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| **Lesson Title :** Different Function, Different Design, Different Velocity | **Unit #:** 1 | **Lesson #:** 1 | **Activity #:** 1 |
| **Activity Title:** Ramp Variables: Mini-Hooks and Traffic Simulation |

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| **Estimated Lesson Duration:** | 4 days, 50 minute classes |
| **Estimated Activity Duration:** | 2 days, 50 minute classes |

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| **Setting:** | Classroom |

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| **Activity Objectives:** |

1. I can identify design problems that exist in different types of ramps and propose modifications.
2. I can identify different factors that affect the safety of a ramp.
3. I can explain the different restrictions that exist for different types of ramps.
4. I can identify different functions or jobs that ramps help accomplish.

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| **Activity Guiding Questions:** |

1. What design problems exist in the entrance ramp you are analyzing and how can they be fixed?
2. What factors affect the safety of a ramp?

What design problems are common in ramps and how can they be fixed?

What restrictions exist for different types of ramps?

What different functions or jobs are ramps used to complete?

| **Next Generation Science Standards (NGSS)** | |
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| **Science and Engineering Practices (Check all that apply)** | **Crosscutting Concepts (Check all that apply)** |
| ☒ Asking questions (for science) and defining problems (for engineering) | ☐ Patterns |
| ☐ Developing and using models | ☒ Cause and effect |
| ☐ Planning and carrying out investigations | ☐ Scale, proportion, and quantity |
| ☒ Analyzing and interpreting data | ☐ Systems and system models |
| ☐ Using mathematics and computational thinking | ☐ Energy and matter: Flows, cycles, and conservation |
| ☐ Constructing explanations (for science) and designing solutions (for engineering) | ☒ Structure and function. |
| ☐ Engaging in argument from evidence | ☐ Stability and change. |
| ☐ Obtaining, evaluating, and communicating information |  |

| **Ohio’s New Learning Standards for Science (ONLS)** |
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| **Expectations for Learning - Cognitive Demands (Check all that apply)** |
| ☐ Designing Technological/Engineering Solutions Using Science concepts **(T)** |
| ☐ Demonstrating Science Knowledge **(D)** |
| ☒ Interpreting and Communicating Science Concepts **(C)** |
| ☐ Recalling Accurate Science **(R)** |

| **Common Core State Standards -- Mathematics (CCSS)** | |
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| **Standards for Mathematical Practice (Check all that apply)** | |
| ☐ Make sense of problems and persevere in solving them | ☐ Useappropriate tools strategically |
| ☐ Reason abstractly and quantitatively | ☐ Attendto precision |
| ☒ Construct viable arguments and critique the reasoning of others | ☐ Look for and make use of structure |
| ☐ Model with mathematics | ☐ Look for and express regularity in repeated reasoning |

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| **Unit Academic Standards (NGSS, ONLS and/or CCSS):** |

**(ONLS)**

* Science Inquiry and Application:
  + Identify questions and concepts that guide scientific investigations;
  + Use technology and mathematics to improve investigations and communications;
  + Recognize and analyze explanations and models; and

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| **Materials**: (Link Handouts, Power Points, Resources, Websites, Supplies) |

* Youtube videos for the hook: <http://www.youtube.com/watch?v=aggptP6zw7Y>, <http://www.youtube.com/watch?v=1yzdXZzIEik>, and <http://www.youtube.com/watch?v=z2EfBPgwi8E>
* Worksheets (1. 1. 1a RampVariables\_Acc&Veloc\_AGunderman\_072214)
* Traffic Simulation Applet: <http://www.traffic-simulation.de/>
* Traffic Statistics and ramp regulations: (<http://www.dot.state.oh.us/Divisions/Engineering/Roadway/Pages/default.aspx>), (<http://safety.fhwa.dot.gov/intersection/>), (<http://www.flysanjose.com/fl/business/training/Ramp_Rules.pdf>)
* Computers (preferably enough for one computer to every two students)

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| **Teacher Advance Preparation:** |

* Be sure to administer the pre-test to the students the day prior to starting the unit.
* Locate the three different youtube videos on the internet and have them loaded and ready to show to the students.
* Copy necessary worksheets (1. 1. 1c RampVariables\_Acc&Veloc\_AGunderman\_021315)
* Have a Google Doc ready on day 2 for recording the student data

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| **Activity Procedures:** |

(If possible, give the students the pre-test for this unit on the day before starting this unit.)

**Day 1** (50 mins) - Introduce the Big Idea, produce the essential questions, identify the Challenge, and brainstorm the guiding questions.

