I. Lesson Overview

Strand	Measurement and Geometry
Sub-Strand	Rotational Symmetry
Specific Learning Outcome	Determine the order of rotational symmetry of plane figures. Appreciate the application of rotation in real-life situations.
Grade Level	Grade 10
Duration	40 minutes
Key Inquiry Question	How is rotation applied in real-life situations? How can we determine how many times a shape looks the same during one complete turn?
Learning Resources	CBC Grade 10 Mathematics Textbooks, printed figures (star, regular polygons), construction paper, push pins, pencils, scissors, protractors

II. Learning Objectives

Category	Objective
Know	Define rotational symmetry as the property of an object where it can be rotated around a central point and still look the same. Define the order of rotational symmetry as the number of times a figure fits onto itself in one complete turn (360°). State the formula: Order of rotational symmetry = 360° / angle between identical parts. Understand that all shapes have at least order 1 (the original position).
Do	Trace and cut a figure on construction paper. Place the tracing on top of the printed copy with a pin through the centre. Manually rotate the tracing and count how many times the shape looks exactly the same in one full turn. Apply the formula to calculate the order of rotational symmetry when given the angle between identical parts. Identify the order of rotational symmetry for common shapes: equilateral triangle (3), square (4), regular pentagon (5), regular hexagon (6), circle (infinite).

Apply	Determine the order of rotational symmetry for given plane figures. Use the formula to solve problems involving angles between identical parts. Identify rotational symmetry in real-life objects such as wheels, flowers, logos, and architectural designs. Recognise letters of the alphabet with rotational symmetry (H, I, N, O, S, X, Z).

III. Materials & Resources

- CBC Grade 10 Mathematics Textbooks
- Printed copies of figures: 5-pointed star, regular polygons (triangle, square, pentagon, hexagon, octagon)
- Construction paper (one sheet per group)
- Push pins (one per group)
- Pencils and scissors
- Protractors (for measuring angles)
- Alphabet letter cards (H, I, N, O, S, X, Z, A, B, C)
- Optional: pictures of real-life objects with rotational symmetry (wheels, flowers, logos)

IV. Lesson Procedure

Phase 1: Problem-Solving and Discovery (15 minutes)

Anchor Activity: "How Many Times Does It Fit?"

Materials: Printed copy of a 5-pointed star, construction paper, push pin, pencil, scissors.

Instructions (Work in groups of 3–4):

- 1. On construction paper, trace and cut the 5-pointed star figure.
- 2. Place the tracing on top of the printed copy.
- 3. Place a push pin through the centre of both the tracing and the printed copy so that the tracing can rotate freely.
- 4. Manually rotate the tracing around the centre slowly.
- 5. Count how many times the shape looks EXACTLY the same as the original in one full turn (360°).

- 6. Record your count in the table below.
- 7. Discuss with your group: What does this number represent? Why does the star fit onto itself multiple times?

Recording Table:

Figure	Number of Times It Fits	Group Observation
5-pointed star	___	What pattern do you notice?

Teacher's Role During Discovery:

- Circulate among groups, ensuring students rotate the tracing slowly and carefully.
- Ask probing questions: "How many times did the star fit onto itself?" "Did you count the starting position?" "What makes the star fit multiple times?"
- For struggling groups: "Start with the star in its original position. That's position 1. Now rotate it slowly. When does it look EXACTLY the same again? That's position 2. Keep going."
- For early finishers: "What if you had a 6-pointed star? How many times would it fit? What about an 8-pointed star?"
- Guide students to articulate: "The star fits 5 times because it has 5 identical points."
- Identify 2–3 groups with clear results (should be 5 times) to share with the class.

Expected Student Discoveries:

Observation	Mathematical Significance
The star fits onto itself 5 times in one full turn.	This number is called the ORDER of rotational symmetry.
The star has 5 identical points.	The number of identical parts equals the order of rotational symmetry.
The star looks the same at regular intervals.	The angle between each identical position is 360° / 5 = 72°.
Every shape fits at least once (the starting position).	All shapes have at least order 1 rotational symmetry.

Phase 2: Structured Instruction (10 minutes)

Key Takeaways:

The number of times the tracing of the star fits onto the printed copy in one complete turn is 5 times. This is called the ORDER OF ROTATIONAL SYMMETRY — the number of times the figure fits onto itself in one complete turn (360°).

Formula:

Order of rotational symmetry = 360° / angle between the identical parts

Order of Rotational Symmetry for Common Shapes:

Shape	Order of Rotational Symmetry	Angle Between Identical Parts
Equilateral triangle	3	360° / 3 = 120°
Square	4	360° / 4 = 90°
Regular pentagon	5	360° / 5 = 72°
Regular hexagon	6	360° / 6 = 60°
Regular octagon	8	360° / 8 = 45°
Circle	Infinite	Any angle
Rectangle (non-square)	2	360° / 2 = 180°
Scalene triangle	1	No rotational symmetry (only original position)

Important Notes:

- All shapes have at least order 1 rotational symmetry (the original position).
- Regular polygons with n sides have order n rotational symmetry.
- A circle has infinite rotational symmetry because it looks the same at any angle.
- Shapes with NO rotational symmetry (other than order 1) are called asymmetric.

Phase 3: Practice and Application (10 minutes)

Problem 1 (Worked Example from Textbook): Finding Order Using the Formula

Find the order of rotational symmetry in a figure where the angle between the identical parts is 45°.

