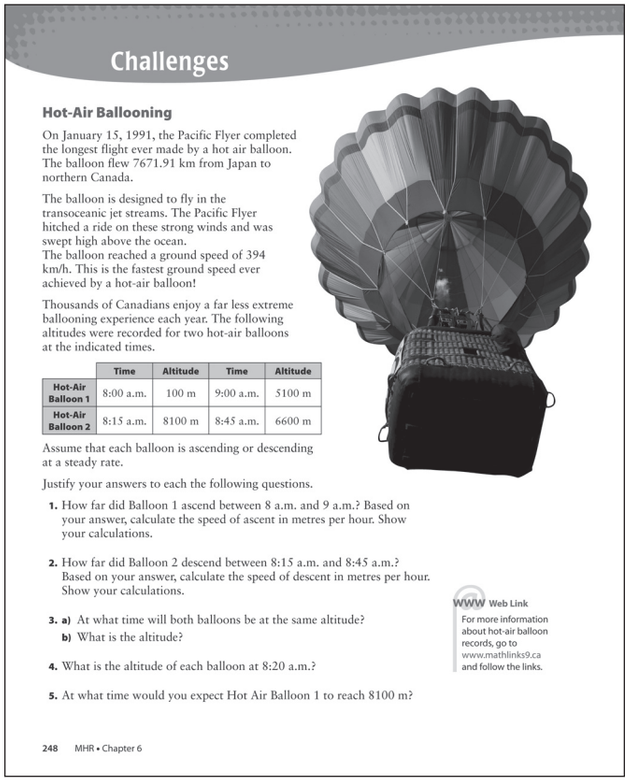

Challenges

Hot-Air Ballooning

On January 15, 1991, the Pacific Flyer completed the longest flight ever made by a hot air balloon. The balloon flew 7671.91 km from Japan to northern Canada.

The balloon is designed to fly in the transoceanic jet streams. The Pacific Flyer hitched a ride on these strong winds and was swept high above the ocean.
The balloon reached a ground speed of 394 km/h. This is the fastest ground speed ever achieved by a hot-air balloon!

Thousands of Canadians enjoy a far less extreme ballooning experience each year. The following altitudes were recorded for two hot-air balloons at the indicated times.

	Time	Altitude	Time	Altitude
Hot-Air Balloon 1	8:00 a.m.	100 m	9:00 a.m.	5100 m
Hot-Air Balloon 2	8:15 a.m.	8100 m	8:45 a.m.	6600 m

Assume that each balloon is ascending or descending at a steady rate.

Justify your answers to each the following questions.

1. How far did Balloon 1 ascend between 8 a.m. and 9 a.m.? Based on your answer, calculate the speed of ascent in metres per hour. Show your calculations.
2. How far did Balloon 2 descend between 8:15 a.m. and 8:45 a.m.? Based on your answer, calculate the speed of descent in metres per hour. Show your calculations.
3. a) At what time will both balloons be at the same altitude?
   b) What is the altitude?
4. What is the altitude of each balloon at 8:20 a.m.?
5. At what time would you expect Hot Air Balloon 1 to reach 8100 m?

WWW Web Link
For more information about hot-air balloon records, go to www.mathlinks9.ca and follow the links.

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***MathLinks 9*, page 248**

Suggested Timing
60–80 minutes

Materials
- grid paper
- ruler

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

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

Specific Outcomes
PR1 Generalize a pattern arising from a problem-solving context using linear equations and verify by substitution.
PR2 Graph linear relations, analyze the graph and interpolate or extrapolate to solve problems.

Planning Notes: Hot-Air Ballooning

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

1. Read through the Challenge as a class, ensuring that students recognize from the table of values that Balloon 1 is ascending and Balloon 2 is descending. Provide copies of **Master 9 0.5 Centimetre Grid Paper** to students for creating their graph.
2. Encourage students to use different strategies to solve the problems. You might use the following prompts:
   - How can you use patterns?
   - How can you use linear equations?
   - Is there a formula you can use?

