Task

***MathLinks 8*, page 159**

Suggested Timing
80–100 minutes

Materials
- toy vehicles, such as Hot Wheels®
- material for platform (books, chair)
- material for ramps (board, stiff cardboard)
- metre stick
- tape measure
- calculator

Blackline Masters
Master 1 Project Rubric
BLM 4–19 Trial Record

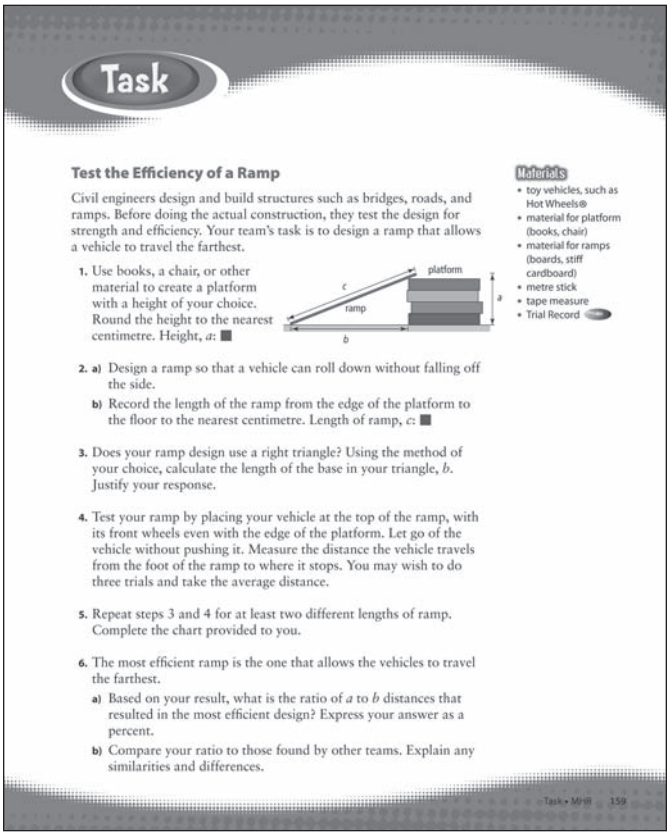
Mathematical Processes
- ☑ Communication (C)
- ☑ Connections (CN)
- ☑ Mental Mathematics and Estimation (ME)
- ☑ Problem Solving (PS)
- ☑ Reasoning (R)
- ☑ Technology (T)
- ☑ Visualization (V)

Specific Outcomes
N3 Demonstrate an understanding of percents greater than or equal to 0%.
N4 Demonstrate an understanding of ratio and rate.
SS1 Develop and apply the Pythagorean theorem to solve problems.

Planning Notes

You may wish to use the following steps to introduce and complete this task:

1. Introduce the task by having students brainstorm as many examples of ramps used in daily life as they can. You might record the list on chart paper and then, as a class, discuss the similarities and differences of the ramps. Have students brainstorm some purposes of ramps, which may include the following:
   - connecting two locations at different levels (e.g., ramp between land and a ferry on water; ramp used to roll large items on and off a moving van)
   - allowing access to an area (e.g., wheelchair ramp)
   - facilitating entry to an area (e.g., ramp that makes a steep rise easier for the elderly or people with disabilities)


Task

Test the Efficiency of a Ramp

Civil engineers design and build structures such as bridges, roads, and ramps. Before doing the actual construction, they test the design for strength and efficiency. Your team's task is to design a ramp that allows a vehicle to travel the farthest.

Materials
- toy vehicles, such as Hot Wheels®
- material for platform (books, chair)
- material for ramps (boards, stiff cardboard)
- metre stick
- tape measure
- Trial Record

1. Use books, a chair, or other material to create a platform with a height of your choice. Round the height to the nearest centimetre. Height, a: ■

2. a) Design a ramp so that a vehicle can roll down without falling off the side.
   b) Record the length of the ramp from the edge of the platform to the floor to the nearest centimetre. Length of ramp, c: ■
3. Does your ramp design use a right triangle? Using the method of your choice, calculate the length of the base in your triangle, b. Justify your response.
4. Test your ramp by placing your vehicle at the top of the ramp, with its front wheels even with the edge of the platform. Let go of the vehicle without pushing it. Measure the distance the vehicle travels from the foot of the ramp to where it stops. You may wish to do three trials and take the average distance.
5. Repeat steps 3 and 4 for at least two different lengths of ramp. Complete the chart provided to you.
6. The most efficient ramp is the one that allows the vehicles to travel the farthest.
   a) Based on your result, what is the ratio of a to b distances that resulted in the most efficient design? Express your answer as a percent.
   b) Compare your ratio to those found by other teams. Explain any similarities and differences.

