Chapter 11: Fun with Symmetry

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Exercise 11.1 — Let Us Do — Ink Design

Q1 Ink Design: Take a sheet of paper, fold it in half, sprinkle drops of water colours near the fold, then press it. Is the pattern you made symmetrical? Where would you draw the line that divides this design into two equal halves?

SOLUTION

When you fold the paper and press the wet colours, the colour spreads equally on both halves. The left half and the right half become mirror images of each other.

Yes, the pattern is symmetrical.

The line of symmetry is the fold line — the crease in the middle of the paper — which divides the design into two equal halves.

Exercise 11.2 — Let Us Do — Making a Paper Airplane

Q1 a) Mark the line of symmetry in Fig. 3, Fig. 4, and Fig. 5 of the paper airplane folding steps.

SOLUTION

In Fig. 3, the paper is folded horizontally across its width — the line of symmetry is the horizontal fold crease running across the middle of the rectangle. In Fig. 4, the paper is folded again to form the airplane nose — the line of symmetry is now the diagonal fold crease from the top-centre down to the bottom-centre. In Fig. 5, the wings are spread but still folded at the centre — the line of symmetry is the lengthwise fold crease running from the pointed nose down to the tail end. Draw a dotted line along each of these fold creases in Fig. 3, Fig. 4, and Fig. 5.

Q2 b) How many lines of symmetry can you see in Fig. 8 (the completed paper airplane)?

SOLUTION

The completed paper airplane (Fig. 8) has both wings folded symmetrically about the central fold line.

When you look at it from the front or top, only the lengthwise fold (running nose to tail) makes the two halves identical.

There is 1 line of symmetry in Fig. 8.

Q3 c) Where will you place a mirror to see the reflection of the right half side of Fig. 8? Will it look the same as the left half side?

SOLUTION

Place the mirror along the line of symmetry — the central fold line that runs from the nose to the tail of the plane.

When the mirror reflects the right half, the reflection shows the left half.

Yes, it will look exactly the same as the left half side because the airplane is symmetrical about that fold line.

Q4 e) Will the plane fly if there is no line of symmetry?

SOLUTION

A plane needs both wings to be equal in size and shape to balance during flight.

If there is no line of symmetry, the two wings are unequal.

An asymmetrical plane will not fly straight — it will tilt and fall quickly because one wing creates more lift than the other.

No, the plane will not fly properly without a line of symmetry.

Q5 f) Try to make an asymmetrical plane. g) Fly both the planes and see which plane flies for a longer time. h) Share your observations with your friends.

SOLUTION

Make an asymmetrical plane by folding one wing more than the other so the two sides are not equal.

When you fly both planes, the symmetrical plane (equal wings) flies in a straight path and stays airborne longer.

The asymmetrical plane spins or curves to one side and lands sooner.

Observation: The symmetrical plane flies for a longer time because balanced wings share the air resistance equally.

Exercise 11.3 — Let Us Do — Holes and Cuts

Q1 Challenge 1: Rani folds a piece of paper twice. She makes a straight cut at the corner and cuts out two squares on two sides. Where would the hole and cut appear when you open the paper?

SOLUTION

When paper is folded twice, it creates 4 layers arranged in 4 quarters.
A straight cut at the corner (the folded corner = centre of the original sheet) creates a triangular notch. When unfolded, this appears as a square/diamond hole exactly at the centre of the paper.
The two squares cut on the sides: each cut on the folded paper appears on both halves when unfolded. Since the paper was folded twice, each side-cut appears on all 4 sides (or symmetrically on opposite edges).
The hole appears at the centre of the paper; the cuts on the sides appear symmetrically (reflected) on all four sides of the sheet.

Q2 Challenge 2: Fold a piece of paper once; put two cuts in the middle as shown. How many sides will this shape have when you open the folded paper?

SOLUTION

Start with a rectangle (4 sides).
Fold it once — now there are 2 layers.
Make 2 straight cuts (slits) through the folded paper in the middle area.
When unfolded, each cut appears on both halves of the paper (above and below the fold line), creating 2 pairs of matching cuts = 4 cuts total.
Each cut pair turns the outline of the shape from a straight edge into a notch with 3 new sides, removing 1 original side segment — net gain of 2 sides per cut pair.
2 cut pairs × 2 extra sides + original 4 sides = 4 + 4 = 8 sides.
The shape will have 8 sides when opened.

Q3 Challenge 3: Fold a paper twice. Where would you cut to make a square hole in the center of the paper? How many cuts are required?

