I. Lesson Overview

Lesson Title	Properties of symmetry and reflection
Strand	Measurement and Geometry
Sub-Strand	Reflection and Congruence
Grade Level	10
Estimated Duration	40 minutes
Key Inquiry Questions	How do we use reflection in day-to-day life? Where do we use congruence in real life?
Materials & Resources	CBC Grade 10 Mathematics Textbooks, pieces of paper (A4), scissors, rulers, pencils

II. Learning Objectives

Know (Conceptual Understanding): Understand that symmetry means an object looks exactly identical on both sides when folded, flipped, rotated, or reflected. Understand that a line of symmetry divides a shape into two identical halves where one half is the mirror image of the other.

Do (Procedural Skill): Identify lines of symmetry in plane figures by folding, drawing, and visual inspection. Determine the number of lines of symmetry for regular polygons, letters, and everyday objects.

Apply (Application/Problem-Solving): Recognise and identify lines of symmetry in real-world objects, classroom items, and everyday situations involving reflection and congruence.
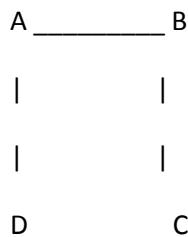
III. Lesson Procedure

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

Objective: Activate prior knowledge of symmetry through a hands-on paper folding activity that allows students to discover lines of symmetry.

Anchor Activity: Paper Folding Exploration

Instructions: Work in groups. From a piece of paper, cut out a square shape and label the corners A, B, C, D as shown:

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    A _____ B

    |          |

    |          |

    D _____ C
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Step 1 – Vertical Fold: Fold the square in half from left to right such that corner A aligns with corner B and corner D aligns with corner C. This creates a rectangle. Unfold the paper and draw a dotted line across the fold line. Label it XY.

Observation: The left side of line XY and the right side are exactly the same/identical.

Step 2 – Horizontal Fold: Fold the square in half from top to bottom such that corner D aligns with corner A and corner C aligns with corner B. This creates another rectangle. Unfold and draw a dotted line across the fold line. Label it RS.

Observation: The upper side of line RS and the lower side are exactly the same/identical.

Step 3 – Diagonal Fold (A to C): Fold the paper in half from bottom left corner A to the top right corner C. This creates a triangle. Unfold and trace a dotted line along the fold line BD.

Step 4 – Diagonal Fold (D to B): Fold the paper in half from top left corner D to the bottom right corner B. This creates another triangle. Unfold and trace a dotted line along the fold line AC.

Teacher Circulation Questions

- "How many fold lines did you create in total?"
- "What do you notice about the two halves on either side of each fold line?"
- "Are all four fold lines the same type, or are some different?"
- "Can you think of other shapes that might have similar fold lines?"
- "What would happen if you tried this with a rectangle instead of a square?"

Phase 2: Structured Instruction (10 minutes)

Objective: Formalise the concept of symmetry and lines of symmetry, connecting student discoveries to mathematical definitions.

Connecting Discoveries to Formal Concepts

From the Anchor Activity: Students discovered four dotted lines: XY (vertical), RS (horizontal), BD (diagonal), and AC (diagonal). Both sides of each line are exactly the same.

Key Definition: Symmetry

Symmetry is when an object or shape looks exactly similar or identical on one side and the other side when the object is folded, flipped, rotated, or reflected.

Key Definition: Line of Symmetry

A **line of symmetry** divides an object or shape into similar/identical parts – that is, one half is the mirror image of the other half.

Conclusion from Activity: The four dotted lines XY, RS, AC, and BD are all lines of symmetry. Therefore, a square has 4 lines of symmetry.

Lines of Symmetry in Common Shapes

Shape	Number of Lines of Symmetry
Equilateral Triangle	3
Square	4
Rectangle	2
Regular Pentagon	5
Regular Hexagon	6
Circle	Infinite
Isosceles Triangle	1

Key Pattern: A regular polygon with n sides has exactly n lines of symmetry.

Addressing Misconceptions
- Not every line through the centre of a shape is a line of symmetry – both halves must be mirror images.
- A rectangle has only 2 lines of symmetry (not 4) because its diagonal does NOT create identical halves.
- Irregular shapes may have 0 lines of symmetry.
- A line of symmetry must create two halves that are exact mirror images, not just "roughly equal."

Phase 3: Practice and Application (15 minutes)

Objective: Apply the concept of lines of symmetry to various shapes, letters, and real-world objects.

Worked Example: Equilateral Triangle

Problem: Find the number of lines of symmetry in an equilateral triangle.

Solution: An equilateral triangle has 3 lines of symmetry. Each line runs from a vertex to the midpoint of the opposite side. Since all three sides and angles are equal, each vertex-to-midpoint line divides the triangle into two identical halves.

Practice: Lines of Symmetry in Alphabet Letters

Task: Identify lines of symmetry in each of the 26 alphabetical letters.

