# Parallelograms and Symmetry

The drawings below show how four dots can be connected to make a parallelogram. These are the only general possibilities. All four sides may be equal length (top 3 drawings) or unequal (bottom 2 drawings). The angles between sides may be 90° or not. Note that the 60° rhombus is a special case of the general rhombus that has angles of 60° and 120° at the corners.

For each drawing, in the space provided, indicate whether the parallelogram has a 2-fold axis of symmetry, a 3-fold access of symmetry, a 4-fold access of symmetry, a 6-fold axis of symmetry, and/ or any mirror planes of symmetry. Also state whether the parallelogram has an inversion center of symmetry.

What symmetry is present?
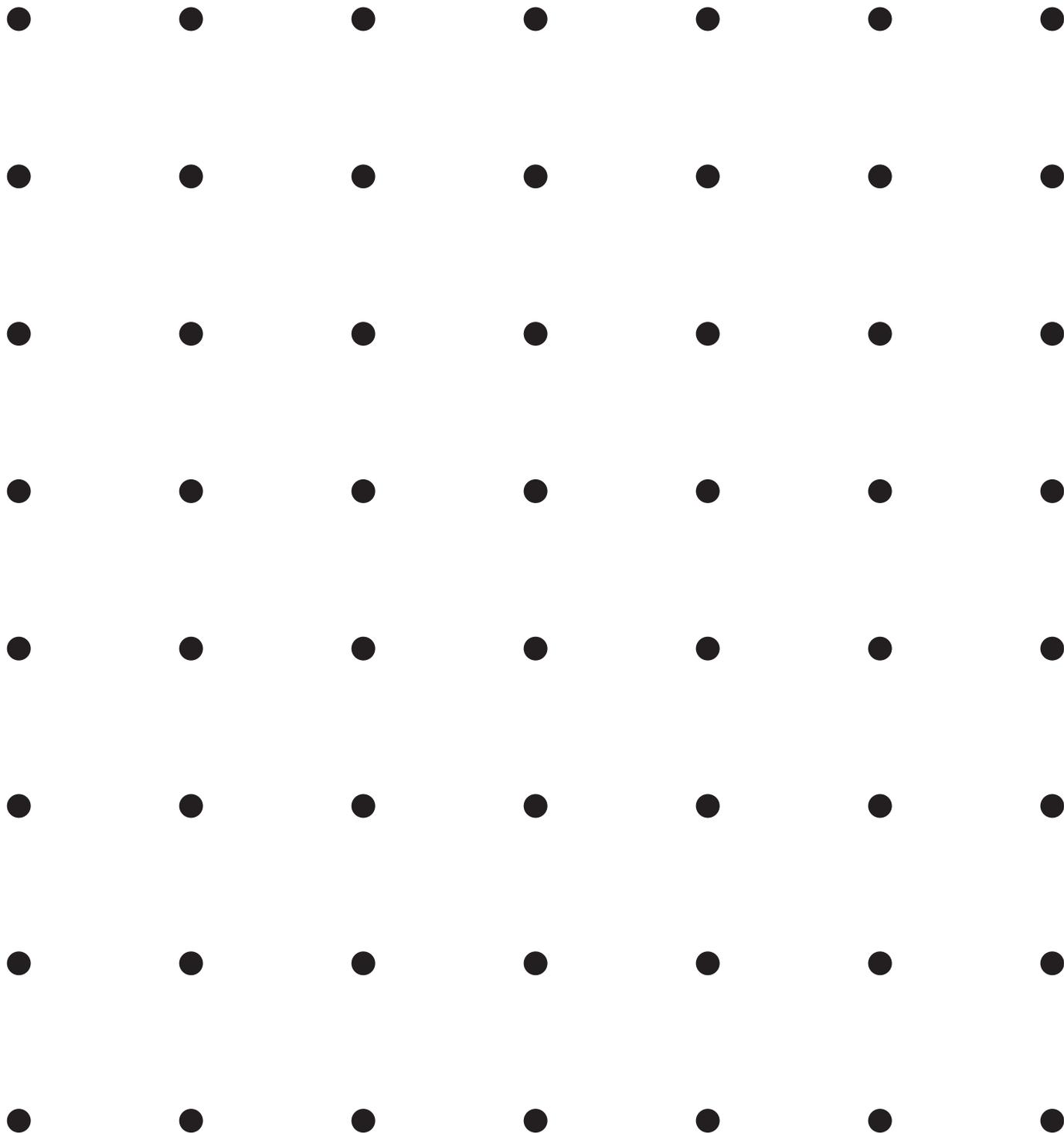
square
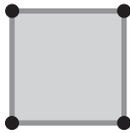
rhombus

60° rhombus

rectangle

rhomboid

Square net: The pattern below shows dots arranged in a "square" pattern. This pattern should be thought of as part of a pattern the extends infinitely in all directions.

Use conventional symbols (shown below) to show the symmetry of the pattern. If present, show 6-fold rotation axis with hexagons, 4-fold rotation axes with squares, 2-rold rotation axes with lens shapes, and mirror planes with solid lines.

⬡	☐	△	◊	╱
6-fold axis	4-fold axis	3-fold axis	2-fold axis	mirror plane

Be neat – there may be many rotation axes or mirrors.

Does this pattern have an inversion center of symmetry?

