

FRIEZE PATTERNS

Lesson 1: Footprints in the Sand

Australian Curriculum: Mathematics - Year 5

ACMMG114: Describe translations, reflections and rotations of two-dimensional shapes. Identify line and rotational symmetries.

- Identifying and describing the line and rotational symmetry of a range of two-dimensional shapes, by manually cutting, folding and turning shapes and by using digital technologies.
- Identifying the effects of transformations by manually flipping, sliding and turning two-dimensional shapes and by using digital technologies.

Lesson abstract

Students physically recreate the movements used to make patterns of footprints left in sand. Through this, they revisit the ideas of flip, slide, turn and mirror image and symmetry and learn more precise language. They then explore the symmetries in the footprint patterns and record them in a table.

Mathematical purpose (for students)

Shapes, and patterns made from shapes, can have several different types of symmetry.

Mathematical purpose (for teachers)

This lesson reviews flip, slide and turn transformations introduced in earlier years by looking at how patterns of footprints can be made. It introduces the language of rotation, reflection and translation. In addition to line symmetry (associated with reflection) introduced in earlier years, students encounter rotational symmetry (half turn only) and translation symmetry. There is potential to discuss centre of rotation and axis of symmetry.

Lesson Length 60 minutes approximately

Vocabulary Encountered

- transformation
- translation
- rotation
- reflection
- half turn
- glide reflection
- symmetry
- horizontal reflection
- vertical reflection
- axis

Lesson Materials

- footprint patterns ([1a Footprint Pattern Strips powerpoint](#)) 1 per pair of students printed on paper and on a transparent overlay, or printed on paper with tracing paper also provided)
- slide show [1b Looking at Symmetries powerpoint](#)
- [Student Sheet 1 - Footprints in the Sand](#) (1 per student)
- [Teacher Sheet 1 - Footprints in the Sand](#)
- [Student Sheet 2 - Footprint Symmetries](#) (1 per student)
- [Teacher Sheet 2 - Footprint Symmetries](#)

Making Footprints in the Sand

Show students one of the footprint patterns from [1a Footprint Pattern Strips powerpoint](#). Explain that some people were playing on the beach leaving interesting patterns made from footprints in the sand. The patterns went as far as we could see.

Ask students to think how the people made the footprint patterns.



Students try to produce all seven of the footprint patterns provided by actually performing the movements. The footprint patterns are also on [Student Sheet 1 - Footprints in the Sand](#). Students can record how the patterns can be made in the space provided in the table.

During the activity, describe features of the patterns using the informal language of flips, slides and turns and mirror image. Introduce the formal language of translations, rotations and reflections. In describing the transformations, point out the axes of reflection and the centres of rotation.

NOTE: These lessons use 'horizontal reflection' to mean a reflection with the axis along the direction of travel of the footprints. 'Vertical reflection' means a reflection with the axis across the direction of travel.

Searching for Symmetries

The main inquiry is to find the symmetries of each of the footprint patterns. The patterns have been chosen because they each have a different form of symmetry. The physical movements students used to generate the pattern will help to highlight these symmetries. [Teacher Sheet 1 - Footprints in the Sand](#) has answers.

The slide show [1b Looking at Symmetries powerpoint](#) shows the five different symmetries that a long strip can have and how they can be found using a transparent overlay. As the students explore the symmetry of the different footprint patterns they need to look for the symmetry in whole strip. This is demonstrated in the video where one strip or part thereof, is overlayed over another strip to show different forms of symmetry.

Students work to identify symmetries in the footprint pattern strips. [Student Sheet 2 - Footprint Symmetries](#) can be used to record and organise the results. (Answers on [Teacher Sheet 2 - Footprint Symmetries](#))

Two approaches to facilitate the exploration are:

- Provide students with 2 copies of [1a Footprint Pattern Strips powerpoint](#), one copied onto paper and the other copied on clear plastic film or an OHP transparency. The clear plastic strip of footprints can then be manipulated to explore the symmetry, as in the slideshow.
- Provide the students with a copy of [1a Footprint Pattern Strips powerpoint](#) and some tracing paper or non-greased baking paper. Working in pairs, students can trace over the strips and then manipulate the tracing paper to check for symmetries.

Show students that flipping the transparency or tracing paper produces the same image as reflecting in a mirror (so the transformation is called a reflection).