1. At the start of the class, pass out to each student a copy of the “Big Idea to Guiding Questions” worksheet.
2. Show the three different youtube video clips (<http://www.youtube.com/watch?v=aggptP6zw7Y>, <http://www.youtube.com/watch?v=1yzdXZzIEik>, and <http://www.youtube.com/watch?v=z2EfBPgwi8E>), asking students to silently jot down their observations, without sharing their thoughts with any of their classmates. Have the students think about different factors in the crashes / videos… How could these situations have been made safer or easier? (Play the videos on silent, due to some inappropriate language).
3. From their observations and notes they took during the videos, have each student silently write on their paper what they think the Big Idea is for this unit.
4. Think – Pair – Share: Give the students 2 minutes to write down everything that they know about the Big Idea, then give them 3 minutes to share with a partner (and record on their worksheets).
5. Have one student from each group share with the entire class what they and their partner came up with relating to the Big Idea. It may be helpful to bring up the topics of velocity and acceleration and have the students compare the general rates of each in relation to the different ramps that they observe in the videos.
6. Combine groups together (there should now be 4 students per group) and give them 3 minutes to brainstorm “Essential Questions” as a group.
7. Circulate the room and listen to the groups working. If necessary, help plant some ideas for the groups, if they seem completely lost. Some possible “Essential Questions” that they may come up with include:
   1. What is the purpose of a ramp?
   2. What makes a ramp safe / not safe?
   3. How does the design of a ramp change, based off of its function?
   4. How does physics relate to ramps?
   5. Do all ramps produce the same velocity for any object that is rolled down them?
8. Through class discussion, come up with a class list of essential questions (and display this list on the board). Use the Big Idea worksheet to record and organize any important background information on the unit Big Idea.
9. Use guiding mechanisms to help the students come up with the essential questions that will serve as the backbone for their challenge: What variables impact the safety and specific function for different types of ramps? How can we use physics to design an ideal ramp for a specific location or to fit a specific need? Be sure to have the students record these two Essential Questions on their worksheets.
10. Have the students discuss possible real-world challenges that they could solve relating to these essential questions. Guide the students to the following design Challenge: Select a real life location for a needed ramp. Make a proposal for your ramp that you will present to the rest of the class. Your proposal needs to include a sketch or labeled diagram with measurements, a detailed description, justification for your ramp length and incline (using experimental data), and 3 graphs (position vs time, velocity vs. time, and acceleration vs time). The goal is to have the students come up with the challenge of proposing a ramp for a specific location. Realistically, the additional constraints of the Challenge will likely need to be expressed by the teacher.
11. Still within their groups, have the students generate 3-5 guiding questions for the Challenge. What do they need to know in order to complete this Challenge? (If time is running short, this step can be converted into an individual homework activity instead). Share the questions as a class to produce a final class list of guiding questions for the Challenge.

**Day 2** (50 mins) –

1. One major goal of this exercise is to have the students research to gather their own data relating to ramp safety, ramp regulations, ramp types, and ramp functions. At the very beginning of the class, remind the students of the Big Idea and Challenge, then have them record both on the top of their papers.
2. Write a few guiding questions on the board that relate to the specific goal of this exercise. See below for some examples:
   1. What design problems exist in the entrance ramp you are analyzing and how can they be fixed?
   2. What factors affect the safety of a ramp?

What design problems are common in ramps and how can they be fixed?

What restrictions exist for different types of ramps?

This portion of Activity 1 will be split into two different portions. The students will have the chance to be investigators, both through the analysis of the gathered data of others and through their own manipulation of variables. Pair the students up into groups of 2, and have half of the groups go over to the computers (1 computer per group) and the other half can remain at their desks.

Instruct the group of students at the computers to log-in and go to the following website: <http://www.traffic-simulation.de/>. These students will be exploring freeway entrance ramps. The Students will have 10 minutes to explore the simulation with their partner, adjusting the different variables and recording their observations on a sheet of notebook paper.

The second half of the class, in groups of two, will be analyzing various forms of traffic data relating to entrance and exit ramps. They will be provided with data from the summer RET research project, “Ramp Metering Control for Mitigating Freeway Congestion,” from the Ohio Department of Transportation, and from the San Jose Airport Ramp Safety and Traffic Regulations Handbook. Students will need to analyze tables, charts, graphs, technical documents, and Journal Articles. Additional resources may be provided, based off of the teacher’s recommendation. Students will need to record their findings on a sheet of notebook paper. One piece of paper per group is fine. Be sure to circulate around the room as the students work in pairs to ensure that all are actively contributing. Ask open-ended, broad questions to help guide the students or to help get them back on track if they seem to have hit a wall.