● ● ● ● ● ● ●

● ● ● ● ● ● ●

● ● ● ● ● ● ●

● ● ● ● ● ● ●

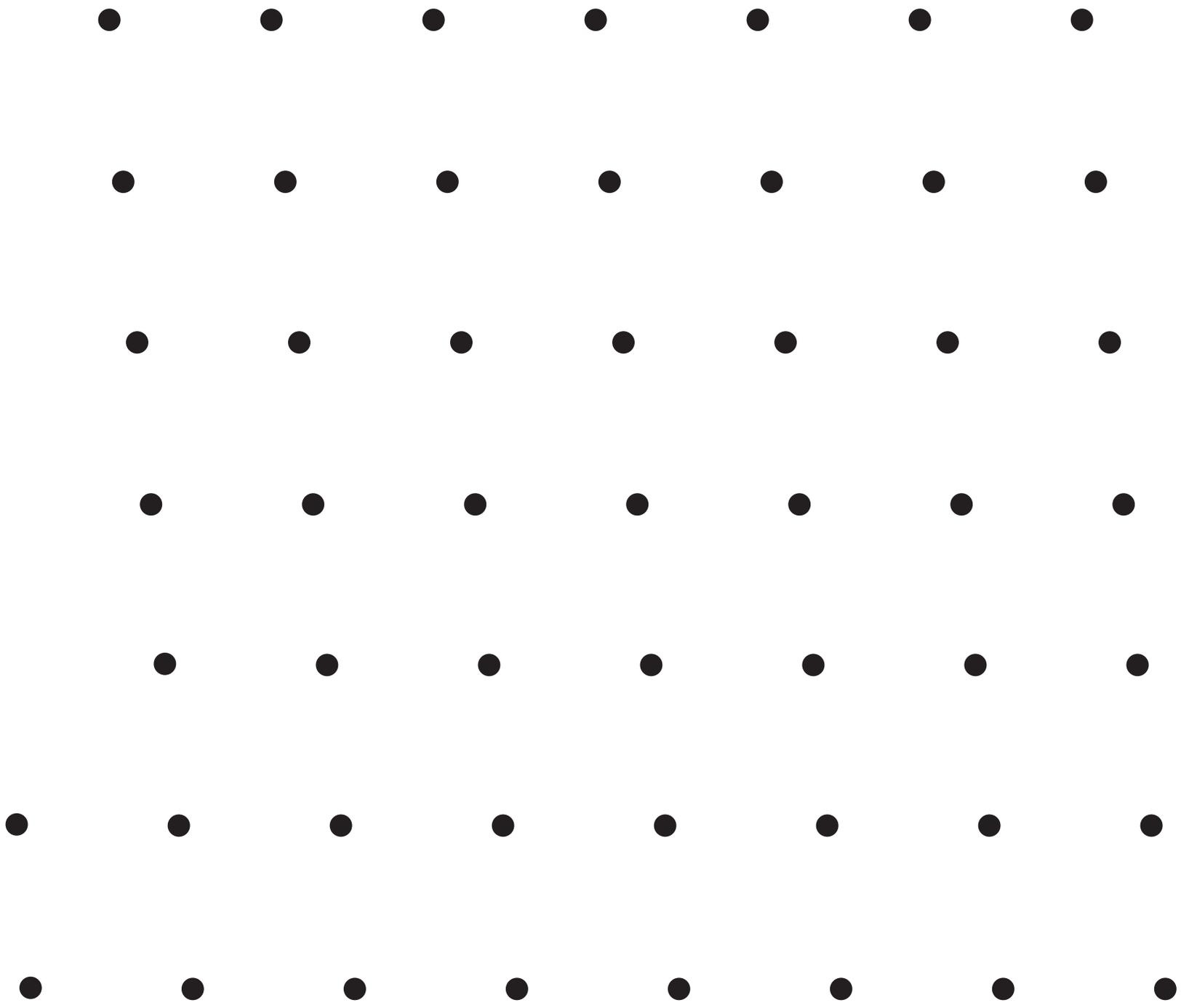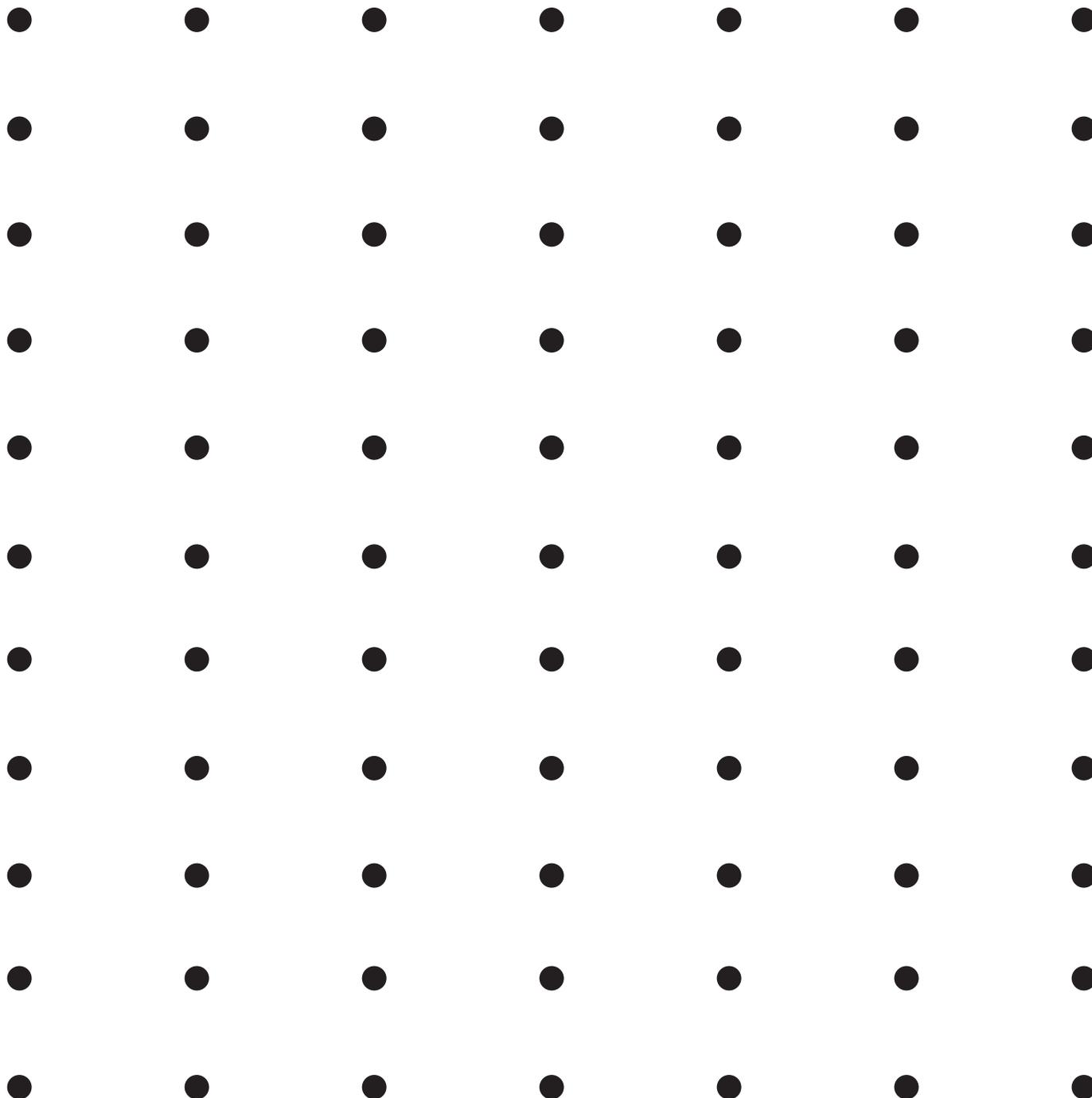● ● ● ● ● ● ●

