1.2 Rotation Symmetry and Transformations

***MathLinks 9*, pages 16–25**

Suggested Timing
90–100 minutes

Materials
- scissors
- tracing paper
- isometric dot paper
- grid paper
- ruler
- paper clips (optional)

Blackline Masters
Master 7 Isometric Dot Paper
Master 8 Centimetre Grid Paper
BLM 1–4 Chapter 1 Warm-Up
BLM 1–9 Section 1.2 Extra Practice
BLM 1–10 Section 1.2 Math Link

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

Specific Outcomes
SS5 Demonstrate an understanding of line and rotation symmetry.

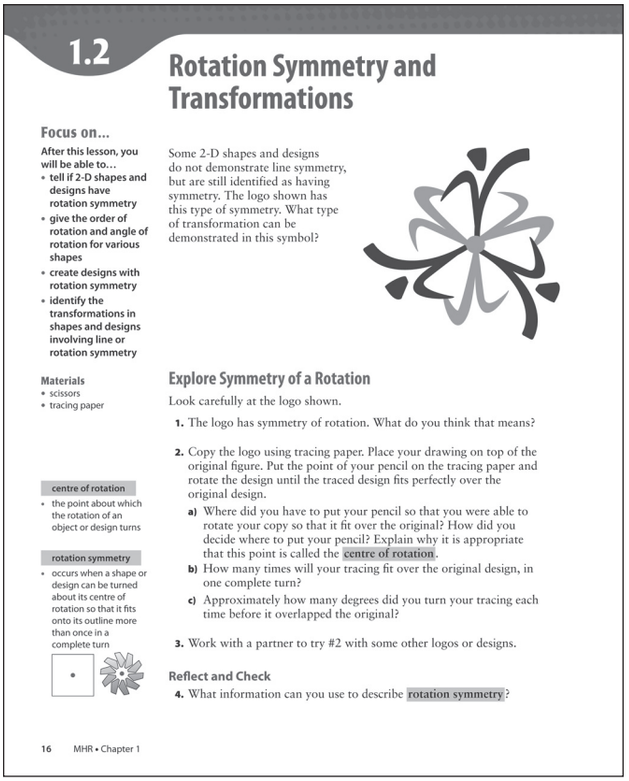
Category	Question Numbers
Essential (minimum questions to cover the outcomes)	#1–3, 4, 7, 9, 10, 12, 16, Math Link
Typical	#1–3, 4, 7, 9, 10, 12, 16, 17, 19, Math Link
Extension/Enrichment	#1–3, 10, 17–26, Math Link

Planning Notes

Have students complete the warm-up questions on **BLM 1–4 Chapter 1 Warm-Up** to reinforce material learned previously.

Have students examine the logo for Population Health. Discuss any symmetry demonstrated and relate the discussion to transformations.

Students may wish to use **Master 7 Isometric Dot Paper** and **Master 8 Centimetre Grid Paper** as they work through the section.



1.2 Rotation Symmetry and Transformations

Focus on...
After this lesson, you will be able to...
- tell if 2-D shapes and designs have rotation symmetry
- give the order of rotation and angle of rotation for various shapes
- create designs with rotation symmetry
- identify the transformations in shapes and designs involving line or rotation symmetry

Some 2-D shapes and designs do not demonstrate line symmetry, but are still identified as having symmetry. The logo shown has this type of symmetry. What type of transformation can be demonstrated in this symbol?

Materials
- scissors
- tracing paper

Explore Symmetry of a Rotation

Look carefully at the logo shown.

1. The logo has symmetry of rotation. What do you think that means?
2. Copy the logo using tracing paper. Place your drawing on top of the original figure. Put the point of your pencil on the tracing paper and rotate the design until the traced design fits perfectly over the original design.
   a) Where did you have to put your pencil so that you were able to rotate your copy so that it fit over the original? How did you decide where to put your pencil? Explain why it is appropriate that this point is called the centre of rotation.
   b) How many times will your tracing fit over the original design, in one complete turn?
   c) Approximately how many degrees did you turn your tracing each time before it overlapped the original?
3. Work with a partner to try #2 with some other logos or designs.

Reflect and Check
4. What information can you use to describe rotation symmetry?

centre of rotation
- the point about which the rotation of an object or design turns

rotation symmetry
- occurs when a shape or design can be turned about its centre of rotation so that it fits onto its outline more than once in a complete turn

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Explore Symmetry of a Rotation

In this Explore, students examine a logo for Population Health to determine characteristics of rotation symmetry. This activity should be completed individually since it is necessary for each student to physically rotate the design until it fits perfectly onto itself and then answer the questions in #2.

Students should find other logos or designs to explore in #2 from advertising brochures, magazines or newspapers, or the Internet.

Have students discuss #3 in pairs, then in larger groups, and then as a class. Challenge students to identify any aspect associated with a rotation in their response. As they discuss, ask:
- What do you need for a rotation to occur?
- How can you describe the turning associated with a rotation?
- What units can be used to measure the amount of rotation?
- If you need to check that a design has rotation symmetry, what is the first thing you should identify?

