

Investigating the maths inside:

Maths in 3D

Activity 3

Scientific notation



How do scientists and mathematicians write very big (and very small) numbers?

# Very large numbers

Astronomers have determined the distance between the centre of the Milky Way and the Earth is

300 000 000 000 000 000 000 km

The speed of light is exactly 299 792 458 metres per second   
or close enough to 300 000 000 ms–1.

# Very small numbers

Nanotechnology is science, engineering, and technology conducted at the nanoscale, typically with sizes from 1 to 100 nanometres. Zebedee uses electrical and mechanical components built on the nanoscale with objects 1 to 100 nanometres in size.

Research the size of a nanometre. Compare a nanometre with a millimetre, a micrometre and a metre.

It is hard to imagine [just how small nanotechnology is](http://www.nano.gov/nanotech-101/what/nano-size). For example, a sheet of newspaper is about 100 000 nanometres thick.

# Scientific numbers

Very small and very large numbers are difficult to work with, even using scientific calculators. They cannot be entered into a basic calculator.

We can write these numbers in a much more convenient form called scientific notation (so called, because scientists often deal with very large and very small numbers).

For example, 300 000 000 000 000 000 = 3 × 100 000 000 000 000 000

Writing 100 000 000 000 000 000 as a power of 10, we have

300 000 000 000 000 000 = 3 × 1017

Written in this form, the number is in scientific notation.

Similarly, 4 nanometres = 0.000 000 004

= 4 × 0.000 000 001

= 4 × 10–9

A number is in scientific notation if it is written in the form

*a* × 10*n*

where *a* is a number between 1 and 10 and *n* is an integer.

It is more convenient to make calculations with large or small numbers when they are written in scientific notation than when they are written in decimal form.

# Estimation

Neil Armstrong landed on the Moon on 20 July 1969. He sent messages, including his most famous words, “One small step for man…” from the Moon. The messages (radio waves) travel at the speed of light.

If the Moon is 384 000 km away from us, how long did it take for a message to travel from the Moon to Earth?

Working in pairs (and without using a calculator or a formula or recording calculations) make an estimate of the answer.

Share your strategy with other class members.

# Calculation

You can also use the formula. It is easier to use scientific notation. Can you see why?

Convert 384 000 into scientific form 384 000 = 3.84 × 105 km

= 3.84 × 105 × 1000 m

= 3.84 × 108

Speed of light = 300 000 000 m/s = 3.0 × 108

Therefore 

The message from the Moon took 1.28 seconds

# Try these

1. The Zebedee has a maximum range of approximately 30 m. Light moves at the fastest speed known in the universe. It travels at an incredible 300 000 kilometres per second.

How long would the laser light take to travel 30 metres and return to the Zebedee?

2. Planning is well advanced for people to travel to Mars.

Mars was closest to the Earth in 2003, the distance being 56 million kilometres. The distance can be as much as 401 million kilometres.

How long will it take for a radio signal (which travels at approximately the speed of light) from Earth to reach Mars when Mars is at its furthest distance from Earth?

3. The average distance between Mars and Earth is 140 million kilometres. The fastest spacecraft launched from Earth was NASA's New Horizons mission (see www.space.com/18377-new-horizons.html), which is en route to Pluto. In January 2006, the probe left Earth travelling at 58 000 km per hour.

What is the time it would take such a probe to get to Mars at its average distance from Earth?

4. Nanotechnology can be used to make molecules. There are around 2.69 × 1019 molecules in every cubic centimetre of air. That’s 2 690 000 000 000 000 000 000 molecules.

How many molecules are in a room 8 m × 8 m × 3 m?

5. When watching television you will notice that when an interviewer in Australia is talking to somebody in the UK or USA there is always a slight delay between the interviewer asking the question and an answer being given. This makes the person being interviewed appear hesitant.

(a) Imagine you are trying to talk to somebody on Mars when Mars is at its closest point, 56 million kilometres away. How long will it take for a signal to travel from Australia to Mars?

(b) Imagine you wanted to carry out a three-way conversation between you in Australia and two friends, one on Mars and one on the Moon. Describe what the conversation would be like. (Assume the distance between Mars and the Moon is the same as the distance from Earth to Mars, i.e., 56 million km).

6. Stars other than our sun are so far distant that astronomers refer to their distances from Earth not in terms of kilometres but in light-years.

A light-year is the distance light travels in one year.

How far is that?