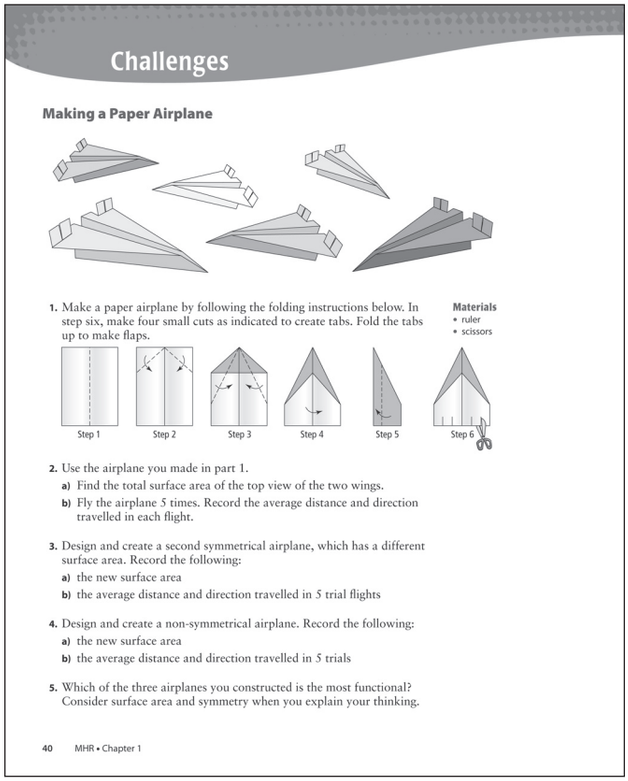

Challenges

Making a Paper Airplane

1. Make a paper airplane by following the folding instructions below. In step six, make four small cuts as indicated to create tabs. Fold the tabs up to make flaps.

Materials
- ruler
- scissors

Step 1 Step 2 Step 3 Step 4 Step 5 Step 6

2. Use the airplane you made in part 1.
   a) Find the total surface area of the top view of the two wings.
   b) Fly the airplane 5 times. Record the average distance and direction travelled in each flight.

3. Design and create a second symmetrical airplane, which has a different surface area. Record the following:
   a) the new surface area
   b) the average distance and direction travelled in 5 trial flights

4. Design and create a non-symmetrical airplane. Record the following:
   a) the new surface area
   b) the average distance and direction travelled in 5 trials

5. Which of the three airplanes you constructed is the most functional? Consider surface area and symmetry when you explain your thinking.

40 MHR • Chapter 1

***MathLinks 9*, page 40**

Suggested Timing
50–100 minutes

Materials
- rulers
- scissors

Blackline Masters
Master 1 Project Rubric
Master 8 Centimetre Grid Paper (optional)

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

Specific Outcomes
SS2 Determine the surface area of composite 3-D objects to solve problems.
SS5 Demonstrate an understanding of line and rotation symmetry.

Planning Notes: Making a Paper Airplane

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

1. Most students will already know how to make paper airplanes of different designs. Discuss their experiences with paper airplanes in various venues. They may have used them in science class, for example. Ask: How can we use paper airplanes to study math? (Surface area and symmetry are involved.)
2. Read over the Challenge with students and make sure that they understand what is expected. You may wish to ask the following questions to individuals or the entire class before students start or as they are working:
   - Why do you give each airplane five trials?
   - How can you record the results of your trials?
   - How can you determine the average result from the five trials?
   - How can you tell if an airplane is symmetrical?
   - How can you tell if an airplane is non-symmetrical?
   - According to your results, how does surface area and symmetry affect the distance and direction travelled?
   - Do your results agree with the results of other students? Explain.
   - How did you consider surface area and symmetry in this new design?
3. Clarify that the task is to
   - investigate how surface area affects the distance and direction travelled
   - investigate the distance and direction travelled by a symmetrical and a non-symmetrical paper airplane
   - use your knowledge of surface area and symmetry to design a plane that is eye-catching and functional
4. Review the **Master 1 Project Rubric** with students so that they will know what is expected.

Meeting Student Needs

- Encourage students to use a table such as the one below to record the results of their trials.

	Surface Area	Average Distance Travelled (m)
Plane 1 (symmetrical)		
Plane 2 (symmetrical)		
Plane 3 (non-symmetrical)		

- Ask students what happens to the distance travelled as the wing surface increases. How is this related to surface area?
- Students may wish to use **Master 8 Centimetre Grid Paper** to trace the wing surface in order to calculate the wing surface area. They can use the area of a rectangle minus the areas of right triangles to find the surface area of the plane.

Gifted and Enrichment

- Have students investigate the flight distance based on different weights of paper. Encourage them to make sure that other variables (e.g., size of paper, design, fold lines) remain the same.

Answers

5. Example: For a symmetrical plane, a larger wing surface provides more area for the air to press down on; the plane may not fly as far. However, the plane will likely fly in a relative straight line. Non-symmetrical paper planes will fly; however, the plane may nosedive. A real airplane that was non-symmetrical would not be able to take off as there would be uneven lift on the two sides.

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

Assessment	Supporting Learning
Assessment *for* Learning	
Making a Paper Airplane 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	
Making a Paper Airplane 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 47 provides notes on how to use the rubric for this 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, Making a Paper Airplane, 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: • completes the question but has a calculation error in #2, 3, or 4 • provides a complete response to the question, with weak communication in #5
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: • provides a correct and complete response to #1 and 2 • provides a complete and correct response to #3 • provides a complete and correct response to #4
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 calculates the surface area for two of # 2, 3, or 4 without trials • correctly indicates the trials for two of #2, 3, or 4, with incorrect or no attempt at surface area Note: If students consistently carry through the same calculation error in #3 and 4, they are not penalized
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**	• provides a correct initial start to any part of the question

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