To help students better visualize rotation, have additional shapes prepared for students to examine.

Meeting Student Needs

- Students may benefit from working through the Explore as a whole-class activity.

ELL

- Teach the following terms in context: *tracing*, *turn*, *rotate*, and *original design*.
- Work through the steps with English language learners to ensure that they are able to follow them, or partner them with English-speaking students.

Gifted and Enrichment

- Challenge students by having them investigate how to create flip cartoon books, and then have them create their own cartoon that uses rotation symmetry.

Answers

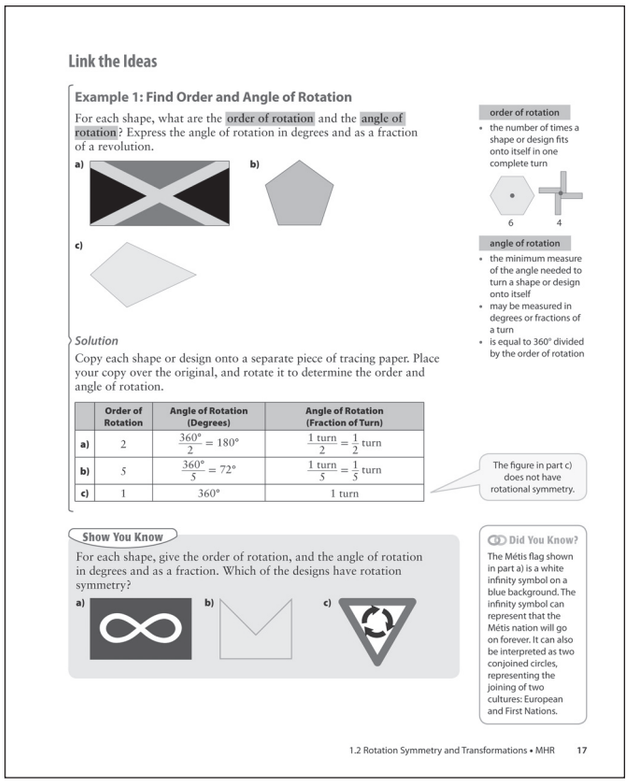
Explore Symmetry of a Rotation

1. Symmetry of rotation means the symmetry of the image occurs when a part of the image is rotated onto itself.

2. a) The centre of the rotation should be in the centre of the image.
b) Three
c) 120°

4. Example: Part of the image rotates to fit onto itself and the design is often circular.

Assessment	Supporting Learning
Assessment *as* Learning	
Reflect and Check Listen as students discuss what they discovered during the Explore. Try to have students generalize the information they use to describe *rotation symmetry* by encouraging statements that apply to all figures with rotation symmetry.	• Encourage students to write their description in their Foldable. Have them share their explanation with a partner. • Encourage students to share their ideas for #4. In a large group discussion, have students decide what always could be used to describe *rotation symmetry* in a given figure, • Have students give examples or non-examples to support their position.



Link the Ideas

Example 1: Find Order and Angle of Rotation

For each shape, what are the order of rotation and the angle of rotation? Express the angle of rotation in degrees and as a fraction of a revolution.

a)

b)

c)

order of rotation
- the number of times a shape or design fits onto itself in one complete turn

6 4

angle of rotation
- the minimum measure of the angle needed to turn a shape or design onto itself
- may be measured in degrees or fractions of a turn
- is equal to 360° divided by the order of rotation

Solution

Copy each shape or design onto a separate piece of tracing paper. Place your copy over the original, and rotate it to determine the order and angle of rotation.

	Order of Rotation	Angle of Rotation (Degrees)	Angle of Rotation (Fraction of Turn)
a)	2	$\frac{360°}{2} = 180°$	$\frac{1 \text{ turn}}{2} = \frac{1}{2}$ turn
b)	5	$\frac{360°}{5} = 72°$	$\frac{1 \text{ turn}}{5} = \frac{1}{5}$ turn
c)	1	360°	1 turn

The figure in part c) does not have rotational symmetry.

Show You Know

For each shape, give the order of rotation, and the angle of rotation in degrees and as a fraction. Which of the designs have rotation symmetry?

a)

b)

c)

Did You Know?

The Métis flag shown in part a) is a white infinity symbol on a blue background. The infinity symbol can represent that the Métis nation will go on forever. It can also be interpreted as two conjoined circles, representing the joining of two cultures: European and First Nations.