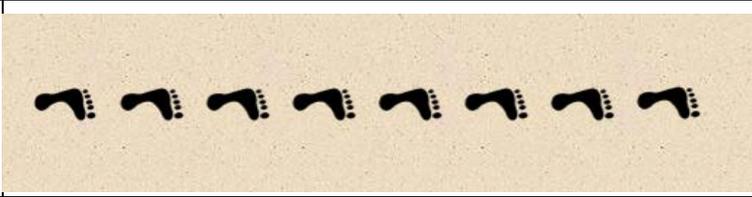
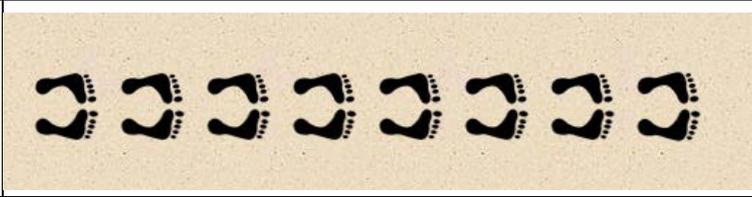
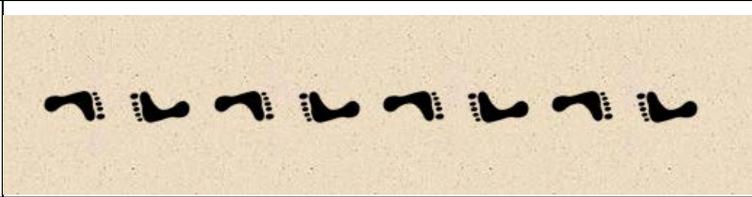
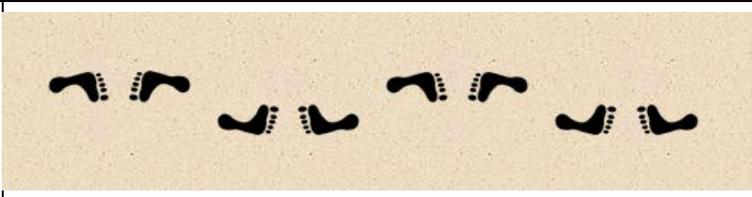
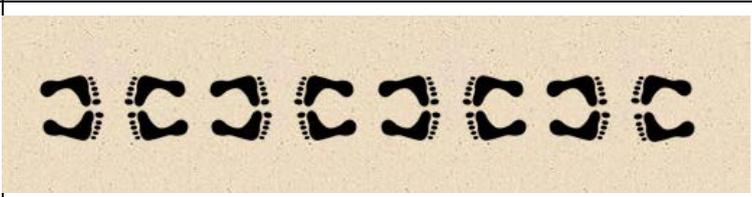
Extending Prompt

- Make several other footprint patterns with the same symmetry as one of the footprint strips. For example, Footprints 1 has translational symmetry only. Another footprint pattern like this is hop-hop-jump repeated. Jumping with heels together and feet pointed outwards will have the same symmetry as Footprints 4.

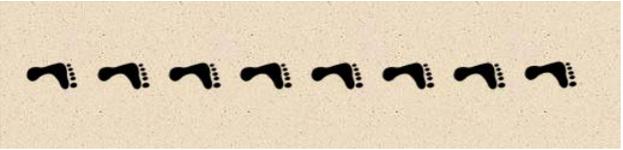
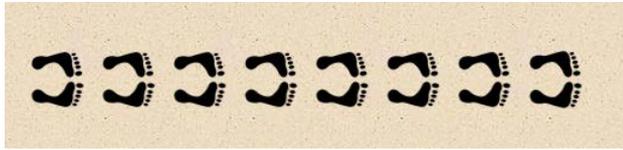
Some people were playing on the beach leaving interesting patterns made from footprints in the sand. The patterns went as far as we could see.

How do you think they made these footprint patterns?

What forms of symmetry can you find in each footprint pattern?

<p><i>Footprints 1</i></p>		
<p><i>Footprints 2</i></p>		
<p><i>Footprints 3</i></p>		
<p><i>Footprints 4</i></p>		
<p><i>Footprints 5</i></p>		
<p><i>Footprints 6</i></p>		
<p><i>Footprints 7</i></p>		

Teacher Sheet - Footprints in the Sand

	Footprint Patterns	Movements* & Symmetry
Footprints 1		1 person HOP <i>Translation symmetry only</i>
Footprints 2		1 person STEP <i>Translation and glide reflection symmetry</i>
Footprints 3		1 person JUMP <i>Translation and horizontal reflection symmetry</i>
Footprints 4		1 person SPIN HOP <i>Translation and half turn rotation symmetry</i>
Footprints 5		2 person MIRROR HOP <i>Translation and vertical reflection symmetry</i>
Footprints 6		2 person MIRROR STEP <i>Translation, vertical reflection, glide reflection and half turn symmetry</i>
Footprints 7		2 person MIRROR JUMP <i>Translation, horizontal reflection, vertical reflection and half turn rotation symmetry</i>

* Other movements may create the same symmetries

Explore the different footprint patterns. Place a tick in the columns to identify which symmetries can be found in each footprint strip.

	SYMMETRIES				
	Translation	Horizontal Reflection	Vertical Reflection	Half Turn Rotation	Glide Reflection
<i>Footprints 1</i>					
<i>Footprints 2</i>					
<i>Footprints 3</i>					
<i>Footprints 4</i>					
<i>Footprints 5</i>					
<i>Footprints 6</i>					
<i>Footprints 7</i>					

Teacher Sheet - Footprint Symmetries

	SYMMETRIES				
	Translation	Horizontal Reflection	Vertical Reflection	Half Turn Rotation	Glide Reflection
<i>Footprints 1</i>	✓				
<i>Footprints 2</i>	✓				✓
<i>Footprints 3</i>	✓	✓			
<i>Footprints 4</i>	✓			✓	
<i>Footprints 5</i>	✓		✓		
<i>Footprints 6</i>	✓		✓	✓	✓
<i>Footprints 7</i>	✓	✓	✓	✓	