What Do Sine Waves Sound Like?

Key Learning Content

This film introduces the ideas of trigonometric ratios for angles greater than 90 degrees, and functions of a variable, in this case the sine function as a function of time. The film begins by explaining that every sound in the world occurs as a result of vibrating particles. Viewed with the aid of an oscilloscope, sounds appear as waves which can be described by a mathematical equation based on the sine function. The amplitude and frequency of a sine function are defined, and their effect on the sound we hear is explained.

Familiarity with trigonometry and graphs of functions is necessary before watching the film.

Core Outcomes

Learning Points

- Be able to understand and use sine, cosine and tangent of obtuse angles.
- Be able to interpret information presented in a range of linear and non-linear graphs.
- Be able to understand that symbols may be used to represent numbers in equations, or variables in expressions and formulae.

Suggested Activities

- Generate the sine of angles greater than 90 degrees using circle constructions.
- Plot graphs of sin, cos and tan functions.
- Explore the relationship between $sin(\theta)$ and $cos(90-\theta)$ and relate this to the shape of sin and cos curves.

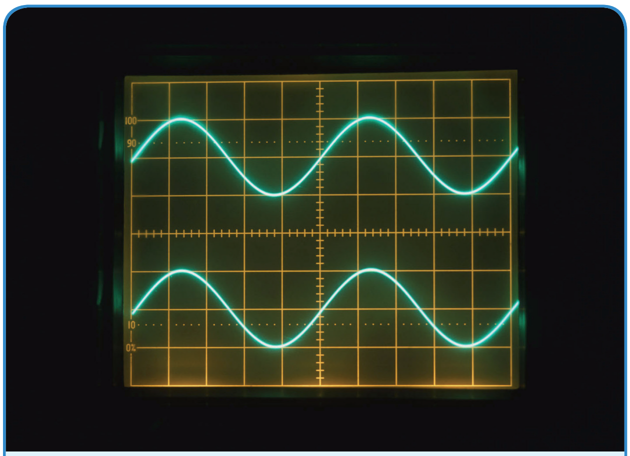
Extension Outcomes

Learning Points

- Be able to understand and use function notation.
- Be able to understand how graphical transformations affect the shape of curves.

Suggested Activities

- Work out the domains and ranges of given functions.
- Use graphing software to explore the shape of polynomial and trig function.
- Use graphing software to explore graphical transformations of sine functions.



The sine function can produce a sound.

Related Films

To use before the lesson plan:

The History of the Golden Ratio

This film gives an overview of occurrences of the Golden Ratio in architecture throughout history, from the building of the pyramids to present day skyscraper design.

Fractions: Pythagorean Tuning

This film features one of the first mathematical analyses of sound, and the basis of the musical scale.

Distance to the Sun and Moon

This film demonstrates the use of the sine function to calculate the relative distance of the Moon and Sun from Earth.

To use after the lesson plan:

Measuring the Earth

This film shows a way to work out the diameter of the Earth simply by climbing a mountain.

The Tunnel of Samos

This film looks at one of the first engineering projects to use properties of triangles in its design.

Guide Lesson Plan

Introduction

Bring a guitar or similar stringed instrument to the group and demonstrate to students how a long vibrating string makes a lower note than a short vibrating string. Explain how mathematicians sought to model this effect using equations.

Show Film

What Do Sine Waves Sound Like?

Main Activity

Foundation

Using a calculator, get students to plot a graph of $sin(\theta)$ for $0 \leq \theta \leq 360$ degrees. Then take selected values of θ outside this range and work out what the curve looks like for any value of θ. Repeat for $cos(\theta)$ and work out the relationship between cos and sin curves.

Advanced

Explain function notation and define the domain and range of a function. Get students to use graphing software to plot trig functions and work out the domain and range of the functions they plot. Then explore graphs of polynomial and other trig functions and define their domains and ranges.

Extension Activity

Foundation

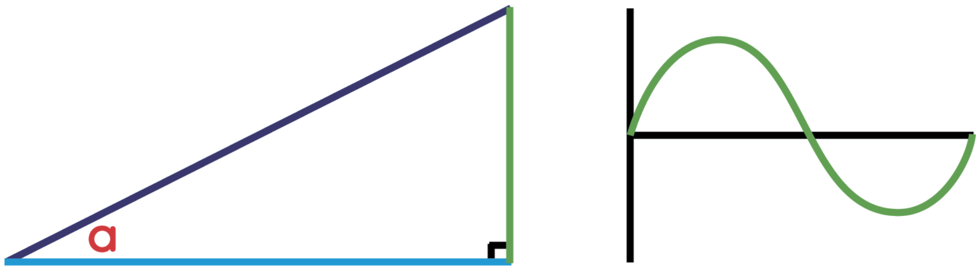
Get students to draw a right-angled triangle and mark angles θ and $(90\text{-}\theta)$. Label sides. Then ask students to work out *sin* and $cos(\theta)$, and *sin* and $cos(90\text{-}\theta)$ – what do they notice? How does this relate to the shape of *sin* and *cos* curves?

Advanced

Use the graphing software to plot A.$sin(k\theta)$ for constants A and k and variable θ and explore what happens to the shape of the curves as A and k change.

Optional Extra

Get students to sketch what they think a graph of $tan(\theta)$ would look like, based on sin and cos curves (using $tan(\theta) = sin(\theta)/\ cos(\theta)$), then check using graphing software. What is the domain and range of $tan(\theta)$?



$$\text{Sin } a = \frac{\text{opposite}}{\text{hypotenuse}}$$

The sine function can be used to calculate the missing values of right-angled triangles.