3. a) Imagine you are driving a car in a residential area and a ball rolls onto the road in front of you. You move your foot toward the brake. Based on the reaction time you calculated in #2, if you are driving at 40 km/h, how far will the car travel before you step down on the brake?
   b) What distance would you have travelled before stepping down on the brake if your original speed was 100 km/h?
   c) What other factors might influence your reaction time and your stopping distance? Share your ideas with your classmates.

Going Up?

You be an engineer! Your job is to design an elevator. It will work alongside an existing escalator to move people between levels at a local sports and entertainment arena.

1. The escalator that is already in place can move 30 people per minute from the main level to the upper level. Based on this information, how long would it take to use the escalator to move 100 people from the main level to the upper level?

2. The design of an elevator is based on the available building space, the load capacity, and the need to allow for people's personal space. An average person represents a load of 67 kg, and needs a radius of 26 cm for personal space. The area of the floor space for the elevator you are designing will be 3.75 m².
   a) To maximize the number of people that can be carried, what dimensions would you recommend for the elevator?
   b) Why did you choose these dimensions?
   c) What is the maximum number of people that your elevator could carry?
   d) What would be its load capacity? Justify your answer.

3. a) If the average time the elevator takes to move between the main level and the upper level is 8 s, how many people could move from the main level to the upper level in 1 min?
   b) What assumptions did you make?

4. There is a concert tonight. You want to minimize the time for moving 2000 concert goers from the main level to the upper level.
   a) What recommendations would you have for the staff who are directing people to the escalator and elevator? Justify your thinking.
   b) What assumptions did you make?

Planning Notes: Going Up?

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

1. Brainstorm with the class the differences between an elevator and an escalator. You may wish to include the ideas in the table shown.
2. Redirect students' attention to the main function of both types of equipment (i.e., to move people and/or cargo from one floor to another in the least amount of time). While escalator design is quite universal, students could be creative in designing their elevators. Talk about the pros and cons of different shapes (rectangular, square, circular, and hexagonal).
3. Clarify that the task is to
   - calculate how long it would take to use the escalator to move 100 people from the main level to the upper level
   - choose dimensions for an efficient elevator and then justify the use of these dimensions
   - calculate how many people the elevator could transport from the main level to the upper level in 1 min.

***MathLinks 9*, page 87**

Suggested Timing
40–50 minutes

Materials
- grid paper

Blackline Masters
Master 1 Project Rubric
Master 9 0.5 Centimetre Grid Paper

Mathematical Processes
- ☑ Communication
- ☑ Connections
- ☑ Mental Mathematics and Estimation
- ☑ Problem Solving
- ☑ Reasoning
- ☑ Technology
- ☑ Visualization

Specific Outcomes
N3 Demonstrate an understanding of rational numbers by:
- comparing and ordering rational numbers
- solving problems that involve arithmetic operations on rational numbers.

N5 Determine the square root of positive rational numbers that are perfect squares.
N6 Determine an approximate square root of positive rational numbers that are non-perfect squares.

Characteristic	Elevator	Escalator
Floor space needed	• little more than the size of the elevator	• very long and quite wide to accommodate up and down traffic
Location	• centre or the side of building	• in various locations, depending on need, often toward the centre of a building, sometimes just inside
Number of floors	• can go up many floors	• one set between every two floors • usually up to four to five floors at most
Volume of traffic	• wait time involved as the elevator moves between levels • delay exists as people load onto the elevator and wait for it to begin operation • need multiple elevators to accommodate a sudden or large volume of people to reduce wait-time • need to consider interior size in regard to rider capacity	• continuous flow of traffic with little or no stoppage or delay
Etiquette	• allow personal space • usually face the front	• stay on right side while standing, so people can walk by on left
Users	• anyone, including people using wheelchairs, walkers, and strollers	• only people who can stand can use • not safe for children in strollers

- consider the most efficient way to move 2000 people from the foyer to the upper level and explain why

4. Review the **Master 1 Project Rubric** with students so that they will know what is expected.

Meeting Student Needs

- Have students use **Master 9 0.5 Centimetre Grid Paper** to design their elevator. Work with them to decide how many squares might be equivalent to the diameter of one person's personal space. Have students draw the outline of the elevator based on the floor space and count the number of squares inside the outline to determine the maximum number of passengers.

Answers

Going Up?

1. Time $= \frac{\text{number of people}}{\text{rate}}$

$= \frac{100}{30}$

$= 3.33$

It would take about 3.33 min to move 100 people.

2. a) Example: Elevators are usually rectangular, square, or circular in shape. Although circular elevators look pleasing, they lack practical space. To conserve the same area, but minimize the perimeter, a square space is preferable. Thus, the length of one side is $\sqrt{3.75}$ or approximately 193 cm. Dividing by the diameter of personal space, $\frac{193}{52} = 3.7$. So, the elevator would fit three people across and three people deep or nine people per trip. This means that its load capacity is 603 kg.

b) Example: It takes 16 s for a round trip. Add another 10 s to load and unload people. The elevator should be able to make two round trips at most in 1 min. Using the answer from a), the elevator can carry 18 people between the foyer and upper level in 1 min.

3. Example: The escalator can move 30 people in 1 min, while the elevator moves 18. Staff may want to direct all concert-goers to the escalator to avoid long lineups or wait times. Reserve the elevator for parents with small children and/or strollers, and people in wheelchairs.

This Challenge can be used for either Assessment *for* Learning or Assessment *of* Learning.

Assessment	Supporting Learning
Assessment *for* Learning	
Going Up? Discuss the Challenge as a class.	• Consider allowing students to work with a partner.
Assessment *of* Learning	
Going Up? Introduce the Challenge to the class. Have students provide individual responses.	• **Master 1 Project Rubric** provides a holistic descriptor that will assist you in assessing student work on this Challenge. Page 122 provides notes on how to use this rubric for the Challenge. • To view student exemplars, go to www.mathlinks9.ca, access the Teacher Centre on the Online Learning Centre, go to Assessment, and then follow the links.

The chart below shows the **Master 1 Project Rubric** for tasks such as this Challenge, Going Up?, 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 Note: If the assumptions are the only area of weakness, the paper still receives a 5.
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	Demonstrates one of the following: • provides a complete response to all parts of the problem, with not more than two weak explanations or justifications • provides a complete and correct response to #2, 3, and 4, based on an incorrect #1
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	Demonstrates one of the following: • correctly completes #1, 2, and 3, with some minor calculation or rounding errors; communication is weak • correctly completes #1, 2, and 4, based on an incorrect #3 • provides answers only, with no work or justification • provides correct partial solutions to all parts of the problem, with some communication and justification
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**	Demonstrates one of the following: • provides correct #1 and 2; communication may be weak or absent • provides correct #1 and 3, based on an incorrect #2 load capacity; communication may be weak or absent
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**	Demonstrates one of the following: • makes an initial correct start to either #1 or 2 • provides a correct #1

For student exemplars, go to www.mathlinks9.ca and follow the links.