Mag Lev

Amount of time Demo takes: 5 minutes

Try this in the classroom!

Lesson's Big Idea

High school level:

- Magnetic fields can be used to create levitation and therefore eliminate sliding friction between two surfaces.
- Air resistance must be dealt with through an aerodynamic car design.
- Electronic sensors used to measure the race time remove error due to human interpretation of the location of the car and reaction time in starting and stopping a stopwatch.
- The bean bag or foam at the end of the track slows and absorbs the impact from the car resulting in little to no damage to the car.

Elementary school level:

- Two magnets located with their north poles facing each other will repel one another – this causes the car to float in the air.

Materials

- MagLev demo unit (track with magnets down each lane)
- Legos
- Lego rectangular bases with magnets attached to underside
- Foam stoppers or beanbag

Optional for timing system:

- 9-volt batteries (2)
- Small Phillips-head screwdriver
- Battery Powered Lights
- Whiteboard/Dry erase marker

  Note: Some items are stored in a separate plastic bin.

SAFETY!

- Be careful of pinch points.
- Only lift center race tracks into position from the end support located

between the two tracks.
- Place a foam piece at the end of each track to prevent damage.

Background Information

- Mag Lev – magnetic levitation
- Relay – a switch controlled with an electromagnet, used to start and stop the stopwatch

Setup Instructions

1. Set demo unit on a sturdy table directly underneath a constant light source.
2. Carefully lift the center tracks by holding onto the black support located between the tracks at the instrument end of the unit. (Lifting with one track may cause excessive torsion on the system). While lifting with one hand guide the support leg over the top of the LEGO brick tubs with your other hand. Check that the center support leg is vertically aligned.
3. Slide the plastic cover off the instrument panel and set aside.
4. Connect the two 9-volt batteries (located in a LEGO tub) you will hear clicking as the relay powers up.
5. The two LEDs located next to the relay (black box on the circuit board) should be off. If they are lit there is not enough light on the photo resistors located at the ends of the track. Increase the light source or carefully adjust the variable resistor (lower left corner of the circuit board) with a small Phillips screwdriver. The variable resistor has 180 degrees of movement, **do not force** the adjustment, it will move very easily.
6. Turn on the stopwatch. The stopwatch will start and stop when the photoresistors sense a shadow.
7. Place a bean bag/foam at the bottom of each track to prevent damage to the cars.
8. Attach battery powered lights to track using velcro. Ensure that these are directed at photosensors yet provide enough clearance for cars to travel down the track.
9. Wipe down entire MagLev with Clorox Wipes, the MagLev gets dusty in transit.

Instructional Procedure

1. Zero-out the stopwatch (will not zero if a car is located at the bottom of

the track).
2. Place a car at the top of the track, release.
3. The photoresistors will trip the relay and initiate the start and stop sequence on the stopwatch.
4. The whiteboard can be used to record track records.
5. Clear track and repeat.

Tips & Tricks

- Have one kid make a cart using wheels and another using the magnetic strips. This will help show the difference in friction.
- Ensure there are no obstructions in-between the light source and photoresistors. This will help keep the stopwatches working.

Assessment Questions

- Why is the method of using light to measure the race time better than using a student with a stopwatch or a mechanical switch tripped by the car?
    - Using light to measure the race time has less lag time for timing than a student using a stopwatch or a mechanical switch. It also reduces the possibility of the mechanical switch not being triggered/malfunctioning.
- What would happen if the track was magnetized with North facing up and the bottom of the car was magnetized with South downward?
    - The car would be magnetized to the track and not move.
- Which would be fastest down the track a Mag Lev or a wheeled car?
    - Mag Lev

Careers & Real-World Applications

- Electrical Engineer: Electrical engineers have the knowledge in electricity and circuits that enable the MagLev to function.
- Civil Engineer: Automobiles may one day use this technology and roads would need to be redesigned to accommodate the technology.

Clean Up

- Place all loose objects into the Lego tubs, latch down.
- Wipe down entire track with Clorox wipes.
- Carefully follow the setup instructions **in reverse** to lower the center race tracks.

Related Next Generation Science Standards

- K-5
    - K-PS2 Motion and Stability: Forces and Interactions
    - 3-PS2 Motion and Stability: Forces and Interactions
    - 5-PS2 Motion and Stability: Forces and Interactions
- 6-8
    - MS-PS2 Motion and Stability: Forces and Interactions
    - MS-PS3 Energy
    - MS-ETS1 Engineering Design
- 9-12
    - HS-PS2 Motion and Stability: Forces and Interactions
    - HS-PS3 Energy