The Mirror Lines of the Taj Mahal

Key Learning Content

This film illustrates the use of reflections in the design and appreciation of the Taj Mahal, one of the most beautiful buildings in the world. Reflective symmetry is defined and illustrated on screen. Shapes are shown with several mirror lines of symmetry. The film shows how to construct the mirror image of an object, and gives examples using Cartesian Coordinates. The effect of reflecting in x- and y-axes is then explained in terms of changing the signs of one of the coordinates.

Knowledge of graphs and positive and negative coordinates would be useful prior to watching the film.

Core Outcomes

Learning Points

- Be able to understand that reflections are specified by a mirror line.
- Be able to recognise reflective or line symmetry.
- Be able to identify any lines of symmetry of a given two-dimensional figure.

Suggested Activities

- Reflect objects in a mirror line.
- Classify objects in terms of their reflective symmetry.

The Taj Mahal was designed using the mathematical principle of mirror lines, which makes images appealing to the eye.

Extension Outcomes

Learning Points

- Be able to understand and use conventions for rectangular Cartesian Coordinates.
- Be able to locate and plot points (x, y) in any of the four quadrants of a graph.
- Be able to construct the reflection of a shape in a mirror line given by an equation on a graph.
- Be able to identify and give complete descriptions of transformations.

Suggested Activities

- Draw shapes on a graph and reflect in mirror lines given algebraically, e.g. reflect a triangle in the lines $y = 0$ and $y = x$.
- Explore equivalences between multiple transformations, e.g. two reflections in intersecting mirror lines are equivalent to a single rotation.

Related Films

To use before the lesson plan:

Transformations: Skateboarding	This film introduces the three shape-preserving transformations of translation, rotation and reflection.

To use after the lesson plan:

Tessellated Designs	This film looks at the use of symmetry and reflection to create patterns pleasing to the eye.
India and Negative Numbers	This film describes the scope of Indian mathematics before the European Renaissance, encompassing trigonometry, astronomy, and the number system itself.
The Beauty Formula	This film argues that reflective symmetry has a lot to do with the perception of human beauty.

Guide Lesson Plan

Introduction

Ask students what the Seven Wonders of the World are, or were, and show images of them. Then ask students what they know about the Taj Mahal – where is it, when and why was it built – and what has it to do with mathematics.

Show Film

The Mirror Lines of the Taj Mahal

Main Activity

Foundation

Give students images of real-world objects and get them to identify mirror lines of symmetry and assess the order of reflective symmetry. Then do the same with geometric designs, e.g. tile patterns. Ask if there is any limit to the order of reflective symmetry of an object and see if students can construct designs with 8, 16 or more lines of reflective symmetry, using graph paper.

Advanced

Get students to plot points on a graph and hence create shapes on a graph. Then get them to reflect the shape(s) in the lines $x = 0$, $y = 0$ and $y = x$.

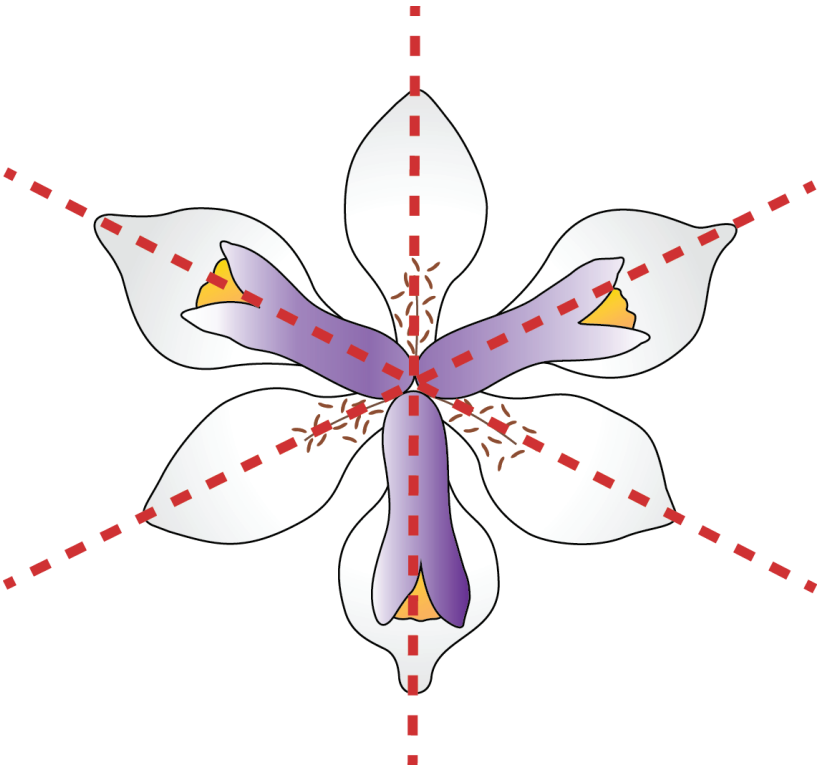
Note what happens to the coordinates in each case. Then get them to predict what happens to object and image coordinates when the mirror line is $y = -x$. Extend to reflection in $x = n$, $y = n$, and $y = nx$ for integer n.

Extension Activity

Get students to draw an object on a graph and then reflect it in two intersecting lines to form an image after two reflections. Work out the single transformation that is equivalent to the two reflections. Do this several times and try to work out the connection between the position of the mirror lines and the centre of the rotation.

Optional Extra

Can a reflection ever be equivalent to a combination of rotations and translations? Can three reflections ever be equivalent to a combination of rotations and translations? (Hint: consider the clockwise order of vertices on object and image.)



A mirror line is the central line across which an image is reflected; this flower has three.