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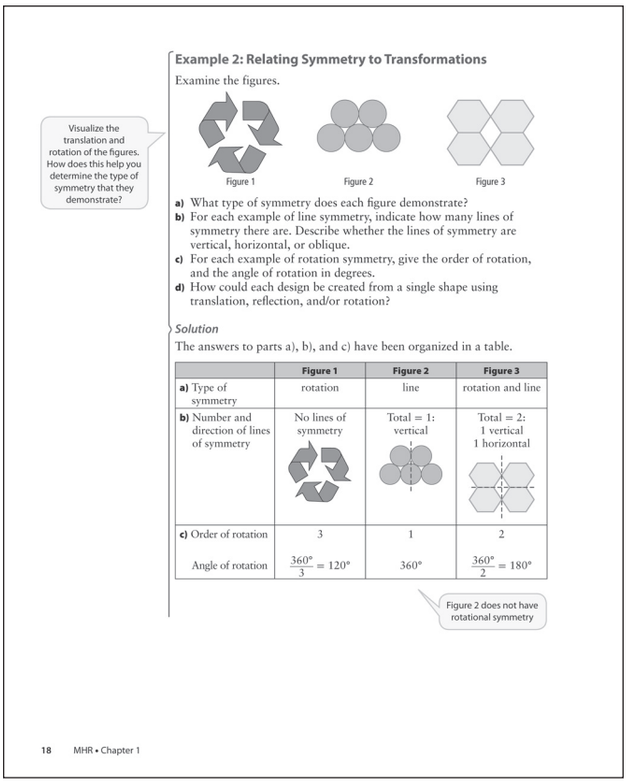

Example 2: Relating Symmetry to Transformations

Examine the figures.

Visualize the translation and rotation of the figures. How does this help you determine the type of symmetry that they demonstrate?

Figure 1 Figure 2 Figure 3

a) What type of symmetry does each figure demonstrate?
b) For each example of line symmetry, indicate how many lines of symmetry there are. Describe whether the lines of symmetry are vertical, horizontal, or oblique.
c) For each example of rotation symmetry, give the order of rotation, and the angle of rotation in degrees.
d) How could each design be created from a single shape using translation, reflection, and/or rotation?

Solution

The answers to parts a), b), and c) have been organized in a table.

	Figure 1	Figure 2	Figure 3
a) Type of symmetry	rotation	line	rotation and line
b) Number and direction of lines of symmetry	No lines of symmetry	Total = 1: vertical	Total = 2: 1 vertical 1 horizontal
c) Order of rotation	3	1	2
Angle of rotation	$\frac{360°}{3} = 120°$	360°	$\frac{360°}{2} = 180°$

Figure 2 does not have rotational symmetry

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Link the Ideas

Example 1

Have students try Example 1, based on their prior knowledge. For each figure in Example 1, ask students to describe the location of the centre of rotation they are using. You may wish to ask questions such as:

- Can the centre of rotation be outside the figure?
- Does the number of sides in a figure affect the angle of rotation?

Have all students complete the Show You Know to ensure that they understand the concept of rotation symmetry and its associated terminology. Draw students' attention to the Did You Know? about the Métis flag.

Example 2

It might work well to complete Example 2, using one of the given figures with the entire class, and then have students attempt the questions with the two remaining figures, either individually or in pairs. Some students may be confused with part d). Explain that each figure is made by repeating a part of itself. Ask:

- What shape is repeated for each figure?
- How many times has the shape been repeated in each figure?
- Which figure could be created using only translations? How many?
- Which figures can be created using reflections?
- Which figures can be created using more than one transformation?

Have students work on the Show You Know individually or with a partner. Encourage each to explain their answer to part a) orally in order to see if mathematical vocabulary is correctly used.

Key Ideas

The Key Ideas provide a summary of the main ideas from section 1.2, with different examples from those shown previously. Students should not copy these Key Ideas as notes but rather make their own notes by identifying vocabulary, concepts, and methodology that are important to them. Have students record their ideas in their Foldable or notebook.

Meeting Student Needs

- To help students with their organization skills, remind them that a chart can be a good way to present part or all of the solution for a mathematical problem. Discuss with students why the charts in Example 1 and 2 seem to work.

d) Figure 1 can be created from a single arrow by rotating it $\frac{1}{3}$ of a turn about the centre of rotation, as shown.

Figure 2 can be created from a single circle by translating it four times.

How could you use reflection to create this figure?

Figure 3 can be created from one of the hexagons by reflecting it in a vertical line, followed by a horizontal reflection (or vice versa).

How could you use translation and reflection to create this design?

WWW Web Link
To see examples of rotation symmetry, go to www.mathlinks9.ca and follow the links.

Show You Know

Consider each figure.

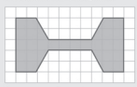


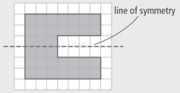
Figure A

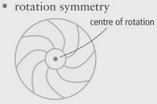
Figure B

a) Does the figure show line symmetry, rotation symmetry, or both?
b) If the figure has line symmetry, describe each line of symmetry as vertical, horizontal, or oblique.
c) For each example of rotation symmetry, give the order of rotation.
d) How could each design be created from a single part of itself using translations, reflections, or rotations?