● ● ● ● ● ● ●

● ● ● ● ● ● ●

● ● ● ● ● ● ●

Rombohedral net: The pattern below shows dots arranged in a "rhombus" pattern. This pattern should be thought of as part of a pattern the extends infinitely in all directions.

Use conventional symbols (shown below) to show the symmetry of the pattern. If present, show 6-fold rotation axis with hexagons, 4-fold rotation axes with squares, 2-rold rotation axes with lens shapes, and mirror planes with solid lines.
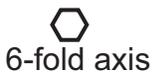
6-fold axis ⬡   4-fold axis ☐   3-fold axis △   2-fold axis ◊   mirror plane ⟍

Be neat – there may be many rotation axes or mirrors.

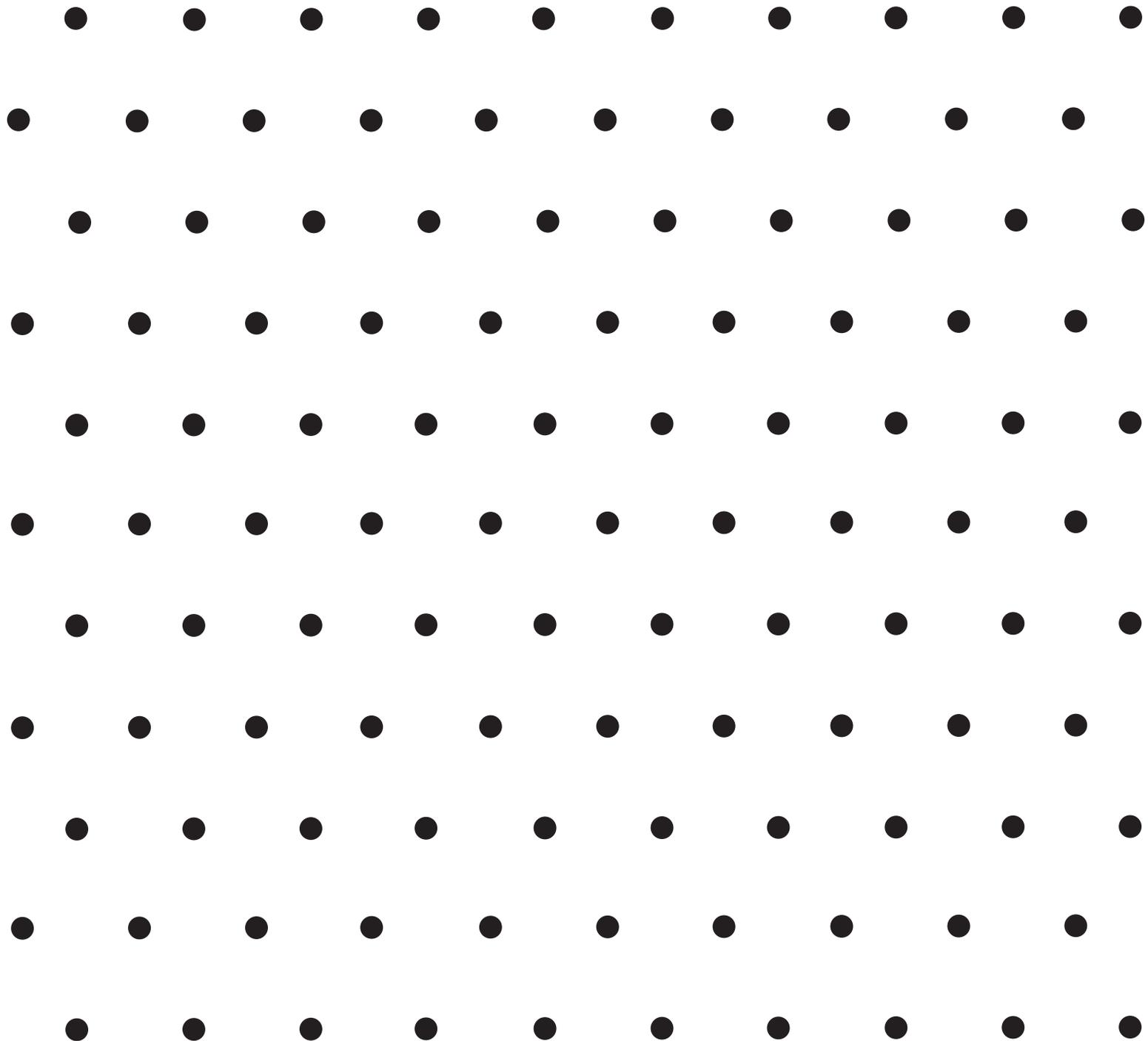Does this pattern have an inversion center of symmetry?

