

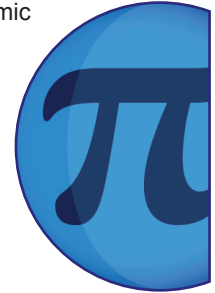


# Spirals in Nature

## Key Learning Content

This film shows the many different forms of spiral that occur in nature. Examples are shown of logarithmic spirals in animals, Archimedean spirals in cobwebs, hyperbolic spirals in plants, and elliptic vortices in fluids. The radius of curvature is mentioned.

The detailed mathematics of these spirals will be beyond most school-level students, but the film does provide the opportunity to plot complex curves.



### Core Outcomes

#### Learning Points

- Be able to understand that there are many types of spiral which occur in nature.
- Be able to understand the concept of the radius of curvature.
- Be able to plot points  $(x,y)$  in any of the four quadrants of a graph.

#### Suggested Activities

- Draw logarithmic and Archimedean spirals on graph paper.
- Identify points on spirals by their radius of curvature.

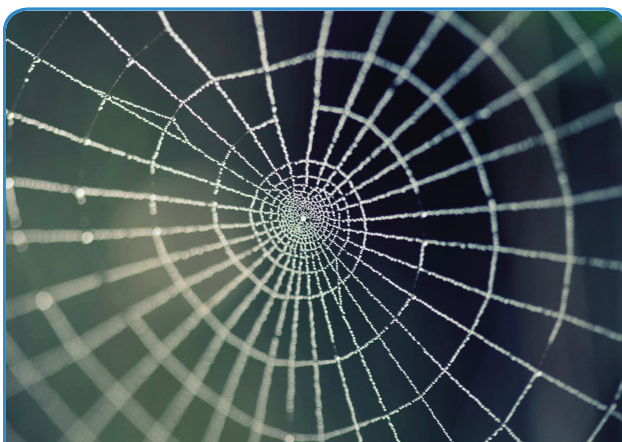
### Extension Outcomes

#### Learning Points

- Be able to understand the idea of a geometric sequence.
- Be able to understand the properties of logarithms.

#### Suggested Activities

- Generate a geometric sequence from a logarithmic spiral.
- Multiply and divide numbers using logarithms.



Archimedean spirals are seen in the creation of spiders' webs.

## Related Films

To use before the lesson plan:

### Calculus: Newton

This film introduces the branch of mathematics that calculates the gradients of curves and the areas under curves.

To use after the lesson plan:

### Arches

This film highlights the practical use of curved structures to support buildings.

### Why Are Eggs Egg-Shaped?

This film examines the radius of curvature to explain the strength of eggs.

### The Fibonacci Sequence

This film describes the mathematical sequence that lies at the heart of a natural spiral.

### Maths and the Mona Lisa

This film asks whether the beauty of the Mona Lisa is explained by a hidden spiral in its design.

## Guide Lesson Plan

### Introduction

Draw a rough spiral on the board then ask students for all the examples of spirals they can think of in nature. Ask them if they know of any differences between types of spiral, where possible grouping their examples into similar types.

### Show Film

### Spirals in Nature

### Main Activity

#### Foundation

Take a graph with  $x,y$  axes with  $(0,0)$  centred in the page and add 45 degree lines through the origin so that there are eight equally spaced rays from the origin. Place a point near the origin along one ray then draw a perpendicular line from that ray to the next and mark this as the next point. Repeat the process to construct a logarithmic spiral. For smoother spirals, start with more equally spaced rays from the centre.

#### Advanced

Take a logarithmic spiral (preprinted or constructed as above) and draw in equally spaced rays from the origin. Take any ray; measure the distance from the origin to each of the points where the spiral cuts the ray and find a pattern in the distances. Distances should go up by a constant multiplier each time. Explain that this is a geometric progression and give its formal mathematical definition.

## Extension Activity

### Foundation

Take two pencils and tie a long length of string midway up both pencils. Then wind the string around one of the pencils taking care that the string is not wound over itself. Place the pencil with the wound string stationary in the middle of the page and then start drawing a spiral with the second pencil by unwinding the string, keeping both pencils vertical. The resulting spiral should be an Archimedean spiral. Compare and contrast with the logarithmic spiral.

### Advanced

Outline briefly the properties of logarithms and get students to multiply numbers by adding their logs. Examine what happens to a geometric progression if you take the logarithm of all terms. Ask students why they think the logarithmic spiral is so named.

## Optional Extra

Ask students to research the use of spirals in biology, particularly spirals in three dimensions. What is the connection between spirals and DNA?