Key Ideas

- The two basic kinds of symmetry for 2-D shapes or designs are
  - line symmetry
  - rotation symmetry





- The order of rotation is the number of times a figure fits on itself in one complete turn.
  For the fan shown above, the order of rotation is 8.
- The angle of rotation is the smallest angle through which the shape or design must be rotated to lie on itself. It is found by dividing the number of degrees in a circle by the order of rotation.
  For the fan shown above, the angle of rotation is $360° \div 8 = 45°$ or $1 \div 8 = \frac{1}{8}$, or $\frac{1}{8}$ turn.
- A shape or design can have one or both types of symmetry.

line symmetry rotation symmetry both

Check Your Understanding

Communicate the Ideas

1. Describe rotation symmetry. Use terms such as centre of rotation, order of rotation, and angle of rotation. Sketch an example.

2. Maurice claims the design shown has rotation symmetry. Claudette says that it shows line symmetry. Explain how you would settle this disagreement.

3. Can a shape and its translation image demonstrate rotation symmetry? Explain with examples drawn on a coordinate grid.

- Some students benefit from physically rotating their own body using a 90° or a $\frac{1}{4}$ turn rotation. Have other students describe the view after each 90° rotation.
- Students may benefit from working through the examples as a whole-class activity.
- Remind students that the term *rotation* means to turn around. Inform students that one full turn is 360º, a half a turn is $360º \div 2 = 180º$, and a quarter turn is $360º \div 4 = 90º$.
- To help students determine the order of rotations, have them trace the figure and then cut it out. Place the cut-out figure on top of the original and have the students turn it. Each time the cut-out figure matches the original is one order of rotation.
- Some students may benefit from rotating their figure about a vertex point until they become comfortable with the rotations. They can move to point symmetry by drawing a line from a vertex to the point of symmetry. Watching the line as the figure is rotated may be somewhat easier for students to visualize.
- Students may benefit from working through the Show You Know questions with a partner or in small groups.

ELL

- Teach the following terms in context: *fraction of a revolution* and *rotation symmetry*.

Common Errors

- Some students may have difficulty identifying the single shape from which a figure is created or describing the transformations needed to make it.

R_x In Example 2, begin with Figure 3, then Figure 2, and finally use Figure 1. Figures 2 and 3 are relatively easy for students to create using translations. Figure 1 requires rotations.

Answers

Example 1: Show You Know

a) Order of rotation = 2, angle of rotation = 180°

b) No rotation symmetry

c) Order of rotation = 3, angle of rotation = 120°

Example 2: Show You Know

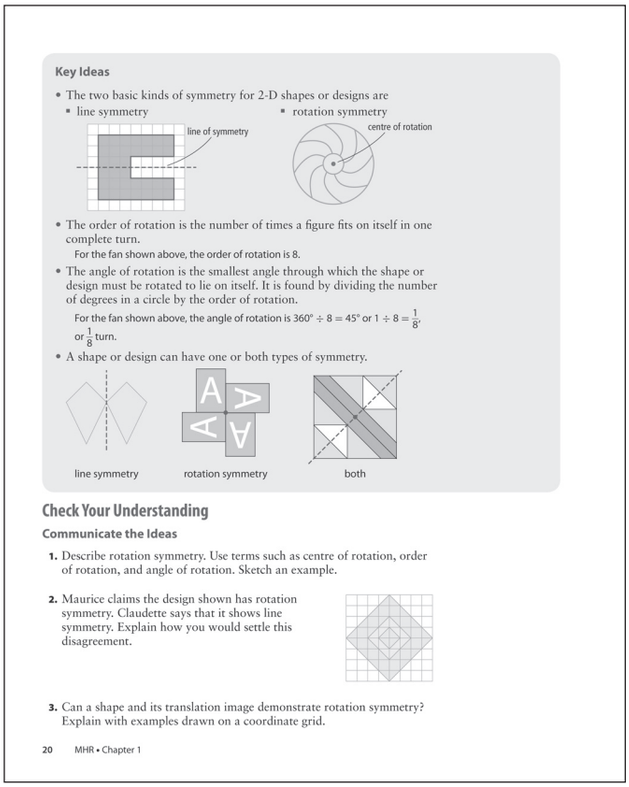
a) A: both; B: rotation symmetry

b) A: vertical line and horizontal line

c) A: 2; B: 4

d) A: reflection about a vertical or a horizontal line; B: rotation about the centre

Assessment	Supporting Learning
Assessment *for* Learning	
Example 1 Have students do the Show You Know related to Example 1.	• Encourage students to verbalize their thinking. • You may wish to have students work with a partner. • Give students a similar problem to solve. Allow time for students to work with a partner and to talk through their thinking in arriving at the solution. • For variation and to extend understanding, give students the angle of rotation and ask them for the order of rotation and for an example that satisfies the conditions.
Example 2 Have students do the Show You Know related to Example 2.	• Encourage students to verbalize their thinking. • You may wish to have students work with a partner. • Some students may benefit from copying the shapes and being able to manipulate them to answer parts a) and b). • For part c), remind students that the term *rotation* means to turn around. Inform students that one full turn is 360º, a half turn is 360º ÷ 2 = 180º, and a quarter turn is 360º ÷ 4 = 90º. • Part d) requires students to combine the concepts in the lesson and use previous skills to identify ways of generating the shapes. Students experiencing difficulty will benefit from a hands-on approach. For Figure B, consider giving students paper clips and allowing them to rearrange them to answer the question. • If students are not having difficulty, you may wish to introduce a tessellation and ask students to identify the repeating shape and the transformations used to create the pattern. • Have students explain, using models or diagrams, the connection between rotation symmetry and transformations. Emphasize that many examples of rotation symmetry have more than one combination of transformations that can be used to generate the figures or design.