Rectangular net: The pattern below shows dots arranged in a "rectangular" pattern. This pattern should be thought of as part of a pattern the extends infinitely in all directions.

Use conventional symbols (shown below) to show the symmetry of the pattern. If present, show 6-fold rotation axis with hexagons, 4-fold rotation axes with squares, 2-rold rotation axes with lens shapes, and mirror planes with solid lines.

⬡	▢	△	◊	⟋
6-fold axis	4-fold axis	3-fold axis	2-fold axis	mirror plane

Be neat – there may be many rotation axes or mirrors.
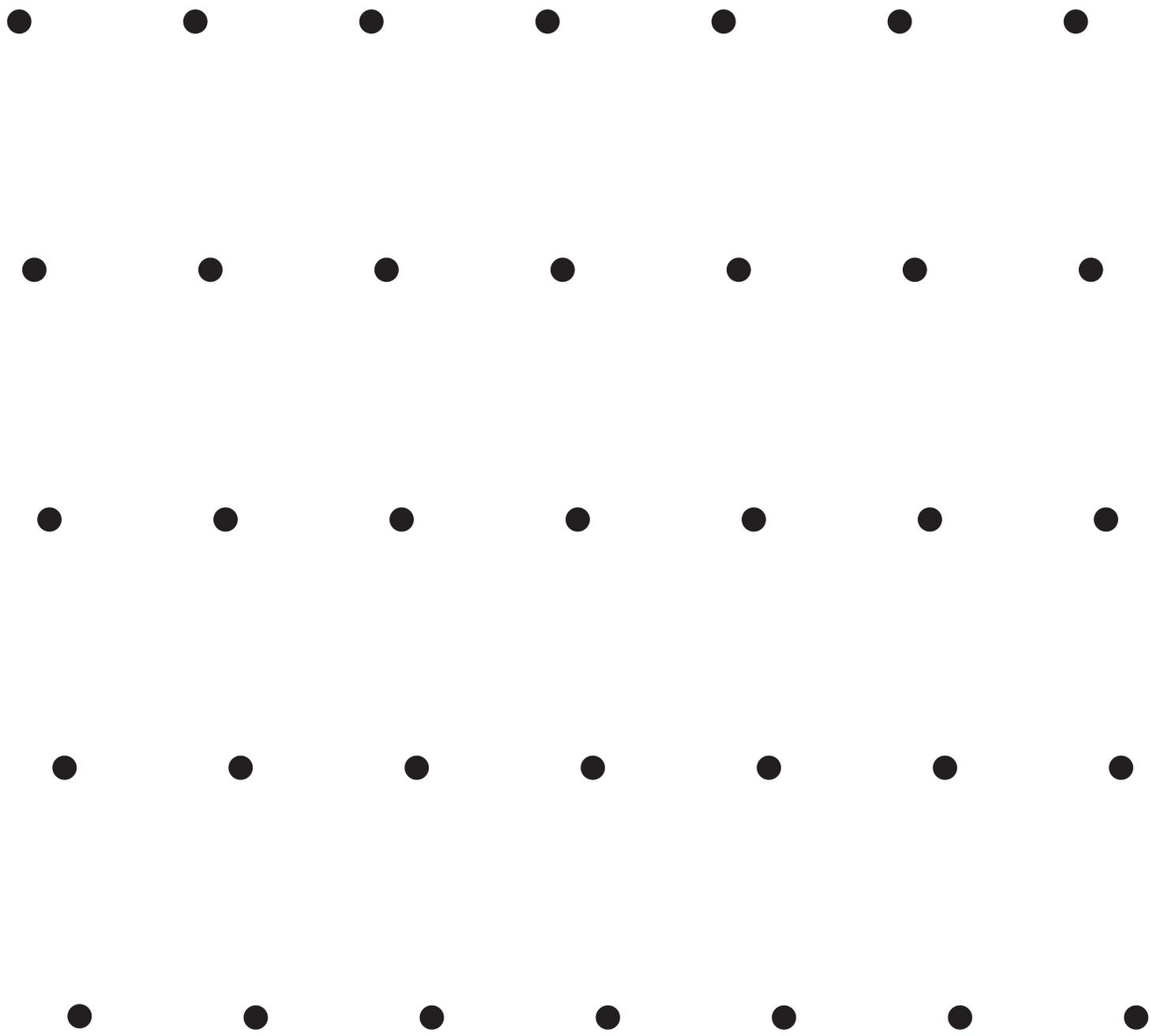
Does this pattern have an inversion center of symmetry?

Hexanet: The pattern below shows dots arranged in a "hexagonal" pattern. This pattern should be thought of as part of a pattern the extends infinitely in all directions.

Use conventional symbols (shown below) to show the symmetry of the pattern. If present, show 6-fold rotation axis with hexagons, 4-fold rotation axes with squares, 2-rold rotation axes with lens shapes, and mirror planes with solid lines.

