Chapter 10: Symmetrical Designs

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Exercise 10.1 — Alphabet Cutout — Lines of Symmetry in Letters (p. 136)

Q1 Which of the following alphabet cutouts can be made by just drawing half (1/2) or quarter (1/4) of the letter? Draw lines of symmetry on the letters to find out.

E N X T K V O

(a) Which of the letters have a horizontal line of symmetry?

(b) Which of the letters have a vertical line of symmetry?

(c) Which letters have both vertical and horizontal lines of symmetry?

SOLUTION

A letter can be cut from a half-fold if it has at least one line of symmetry.

A letter can be cut from a quarter-fold if it has both a vertical AND a horizontal line of symmetry.

Check each letter:

E — horizontal line of symmetry only (top half mirrors the bottom half).

N — no line of symmetry (N has rotational symmetry but not reflection symmetry).

X — vertical AND horizontal lines of symmetry.

T — vertical line of symmetry only (left half mirrors the right half).

K — horizontal line of symmetry only (top half mirrors the bottom half).

V — vertical line of symmetry only.

O — vertical AND horizontal lines of symmetry.

(a) Letters with a horizontal line of symmetry: E, K, X, O

(b) Letters with a vertical line of symmetry: T, V, X, O

(c) Letters with BOTH vertical and horizontal lines of symmetry: X, O

Letters that can be cut by folding in half (1/2): E, X, T, K, V, O (all with at least one line of symmetry).
Letters that can be cut by folding into quarters (1/4): X, O (both lines of symmetry).
N cannot be made this way as it has no line of symmetry.

Answer: (a) Horizontal line of symmetry: E, K, X, O (b) Vertical line of symmetry: T, V, X, O (c) Both: X, O

Exercise 10.2 — Let Us Do — Paper Cutouts of Diya, Boat and Designs (p. 136)

Q1 Use lines of symmetry to make paper cutouts of a diya, a boat, and other designs. Look along the border of the page to find the pictures.

SOLUTION

This is a hands-on activity. Here is how to do it:

1. Look at the diya (lamp) shape shown on the border of the page. Notice it has a vertical line of symmetry — the left and right halves are mirror images.
2. Fold a paper in half vertically.
3. Draw half the diya shape along the fold (the fold = the line of symmetry).
4. Cut along the outline and open the paper to see the full diya.

For the boat: the boat shape also has a vertical line of symmetry. Repeat the same steps.

For designs with both vertical and horizontal symmetry (like a flower or star), fold the paper into quarters and draw one quarter of the design along the corner of the fold.

Tip: The fold always represents the line (or lines) of symmetry.

Answer: Hands-on activity. Fold paper along the line(s) of symmetry, draw half (or quarter) of the shape along the fold, cut, and unfold to get the full symmetrical cutout.

Exercise 10.3 — Let Us Make a Windmill Firki — Rotational Symmetry (p. 137)

Q1 Observe the dot in the firki. Does the firki look the same after 1/4, 1/2, 3/4, and a full turn?

SOLUTION

A firki (windmill) has 4 blades arranged equally around the centre.
When you turn it by 1/4 turn (90 degrees), one blade moves to where the next blade was — the firki looks exactly the same.
This is true for every 1/4 turn: after 1/4, 2/4 (= 1/2), 3/4, and a full (4/4) turn, the firki looks the same.

The dot on the blade helps you track how far it has turned, but the overall shape (all 4 blades) looks identical at each of these positions.
So: Yes, the firki looks the same after 1/4 turn, 1/2 turn, 3/4 turn, and a full turn.

Answer: Yes. The firki looks the same after every 1/4 turn (at 1/4, 1/2, 3/4, and full turn) because it has 4 equal blades.

Q2 Observe the letters H, I, X, and Y in the table. Do they look the same when turned? Complete the table to show which letters have rotational symmetry.

SOLUTION

H — already filled in the table: looks the same at 1/2 turn. Rotational symmetry: Yes, at 1/2 turn.

I (vertical bar) — At 1/4 turn: the bar becomes horizontal — different. At 1/2 turn: the bar is vertical again — looks the same (with the dot back at top/bottom). Rotational symmetry: Yes, at 1/2 turn.

X — At 1/4 turn: the top and bottom arms are closer together than the left and right arms, so after a 90 degree turn the X does NOT look the same. At 1/2 turn (180 degrees): it looks the same. Rotational symmetry: Yes, at 1/2 turn.

Y — At 1/4 turn: Y with stem to the left — different. At 1/2 turn: Y upside down — different from original Y. At 3/4 turn: different. Rotational symmetry: No.