Key Ideas

- The two basic kinds of symmetry for 2-D shapes or designs are
  - line symmetry
  - rotation symmetry

line of symmetry

centre of rotation

- The order of rotation is the number of times a figure fits on itself in one complete turn.
  For the fan shown above, the order of rotation is 8.
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- A shape or design can have one or both types of symmetry.

line symmetry | rotation symmetry | both

Check Your Understanding

Communicate the Ideas

1. Describe rotation symmetry. Use terms such as centre of rotation, order of rotation, and angle of rotation. Sketch an example.

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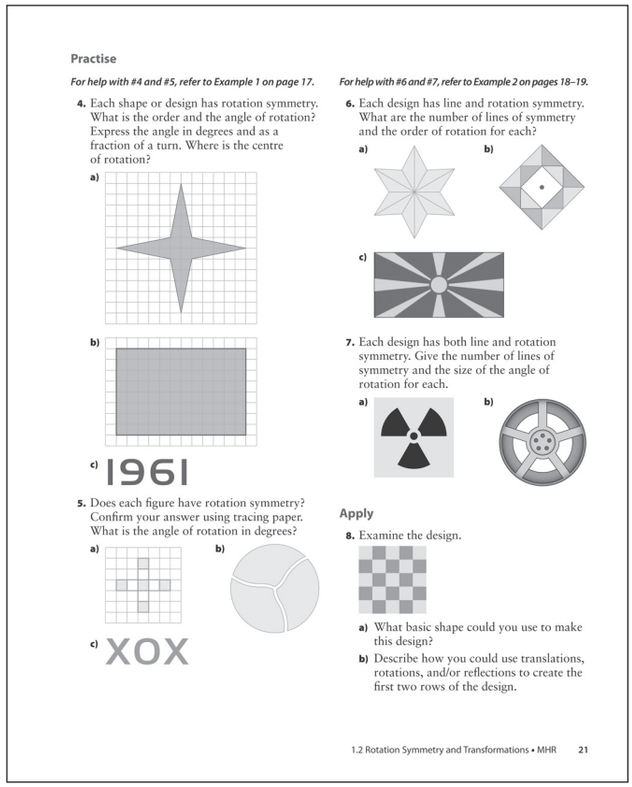

Practise

For help with #4 and #5, refer to Example 1 on page 17.

4. Each shape or design has rotation symmetry. What is the order and the angle of rotation? Express the angle in degrees and as a fraction of a turn. Where is the centre of rotation?

a)

b)

c) 1961

5. Does each figure have rotation symmetry? Confirm your answer using tracing paper. What is the angle of rotation in degrees?

a) b)

c) XOX

For help with #6 and #7, refer to Example 2 on pages 18–19.

6. Each design has line and rotation symmetry. What are the number of lines of symmetry and the order of rotation for each?

a) b)

c)

7. Each design has both line and rotation symmetry. Give the number of lines of symmetry and the size of the angle of rotation for each.

a) b)

Apply

8. Examine the design.

a) What basic shape could you use to make this design?
b) Describe how you could use translations, rotations, and/or reflections to create the first two rows of the design.

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Check Your Understanding

Communicate the Ideas

Have students work individually or in pairs to answer the assigned questions. In #1, students are asked to describe rotation symmetry using an example. Their description gives them the opportunity to use mathematical terminology.

In #2, students are asked to settle a disagreement between two students. One claims that a figure has rotation symmetry, while the other says it has line symmetry. It turns out that they are both correct.

Students may find #3 more difficult as it is an extension-type question. Students are asked to indicate if a shape and its translation image can demonstrate rotation symmetry. The answer depends on the initial shape. If the shape is a square, it is possible to translate it over and down to create what looks like rotation symmetry. For most shapes, it is not possible to translate the shape and end with rotation symmetry.

Practise

Students could be given a choice of one question within each of the pairs of questions (#4 or 5, #6 or 7) since each pair is similar.

Students should work individually on these questions and then check against the answers in the back of the student resource.

Apply

Note that #8, 9, 11, 14, and 16 relate rotation symmetry to designs and emphasize the mathematical aspects of the symmetry, often in relation to transformations. When students work on #11, you may wish to have them research Cree symbols. Refer to the related Web Link that follows.