⬡   ▢   △   ◊   ⟋
6-fold axis   4-fold axis   3-fold axis   2-fold axis   mirror plane

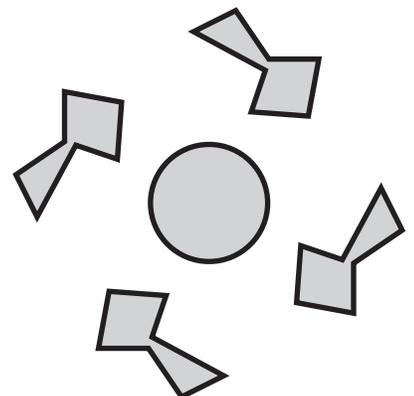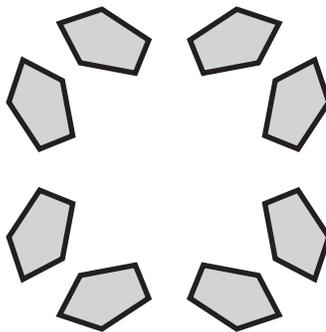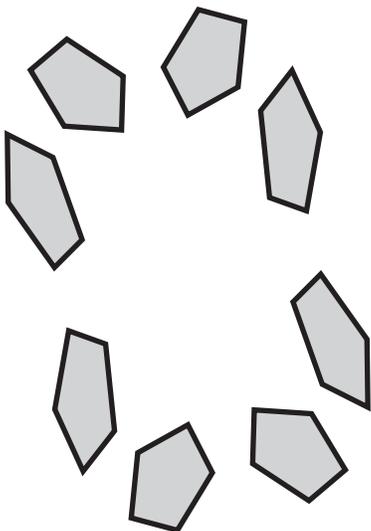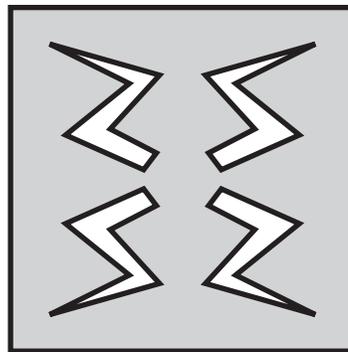Be neat – there may be many rotation axes or mirrors.

Does this pattern have an inversion center of symmetry?

Clnonet: The pattern below shows dots arranged in a "rhomboid" pattern. This pattern should be thought of as part of a pattern the extends infinitely in all directions.

Use conventional symbols (shown below) to show the symmetry of the pattern. If present, show 6-fold rotation axis with hexagons, 4-fold rotation axes with squares, 2-rold rotation axes with lens shapes, and mirror planes with solid lines.

6-fold axis ⬡   4-fold axis ☐   3-fold axis △   2-fold axis ◊   mirror plane ⫽
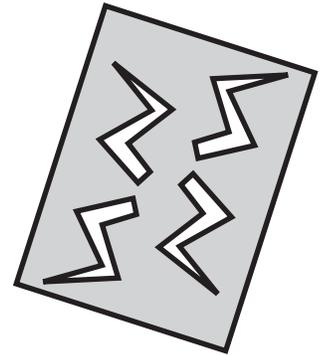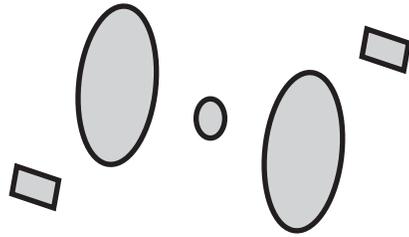
Be neat – there may be many rotation axes or mirrors.

Does this pattern have an inversion center of symmetry?

●   ●   ●   ●   ●   ●   ●

●   ●   ●   ●   ●   ●   ●

 ●   ●   ●   ●   ●   ●   ●
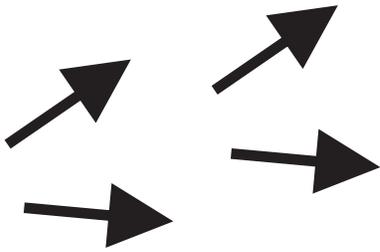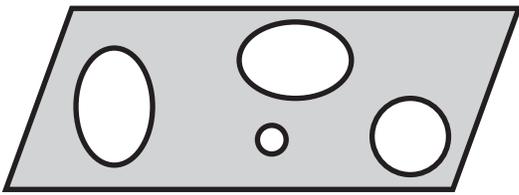
  ●   ●   ●   ●   ●   ●   ●