Answer: H: Yes, at 1/2 turn. I: Yes, at 1/2 turn. X: Yes, at 1/2 turn. Y: No rotational symmetry.

Exercise 10.4 — Let Us Do — Symmetry in Digits 0–9 (p. 138)

Q1 Find symmetry in the digits 1 2 3 4 5 6 7 8 9 0.
(a) Which digit(s) have reflection symmetry?
(b) Which digit(s) have rotational symmetry?
(c) Which digit(s) have both rotational and reflection symmetries?
Now look at the numbers: || and |00|
Do these have (a) rotational symmetry, (b) reflection symmetry, or (c) both symmetries?
Give examples of 2-, 3-, and 4-digit numbers which have rotational symmetry, reflection symmetry, or both.

SOLUTION

Check each digit (using standard printed form):
0 — vertical and horizontal lines of symmetry; looks same upside down. => Both.
1 — vertical line of symmetry (left-right mirror). => Reflection only.
2 — no line of symmetry; upside-down 2 does not look like 2. => Neither.
3 — horizontal line of symmetry (top mirrors bottom). => Reflection only.
4 — no line of symmetry. => Neither.
5 — no line of symmetry; upside-down 5 looks like 2 (different digit). => Neither.
6 — no line of symmetry; upside-down 6 looks like 9 (different digit). => Neither.
7 — no standard line of symmetry. => Neither.
8 — vertical and horizontal lines of symmetry; looks same upside down. => Both.
9 — no line of symmetry; upside-down 9 looks like 6 (different digit). => Neither.

(a) Reflection symmetry: 0, 1, 3, 8
(b) Rotational symmetry (half turn, looks like itself): 0, 1, 8
(c) Both: 0, 1, 8

Now for the numbers:

		(two vertical bars):		
Reflection (vertical mirror):		flipped left-right =>		(same). Yes.
Reflection (horizontal mirror):		flipped up-down =>		(same). Yes.
Rotational (half turn):		rotated 180 degrees =>		(same). Yes.
=>		has both rotational and reflection symmetry.		

	00	(bars and zeros):		
Reflection (vertical mirror):	00	reversed =>	00	(palindrome of symmetric digits). Yes.
Reflection (horizontal mirror): each digit (	, 0) is horizontally symmetric. Yes.			

	00	(bars and zeros):		
Rotational (half turn):	00	upside-down =>	00	(same). Yes.
=>	00	has both rotational and reflection symmetry.		

Examples of multi-digit numbers (use only digits that stay the same themselves: 0, 1, 8; and read the same forwards and backwards):

2-digit, both symmetries: 11, 88

3-digit, both symmetries: 101, 111, 181, 808, 888

4-digit, both symmetries: 1001, 1111, 8008, 1881

Answer: (a) Reflection: 0, 1, 3, 8 (b) Rotational: 0, 1, 8 (c) Both: 0, 1, 8. ||: both symmetries. |00|: both symmetries. Examples — 2-digit both: 11, 88; 3-digit both: 808, 888; 4-digit both: 1001, 8008.

Exercise 10.5 — Making Designs — Rotational and Reflection Symmetry (p. 139)

Q1 Look at the design (a large blue cross shape with triangles and circles). Answer the following:
(a) Does the design have rotational symmetry? Yes/No.
(b) Try to change the design by adding some shape(s) so that the new design looks the same after a 1/2 turn. Draw the new design in your notebook.
(c) Now try to modify or add more shapes so that the new design looks the same after a 1/4 turn. Draw the new design in your notebook.
(d) Do the new designs have reflection symmetry? If yes, draw the lines of symmetry.

SOLUTION

(a) The original design shows a cross shape with blue arrows pointing left and right, circles at the sides, and triangles pointing up and down.
Looking at the design: the top has a downward-pointing triangle, the bottom has an upward-pointing triangle (different), the left and right have circles. This design does NOT look the same after a 1/4 turn or a 1/2 turn because the triangles and arrows are different at top vs bottom.
Answer: No, the original design does not have rotational symmetry.

(b) To make it look the same after a 1/2 turn, the bottom must be a 180-degree rotation of the top.
Add a downward-pointing triangle at the bottom (matching the one at top), and make the left and right identical too.
Example: place identical shapes on opposite sides (top = bottom after half turn, left = right after half turn).
Draw this design in your notebook.

(c) To make it look the same after every 1/4 turn, all four sides (top, right, bottom, left) must be identical.
Replace the circles and triangles with the same shape on every side (for example, four identical arrows or four identical triangles pointing outward).
Draw this design in your notebook.

