

## I. Lesson Overview

<b>Strand</b>	Measurement and Geometry
<b>Sub-Strand</b>	Similarity and Enlargement
<b>Specific Learning Outcome</b>	Determine the image of an object under enlargement given the centre and the positive scale factor
<b>Grade Level</b>	Grade 10
<b>Duration</b>	40 minutes
<b>Key Inquiry Question</b>	How is similarity and enlargement applied in day-to-day life?
<b>Learning Resources</b>	CBC Grade 10 Mathematics Textbooks

## II. Learning Objectives

Category	Objective
Know	Define enlargement as a transformation that changes the size of a shape by a scale factor while preserving its shape. Identify the centre of enlargement, scale factor, object, and image.
Do	Construct the image of a triangle under enlargement with a positive scale factor using the centre of enlargement and coordinate methods. Calculate unknown lengths using the scale factor.
Apply	Apply enlargement with positive scale factors to determine image coordinates, find unknown distances, and solve real-world problems involving maps, models, and scaled drawings.

## III. Materials & Resources

- CBC Grade 10 Mathematics Textbooks
- Graph paper, rulers, pencils, protractors
- Digital textbook: INNODEMS CBC Grade 10 Maths — Section 2.1.2 Enlargement

## IV. Lesson Procedure

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

#### Anchor Activity: "Discovering Enlargement on the Coordinate Plane"

Students work in pairs to complete the following construction and investigation on graph paper:

##### Instructions:

- (a) Draw and label the x-axis and y-axis on the graph paper.
- (b) Mark the origin at  $(0, 0)$  and label it as O.
- (c) Plot the points A(2, 3), B(1, 1), and C(4, 1).
- (d) Connect points A, B, and C with straight lines to form triangle ABC.
- (e) Draw straight lines from O to A, O to B, and O to C.
- (f) Measure and record the lengths of OA, OB, and OC.
- (g) Extend each line to twice its original length and mark the new points as A', B', and C'.
- (h) Connect A', B', and C' to form the enlarged triangle A'B'C'.
- (i) Compare the two triangles and note any similarities.
- (j) Calculate the ratios  $OA'/OA$ ,  $OB'/OB$ , and  $OC'/OC$ . What do you notice between the three ratios?
- (k) Discuss your findings with the rest of the class.

##### Teacher's Role During Discovery:

- Circulate among pairs, checking that axes are correctly drawn and points are accurately plotted.
- Ask probing questions: "What coordinates did you get for A'?" "What is  $OA'$  compared to  $OA$ ?"
- For pairs who finish early: "Can you predict what would happen if you extended each line to THREE times its length instead of twice?"
- Encourage students to compare the shapes of both triangles — are they the same shape? Different size?
- Identify groups with clear findings to present during the sharing phase.
- Surface common errors (e.g., extending from the point instead of from the origin) for class discussion.

##### Expected Student Discoveries:

- $A' = (4, 6)$ ,  $B' = (2, 2)$ ,  $C' = (8, 2)$  — each coordinate is doubled.

- All three ratios  $OA'/OA = OB'/OB = OC'/OC = 2$ .
- Triangle  $A'B'C'$  is the same shape as triangle  $ABC$  but exactly twice the size.
- The corresponding angles of both triangles are equal.
- The corresponding sides of  $A'B'C'$  are exactly twice the corresponding sides of  $ABC$ .
- Both triangles share the same centre point  $O$  (the origin).

## Phase 2: Structured Instruction (10 minutes)

### Key Takeaways:

#### Definition of Enlargement:

The process of obtaining triangle  $A'B'C'$  from triangle  $ABC$  is known as enlargement. Triangle  $ABC$  is said to be the object and triangle  $A'B'C'$  is its image under enlargement. The point  $O$  is known as the centre of enlargement.

#### Scale Factor:

To determine the scale factor, divide the length of the enlarged image by the corresponding length of the original object:

$$OA'/OA = OB'/OB = OC'/OC = \text{Scale Factor}$$

$$A'B'/AB = A'C'/AC = B'C'/BC = \text{Scale Factor}$$

#### Properties of Enlargement with Positive Scale Factor:

- Enlargement is a transformation that changes the size of a shape by a scale factor while preserving its shape.
- The scale factor is used to multiply the length of each side of the shape to get the length of the corresponding side of the enlarged shape.
- If scale factor  $> 1$ : the image is LARGER than the object (enlargement).
- If  $0 < \text{scale factor} < 1$ : the image is SMALLER than the object (reduction).
- In an enlargement, the object and its image remain similar. The linear scale factor determines the proportional transformation.
- Lines connecting object points to their corresponding image points intersect at the centre of enlargement.
- For enlargement centred at the origin with scale factor  $k$ : the image of point  $(x, y)$  is  $(kx, ky)$ .