SOLUTION

Fold the paper in half, then fold it in half again — the paper is now in quarters.
The innermost corner of the folded paper corresponds to the centre of the original sheet.
Make 1 diagonal or small square cut at that inner corner.
When the paper is unfolded, the 4 layers mean that 1 cut produces 4 matching cuts that together form a square hole exactly at the centre.
Only 1 cut is required.

Q4 Complete the designs: Complete the half-designs given so that the finished shape is symmetrical.

SOLUTION

The page shows 6 half-designs on dot grids. For each, the line of symmetry is the dotted or straight edge dividing the given half from the empty half. To complete each design: (1) X-star half — reflect each arm of the star across the vertical centre line to draw the matching right half. (2) 6-pointed star half — reflect each point across the vertical centre line. (3) Kolam diagonal pattern (top-right) — reflect the chain of looping curves across the vertical centre line. (4) Heart/arrow half (bottom-left) — reflect the curved and pointed shape across the vertical centre line to make a complete heart with a point at the bottom. (5) Zigzag arrow half (bottom-middle) — reflect the staircase zigzag across the vertical centre line to make a symmetric arrow pointing right. (6) Kolam loop pattern (bottom-right) — reflect the looping kolam design across the vertical centre line. In every case, each dot that is the same distance from the line of symmetry on the given side must be matched by a dot at the same distance on the other side.

Exercise 11.4 — Symmetry in Shapes — Shapes on Dot Grid

Q1 Look at the shapes given along the border. Draw these shapes on the dot grid. Which of the shapes are symmetrical? Draw the lines of symmetry.

SOLUTION

The four shapes shown along the border are: a kite (top-left), an upward-pointing arrow (top-right), an envelope (bottom-left), and an orange triangle (bottom-right). Draw each on the dot grid. Kite: symmetrical — draw 1 vertical line of symmetry from the top tip to the bottom tip. Upward-pointing arrow (pentagon shape): symmetrical — draw 1 vertical line of symmetry from the arrow tip down through the middle. Envelope: symmetrical — draw 1 vertical line of symmetry from the top flap point down through the centre. Orange triangle: this is a scalene triangle (all sides different lengths) — it is NOT symmetrical and has 0 lines of symmetry. The kite, arrow, and envelope are symmetrical; the orange triangle is not.

Exercise 11.5 — Symmetry in Shapes — Games with a Mirror

Q1 a) Where should we place the mirror on Shape A to get each of the 6 shapes shown (1 to 6)?

SOLUTION

Shape A is an L-shaped piece made of 3 pink squares (2 squares in the top row and 1 square below on the left). Placing the mirror at different positions gives the 6 shapes: Shape 1 (two small squares side by side) — place the mirror vertically on the right side of the top square of A; the reflection of just that top-right square appears, giving 2 squares. Shape 2 (2×2 block of 4 squares) — place the mirror vertically to the right of the full L-shape; the reflected image fills in the missing square to complete a 2×2 block. Shape 3 (tall T or wider block) — place the mirror horizontally on top of the 2-square row; the reflection doubles the shape upward. Shape 4 (3 squares in a horizontal row) — place the mirror to the right of the single bottom square of A; the reflection adds 2 more squares to the right, making a 1×3 row. Shape 5 (2×2 block, 4 squares) — place the mirror vertically along the inner corner of the L; Shape 6 (4 squares in an L or row) — place the mirror at the bottom edge. For each numbered result shape, position the mirror so that shape A and its reflection together match the outline shown.

Q2 b) Circle the numbers whose mirror image is the same number. The numbers shown are 686 and 181.

SOLUTION

A number looks the same in a mirror (placed on the side) if all its digits are individually symmetric AND the whole number is a palindrome (reads the same forwards and backwards).
Digits that look the same in a vertical mirror: 0, 1, 8.
Check 686: digits are 6, 8, 6. The digit 6 is NOT vertically symmetric. So 686 does NOT have the same mirror image.
Check 181: digits are 1, 8, 1. All three digits (1, 8, 1) are vertically symmetric, and 181 reads the same forwards and backwards. So 181 DOES have the same mirror image.
Circle 181. (686 does not qualify because 6 is not symmetric.)

Q3 Which digits from 0 to 9 have the same mirror image?

SOLUTION

Check each digit for vertical symmetry (left half = right half): 0 — symmetric (oval shape, same both sides); 1 — symmetric (straight vertical line); 2 — NOT symmetric; 3 — NOT symmetric; 4 — NOT symmetric; 5 — NOT symmetric; 6 — NOT symmetric; 7 — NOT symmetric; 8 — symmetric (two stacked ovals); 9 — NOT symmetric.
Digits with the same mirror image: 0, 1, and 8.

