

Runaway Train

Grades 9-12	Ongoing Lesson 3-4 hours
Level of Inquiry: Bundled Inquiry - the student will work on their own lab to determine a quantitative relationship between variables.	
Lesson Goals: <ul style="list-style-type: none">• The student will carry out an experiment to collect data about a trolley rolling down a slope.• The student will simulate the motion of the train by fitting a quadratic curve to their data• As an extension, the students will find the relationship between distance and time• The students will also collect data to calculate the speed of the trolley directly	
Missouri State Standards: 9-12.PS2.A.1 Analyze data to support and verify the concepts expressed by Newton's 2nd law of motion, as it describes the mathematical relationship among the net force on a macroscopic object, its mass, and its acceleration. 9-12.PS2.A.2 Use mathematical representations to support and verify the concepts that the total momentum of a system of objects is conserved when there is no net force on the system. 9-12.PS2.A.3 Apply scientific principles of motion and momentum to design, evaluate, and refine a device that minimizes the force on a macroscopic object during a collision.	
5E Lesson	
Engagement Phase:(15 Minutes) Students will watch the video "Train Crashes into platform in Chicago After Engineer Falls Asleep" https://www.youtube.com/watch?v=-f9sVhn49 Present "Runaway Train" powerpoint. https://drive.google.com/file/d/1ABCiwbm3jkOFZfaaLANyVIL30INs6UvG/view?usp=sharing	
Teacher Notes: <ul style="list-style-type: none">• The video is about one and a half minutes long.• I suggest turning the volume off and just let the student watch the train crash, it replays the accident many times.• Discuss with the students what they are seeing happening during the train crash.• Present Runaway Train powerpoint to discuss the lesson objectives.	
Teacher Role- Facilitate learning and guide students understanding.	

Materials:

- A trolley
- Tape measure
- Stopwatch
- Track

Goals:

- Connect student's experiences
- Create interest
- Ask questions
- Understand the objectives of the lesson

Exploration Phase:

Lab- Runaway Train (1 hours)

- In groups of 2-3 have your students complete the exploration lab. The students will set up the model and collect data.
- Complete student instructions attached.
- <https://drive.google.com/file/d/1PGLpg9ItxHZWvTJqq0ZQHRntwV2C-DNo/view?usp=sharing>

Teacher Notes:

- The complete instructions for the lab can be found in the attached document
- <https://drive.google.com/file/d/1KnLzoY2oiDGG360GHcZ-gz1z2x1YhP9/view?usp=sharing>

Teachers Role : Facilitate learning and guide students understanding during the lab.

Goals:

- Students will receive real experience with the topic
- Students will use and develop critical thinking skills
- Students will make observations, record results, and make connections

Explanation Phase:(1 hour)

PowerPoint lesson over Comparing Graphs:Distance/Time Graphs VS. Speed (Velocity)/Time Graphs

https://drive.google.com/file/d/10o6hFraClbVKFmAngl9Ip_q6zXQS83i/view?usp=sharing

Teacher Notes:

To print the powerpoint and make sure the students have an understanding on how to complete the graphs and data needed in the Exploration Phase.

Teacher Role- Explain the concepts by presenting the material found in the presentation.

Goals:

- Students develop understanding of the content
- Observations for the lab are discussed
- Students develop and understanding of the vocabulary and formulas needed for this lesson
- Students are able to connect the content presented to previous experiences

Elaborate Phase: (1 hour)

The student will do the extension part of the experiment. The students will use find the relationship between distance and time for the extension part of the experiment.

Teacher Notes:

- The students should continue working in the same groups for this part of the lab.
- If possible the experiment should be left as it was in the first part of the lab or ensure that they use the same equipment and the angle of slope of the track must be the same for both experiments.

Goal:

- Students use their newly obtained knowledge to propose solutions and extend their learning to new situations.

Evaluate Phase: (1hour)

CER- Have your students complete - Evaluate: Claim, Evidence, Reasoning graphic organizer and write an explanation paragraph using the information from the graphic organizer to answer the question you decide on.

This is the form that I like to use, but there are many different one available.

<https://www.urbanadvantagenyc.org/wp-content/uploads/2018/04/BSCS-DSET-Data-first-What-is-CER.pdf>

Teacher Notes:

Possible questions:

- What affects the motion of the trolley?
- How realistic is the model? Is it appropriate to model the motion of a train in this way?
- Place students back into their small groups and have them share what they wrote in the Evidence and Reasoning sections of the graphic organizer, before they write the final paragraph.
- Have the groups share the conclusions and data they gathered from the lab, compare the groups graphs with each other and discuss similarities and differences.

Goal:

- Students are given the opportunity to demonstrate their understanding and evaluate their own progress.

Sources:

Runaway Train Activity:

<https://www.stem.org.uk/resources/elibrary/resource/31129/runaway-train>

Comparing Graphs: Distance/Time Graphs VS. Speed (Velocity)/Time Graphs

<https://www.kyrene.org/cms/lib/AZ01001083/Centricity/Domain/2932/graphing%20comparison.pptx>

Claim, Evidence and Reasoning explanation and form.

https://media.bsccs.org/mss/se/icans/ps_i_can_develop_a_scientific_explanation.pdf

<https://www.urbanadvantagenyc.org/wp-content/uploads/2018/04/BSCS-DSET-Data-first-What-is-CER.pdf>

DESE: 6-12 Science Grade-Level Expectations

<https://dese.mo.gov/sites/default/files/curr-mls-standards-sci-6-12-sboe-2016.pdf>