Solution:

Order of rotational symmetry = 360° / angle between the identical parts

Order of rotational symmetry = 360° / 45°

Order of rotational symmetry = 8

Problem 2: Identifying Order from a Shape

A regular hexagon has 6 equal sides and 6 equal angles. What is its order of rotational symmetry?

Solution:

A regular hexagon has 6 identical parts.

Order of rotational symmetry = 6

Verification using the formula:

Angle between identical parts = 360° / 6 = 60°

Order = 360° / 60° = 6 ✔

Problem 3: Finding the Angle from the Order

A shape has order 10 rotational symmetry. What is the angle between the identical parts?

Solution:

Order of rotational symmetry = 360° / angle between identical parts

10 = 360° / angle

angle = 360° / 10

angle = 36°

Problem 4: Letters of the Alphabet

Which of the following letters have rotational symmetry of order 2? H, I, N, O, S, X, Z

Solution:

Letters with order 2 rotational symmetry (look the same when rotated 180°):

H, I, N, O, S, X, Z — all have order 2.

Note: O has infinite rotational symmetry (it's a circle), but it also has order 2.

Phase 4: Assessment — Exit Ticket (5 minutes)

Assessment Questions:

1. Define the order of rotational symmetry.

2. A figure has an angle of 30° between its identical parts. What is its order of rotational symmetry?

3. State the order of rotational symmetry for: (a) an equilateral triangle, (b) a square, (c) a regular pentagon.

4. Which of the following letters have rotational symmetry? A, B, H, N, Z

5. Give two real-life examples of objects with rotational symmetry and state their order.

Answer Key:

1. The order of rotational symmetry is the number of times a figure fits onto itself in one complete turn (360°).

2. Order = 360° / 30° = 12.

3. (a) 3, (b) 4, (c) 5.

4. H, N, Z have rotational symmetry (order 2). A and B do not.

5. Examples: (i) A car wheel — order 5 (if it has 5 spokes). (ii) A flower with 6 petals — order 6. (iii) A snowflake — order 6. (iv) A clock face — order 12.

V. Differentiation Strategies

Learner Level	Strategy
Struggling Learners	Provide pre-cut figures with the centre already marked. Use simple shapes: equilateral triangle, square, regular pentagon. Count together as a class for the first shape. Provide a reference card with the formula. Allow students to use tracing paper instead of push pins. Pair with a stronger student during the discovery phase.
On-Level Learners	Complete all four practice problems using the formula. Identify the order of rotational symmetry for regular polygons. Find the angle between identical parts given the order. Identify letters of the alphabet with rotational symmetry. Recognise rotational symmetry in real-life objects.
Advanced Learners	Investigate: What is the relationship between the number of sides of a regular polygon and its order of rotational symmetry? Explore irregular shapes: Does a rectangle have rotational symmetry? What about a parallelogram? Design a logo with order 8 rotational symmetry. Investigate 3D rotational symmetry: How many axes of rotational symmetry does a cube have? Prove that the sum of angles in a regular n-gon is $(n-2) \times 180°$ and connect this to rotational symmetry.

VI. Extension Activity

Activity: "Rotational Symmetry in the Real World and Beyond"

1. Identify five objects in your classroom or school that have rotational symmetry. For each object, state its order of rotational symmetry.

2. Design a company logo that has order 6 rotational symmetry. Draw it on graph paper and verify by tracing and rotating.

3. Investigate: A regular polygon has order 15 rotational symmetry. How many sides does it have? What is the angle between the identical parts?

4. Challenge: A shape has TWO different orders of rotational symmetry: order 2 and order 4. Is this possible? If yes, give an example. If no, explain why.

Extension Answer Key:

1. Examples: (i) Clock face — order 12. (ii) Ceiling fan with 3 blades — order 3. (iii) Hexagonal floor tile — order 6. (iv) Square window — order 4. (v) Circular table — infinite.

2. Student designs will vary. Verify by checking that the logo fits onto itself 6 times in one full turn.

3. A regular polygon with order 15 has 15 sides. Angle between identical parts = 360° / 15 = 24°.

4. No, this is NOT possible. If a shape has order 4, it automatically has order 2 (because 180° is half of 360° / 2). A shape cannot have TWO different primary orders. However, a shape with order 4 will ALSO look the same at 180° (order 2), but we report the HIGHEST order, which is 4.

VII. Assessment Methods

Type	Method
Formative	Observation during group work: Are students rotating the tracing carefully? Do they count the starting position? Questioning: "How many times did it fit?" "What is the order of

	rotational symmetry?" "Can you use the formula to verify?" Recording table: Check that students complete the table with correct counts.
Summative	Exit ticket with 5 questions: (1) Define order of rotational symmetry, (2) Apply the formula to find order, (3) State order for common shapes, (4) Identify letters with rotational symmetry, (5) Give real-life examples. Complete answer key provided for marking.

VIII. Teacher Reflection

1. Did the hands-on tracing and rotating activity effectively help students discover the concept of order of rotational symmetry?

2. Were students able to count the number of times the shape fit onto itself accurately?

3. Did students understand the formula: Order = 360° / angle between identical parts?

4. Were students able to apply the formula to solve problems?

5. Did students recognise rotational symmetry in real-life objects?

6. What common errors arose (e.g., not counting the starting position, confusing rotational symmetry with line symmetry)?

7. What adjustments would improve the lesson for future delivery?