Q4 Make some 4-digit numbers such that the mirror image is the same number. Where would you keep the mirror in each case?

SOLUTION

For a 4-digit number to look the same in a mirror, every digit must be from {0, 1, 8} and the number must be a palindrome (same forwards and backwards).
Examples: 1001, 1111, 1881, 8008, 8118, 8888.
Check 1001: digits 1,0,0,1 — all symmetric, and 1001 reversed = 1001. Valid.
Check 1881: digits 1,8,8,1 — all symmetric, and 1881 reversed = 1881. Valid.
For all these numbers, place the mirror vertically to the RIGHT side (or left side) of the written number — the reflection reads the same number.

Q5 Guess my number. It is a 3-digit number near 120 whose mirror image is the same number. Where is the mirror kept?

SOLUTION

A 3-digit mirror-same number must use only the digits 0, 1, 8 and be a palindrome: the form is A B A where A $\in$ {1, 8} and B $\in$ {0, 1, 8}.
All such numbers: 101, 111, 181, 808, 818, 888.
The number nearest to 120: |101−120| = 19, |111−120| = 9, |181−120| = 61. Closest is 111.
The mystery number is 111.
Place the mirror vertically on the RIGHT side (or left side) of the written number 111.

Exercise 11.6 — Symmetry in Shapes — Mirror Words

Q1 What do you notice about the letters written on the ambulance? Why are they written this way? Discuss.

SOLUTION

The word AMBULANCE is written in reverse (as a mirror image) on the front of an ambulance. This is because when a driver looks in their rear-view mirror, the mirror reverses the writing back to normal — so the driver can read AMBULANCE correctly and knows to give way.
Letters are written in mirror script so they appear readable in a reflection.

Q2 Can you identify these words written in mirror script: PAT, CAN, WOW, NEH? Where will you place the mirror to read the following words correctly?

SOLUTION

These words are written as their mirror images (reversed left-to-right). To read them, place a mirror on the LEFT side of each word — the reflection shows the correct word.
PAT (written reversed as mirror script): place mirror on left → reads PAT.
CAN (written reversed): place mirror on left → reads CAN.
WOW (written reversed): WOW is a palindrome and uses the letters W, O, W which are all vertically symmetric — placing the mirror on EITHER side reads WOW correctly.
NEH (written reversed): place mirror on left → reads HEN.

Exercise 11.7 — Symmetry in Shapes — Complete Symmetrical Shapes

Q1 Complete the following to make symmetrical shapes (half-shapes are given; complete each to make a full symmetrical figure).

SOLUTION

The page shows two half-shapes on dot grids, each with a line of symmetry. First half-shape (house with roof): the line of symmetry is the vertical dotted line through the centre. The given left half shows the roof peak at the top-centre and the left wall going down. To complete: draw the right wall of the house mirroring the left wall, and connect at the roof peak — the result is a symmetrical house shape (a rectangle with a triangular roof). Second half-shape (staircase/L-shape): the line of symmetry is the vertical dotted line. The given half shows a descending staircase on the left side. To complete: draw the mirror-image ascending staircase on the right side — each step on the left gets a matching step at the same height on the right. The completed shape is a symmetrical stepped or cross shape.

Exercise 11.8 — Symmetry in Shapes — Lines of Symmetry of Regular Shapes

Q1 Observe the shapes. How many sides does each shape have? How many lines of symmetry does each shape have? You may trace these shapes and check by folding.

SOLUTION

The two panels show various coloured shapes on a grid. Identify each shape, count its sides, and count its lines of symmetry. From the figures: Right-pointing triangle (arrow/chevron shape) — 3 sides, 1 line of symmetry (horizontal through the tip and the midpoint of the flat side). Small blue rectangle — 4 sides, 2 lines of symmetry (one horizontal, one vertical). Purple kite/diamond — 4 sides, 2 lines of symmetry (one along each diagonal). Orange parallelogram — 4 sides, 0 lines of symmetry (a parallelogram with unequal angles has no line of symmetry). Blue diamond (rhombus) — 4 sides, 2 lines of symmetry (both diagonals). Green scalene triangle — 3 sides, 0 lines of symmetry. Orange right-pointing arrow triangle — 3 sides, 1 line of symmetry. Light-blue trapezoid — 4 sides, 0 lines of symmetry (irregular trapezoid). Pattern: shapes where all sides meeting a vertex are equal tend to have more lines of symmetry; irregular shapes have 0.

Exercise 11.9 — Tiling the Tiles — Identifying and Continuing Patterns

Q1 Here are some patterns with tiles. Identify the repeating unit (tile) and continue the patterns.

