Marbles and potential and kinetic energy

Task:

Position the inclined plane so that your ball travels along the plane as far as possible before coming to a stop.

Research:

Review your understanding of mechanical energy conservation.

Strategy and modelling:

Independently adjust the height, length, and material of the inclined plane and record the outcomes.

Draw conclusions based on your observations.

Results:

Prepare a presentation, either handwritten or on a computer, to share your findings with your classmates.

For the teacher:

Materials students may need:

Wooden boards

Various materials for covering the incline and plane

Marbles

Spool car competition.

Task:

Make spool car and compete with your classmates

Research:

Look on the Internet, ask your parents or grandparents to help you.

Strategy and modelling:

Make picture of your design and put down material you will need, so that the teacher can get it ready.

Results:

After having the winner of the race, discuss what features enabled the best result.

For the teacher:

Depending on the time you can spend on the project you may decide to give students information about the design bellow and let them make it and after testing think about possible improvement.

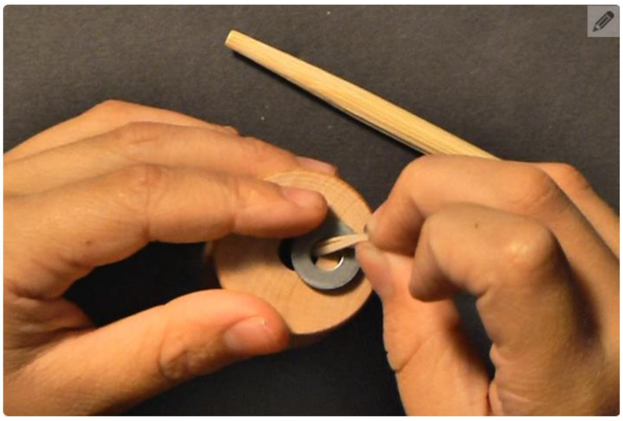
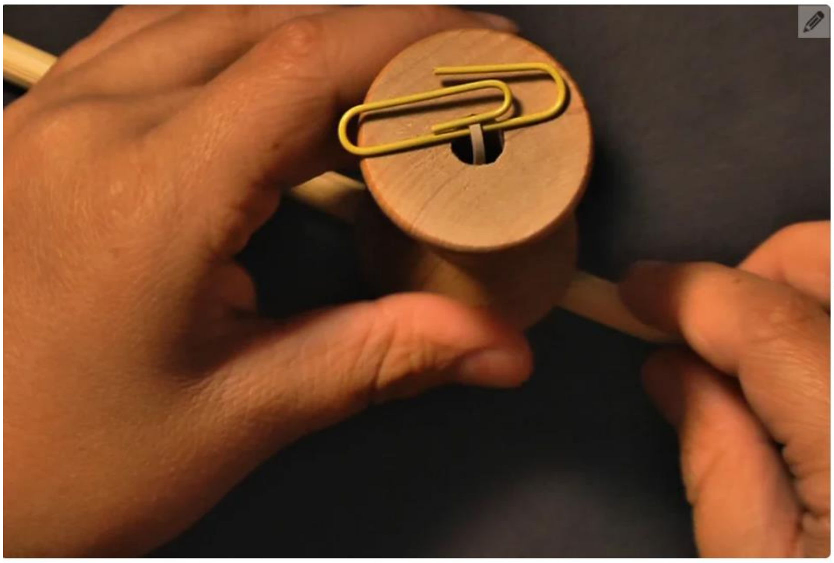
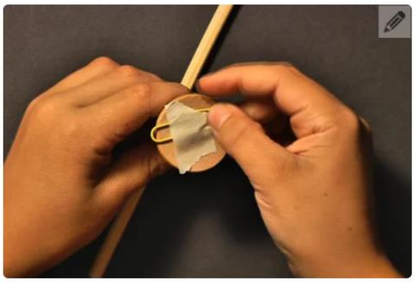
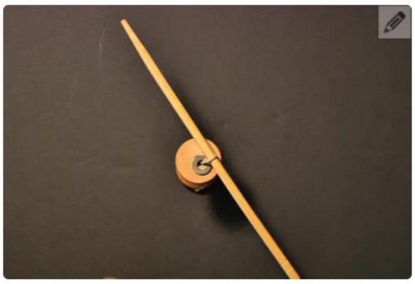
Help student understand that there are always losses when one kind of energy transforms into another, but it does not disappear but dissipates mostly into heat.