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2. Have students discuss materials used to build ramps, such as wood with supports, concrete, and pavement. You may need to prompt students to determine materials that might not be good choices for a ramp, including thin or flexible materials, materials that are unable to hold weight, and materials with a rough surface (for the type of ramp in this task).
3. Read through and discuss the task as a class. Provide students with **BLM 4–19 Trial Record** to record their work.
4. Clarify that the task is to
   - use a right triangle to design a ramp that allows a vehicle to travel the farthest
   - provide two different lengths of ramp
   - test the ramp
   - calculate the value of the base of the ramp
   - calculate the ratio of the height of the platform to length of the base
   - determine the ratio or percent that resulted in the most efficient design
   - compare the ratio with those of other teams and explain any similarities and differences
5. Review the **Master 1 Project Rubric** with students so that they will know what is expected.

Meeting Student Needs

Gifted and Enrichment

- Challenge students to answer the following questions:
  - How would using a different vehicle affect the results?
  - What other adjustments might improve the distance a vehicle travels?
  - Is there a range of ratios of height to length that works best? If so, what is the range?

Answers

Test the Efficiency of a Ramp

1., 2. The heights of the platform and lengths of the ramps will vary depending on the ramp designs.

3. The ramp should include a right triangle between the floor and the platform support. Students may apply the Pythagorean theorem to solve for the missing length and find that the calculated length of the base is equivalent to the measured length of the base, if the design used a right triangle.

6. a) If the ramp is too vertical or too flat, the vehicle will not go as far. The optimal measure of the two angles across from the right angle is 45°. Look for a ratio of height : length = 1 : 1, or a percent of 100%.

b) Answers will vary. Have students explain any similarities and differences.

Assessment	Supporting Learning
Assessment *of* Learning	
Test the Efficiency of a Ramp Introduce the task to the class. Have students work in groups, and then provide individual reports.	• **Master 1 Project Rubric** provides a holistic descriptor that will assist you in assessing student work on this task. Page 207 provides notes on how to use this rubric for the task. • To view student exemplars, go to www.mathlinks8.ca, access the online Teacher Centre, go to Assessment, and then follow the links. • For a second task, complete with teaching notes and student exemplars, go to www.mathlinks8.ca, access the online Teacher Centre, go to Assessment, and then follow the links.

The chart below shows the **Master 1 Project Rubric** for tasks such as this one and provides notes that specify how to identify the level of specific answers for this project.

Score/Level	Holistic Descriptor	Specific Question Notes
5 **(Standard of Excellence)**	❑ Applies/develops **thorough** strategies and mathematical processes making **significant** comparisons/connections that demonstrate a **comprehensive** understanding of how to develop a complete solution ❑ Procedures are **efficient and effective** and may contain a **minor mathematical error** that does not affect understanding ❑ Uses **significant** mathematical language to explain their understanding and provides **in-depth** support for their conclusion	• provides a complete and correct solution
4 **(Above Acceptable)**	❑ Applies/develops **thorough** strategies and mathematical processes for making **reasonable** comparisons/connections that demonstrate a **clear** understanding ❑ Procedures are **reasonable** and may contain a **minor mathematical error** that may hinder the understanding in one part of a complete solution ❑ Uses **appropriate** mathematical language to explain their understanding and provides **clear** support for their conclusion	• provides a complete response with no justification in #3 *or* • provides a complete response with a weak explanation or comparison in #6
3 **(Meets Acceptable)**	❑ Applies/develops **relevant** strategies and mathematical processes making **some** comparisons/connections that demonstrate a **basic** understanding ❑ Procedures are **basic** and may contain a **major error or omission** ❑ Uses **common** language to explain their understanding and provides **minimal** support for their conclusion	• completes #1 to #4 (must be correct in two out of three trial calculations) *or* • completes #1, #2, #4, and #5 *or* • completes #1 to #5 with no work shown
2 **(Below Acceptable)**	❑ Applies/develops **some relevant** mathematical processes making **minimal** comparisons/connections that lead to a **partial solution** ❑ Procedures are **basic** and may contain **several major mathematical errors** ❑ Communication is **weak**	• completes #1 and #2 *or* • completes #1, #2, and #3 with no justification
1 **(Beginning)**	❑ Applies/develops an **initial start** that may be **partially correct** or could have led to a correct solution ❑ Communication is **weak or absent**	• completes #1 or #2

For student exemplars, go to www.mathlinks8.ca and follow the links.