

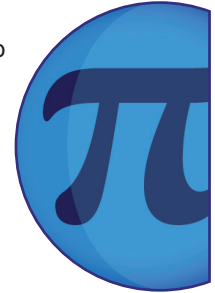


# Counting Crowds

## Key Learning Content

This film explains how statisticians made an estimate that 1.8 million people were present at President Barack Obama's inauguration in January 2009. Using an aerial photograph, they divided the crowd into regions and each was given a density rating – that is the amount of space each person took up. The accuracy of the calculation is considered at the end of the film.

No prior knowledge is assumed beyond basic arithmetic, although density definitions and calculations can be challenging.



### Core Outcomes

#### Learning Points

- Be able to make sensible estimates of a range of measures.
- Be able to use the rules of addition, multiplication and division.
- Be able to carry out calculations using standard units of area and density.

#### Suggested Activities

- Estimate the number of people in a photograph of a crowd.
- Work out density ratings in everyday settings, for example, taking a bus, in a lesson, at lunch, in the playground, on the sports field...etc.

### Extension Outcomes

#### Learning Points

- Be able to evaluate approximate answers to calculations (accuracy to  $n$  decimal places) using estimation.
- Be able to use trigonometry to solve problems in three dimensions.

#### Suggested Activities

- Identify the upper and lower bounds to the values used in the crowd calculation, and work out what the implied maximum and minimum crowd sizes would be.
- Apply trigonometry to calculate the area being photographed, given the height of the camera and the angle of capture of the lens.
- Explore how area varies with height.



Aerial photography and satellite images can be used to count large crowds.

## Related Films

To use before the lesson plan:

### How Long Is a Metre?

This film introduces the basic ideas of measurement and accuracy

### Painting By Numbers

This film demonstrates the maths of how objects appear smaller the further away they are.

### Sample Bias: The Wrong Guy Won

This film introduces the US election system and the early difficulties in estimating the number of people who would vote for a presidential candidate.

To use after the lesson plan:

### Rounding: Snails vs Rockets

This film explores the appropriate levels of accuracy to use in calculations.

### Counting Stars

This film makes rough estimates of complicated natural phenomena.

### The Most Populous Country

This film explores the implications of overcrowding and global population growth.

## Guide Lesson Plan

### Introduction

Ask the students about their journey to school, specifically when they felt most jostled or crowded. Take two or three examples – a crowded bus or train, a traffic jam, or a busy pavement – and ask the students to estimate how many people were within 10m of them in these places.

### Show Film

### Counting Crowds

### Main Activity

#### Foundation

Construct and distribute a table of data for the Obama Inauguration, which includes areas and densities.

Ask the students to calculate the total crowd size.

To make the task more difficult use different units (cm, m, km) and ask the students to convert between them.

Consider using triangles, circles or trapezia-shaped areas to make the calculations more complicated.

#### Advanced

Distribute images of other large crowds, such as public demonstrations, sports events... etc. and ask the students to estimate the total number of people (by dividing the image into grids, counting the number of people in one grid box, and scaling up the answer).

Compare the range of results from different students and discuss the appropriate level of accuracy.

**Extension Activity**

Ask the students to consider how to use perspective when dividing images not taken from vertically above the crowd, for example, using the vanishing point. Ask the students to think about how they would draw a perspective grid so that each grid box represented the same area. Hint: try using diagonal grid lines.

**Optional Extra**

The method described in the film is used extensively in wildlife research to estimate, for example, the number of insects in an acre of land.

Depending on the location and weather, ask the students to estimate the number of bugs in a garden or public area by sampling a small grid box.



Each grid square can be given a 'density rating' according to how many people can fit into the space.