Materials students may need:

Wood spools, metal washers, rubber bands, cello tape, paper clips, chopsticks, pencils, paper rolls

One possible model:

https://www.instructables.com/Spool-Car/

Thread the rubber band through the hole in the spool. On one end of the spool, thread the rubber band through the washer.

Clip one end of the rubber band’s loop to the paper clip. Tape the paper clip to the spool centered on the spool with no parts of the paper clip sticking out. Push the thick end of the chop stick through the rubber band’s other loop.

Spin the chopstick around clockwise many times. Test how does the spinning influence the movement.

Place the spool onto the table with the chopstick to the right and behind it.

The Spool Car works due to transformation of energy. The twisted rubber band inside the spool stores energy because it is elastic, meaning it will return to its original shape after being stretched or twisted. As the rubber band untwists, the stored energy transforms into kinetic, energy. Because the rubber band is attached to the spool, the kinetic energy of the rubber band makes the spool spin.

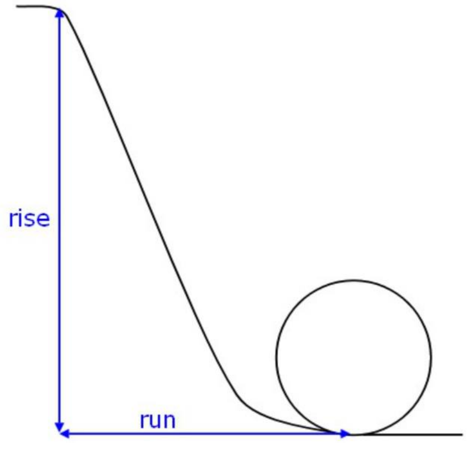
Test how does different rubber bands and surface influence the movement.

Test whether it can move up the incline.

Roller coaster

Task:

Construct a roller coaster for marbles using foam pipe insulation, paper tubes, or other materials of your choice. Investigate the required height for a marble to successfully pass through a fixed-size loop.



Research:

Refresh your knowledge about the following terms and concepts: potential and kinetic energy, mechanical energy conservation, conservation of energy, gravity, and velocity. Explore examples of roller coasters on the internet and describe how they operate. Discuss your observations with your classmates and teacher.

Strategy and modelling:

Determine the diameter of the loop; a diameter within the range of 30-50 cm should work effectively.

Securely tape two lengths of tubes together, ensuring a smooth joint.

Shape the track into a loop of the desired diameter and tape the loop together at the bottom. Do not tape the loop to the floor yet.

Raise one end of the track to create a downward ramp into the loop and tape the top of the ramp in place on a bookshelf or another piece of furniture.

Securely tape the loop to the floor.

Measure the diameter of the loop, the height of the starting point (rise), and the horizontal distance from the starting point to the beginning of the loop (run).

Run a single marble down the track ten times. How many times does it successfully complete the loop?

Adjust the height and repeat the previous step. Lower the height if the marble often completes the loop, or raise it if the marble struggles to complete the loop.

Record the height at which the marble successfully completes the loop.

Results:

Maybe you noticed that your loop wobbles a bit as your marble passes through it. The energy to move the track comes from the marble. The energy that the marble loses to make the track move means less energy is available to make the marble itself move. Can you think of a way to stabilize the loop so that it doesn't wobble? With a stabilized loop, can the marble start at a lower height and still make it through the loop? Design an experiment to find out!

Further investigation:

Use different lengths of roller coaster track to adjust the slope leading to the loop. Keep the starting height consistent while changing the slope. Test whether marbles can continue to complete the loop as the slope decreases.

Vary the diameter of the loop and observe how the height requirement changes with increasing or decreasing loop diameter.

Experiment with marbles of different diameters.

Use different materials under the same conditions, making sure to record the results.

For the teacher:

Roller caster in fun parks with cars: Cars are pulled up to the top of the first hill, they are acquiring potential energy. The chain that pulls them up the hill works against the force of gravity.