   Challenge students to use different strategies, and then compare their answers.
3. Encourage students to use different strategies for answering #3 to 5. If they graph the linear relation, encourage them to use increments of no more than 1000 on the vertical axis. This will make it easier to interpolate heights from the graph.
4. Clarify that the task is to
   - determine the distance each balloon ascended or descended
   - calculate the speed of ascent or descent for each balloon
   - determine the time when both balloons will be at the same altitude
5. Wrap up by having students account for any differences in their answers. For example, students might note that estimating using a graph was less accurate in comparison to substituting values into an equation.
6. Review the **Master 1 Project Rubric** with students so that they will know what is expected.

Meeting Student Needs

- Encourage students to use a linear graph. You may need to work with them to develop some coordinates for the graph.
- Students who are comfortable with technology may wish to use spreadsheet software or a graphing calculator.
- Students may find it easier to compare the two rates if they convert the data to minutes instead of hours, with the first time becoming zero.
- Have students calculate the altitude of each balloon at 8:30 a.m., which is a midpoint in the data for each. (Answer: Balloon 1: 2600 m; Balloon 2: 7350 m)

ELL

- Ensure students understand the terms *transoceanic jet streams*, *ascending*, and *descending*.

Gifted and Enrichment

- Have students calculate the exact time and altitude at which the two balloons meet. (Answer: 9:05:37.5 a.m. at 5568.75 m)
- Have students present more than one way to find the solution.

Common Errors

- Students may misread times as decimal values.

R$_x$ Remind students that hours are measured in 60 min so that the change from 8:15 to 8:45 is 0.5 h, rather than 0.3 h.

Answers

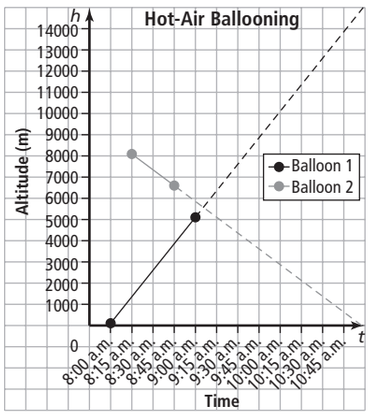
Hot–Air Ballooning

Note: Students may work in either m or km.

1. 5000 m; 5000 m/h

2. 1500 m; 3000 m/h

3. a),b) Example: According to the graph, the two balloons will meet around 9:07 a.m. at an altitude of approximately 5600 m.



4. Examples:
- Using the graph in #3, the altitude appears to be about 1700 m for Balloon 1 and almost 8000 m for Balloon 2.
- Alternatively, Balloon 1 is rising at 83.3 m/min. It is at 100 m at 8:00 a.m. At 8:20 a.m., it will be at $(100 + 20 \times 83.3) = 1766$ m. Balloon 2 is descending at 50 m/min. At 8:15 a.m., it is at 8100 m. At 8:20 a.m., it will be at $(8100 - 50 \times 5) = 7850$ m.

5. Examples:
- Using the graph from #3, the balloon should reach 8100 m a little before 9:45 a.m.
- By calculating, the balloon should reach 8100 m at approximately 9:36 a.m. (3000 ÷ 83.3).

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

Assessment	Supporting Learning
Assessment *for* Learning	
Hot-Air Ballooning Discuss the Challenge as a class. Have students provide individual responses.	• Consider allowing students to work with a partner and then write individual responses.
Assessment *of* Learning	
Hot-Air Ballooning 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 339 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, Hot-Air Ballooning, 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	Demonstrates one of the following: • provides a complete response with weak communication in at most two questions • provides a complete and correct response based on an incorrect #1 *or* 2 • provides a correct response with justification to any 4 out of 5 questions
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 to 3 and makes a start to #4 or 5 with some weak communication • correctly completes #1 to 5 without showing any work or justification • correctly completes #3 to 5
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: • correctly completes #1 and 2; communication for one question may be weak or absent • correctly completes #3 or 4
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**	• correctly completes #1 or 2

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