SOLUTION

Pattern 1 (green and blue rectangular tiles in a basketweave layout): the repeating unit is one horizontal rectangle paired with one vertical rectangle side by side — this pair slides across and down to fill the whole pattern. You can also see a group of 8 rectangles (4 horizontal + 4 vertical in a 2×2 block arrangement) as a larger repeating unit. Continue the pattern in the empty grid by drawing the same arrangement of horizontal and vertical rectangles in alternating rows. Pattern 2 (similar green-and-blue basketweave): the repeating unit is again one horizontal + one vertical rectangle. Continue by sliding this pair to fill the empty grid squares with no gaps or overlaps. Note: different students may identify the single-pair unit or the 8-rectangle block as their repeating unit — both are valid.

Exercise 11.10 — Tiles at the Tile Shop — Designing Tiles

Q1 Which shapes have you used to make your tiles?

SOLUTION

This is an open activity — design your own tile using shapes such as squares, rectangles, triangles, hexagons, or combinations of these.

Name the shapes you used; for example: 'I used squares and right-angled triangles to make my tile.'

Q2 Which of the tiles are symmetrical? Draw the lines of symmetry (if any).

SOLUTION

The six example tiles shown are all hexagonal tiles decorated with triangles and kite shapes. Each has a pinwheel or star design made from coloured triangles. A pinwheel tile (triangles rotating around the centre) is NOT symmetrical — rotating the pinwheel design does not create a matching fold, so it has 0 lines of symmetry. A tile with a star pattern where the coloured triangles are arranged in pairs that mirror each other across a centre line IS symmetrical — it has lines of symmetry along the diagonals between opposite points. For the tiles you designed yourself: if your tile uses equal shapes placed symmetrically around the centre (like the star-flower tile), draw the dotted lines through opposite corners or opposite midpoints as lines of symmetry. If your tile uses a rotating (pinwheel) arrangement, it has no line of symmetry — mark it with 0 lines.

Q3 Make more tiles by joining two or more shapes. Trace them in your notebook to create paths with no gaps or overlaps.

SOLUTION

Join two or more basic shapes (e.g., a square and two triangles) to create a new tile shape.

Make sure the tile can fit with copies of itself — edge-to-edge — with no gaps or overlaps.

Trace the tile repeatedly on your notebook, sliding (translating) it horizontally and vertically to fill the page.

You may also flip or rotate the tile to fill the space — this is called a tessellation.

Exercise 11.11 — Tiles at the Tile Shop — Floor Patterns

Q1 Make a floor pattern with your tile (no overlaps and no gaps). Mini has made a floor pattern — make your own similar pattern.

SOLUTION

Trace your tile shape on a large sheet of paper to create the first tile.
Place copies of the same tile next to it — the edges must line up exactly so there are no gaps between tiles and no tiles overlap.
Continue filling the space by sliding (and/or flipping/rotating) the tile in all directions.
You can use two different colours to make the pattern more interesting, as Mini did.

Q2 Making a catty wall! Follow the steps to cut, slide and paste a square piece of paper to make a cat-shaped tile. Then trace and tile the outline to make a wall pattern.

SOLUTION

Take a square piece of paper and draw the outline of a cat's head and ears on one side.
Cut along the drawn outline on the top part only.
Slide the cut-out top piece straight down so it aligns with the bottom edge of the square — do not rotate or flip it.
Tape the two pieces together: the top now has the cat-head cut-out removed, and the bottom has the matching piece added.
The new shape still tiles perfectly because sliding preserves the interlocking edges — what was removed from the top was added to the bottom.
Trace this cat-shaped tile repeatedly (sliding it) on a large paper to make a wall pattern with no gaps or overlaps.

Exercise 11.12 — Nature Walk Project — Symmetry in Nature

Q1 Go for a nature walk. Collect leaves, petals, and flowers. Categorise the leaves into symmetrical and non-symmetrical. Make designs and patterns. Make a greeting card using imprints. Create animals or designs using leaves and flowers.

SOLUTION

Symmetrical leaves: most leaves (like mango, banana, rose) have a central midrib that acts as the line of symmetry — the left half and right half are mirror images. These are symmetrical.

Non-symmetrical leaves: some leaves (like ivy or certain oak varieties) have irregular lobes and are not symmetrical.

To verify: fold the leaf along the midrib — if both halves overlap, it is symmetrical.

For the project file: press the collected leaves flat, arrange symmetrical ones in one group and non-symmetrical ones in another.

Create patterns by placing leaves in a repeating arrangement; make a greeting card by pressing a leaf, painting its underside, and printing it on paper.

Use leaves as shapes to create animal outlines or decorative designs — enjoy the creativity!