### **Connecting to Student Discoveries:**

- Reference the ratio of 2 that students found — this is the linear scale factor of the enlargement.
- Show how  $A(2,3)$  became  $A'(4,6)$  by multiplying each coordinate by the scale factor 2.
- Demonstrate that the triangles are similar: same shape, different size.
- Explain that the origin was the centre of enlargement — all lines from object to image pass through O.
- Address misconception: "extending to twice the length" means the NEW length from O is twice the original, not adding the original length again from the point.

### **Phase 3: Practice and Application (10 minutes)**

#### **Problem 1: Finding Scale Factor and Image Lengths**

Triangle  $P'Q'R'$  is the enlarged image of triangle  $PQR$ , with centre O.

- (a) Given that  $OP = 6$  cm and  $PP' = 9$  cm, determine the linear scale factor of the enlargement.
- (b) If  $QR = 4$  cm, find the length of  $Q'R'$ .

#### **Solution:**

- (a)  $OP = 6$  cm and  $PP' = 9$  cm, so  $OP' = OP + PP' = 6 + 9 = 15$  cm.
- Linear scale factor =  $OP'/OP = 15/6 = 5/2$ .
- (b) Scale factor =  $Q'R'/QR$ , and  $QR = 4$  cm.
- $Q'R'/4 = 5/2$
- $Q'R' = (4 \times 5)/2 = 20/2 = 10$  cm.

#### **Problem 2: Enlargement Using Coordinates**

Given that  $A(6, 8)$ ,  $B(8, 8)$ ,  $C(12, 8)$ ,  $D(14, 2)$  and  $E(10, 0)$  are the vertices of a pentagon, find the vertices of its image after an enlargement with the origin as the centre and scale factor of:

- (a) 2
- (b)  $1/2$

**Solution:**

Given the centre of enlargement is  $(0, 0)$  and scale factor  $k$ , the image coordinates are:  $(x', y') = (kx, ky)$ .

**(a) For scale factor  $k = 2$ :**

Original Point	Calculation	Image Point
A(6, 8)	$(2 \times 6, 2 \times 8)$	A'(12, 16)
B(8, 8)	$(2 \times 8, 2 \times 8)$	B'(16, 16)
C(12, 8)	$(2 \times 12, 2 \times 8)$	C'(24, 16)
D(14, 2)	$(2 \times 14, 2 \times 2)$	D'(28, 4)
E(10, 0)	$(2 \times 10, 2 \times 0)$	E'(20, 0)

**(b) For scale factor  $k = 1/2$ :**

Original Point	Calculation	Image Point
A(6, 8)	$(\frac{1}{2} \times 6, \frac{1}{2} \times 8)$	A'(3, 4)
B(8, 8)	$(\frac{1}{2} \times 8, \frac{1}{2} \times 8)$	B'(4, 4)
C(12, 8)	$(\frac{1}{2} \times 12, \frac{1}{2} \times 8)$	C'(6, 4)
D(14, 2)	$(\frac{1}{2} \times 14, \frac{1}{2} \times 2)$	D'(7, 1)
E(10, 0)	$(\frac{1}{2} \times 10, \frac{1}{2} \times 0)$	E'(5, 0)

**Key Observation:**

When the scale factor is 2, every coordinate doubles — the image is larger. When the scale factor is  $1/2$ , every coordinate halves — the image is smaller (a reduction). Both are positive scale factors, so the image stays on the same side of the centre as the object.

**Phase 4: Assessment — Exit Ticket (5 minutes)****Assessment Questions:**

1. A triangle has vertices P(1, 2), Q(3, 2), and R(2, 5). Find the coordinates of the image after an enlargement with the origin as centre and scale factor 3.
2. Triangle XYZ is enlarged from centre O. If  $OX = 4$  cm and  $OX' = 12$  cm, what is the scale factor? If  $YZ = 5$  cm, find  $Y'Z'$ .
3. A rectangle ABCD has vertices A(2, 1), B(6, 1), C(6, 3), and D(2, 3). Find the image after an enlargement with the origin as centre and scale factor  $1/2$ . What are the dimensions of the image rectangle compared to the original?

4. Construct any triangle XYZ and choose a point O outside the triangle. Using O as the centre of enlargement and a scale factor of 4, describe the steps to construct the enlarged image of triangle XYZ.