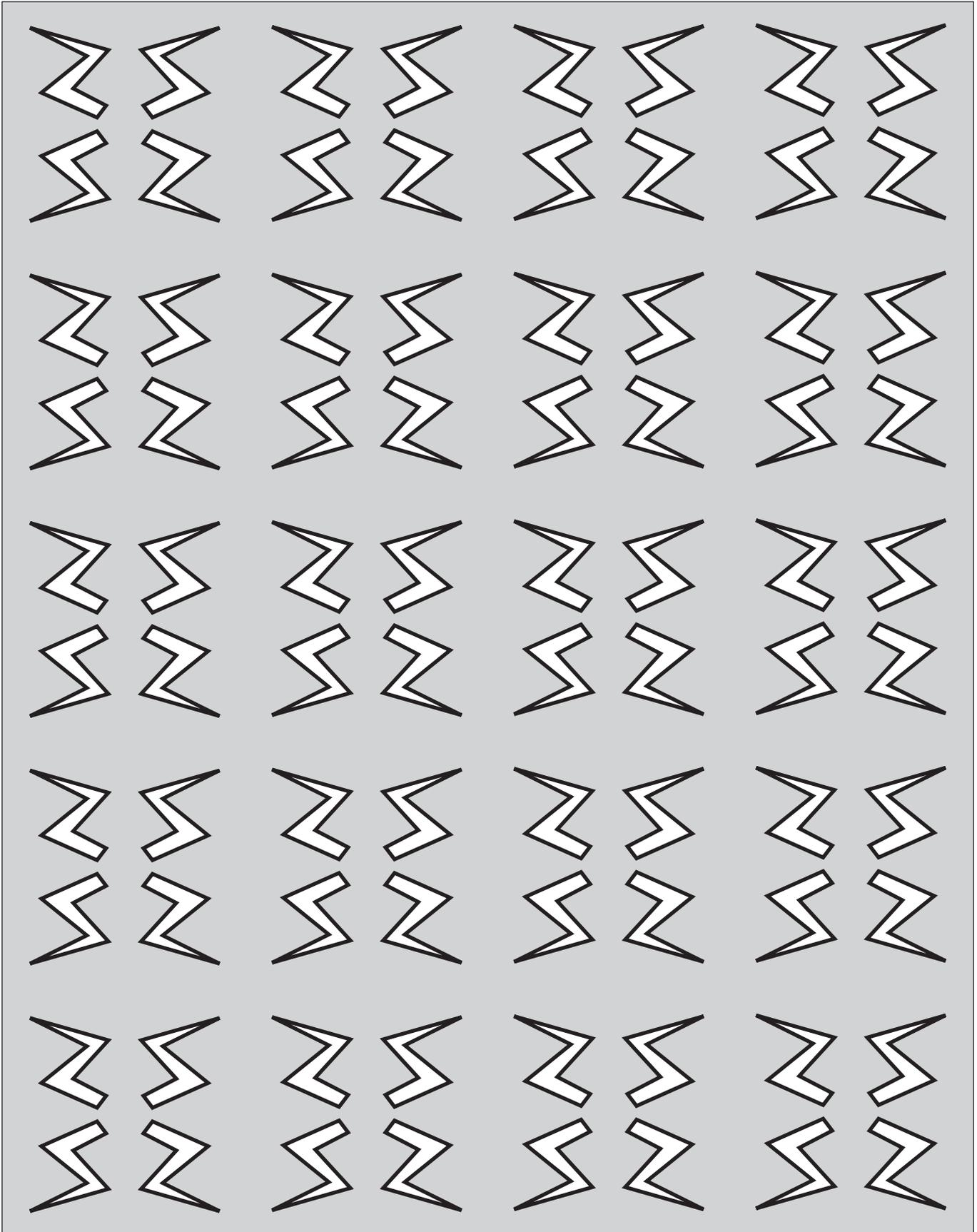   ●   ●   ●   ●   ●   ●   ●

For each of the 8 patterns, use conventional symbols to show where the symmetry operators are.
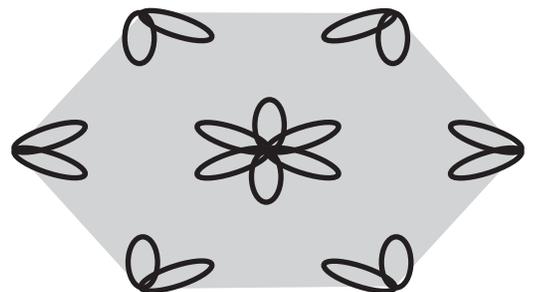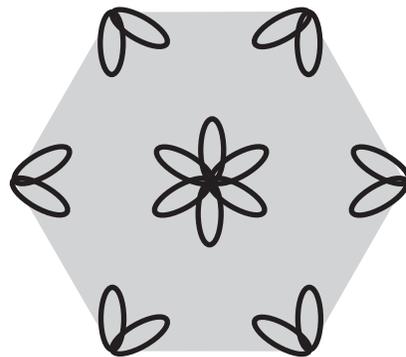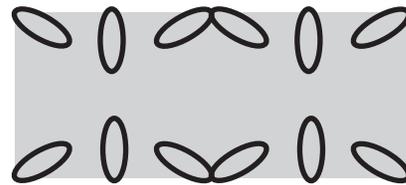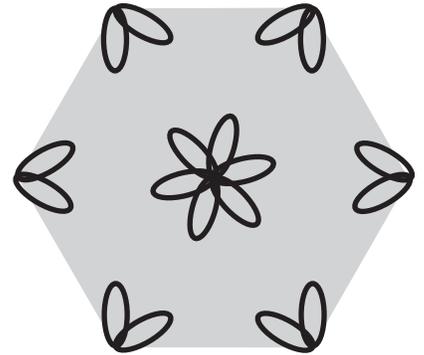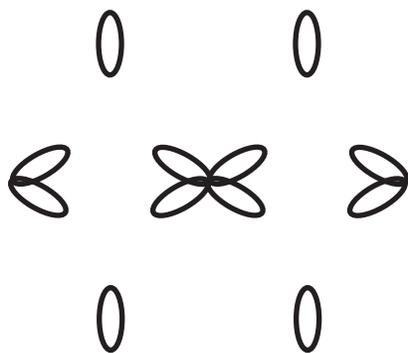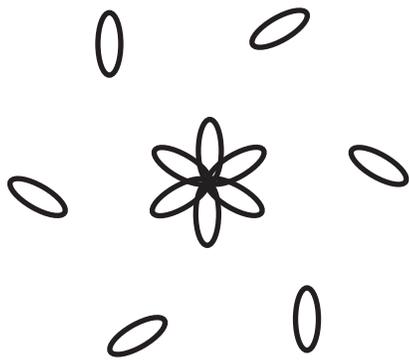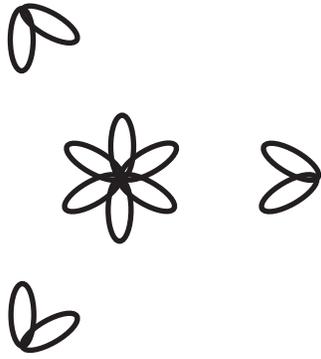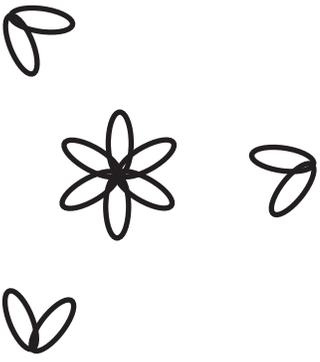
For each of the 8 patterns, use conventional symbols to show where the symmetry operators are.

Assume that this pattern is part of an infinite pattern that extends in all directions.

Use conventional symbols to show where all the symmetry operators are.

Then outline a unit cell that repeats to create the entire pattern.

