Name: Class:

STEM Project

Chapter 7 Motion and Energy

Pages 155–178

Roller coaster

Have you ever been on a roller coaster?

Some of the earliest roller coasters were created in the 15th century in Russia. They were basically wooden ramps covered with ice that people would race down on a sled down at fast speeds. Today, most roller coasters in amusement park involve a carriage on a track, just like a train. However, trains are designed for transportation and roller coasters are designed for fun! So roller coaster tracks twist and turn in loops and patterns to exhilarate their occupants. In this task, you will explore the diameters of roller-coaster loops.

Experiment

Aim: To explore how different starting points affect motion in a roller coaster loop.

Equipment:

- Bike tyres (or hollow foam pipe insulation cut lengthways)
- Stanley knife
- Marbles
- Duct tape
- Tape measure

Method:

1 Cut the bike tyres so that they open into long, open-top tubes.

2 Connect two tubes together using duct tape to create one very long tube.

3 Fasten one end of the tyre to a table top with duct tape and let it slope downwards to the ground. Create a single loop of diameter 20 cm in your tyre at the point where it touches the ground. You might need to support your loop with something (like a chair leg or box on either side) to keep it upright.

4 Drop a marble inside the tyre from table height and see whether it completes the loop de loop. If it does not, increase the steepness of the ramp (move the ramp closer to the table). When you have a successful loop de loop, be sure your ramp angle does not change. You may want to tape your ramp to the floor to make sure that it doesn't move. Use a tape measure to measure the vertical height above the ground from the point where you release the marble. This is the marble starting height.

5 Now let a marble drop (don't push!) from various heights along the ramp. Measure the vertical heights above the ground from each point where you release the marble on the ramp. Record whether the marble successfully completes the loop de loop. Test each height three times.

Oxford Science 10 Western Australian Curriculum Teacher obook assess ISBN 9780190307295

6 Increase the diameter of the loop by increments of 10 cm and repeat step 5 to test which starting heights allow the marble to successfully complete a loop de loop for each loop diameter.

Data and results

Record, using a tick or a cross, whether the marble successfully completed the loop de loop for each loop diameter and starting height. The table provides space to record three attempts for each loop and starting height.

	Loop Diameter											
Marble Starting Height (cm above ground)	10 cm			20 cm			20 cm			40 cm		
10 cm												
20 cm												
30 cm												
40 cm												
50 cm												
60 cm												
70 cm												
80 cm												
90 cm												

Discussion and reflection

What causes the marble to start moving when you let it go?

Where along the roller coaster journey is the marble accelerating?

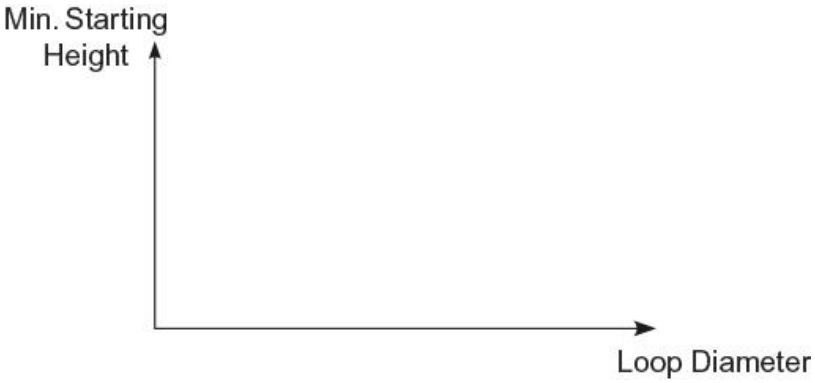
Oxford Science 10 Western Australian Curriculum Teacher obook assess ISBN 9780190307295

Where along the roller coaster journey is the marble decelerating?

What is the minimum height at which the marble can successfully complete the loop de loop for each loop diameter? Enter this height in the table below.

Loop Diameter	Minimum Marble Starting Height (cm)
10 cm	
20 cm	
30 cm	
40 cm	

Graph your results below or on graph paper, giving each axis a scale. Include a title for your graph.



Using your graph, predict the minimum starting height required to achieve a loop de loop for a loop diameter of 50 cm.

Minimum starting height prediction (50 cm loop):

Check this prediction by using your roller coaster apparatus to create a loop of diameter 50 cm.

How accurate was your prediction?

Oxford Science 10 Western Australian Curriculum Teacher obook assess ISBN 9780190307295

Extension activity: Design a roller coaster

Luner Perc Pty Ltd want to build an exciting new roller coaster ride with multiple twists and turns and loop de loops. Using the knowledge you gained from the previous experiments, your job is to design this new roller coaster ride.

The engineering design process below will guide you through the steps to achieving your design.

1 Think Consider the problem or objective from all angles, research it and brainstorm ideas.

Think about: how many loops it might have and their diameters, what height it might start at for maximum gravitational force and speed, how long it might be, how each loop could be supported, what other shapes you could include, etc. Research some existing rollercoasters for inspiration.

2 Design Develop a possible solution and design a prototype.

Choose your best ideas and develop them further. Write up a description of your design and draw a labelled diagram showing all its features.

3 Create Build the prototype.

Build a prototype of your roller coaster. A prototype is a 'first try' to test if your concept will work. Write down the steps you took to build it.

4 Test Evaluate the prototype to see if it meets the objective.

Test your roller coaster with a marble to see if it works as you intended. If there are problems, make notes about where and why these problems have occurred.

5 Improve From the test results, identify how to make your design better.

Based on your test observations, think about how you could improve your design. Note down any ideas you have that could make it better. If you have time, modify your prototype to implement your improvement ideas.

Oxford Science 10 Western Australian Curriculum Teacher obook assess ISBN 9780190307295