(d) A design that looks the same after a 1/2 turn often also has 2 lines of reflection symmetry (one vertical, one horizontal).
A design that looks the same after a 1/4 turn often has 4 lines of reflection symmetry (vertical, horizontal, and two diagonal).
Draw the lines through the centre of your new design to mark its lines of symmetry.

Answer: (a) No. (b) Add shapes so the bottom is a mirror of the top (e.g. matching triangle at bottom); then it has 1/2-turn symmetry. (c) Make all four sides identical; then it has 1/4-turn symmetry. (d) Yes — the 1/2-turn design has 2 lines of symmetry; the 1/4-turn design has 4 lines of symmetry.

Exercise 10.6 — Let Us Think — Colouring for Rotational Symmetry (p. 139)

Q1 Look at the shape below: a 2x2 blue square with a triangle attached on its left side and another on its right side, both pointing outward. Does this shape have reflection symmetry? If yes, draw its line(s) of symmetry. Does it have rotational symmetry? If yes, at which turn? Does it have both symmetries?

SOLUTION

Reflection symmetry: Yes. The shape has 2 lines of symmetry.

- A horizontal line through the middle: the top half matches the bottom half.
- A vertical line through the middle: the left half (with its triangle) matches the right half (with its triangle).

Rotational symmetry: Yes. The shape looks the same after a 1/2 turn (180 degrees) - the left and right triangles swap places and it looks unchanged. A 1/4 turn would move the side triangles to the top and bottom, so it does NOT look the same after a 1/4 turn.

Both symmetries: Yes - the shape has both reflection symmetry and rotational symmetry.

Answer: Reflection symmetry: Yes, 2 lines (one horizontal, one vertical). Rotational symmetry: Yes, at a 1/2 turn. It has BOTH symmetries.

Exercise 10.7 — Let Us Do — Symmetrical Designs with Squares and Triangles (p. 139–140)

Q1 Cut out squares and equilateral triangles with the same side length (provided at the end of the book). Make different symmetrical designs by using these two shapes.
For the sample design shown (two triangles flanking a 2x2 arrangement of blue squares, with triangles on opposite sides):
(a) Does this shape have reflection symmetry? If yes, draw its line(s) of symmetry.
(b) Does it have rotational symmetry? If yes, at which turn?
(c) Does it have both symmetries?
Now make your own designs and sort them into 3 categories: only rotational symmetry, only reflection symmetry, and both.

SOLUTION

The design shown has two equilateral triangles (one on each side) flanking a 2x2 block of blue squares.

(a) Reflection symmetry: The design looks the same if you flip it left-right (the triangles are on opposite sides, both identical) OR flip it top-bottom.
Yes, it has reflection symmetry. Lines of symmetry: one vertical line through the centre of the 2x2 block, and one horizontal line through the centre.

(b) Rotational symmetry: Rotating the design 180 degrees (1/2 turn) gives the same look (the two triangles swap sides, but the design looks identical). So yes, it has rotational symmetry at 1/2 turn.

(c) Yes, this design has both reflection and rotational symmetry.

For your own designs:
Only rotational symmetry: arrange shapes so they look the same after turning but NOT after flipping (e.g. a pinwheel-style arrangement of triangles all facing the same rotational direction).
Only reflection symmetry: arrange shapes that look the same in a mirror but change when rotated (e.g. two squares side by side with a triangle on one end only).
Both: a design balanced both horizontally and vertically (e.g. a cross of squares with triangles on all four sides pointing outward).

Answer: (a) Yes — vertical and horizontal lines of symmetry through the centre. (b) Yes — rotational symmetry at 1/2 turn. (c) Yes, both.

Exercise 10.8 — Let Us Explore — Block Printing and Symmetry (p. 140–141)

Q1 Match each wooden block to its correct print by drawing a line. One is done for you (block iv is matched to print e).
Blocks: (i) large paisley/mango-leaf shape, (ii) lotus flower, (iii) large floral mandala, (iv) half-circle fan [matched to (e) already], (v) thin vertical leaf/vine
Prints: (a) round floral rosette, (b) thin green leaf vine, (c) paisley/mango-leaf half, (d) yellow lotus, (e) red fan [matched]

SOLUTION

From the images in the book:
Block (iv) — half-circle fan => Print (e) red fan. [Already done for you.]

Block (i) — large paisley/mango-leaf shape => Print (c) paisley/mango-leaf half.
Block (ii) — lotus flower block => Print (d) yellow lotus.
Block (iii) — large floral mandala block => Print (a) round floral rosette.
Block (v) — thin vertical leaf/vine => Print (b) thin green leaf vine.