#### **Answer Key:**

- 1. P'(3, 6), Q'(9, 6), R'(6, 15). Each coordinate is multiplied by 3.
- 2. Scale factor =  $OX'/OX = 12/4 = 3$ .  $Y'Z' = 3 \times 5 = 15$  cm.
- 3. A'(1, 0.5), B'(3, 0.5), C'(3, 1.5), D'(1, 1.5). Original dimensions:  $4 \times 2$ . Image dimensions:  $2 \times 1$ . Each dimension is halved (scale factor  $1/2$ ).
- 4. Steps: (i) Measure OX, OY, OZ. (ii) Multiply each by 4 to get OX', OY', OZ'. (iii) Extend lines OX, OY, OZ to the new lengths. (iv) Mark X', Y', Z' and connect to form the image triangle.

## **V. Differentiation Strategies**

Learner Level	Strategy
<b>Struggling Learners</b>	Provide pre-drawn coordinate grids with the original triangle already plotted. Use a step-by-step checklist: (1) Write original coordinates, (2) Multiply each by scale factor, (3) Plot new points, (4) Connect. Use whole-number scale factors only (2, 3). Pair with a stronger student for support.
<b>On-Level Learners</b>	Complete all anchor activity steps and practice problems independently. Encourage peer explanation of the coordinate method. Use the digital textbook interactive checkpoints for additional randomized practice with enlargements.
<b>Advanced Learners</b>	Extension Activity: Explore enlargement with a centre NOT at the origin. Given triangle with vertices P(1, 2), Q(3, 2), R(2, 4) and centre of enlargement at C(1, 1), find the image with scale factor 3 using the formula: Image = Centre + $k \times$ (Point – Centre). Investigate what happens to the area when the scale factor is k (area scales by $k^2$ ).

## **VI. Extension Activity**

### **Enlargement with Non-Origin Centre and Area Investigation:**

1. A triangle has vertices A(2, 1), B(4, 1), and C(3, 3). The centre of enlargement is at (1, 0) with scale factor 2. Find the image coordinates.

- Solution: Use  $\text{Image} = \text{Centre} + k \times (\text{Point} - \text{Centre})$ .
- $A' = (1 + 2(2-1), 0 + 2(1-0)) = (1+2, 0+2) = (3, 2)$
- $B' = (1 + 2(4-1), 0 + 2(1-0)) = (1+6, 0+2) = (7, 2)$
- $C' = (1 + 2(3-1), 0 + 2(3-0)) = (1+4, 0+6) = (5, 6)$

2. Area Investigation: The original triangle ABC from the anchor activity has vertices A(2,3), B(1,1), C(4,1).

- Area of ABC =  $\frac{1}{2}|2(1-1) + 1(1-3) + 4(3-1)| = \frac{1}{2}|0 - 2 + 8| = \frac{1}{2} \times 6 = 3$  square units.
- Area of A'B'C' (scale factor 2) =  $\frac{1}{2}|4(2-2) + 2(2-6) + 8(6-2)| = \frac{1}{2}|0 - 8 + 32| = \frac{1}{2} \times 24 = 12$  square units.
- Ratio of areas =  $12/3 = 4 = 2^2 = k^2$ . The area scales by the SQUARE of the scale factor.

3. A photograph measures 10 cm  $\times$  15 cm. It is enlarged with a scale factor of 2.5. Find the new dimensions and the ratio of the new area to the original area.

- Solution: New dimensions = 25 cm  $\times$  37.5 cm. Area ratio =  $2.5^2 = 6.25$ .

## VII. Assessment Methods

Type	Method
<b>Formative</b>	Observation during pair work: Are students plotting points accurately? Are they extending lines from O correctly? Questioning: "What is the scale factor?" "How do you find the image coordinates?" Monitoring ratio calculations during the anchor activity.
<b>Summative</b>	Exit ticket with 4 questions covering: coordinate enlargement, scale factor calculation, image length determination, and construction steps. Collect and review for mastery assessment.

## VIII. Teacher Reflection

1. Did students accurately plot points and construct both triangles on the coordinate plane?
2. Were students able to discover that the ratios  $OA'/OA$ ,  $OB'/OB$ ,  $OC'/OC$  are all equal to the scale factor?
3. How effectively did pair work support collaborative discovery and peer discussion?

4. Did the structured instruction successfully connect the hands-on activity to formal definitions of enlargement and scale factor?
5. Were students able to apply the coordinate method  $(x', y') = (kx, ky)$  independently?
6. How well did the differentiation strategies meet the needs of struggling, on-level, and advanced learners?
7. What adjustments would improve the lesson for future delivery?