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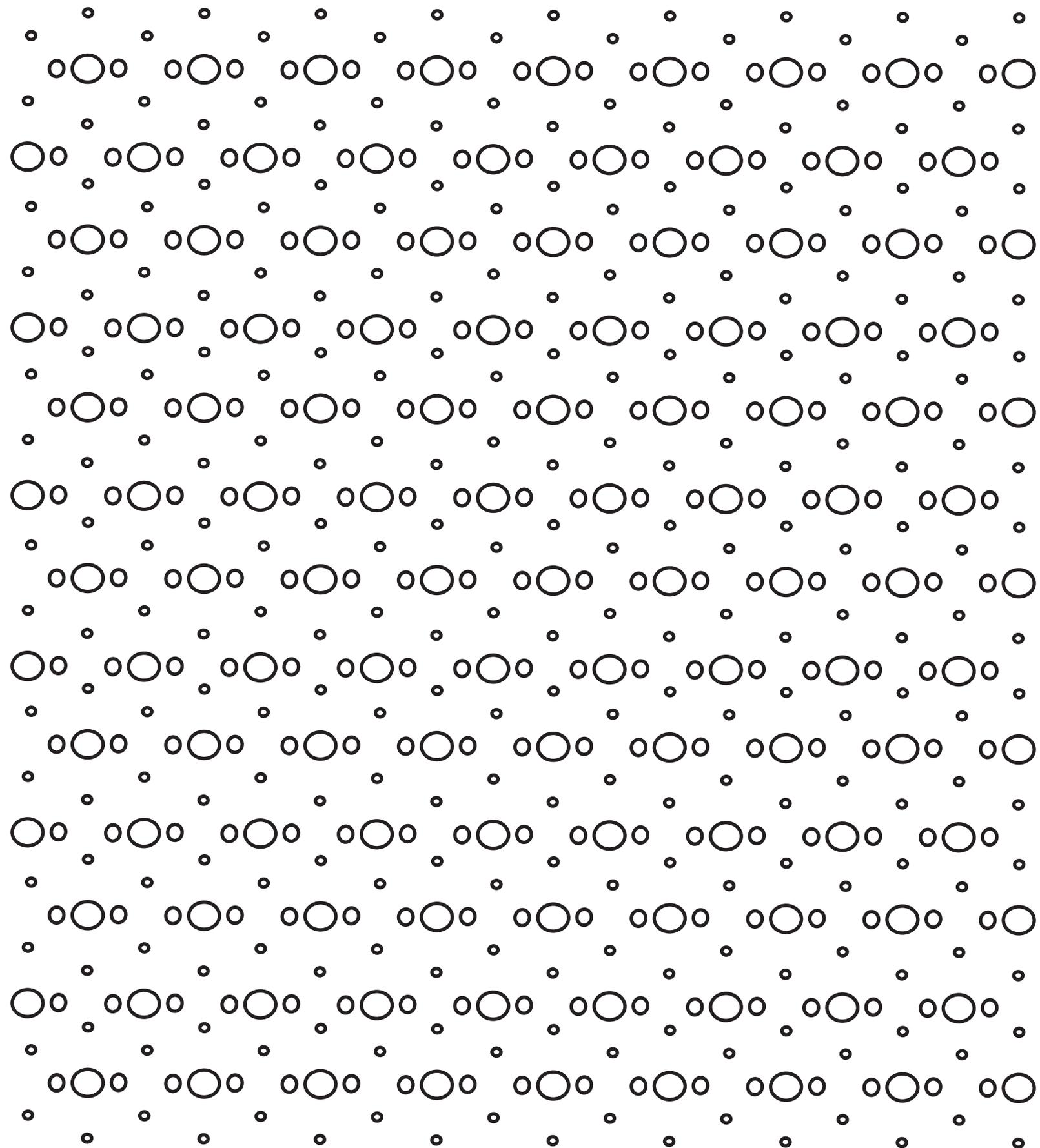
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Assume that this pattern is part of an infinite pattern that extends in all directions.

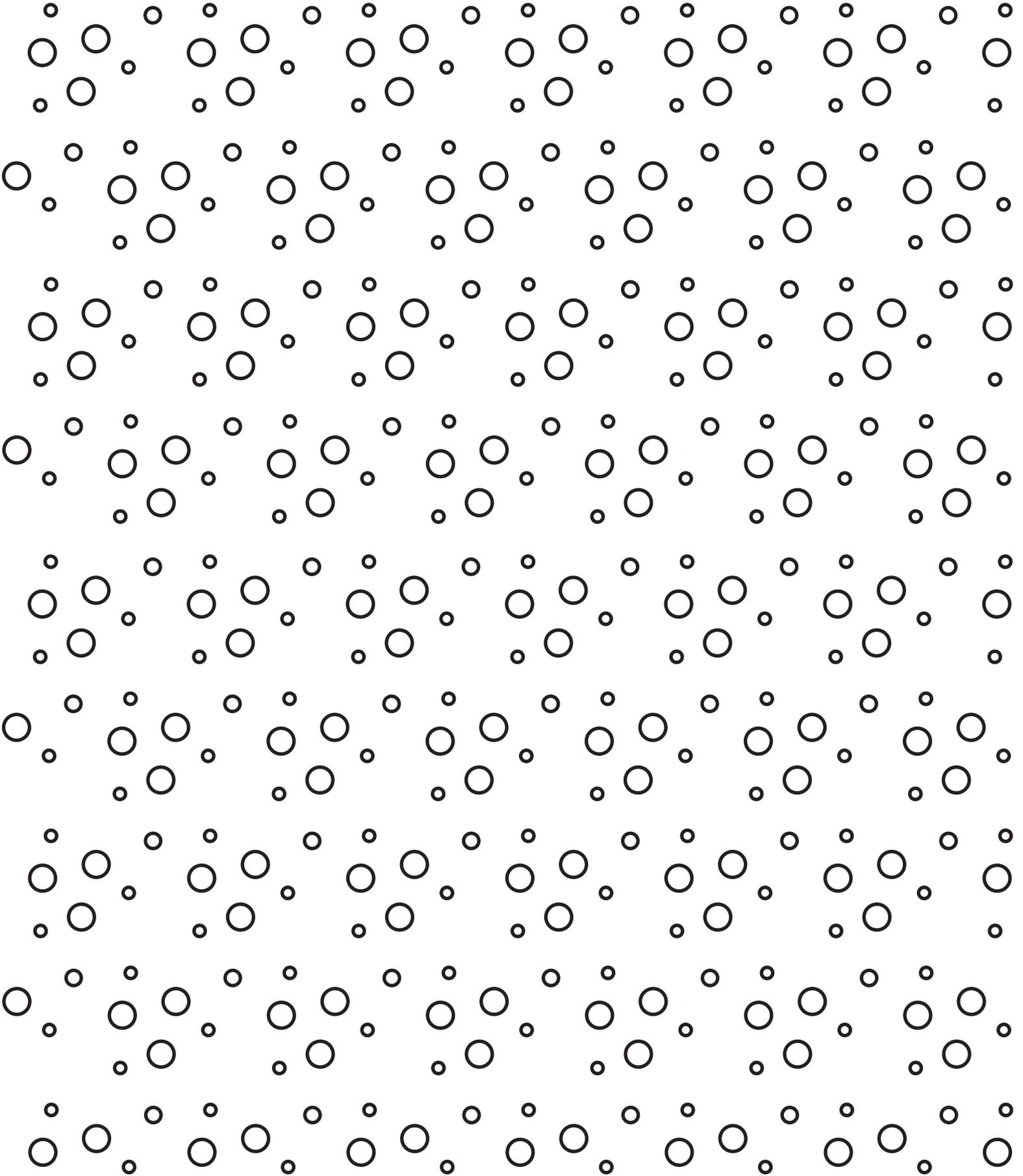Use conventional symbols to show where all the symmetry operators are.