Note that #10, 13, 15, and 17, 19, 20 to 23 are rooted in applications of rotation symmetry in the world around us. These questions introduce students to the usefulness of rotation symmetry in our lives.

9. Consider the figure shown.

a) What is its order of rotation?

b) Trace the figure onto a piece of paper. How could you create this design using a number of squares and triangles?

c) Is it possible to make this figure by transforming only one piece? Explain.

10. Many Aboriginal languages use symbols for sounds and words. A portion of a Cree syllabics chart is shown.

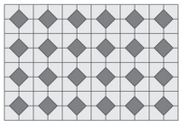
e		i	ii	u	uu	a	aa	
we			wii			wa	waa	
pe		pi	pii	pu	puu	pa	paa	pwaa
te	twe	ti	tii	tu	tuu	ta	taa	twaa
ke	kwe	ki	kii	ku	kuu	ka	kaa	kwaa

a) Select two symbols that have line symmetry and another two that have rotation symmetry. Redraw the symbols. Show the possible lines of symmetry and angles of rotation.

b) Most cultures have signs and symbols with particular meaning. Select a culture. Find or draw pictures of at least two symbols from the culture that demonstrate line symmetry or rotation symmetry. Describe what each symbol represents and the symmetries involved.

11. Does each tessellation have line symmetry, rotation symmetry, both, or neither? Explain by describing the line of symmetry and/or the centre of rotation. If there is no symmetry, describe what changes would make the image symmetrical.

a)



b)

c)

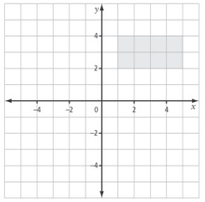
d)

Literacy Link

A *tessellation* is a pattern or arrangement that covers an area without overlapping or leaving gaps. It is also known as a tiling pattern.

12. Reproduce the rectangle on a coordinate grid.

a) Create a drawing that has rotation symmetry of order 4 about the origin. Label the vertices of your original rectangle. Show the coordinates of the image after each rotation.



b) Start again, this time using line symmetry to make a new design. Use the *y*-axis and then the *x*-axis as a line of symmetry. How is this new design different from the one that you created in part a)?

13. Sandra makes jewellery. She created a pendant based on the shape shown.

a) Determine the order and the angle of rotation for this design.

b) If Sandra's goal was to create a design with more than one type of symmetry, was she successful? Explain.

14. Alain drew a pendant design that has both line and rotation symmetry.

a) How many lines of symmetry are in this design? What is the size of the smallest angle between these lines of symmetry?

b) What are the order and the angle of rotation for this design?

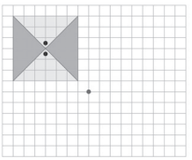
15. Imagine you are a jewellery designer. On grid paper, create a design for a pendant that has more than one type of symmetry. Compare your design with those of your classmates.

16. Copy and complete each design. Use the centre of rotation marked and the order of rotation symmetry given for each part.

a)

Order of rotation: 2

b)



Order of rotation: 4
Hint: Pay attention to the two dots in the centre of the original shape.

Extend

In #26, students are asked a theoretical question relating to the rotation of a chord of length r, where r is the radius of the circle. Students should be encouraged either to draw the situation, model it using toothpicks, or model it on Geometer's Sketchpad. Question #24 relates rotation symmetry to the number of teeth on gears and vice versa.

Literacy Link At the end of section 1.2, have students complete the left circle of the thematic map. Brainstorm and discuss as a class the information needed to complete the rectangle boxes and accompanying definitions.

Math Link

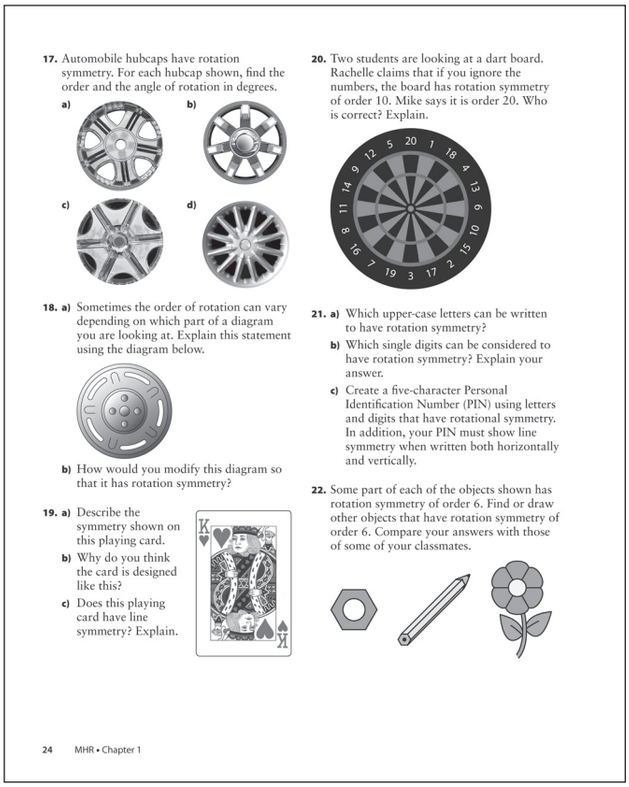
This Math Link continues the theme introduced in section 1.1. Students are designers trying to come up with fresh, new design ideas. This time, they must limit their designs to rotation symmetry and the ideas used in section 1.2. The design created here is to be stored and used as part of the Math Link: Wrap It Up! at the end of the chapter.

