Straight Lines: Bee Lines

Key Learning Content

This film makes the simple point that bees always appear to take the shortest route – a straight line – between any two points, whether in two or three dimensions. (This fact was determined by fitting transmitters to bees.) It is not clear how bees do this and the film makes no claims to understanding it. The learning materials offer opportunities to use Pythagoras, trigonometry or vectors in two and three dimensions to analyse the ‘bee-lines’.

Core Outcomes

Learning Points

- Be able to provide reasons, using standard geometrical statements, to support numerical values for measurements obtained in any geometrical context.
- Be able to apply trigonometrical methods to solve problems in two dimensions.
- Be able to use Pythagoras’ Theorem in two dimensions.

Suggested Activities

- Describe the bee’s starting and end points in terms of (x,y) coordinates.
- Calculate the distance between starting and end points.
- Calculate the direction of travel.

Extension Outcomes

Learning Points

- Be able to understand that a vector has both magnitude and direction.
- Be able to add and subtract vectors.
- Be able to apply trigonometrical methods to solve problems in three dimensions, including finding the angle between a line and a plane.
- Be able to use Pythagoras’ Theorem in three dimensions.

Suggested Activities

- Describe the bee’s journey in terms of 3D vectors.
- Calculate the magnitude (length) of the resultant vector.
- Calculate the angle between a vector and the horizontal plane.

Bees always choose the shortest possible route to reach a source of nectar.

Related Films

To use before the lesson plan:

Fractions: Slow Motion	This film explains how a slow motion shot is taken of a bee in flight, as part of a broader discussion on proportion and film speeds.
Coordinate Geometry: Descartes	This film tells the story of the inventor of Cartesian Coordinates.

To use after the lesson plan:

Bees and their Hives	This film demonstrates that bees seem to have knowledge of tessellation and are able to optimise the use of wax.
Geometry: Euclid	This film explains how Euclid's Geometry, based on straight lines, shaped mathematical education for thousands of years.
Hyperbolic Geometry	This film questions the idea of a straight line in geometry and explores the results.

Guide Lesson Plan

Introduction

Ask students to point to the top of a prominent local landmark that they cannot see from the classroom – a clock tower, tall tree or tall building. Compare the directions they are pointing in. Ask: What would they have to know to calculate the direction precisely?

Show Film

Straight Lines: Bee Lines

Main Activity

Foundation
Provide a 2D map of the bee's starting and end point with a x,y grid so that students can read the coordinates of each point. Get them to use Pythagoras to calculate the distance between points, and trigonometry to calculate the angle to the horizontal.

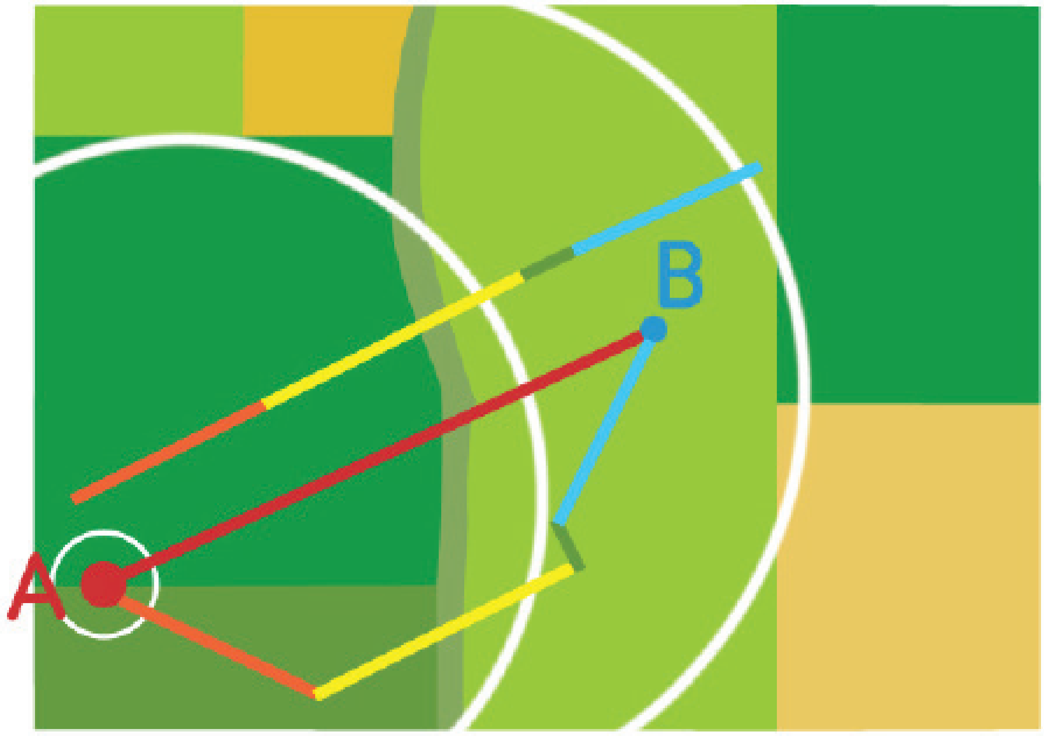
Advanced
Describe the bee's flight path using 3D vectors. Suppose a bee makes a three-stage journey, described in terms of three column vectors. Add the vectors to determine the resultant vector and use 3D Pythagoras to determine the distance back to the starting point. Draw a rough 3D sketch of the resultant vector and use Pythagoras and trigonometry to calculate the angle the vector makes with the horizontal plane.

Extension Activity

Get the map grid reference of the classroom and the local landmark and estimate their respective heights. Get students to calculate the precise direction and distance from the classroom to the landmark.

Optional Extra

All the distances so far calculated have assumed a flat horizontal plane, whereas in reality the surface of the Earth is curved. What difference does the curvature of the Earth make to a calculation of the straight line distance between two points?



Travelling from A to B through any point not on the A-B line will always be longer, because the sum of the new lines will always be greater than the length of A-B.