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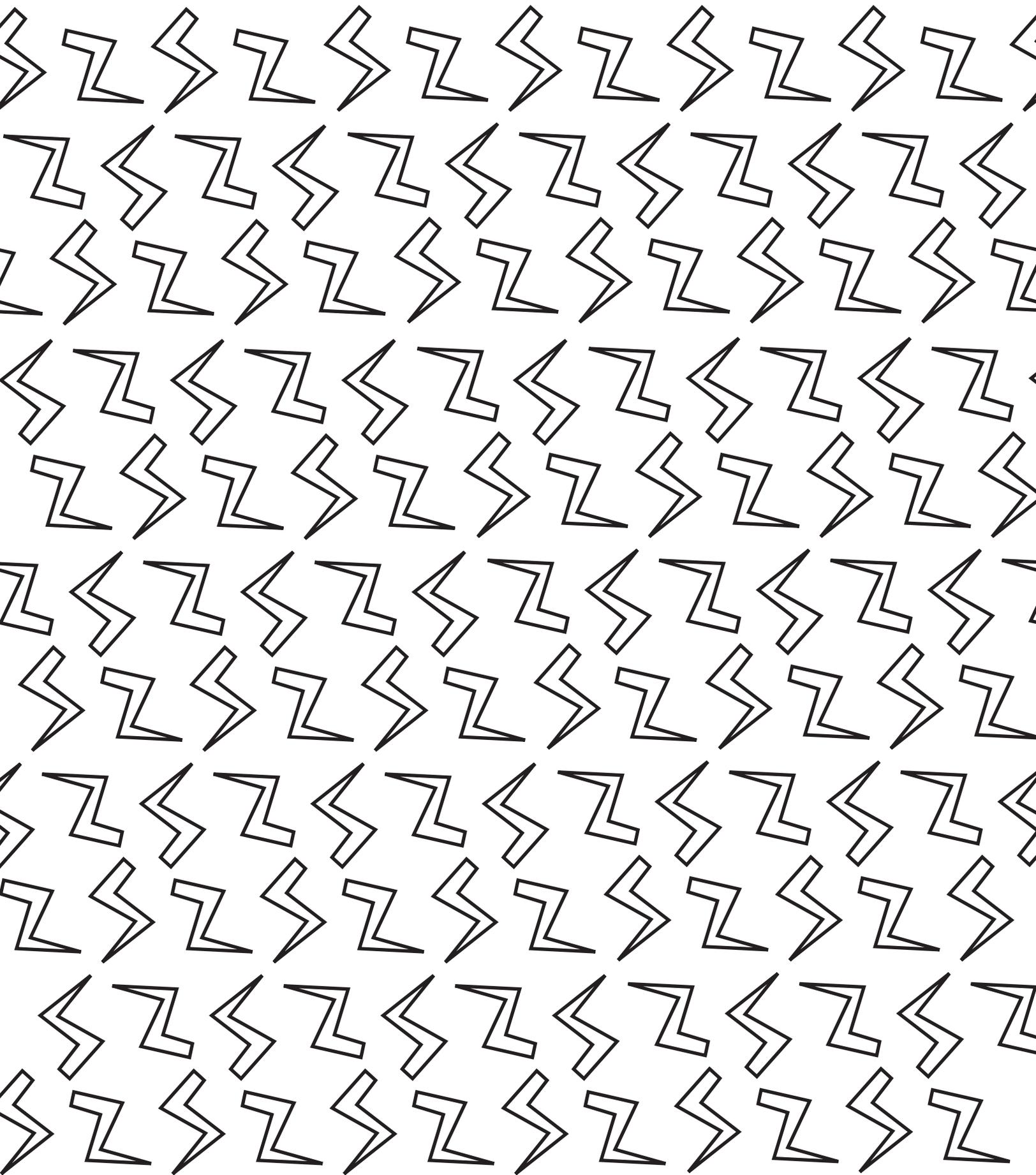Use conventional symbols to show where all the symmetry operators are.

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