Matching: (i) => (c), (ii) => (d), (iii) => (a), (iv) => (e), (v) => (b).

Answer: (i) => (c) (ii) => (d) (iii) => (a) (iv) => (e) [given] (v) => (b)

Q2 Observe the pattern made by a leaf-shaped wooden block printed 4 times to make a cross-like design (Design A). Design A looks the same after every 1/4 turn.
Now look at Design B (a four-petal flower shape with dashed lines).
(a) The design B looks the same after every ___ turn.
(b) This design has ___ symmetry.

SOLUTION

Design A: the leaf block is placed pointing in 4 directions (up, right, down, left), creating a cross/compass pattern. Rotating it 90 degrees (1/4 turn) moves each leaf to where the next one was — it looks identical. So Design A has 1/4-turn rotational symmetry.

Design B: the image shows a four-petal flower shape with dashed lines indicating lines of symmetry. The four petals are arranged symmetrically.

Rotational symmetry: Rotating Design B by 1/4 turn (90 degrees) maps each petal onto the next petal — the design looks the same. So it looks the same after every 1/4 turn.

The dashed lines shown in the design are lines of reflection symmetry (at least 4 lines: horizontal, vertical, and two diagonals).

Design B therefore has BOTH rotational and reflection symmetry.

(a) Design B looks the same after every 1/4 turn.
(b) Design B has both rotational and reflection symmetry.

Answer: (a) 1/4 turn (b) both rotational and reflection symmetry

Exercise 10.9 — Let Us Do — Border Shapes: Reflection and Rotational Symmetry (p. 141)

Q1 Observe the shapes given on the border of the page. Which of the shapes have reflection symmetry? Put a tick (v) mark on them. Put a * on the shapes that have rotational symmetry.

SOLUTION

The border of page 141 shows various shapes: triangles, squares, hexagons, circles, rhombuses, stars, and other geometric shapes.

Shapes with reflection symmetry (tick): most regular shapes like equilateral triangle, square, rectangle, regular hexagon, circle, rhombus, and regular star all have lines of symmetry.

Equilateral triangle: 3 lines of symmetry. Tick.
Square: 4 lines of symmetry. Tick.
Regular hexagon: 6 lines of symmetry. Tick.
Circle: infinite lines of symmetry. Tick.
Rhombus: 2 lines of symmetry. Tick.
Regular star/pentagon: multiple lines of symmetry. Tick.

Shapes with rotational symmetry (*): regular shapes with more than 1 line of symmetry also have rotational symmetry.

Equilateral triangle: 1/3 turn symmetry. *
Square: 1/4 turn symmetry. *
Regular hexagon: 1/6 turn symmetry. *
Circle: any turn. *
Rhombus: 1/2 turn symmetry. *

This is a hands-on activity — mark the shapes on your page as you study each one.

Answer: Regular shapes (triangle, square, hexagon, circle, rhombus, star) all have reflection symmetry (tick) AND rotational symmetry (*). Irregular or asymmetric shapes have neither.

Exercise 10.10 — Project Work — Symmetrical Patterns with Vegetable Blocks (p. 141)

Q1 Create symmetrical patterns and designs using vegetable blocks. Two examples are shown: (a) an okra (bhindi) cross-section stamped to make a flower pattern, and (b) a potato cut to make oval prints arranged in a 3x3 grid with two colours.

SOLUTION

This is a hands-on project activity. Here is how to do it:

1. Choose a vegetable: okra (bhindi), potato, bitter gourd, or any vegetable with a flat cut surface.
2. Cut the vegetable in half to create a flat stamping surface.
3. Dip the flat surface in paint and press it on paper to make prints.

For a symmetrical design:

Plan your design first — decide where each print will go.

For reflection symmetry: place prints as mirror images on either side of a centre line.

For rotational symmetry: rotate the stamp and print at equal angles around a centre point.

Example (a) from the book: okra cross-section has a star shape. Stamping it 4 times around a centre (rotating 90 degrees each time) creates a flower with 4-fold rotational symmetry.

Example (b) from the book: a potato oval stamped in a 3x3 grid using two colours in an alternating pattern creates a design with both reflection and rotational symmetry.

After making your design, check: does it have reflection symmetry? Rotational symmetry? Both? Sort it into the correct category.

Answer: Project activity: use vegetable stamps to create symmetrical prints. Arrange stamps as mirror images for reflection symmetry, or rotate at equal angles for rotational symmetry. The okra example shows 4-fold rotational symmetry; the potato grid example shows both reflection and rotational symmetry.