At the top of the hill, the cars' potential energy is at its maximum. When the cars start down the other side, this potential energy is converted to kinetic energy. The cars pick up speed as they go downhill. As the cars go through the next uphill section, they slow down. Some of the kinetic energy is now being converted to potential energy, which will be released when the cars go down the other side.

Make students notice that the first hill on the roller coaster is always the highest (unless the coaster is given another "boost" of energy along the way). This is because not all the potential energy is converted to kinetic energy.

Some of the potential energy is "lost" in other energy conversion processes. For example, the friction of the wheels and other moving parts converts some of the energy to heat. The cars also make noise as they move on the tracks, so some of the energy is dissipated as sound. The cars also cause the supporting structure to flex, bend, and vibrate. This is motion, so it is kinetic energy, but of the track, not the cars.

Because some of the potential energy is dissipated to friction, sound, and vibration of the track, the cars cannot possibly have enough kinetic energy to climb back up a hill that is equal in height to the first one.

Help students understand that this is when we say that energy is conserved in a closed system like a roller coaster. That is, energy is neither created nor destroyed; there is a balance between energy inputs to the system (raising the train to the top of the initial hill) and energy outputs from the system (the motion of the train, its sound, frictional heating of moving parts, flexing and bending of the track structure, and so on).

Explain, or repeat depending on the time you do the project the difference between conservation of energy and conservation of mechanical energy.

Materials students may need:

At least two 2-meter sections of 4cm diameter foam pipe insulation, paper tubes, or other bendable materials

Glass marbles

Utility knife

Masking tape

Tape measure

Bookshelf, table, or another support for the roller coaster's starting point

Galileo Galilei and falling objects

Task:

Replicate the scientific experiment conducted by Galileo Galilei in the 17th century and compare the results with updated versions.

Research:

Galileo Galilei, often referred to as the father of science, he insisted on testing the theories by repeatable experiments. Find out more about his life and contributions to science.

Strategy and modelling:

Galileo devised experiments to investigate how and why objects move and come to a stop. He was the first to articulate the principle of inertia, which means that objects resist changes in motion and require force to start moving, stop, speed up, or slow down. Galileo also stated that the rate of fall is the same for all objects. While he couldn't measure the time for falling objects directly, he conducted experiments on a ramp to test this hypothesis. His ramp was 5 meters long, designed with a smooth surface to minimize friction. Time was measured using a large container of water with a small outlet pipe at the bottom. Galileo collected the water during the measured time interval and compared times by weighing the water.

Your experiment:

Design your own ramp to replicate Galileo's experiment.

Invent a device to measure time accurately.

Measure the time it takes for different-sized ball bearings (or glass marbles) to roll from the top to the bottom of the ramp.

Adjust the steepness of the ramp and make precise notes of the experiment.

U-spaped ramp:

Create a U-shaped ramp.

To assess the smoothness of the surface, ensure that the ball bearing rolls up to the same height from which it started.

Modify the steepness of one arm of the ramp.

Release two ball bearings (or glass marbles) from the same height and measure the time it takes for them to reach the bottom.

Use different sizes of ball bearings (or glass marbles) for each arm and vary the size for each arm.

Adjust the steepness of the ramp arms and document the experiment precisely.

Results:

Present your findings to your classmates and teacher and engage in a discussion about the results.

For the teacher:

Help students grasp Galileo's conclusion about falling bodies – that all objects fall at the same speed.

Use the following experiments to illustrate this concept:

Take two identical sheets of paper, crumple one into a ball, and then drop both from the same height.

Take two identical plastic bottles, fill one with colored water up to one-third of its volume and the other one full. Drop both bottles from the same height and ask students to listen carefully to the sound upon impact.

Ask students:

What would happen if the bottles were of different sizes?

What would happen if the bottles had different shapes? Conduct these experiments.

What would happen if the bottles contained equal amounts of different liquids?

What would happen if the bottles contained different amounts of various liquids? Conduct these experiments as well.

Depending on the discussion, you can also pose questions about what would happen if the bottles were dropped on different planets.

Materials students may need:

5-meter sections of 4cm diameter foam pipe insulation, paper tubes, or other flexible materials,

ball bearings or glass marbles,

utility knife,

masking tape,

tape measure,

bookshelf, table, or other support for the ramps,

materials for the suggested device to measure time.