After 10 minutes have elapsed, have the groups switch, and give them each 10 more minutes to conduct their research and record their observations.

At the end of this 10 minute increment, have each group working on the computers go pair up with a group working at the desks / tables. Instruct the new groups of 4 students to compile all of their group’s data onto one sheet of paper, in an organized fashion. (Some suggestions may include creating a chart, a table, a list, etc.). Give the students about 5 minutes.

While the students are working in their groups, the teacher needs to pull up a pre-created google doc page that is entitled: Activity 1: Research Findings. As groups begin to finish compiling their results, have them send a representative to come up, one group at a time, and type 2-3 of their major findings onto the google doc. (Be sure to do this with all of the different classes that are going through this unit to produce a greater expanse of findings / conclusions).

At the end of the 5 minutes (or after all of the groups have recorded a few items in the google doc, have a brief class discussion about the findings of different groups from the two research activities. Be sure to discuss how altering the form or structure of the ramps affected the acceleration and / or velocity of the objects traveling up / down them. How do some of the regulations on ramp design and use limit or restrict the velocity that can be achieved on a specific ramp?

**Formative Assessments:** Link the items in the Activities that will be used as formative assessments.

* “Big Idea to Guiding Questions” Worksheet
* Observations of groups brainstorming “Essential Questions.”
* Group data from day 2 (includes traffic simulation findings as well as analysis of research data)
* Google Doc with class findings and the class discussion that follows

**Summative Assessments:** These are optional; there may be summative assessments at the end of a set of Activities or only at the end of the entire Unit.

* No Summative Assessments for this activity.

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| **Differentiation:** Describe how you modified parts of the Lesson to support the needs of different learners.  Refer to Activity Template for details. |

* Student ability levels will be taken into account when grouping students tendencies (I paired highs with mediums, and mediums with lows) successfully allowed the higher of the two in each group to help guide and bring the lower to a higher level of understanding and mastery.
* A graphic organizer will be provided to the students to assist with organizing their thoughts and ideas as they work from the Big Idea to the Challenge.
* Auditory / visual learners’ needs will be met through the use of youtube videos, the traffic simulation, and writing questions / notes on the board. Also, multiple class discussions will take place as additional support for auditory learners.
* Lower-ability students will only be held accountable for creating / providing 3 of the 5 Essential Questions and 3 of the 5 Guiding Questions.

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| **Reflection:** Reflect upon the successes and shortcomings of the lesson. |

* Successes:
  + The students really enjoyed and were engaged with the youtube videos. They found the videos humorous and could personally connect with many of the failed ramp stunts exhibited by the videos. As the “hook” of the unit, the videos were very successful. In the future, I would like to include a mini-fieldtrip around the school (or even to locations in the nearby community) for the students to view, walk down, and measure different ramps that they encounter on a daily basis. My students were greatly shocked when they realized how shallow the maximum grade for a handicap ramp really is! Seeing this earlier on in the unit would have really sparked their interest and heightened their engagement.
  + The intentional grouping of my students by academic ability level and social / behavioral tendencies (I paired highs with mediums, and mediums with lows) successfully allowed the higher of the two in each group to help guide and bring the lower to a higher level of understanding and mastery. To scaffold, I intentionally provided more assistance for medium – low groups. These groups also progressed slower and struggled more to come up with Guiding Questions and Essential Questions, so they were only assessed for 3 of the 5 questions in each category. High – medium groups were required to come up with 5 questions in each of the two categories.
  + The graphic organizer used to assist the students with creating their Challenge from their Big Idea and Guiding Questions / Essential Questions also was extremely helpful and provided the necessary structure to the students, without limiting their creativity and ability to really “own” their Challenge.
* Shortcomings:
  + One major shortcoming of this lesson was the difficulty getting my specific students engaged in the material and guiding them to come up with the Challenge completely on their own. All but two students in the class are seniors and they already are struggling to stay motivated in their final semester of high school. In the future, I plan to implement this unit with a class that is not a majority seniors.
  + The Traffic Simulation Applet also had technical difficulties on a few of the computers in the lab because the technology had not been recently updated on all of the computers. In future implementation of this unit, I will test the program on each of the computers prior to the lesson and / or have a backup program that students may use if the simulation fails to work on their computer.