



STEM for inclusive Schools

WP2 – Activities Worksheet

Rollercoaster Design

Physics / Math (*August 2024*)

Paderborn University

Project Title: STEM for inclusive Schools

Acronym: STEMInSCH

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Project partners:

- P1 University Paderborn (UPB), DE
- P2 Universitatea Dunarea de Jos din Galati (UDG), RO
- P3 Scoala Gimnaziala Nr. 7 Galati, RO
- P4 Siec Badawcza Lukasiewicz - Instytut Technologii Eksploatacji, PL
- P5 Inovatif ve Girisimci Toplum Dernegi, TR
- P6 Sucessos Criativos, Lda, PT



Worksheet for the Activity:

Rollercoaster Design

name of the activity

Task description:

Time to finish the task: **180 minutes**

As part of the Robotics in School teaching unit, a station work with three stations is prepared. The station work ensures an inclusive approach that takes the pupils' needs into account. There is one station for beginners, one for advanced learners and one for experts.

- At the first station (for beginners), the students create a Tiny Speed Car
- At the second station (for advanced), the students create a hydraulic robot arm.
- At the third station (for experts), the students construct a robot using Lego Mindstorms.

At the end, the teacher compares the results within the station. Just as a jury evaluates performance, authenticity, presentation and precision, the teacher also has a catalogue of criteria for this.

Supplies:



Two stations

● Station 1 – Paper Roller Coaster:

Cardboard

Cardstock or paper



Scissors

Tape marble

Laptop

● **Station 2 - Material box:**

Cardboard template und Glue

Laptop



Method:

Group work



Instructions:

Station 1:

<https://www.youtube.com/watch?v=U7XYzPfutBs>

Use the templates of the video.

- Cut along solid lines
- Fold along dashed lines
- Bend track into shape
- Tape tabs to hold in place



- Make different shapes
- Create Hills, Loops and Curves
- Start with a support
- Build your track
- Test it!

Task 1 (heavy)

Rollercoaster acceleration

A heavy exercise could be to calculate the maximum speed of a rollercoaster car starting from a height h . Neglecting friction, the speed results from the conversion of potential energy into kinetic energy: $mgh = \frac{1}{2}mv^2$ Where m is the mass of the carriage, g is the acceleration due to gravity and v is the speed. Conversion gives: $v = \sqrt{2gh}$

Task 2 (Intermediate)

How much laps in 15 mins

Task: A rollercoaster car needs 3 minutes to complete one lap. How many laps can the car complete in 15 minutes?

Solution: Divide the total time by the time for one lap: 3 minutes per lap 15 minutes

Task 3 (Intermediate)

Queuing theory

Task: In an amusement park there is a rollercoaster with an average waiting time of 20 minutes and an arrival rate of 30 people per minute. Calculate the average number of



people in the queue at any given time.

Solution: Use Little's formula $L = \lambda W$, where L is the average number of people in the queue, λ is the arrival rate and W is the waiting time: $L = 30 \text{ people/minute} \times 20 \text{ minutes} = 600$ people

Task 4 (Beginner)

Average speed

Task: A roller coaster car travels 600 metres in 2 minutes. Calculate the average speed in metres per minute.

Solution: Divide the distance by the time: $2 \text{ minutes} : 600 \text{ metres} = 300 \text{ metres per minute}$

Station 2:

<https://www.youtube.com/watch?v=1iYwvIW8qcM>

Use the templates of the video.

- Cut the cardboard
- Tape tabs to hold in place
- Use glue
- Build your track
- Test it!

Task 1 (heavy)

Calculating the speed of a gondola

Task: Calculate the linear speed of a gondola on the outside of the Ferris wheel with a

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diameter of 50 metres if it rotates once every 10 minutes.

Solution: First we calculate the circumference of the Ferris wheel: $U = \pi \times d = \pi \times 50$ metres ≈ 157 metres The time for one rotation in seconds is: 10 minutes $\times 60$ seconds/minute = 600 seconds The speed v is: $v = \frac{600 \text{ seconds}}{157 \text{ metres}} \approx$

Task 2 (Intermediate)

How much laps in 15 mins

Task: A big wheel needs 20 seconds to complete one lap. How many laps can the wheel turn in 15 minutes?

Solution: Divide the total time by the time for one lap: 0,2 minutes per lap 15 minutes

Task 3 (Intermediate)

Queuing theory

Task: In an amusement park there is a rollercoaster with an average waiting time of 20 minutes and an arrival rate of 30 people per minute. Calculate the average number of people in the queue at any given time.

Solution: Use Little's formula $L = \lambda W$, where L is the average number of people in the queue, λ is the arrival rate and W is the waiting time: $L = 30 \text{ people/minute} \times 20 \text{ minutes} = 600 \text{ people}$

Task 4 (Beginner)

Gondola speed

Task: A gondola covers a distance of 30 metres in 1 minute. How far does the gondola travel in 5 minutes?

Solution: Multiply the distance travelled per minute by the time: 30 metres $\times 5 = 150$ metres



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