Web Link

To find out more about Cree Syllabics, go to www.mathlinks9.ca and follow the links.

Meeting Student Needs

- Provide **BLM 1–9 Section 1.2 Extra Practice** to students who would benefit from more practice.
- Give students as much variety and choice as possible to encourage them to take responsibility for their learning. Variety can provide differentiated learning opportunities.
- All students should attempt the Math Link as it is a non-threatening, fun way to explore symmetry as they create a design.



17. Automobile hubcaps have rotation symmetry. For each hubcap shown, find the order and the angle of rotation in degrees.

a) b) c) d)

18. a) Sometimes the order of rotation can vary depending on which part of a diagram you are looking at. Explain this statement using the diagram below.

b) How would you modify this diagram so that it has rotation symmetry?

19. a) Describe the symmetry shown on this playing card.
b) Why do you think the card is designed like this?
c) Does this playing card have line symmetry? Explain.

20. Two students are looking at a dart board. Rachelle claims that if you ignore the numbers, the board has rotation symmetry of order 10. Mike says it is order 20. Who is correct? Explain.

21. a) Which upper-case letters can be written to have rotation symmetry?
b) Which single digits can be considered to have rotation symmetry? Explain your answer.
c) Create a five-character Personal Identification Number (PIN) using letters and digits that have rotational symmetry. In addition, your PIN must show line symmetry when written both horizontally and vertically.

22. Some part of each of the objects shown has rotation symmetry of order 6. Find or draw other objects that have rotation symmetry of order 6. Compare your answers with those of some of your classmates.

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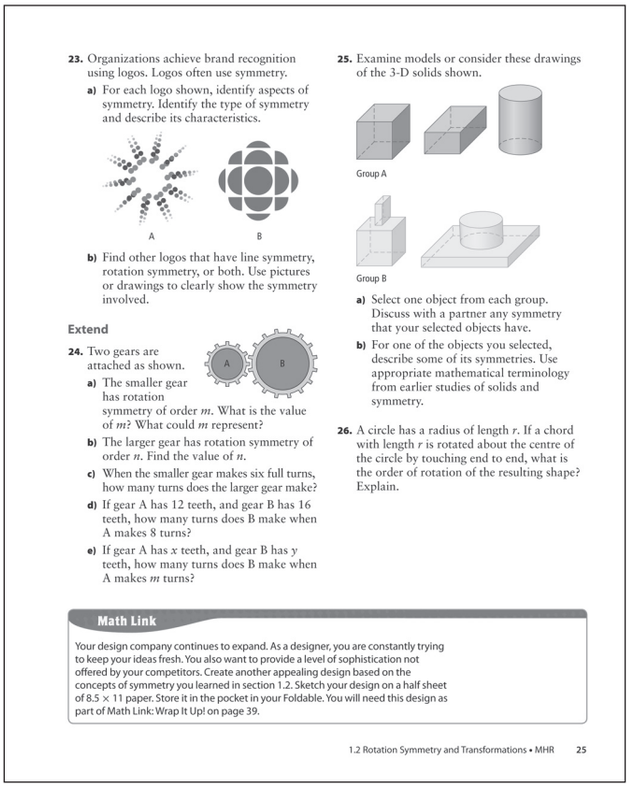


23. Organizations achieve brand recognition using logos. Logos often use symmetry.
a) For each logo shown, identify aspects of symmetry. Identify the type of symmetry and describe its characteristics.

A B

b) Find other logos that have line symmetry, rotation symmetry, or both. Use pictures or drawings to clearly show the symmetry involved.

Extend

24. Two gears are attached as shown.

A B

a) The smaller gear has rotation symmetry of order m. What is the value of m? What could m represent?
b) The larger gear has rotation symmetry of order n. Find the value of n.
c) When the smaller gear makes six full turns, how many turns does the larger gear make?
d) If gear A has 12 teeth, and gear B has 16 teeth, how many turns does B make when A makes 8 turns?
e) If gear A has x teeth, and gear B has y teeth, how many turns does B make when A makes m turns?

25. Examine models or consider these drawings of the 3-D solids shown.

Group A

Group B

a) Select one object from each group. Discuss with a partner any symmetry that your selected objects have.
b) For one of the objects you selected, describe some of its symmetries. Use appropriate mathematical terminology from earlier studies of solids and symmetry.

26. A circle has a radius of length r. If a chord with length r is rotated about the centre of the circle by touching end to end, what is the order of rotation of the resulting shape? Explain.