A B C D E F G H I

J K L M N O P Q R

S T U V W X Y Z

Answer Key: Alphabet Symmetry

Symmetry Type	Letters
Vertical line of symmetry only	A, M, T, U, V, W, Y
Horizontal line of symmetry only	B, C, D, E, K
Both vertical and horizontal lines	H, I, O, X
No line of symmetry	F, G, J, L, N, P, Q, R, S, Z

Real-World Application

Task: Identify lines of symmetry on different objects in your classroom and at home.

- Classroom door – 1 vertical line of symmetry
- Blackboard/whiteboard – 1 vertical line of symmetry
- Clock face – multiple lines of symmetry (12 for analogue clocks)
- Desk – 1 or 2 lines of symmetry depending on shape
- Window panes – varies by design
- Human face – approximately 1 vertical line of symmetry
- Butterfly wings – 1 vertical line of symmetry
- Starfish – 5 lines of symmetry

Phase 4: Assessment (Exit Ticket)

Objective: Assess individual understanding of lines of symmetry in plane figures and real-world objects.

Assessment Questions

1. Identify the lines of symmetry in each of the 26 alphabetical letters:
   A B C D E F G H I J K L M N O P Q R S T U V W X Y Z

2. Identify lines of symmetry on different objects in your classroom and at home. Draw at least 5 objects and mark their lines of symmetry.

3. How many lines of symmetry does a regular hexagon have? Draw and label each one.

4. Explain why a rectangle has 2 lines of symmetry but NOT 4. Use a diagram to support your answer.

5. A designer wants to create a logo with exactly 3 lines of symmetry. What shape could they use as the base? Sketch your design.

Answer Key

1. See Alphabet Symmetry table above in Phase 3.

2. Answers will vary. Examples:

- • Door: 1 vertical line
- • Window: 2 lines (vertical and horizontal)
- • Circular clock: 12 lines
- • Rectangular table: 2 lines
- • Pencil (side view): 1 horizontal line

3. A regular hexagon has 6 lines of symmetry: 3 lines connecting opposite vertices and 3 lines connecting midpoints of opposite sides.

4. A rectangle has only 2 lines of symmetry (1 vertical, 1 horizontal). The diagonals of a rectangle do NOT create identical halves because the resulting triangles, while equal in area, are not mirror images of each other along the diagonal line.

5. An equilateral triangle has exactly 3 lines of symmetry. Students may design a logo based on an equilateral triangle or a shape with 3-fold rotational symmetry.

IV. Differentiation Strategies

Student Group	Strategy
Struggling Learners	Provide pre-cut shapes (square, rectangle, triangle, circle) for physical folding. Use mirrors placed along potential lines of symmetry to visually confirm. Start with simple shapes before progressing to letters. Pair with a peer mentor during practice.
On-Level Learners	Complete all practice activities as designed. Encourage students to verify by folding or using a ruler. Work collaboratively on the classroom objects task.
Advanced Learners	Extend to the Extension Activity below. Investigate rotational symmetry in addition to reflective symmetry. Research symmetry in art, architecture, and nature. Create a symmetry portfolio with photographs of symmetric objects.

Extension Activity

Challenge 1 – Symmetry in Flags: Research and identify lines of symmetry in the flags of at least 5 African countries. Which flags have the most lines of symmetry? Which have none? Create a poster displaying your findings.

Challenge 2 – Symmetry in Architecture: Identify lines of symmetry in famous buildings or structures in Kenya (e.g., KICC, Parliament Building). Sketch the building and draw all lines of symmetry. Explain why architects use symmetry in their designs.

Challenge 3 – Creating Symmetric Designs: Design a tile pattern that has exactly 4 lines of symmetry. Then create a second design with exactly 6 lines of symmetry. Explain how you ensured the correct number of lines in each design.

Challenge 4 – Rotational vs Reflective Symmetry: Some shapes have rotational symmetry but no line of symmetry (e.g., the letter S, a parallelogram). Find 5 examples of shapes or objects with rotational symmetry but no reflective symmetry. Explain the difference between the two types.

V. Assessment Methods

Phase	Method	Purpose
Phase 1	Observation of paper folding activity	Gauge understanding of the folding process and ability to identify fold lines
Phase 2	Questioning during instruction	Check conceptual understanding of symmetry definitions
Phase 3	Monitoring practice work on letters and objects	Identify errors in symmetry identification and correct misconceptions
Phase 4	Exit ticket (5 questions)	Evaluate individual mastery of identifying lines of symmetry

VI. Teacher Reflection

To be completed after the lesson.

1. Did the paper folding activity effectively help students discover lines of symmetry before formal instruction?
2. Were students able to distinguish between lines of symmetry and other lines through a shape?
3. Which shapes or letters caused the most confusion when identifying lines of symmetry?
4. How well did students connect the concept of symmetry to real-world objects in their classroom?
5. Were the differentiation strategies effective in supporting all learners?
6. Was the 40-minute timeframe sufficient for all four phases?
7. What modifications would improve this lesson for future delivery?