeter point on the track. Release the car and time its descent down the track three times, recording each trial in the appropriate location on the "Calculating Acceleration I Data Sheet."

It is best to use a timer or stopwatch that measures to hundredths of a second.

10 Review the "Acceleration" resource page. The acceleration of the cars can be calculated using the formula:

$$a = 2d/t^2$$

This formula is derived from the formula $d = 1/2at^2$. This formula is used to determine distance traveled by an object with constant acceleration and no initial velocity.

Theoretical acceleration has been computed for the students using the formula:

Theoretical acceleration = $9.8\ m/s^2 \times \sin(\text{angle of incline})$

11 Complete the remainder of the "Calculating Acceleration I Data Sheet."

QuickView

Calculate the acceleration of a maglev car traveling down a maglev track at various inclines. Compare the actual accelerations to the theoretical accelerations.

Materials

- Maglev car kit
- Maglev Track
- Metric tape measure or meterstick
- Blocks or books for elevating track
- "Acceleration" resource page
- "Calculating Acceleration I Data Sheet"
- Timer or stopwatch
- Pencil

Procedure

1 Assemble a maglev car base. Assemble only the base; do not connect the body.

2 Locate the Maglev Track. Place the track on a flat surface. Elevate one end of the track to a height of 15 centimeters. Place blocks or books under one end of the track to elevate that end of the track. The bottom of the elevated end should be raised to 15 centimeters above the surface.

3 Measure and mark a point 100 centimeters from the bottom end of the track.

4 Locate the timer or stopwatch. Place the front end of the car at the 100-centimeter point on the track. Release the car and time its descent down the track. This is trial one for this track elevation.

5 In the Descent Table on the "Calculating Acceleration I Data Sheet," record the time of descent for the first trial in the appropriate column. Repeat two additional trials. Record the time for each trial. If the maglev car malfunctions or becomes stuck during any trial, repeat the trial without recording the time.

6 Adjust the height of the track to 30 centimeters. Place blocks or books under one end of the track to elevate that end of the track. The bottom of the elevated end should be raised to 30 centimeters above the surface.

7 Place the front end of the car at the 100-centimeter point on the track. Release the car and time its descent down the track three times, recording each trial in the appropriate location on the "Calculating Acceleration I Data Sheet."

8 Adjust the height of the track to 60 centimeters. Place blocks or books under one end of the track to elevate that end of the track. The bottom of the elevated end should be raised to 60 centimeters above the surface.

9 Place the front end of the car at the 100-centimeter point on the track. Release the car and time its descent down the track three times, recording each trial in the appropriate location on the "Calculating Acceleration I Data Sheet."

10 Review the "Acceleration" resource page. The acceleration of the cars can be calculated using the formula:

$$a = 2d/t^2$$

11 Complete the remainder of the "Calculating Acceleration I Data Sheet."

Calculating Acceleration I Data Sheet

Descent Table

Elevation of Track	Distance Traveled (d)	Time of Descent (t) Trial 1	Time of Descent (t) Trial 2	Time of Descent (t) Trial 3	Acceleration ($a = 2d/t^2$) Trial 1	Acceleration ($a = 2d/t^2$) Trial 2	Acceleration ($a = 2d/t^2$) Trial 3	Theoretical Acceleration
15 cm	100 cm							1.225 m/s^2
30 cm	100 cm							2.45 m/s^2
60 cm	100 cm							4.9 m/s^2

How does the actual acceleration compare to the theoretical acceleration at each elevation?

Explain why the theoretical acceleration is not the same as the actual acceleration.

How does the relationship between the theoretical and actual acceleration change as the elevation changes? Explain the changes.