Math Link

Your design company continues to expand. As a designer, you are constantly trying to keep your ideas fresh. You also want to provide a level of sophistication not offered by your competitors. Create another appealing design based on the concepts of symmetry you learned in section 1.2. Sketch your design on a half sheet of 8.5 × 11 paper. Store it in the pocket in your Foldable. You will need this design as part of Math Link: Wrap It Up! on page 39.

1.2 Rotation Symmetry and Transformations • MHR 25

ELL

- Teach the following words in context: *sketch*, *claims*, *settle* (a disagreement), *disagreement*, *coordinate grid*, *fraction of a turn*, *gears*, *teeth* (on a gear), *sophistication*, and *competitors*.
- Students may find some of the more language-dense questions to be a challenge. Reduce the number of questions assigned, and ensure that students understand the questions they are being asked.

Common Errors

- Some students may not see rotation symmetry in drawings and pictures.

R_x Ensure that students can quickly identify the centre of rotation. This is normally in the centre of the shape or object. Once the centre is located, encourage students to trace the shape on a separate piece of paper, cut it out, and physically rotate it about the centre of rotation. Remind students that this approach to visualizing the rotation can help them solve every problem on rotation symmetry.

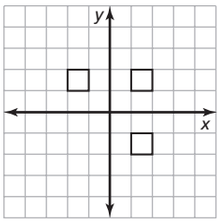
Answers

Communicate the Ideas

1. Rotation symmetry occurs when a section of a design can be rotated about a centre point and shows symmetry with other parts. Example:

2. Both Claudette and Maurice are correct. The design shows both line and rotation symmetry. The design can be folded over a horizontal or vertical line of symmetry to overlap itself, or a corner piece can be rotated four times to create the design.

3. Yes. Any regular object (for example, a square or hexagon) with equal side-lengths can be translated horizontally or vertically and still maintain rotation symmetry with the original. Example:



Assessment	Supporting Learning
Assessment *as* Learning	
Communicate the Ideas Have all students complete #1–3.	• Encourage students to verbalize their thinking. • You may wish to have students work with a partner. • For #1, if students have difficulty, encourage them to select an example of rotation symmetry from Example 1 or 2. Have students brainstorm possible terms that could be used to describe rotation symmetry in #1. • Have a class discussion about the possible responses to #2. This question links directly to #3. • Have students work in pairs to complete #3. They should be encouraged to demonstrate their shape and their explanations to the class. For students experiencing difficulty with #3, provide them with a shape that will meet the criteria and change the question to "Explain and show how this shape and its translation demonstrate rotation symmetry." • You may wish to have students assess each other's responses, using **Master 2 Communication Peer Evaluation**.
Assessment *for* Learning	
Practise and Apply Have students do #4, 7, 9, 10, 12, and 16. Students who have no problems with these questions can go on to the remaining Apply questions.	• If students have difficulty with #4 or 7, provide additional coaching using Example 1 and Example 2, respectively. Then, have them do #5 and 6 on their own. Note that students will require tracing paper to complete the check in #5. • In #10, a portion of a Cree Syllabics chart is used. It is useful to point out that symmetry has been part of language throughout history. This question provides an opportunity for students to see symmetry in the Cree culture. Remind students that they are choosing the symbol and not the word below it. For students who get overwhelmed by choice, limit their search to the first two rows or a limited number of boxes. • In #12, students have the opportunity to use coordinate geometry to track reflections and rotations. Provide students with a large enough grid for them to manipulate their shape. • For students who are having difficulty with #16, provide a grid and the shape that they can cut out. For the visual leaner, it might be easier if the grid was 1-cm grid paper.
Math Link The Math Link on page 25 is intended to help students work toward the chapter problem wrap-up titled Math Link: Wrap It Up! on page 39.	• Students who need help getting started could use **BLM 1–10 Section 1.2 Math Link**, which provides scaffolding. • Have students go back to their original design for the section 1.1 Math Link and see if their original design already has symmetry in it that they could expand upon. • Reinforce that the Math Link is a necessary part of the Math Link: Wrap It Up! on page 39. • Have students show their progress after a set amount of time. This will motivate students to get started and feedback may give them some ideas. • Emphasize the creative aspects of this assignment and discourage students from picking up ideas from others.
Assessment *as* Learning	
Literacy Link (page 3) Help students to recall the new terms introduced in this section by adding them to their map.	• Have students complete the left circle by adding the following terms: *order*, *angle*, and *centre of rotation*. Have students write their own definitions and create an example for each term.
Math Learning Log Have students respond to the following prompts: • The mathematical vocabulary I can use to describe rotation symmetry is … • The similarities and differences between line symmetry and rotation symmetry are …	• Encourage students to use the What I Need to Work On section of their Foldable to note what they continue to have difficulties with. • Have students present answers in oral, written, poster, or PowerPoint format. • Encourage students to use specific examples in their presentations.