What Does the Internet Weigh?

Key Learning Content

This film shows how standard form can be used to establish the 'weight' of the internet. Examples of numbers in standard form are given, both large numbers, with both positive powers of ten, and small numbers, with negative powers of ten. The miniscule mass of electrons is then multiplied by the enormous number of electrons moving around the internet to give an estimate of how much the internet weighs.

Familiarity with index laws for multiplication and division of positive and negative integer powers would be useful prior to watching the film.

Core Outcomes

Learning Points

- Be able to express numbers in the form $a \times 10^n$ where n is an integer and $1 \leq a < 10$.
- Be able to use index notation and index laws for multiplication and division of positive and negative integer powers.
- Be able to solve problems involving standard form.
- Be able to make sensible estimates of a range of measures.

Suggested Activities

- Convert numbers to standard form.
- Multiply and divide numbers by first converting to standard form.
- Estimate the order of magnitude of solutions by using standard form.

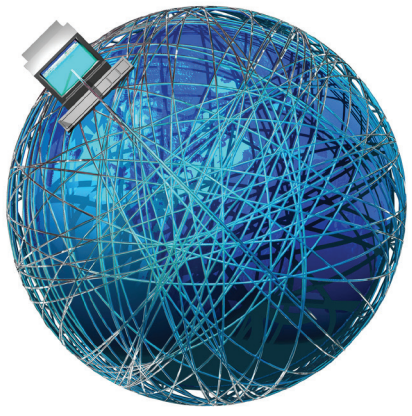
Extension Outcomes

Learning Points

- Be able to add and subtract numbers in standard form.
- Be able to raise numbers in standard form to a power.
- Be able to carry out calculations using standard units of mass, length, area, volume and capacity.

Suggested Activities

- Explore different methods of adding or subtracting numbers in standard form.
- Work out the volume of buildings in cm^3 and mm^3 by using standard form.



It is estimated that throughout the worldwide web, over a trillion, trillion electrons are moving at any one time.

Related Films

To use before the lesson plan:

Counting Crowds	This film looks at techniques for estimating the number and size of things which at first look to be uncountable.
Speed of the Earth	This film further explores the use of estimation in difficult, or even impossible, to measure targets.
The Emperor's Chess Board	This film gives an introduction to powers and their role in arithmetic.

To use after the lesson plan:

The Biggest Number Ever	This film features numbers so large that they cannot be expressed satisfactorily in standard form.
Volume: Counting Stars	This film demonstrates the use of standard form to estimate the number of stars in the universe.

Guide Lesson Plan

Introduction

Give students a mental arithmetic test which includes very large and very small numbers, such as 320 x 200, 3000 x 1200, 91,000 x 3000, 720,000 ÷ 90,000. Give out answers and discuss different strategies for doing the calculations in your head.

Show Film

What Does the Internet Weigh?

Main Activity

Foundation

Return to the mental arithmetic test used at the beginning of the lesson and get students to redo the calculations using standard form. Give examples where the answer needs to be adjusted in order to be in standard form, e.g. $5.2 \times 10^3 \times 2 \times 10^4 = 10.4 \times 10^7 = 1.04 \times 10^8$. Set practice exercises.

Main Activity

Advanced

Show different ways in which numbers in standard form can be added or subtracted, e.g.

$3.4 \times 10^6 + 2.07 \times 10^7$

$= 3.4 \times 10^6 + 20.7 \times 10^6 = 24.1 \times 10^6$

or

$= 34 \times 10^5 + 207 \times 10^5 = 241 \times 10^5$

or

$= 3{,}400{,}000 + 20{,}700{,}000 = 24{,}100{,}000$ ...

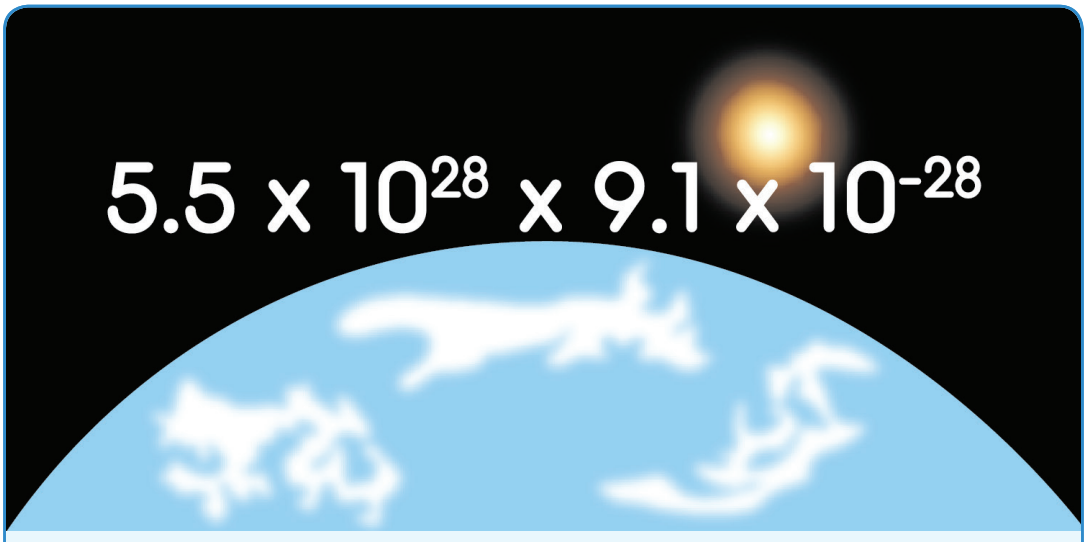
Discuss cases when different approaches might be appropriate. Set practice exercises.

Extension Activity

Tell students that you want to estimate the volume in mm^3 of all the buildings in the school. Suggest that students first estimate the dimensions in metres, then convert to mm in standard form before multiplying through. If oxygen weighs 1.43×10^{-9} kg per cubic mm, what is the weight of oxygen in the school? If the average person needs 8.4×10^{-1} kg per day, how many people could survive in the school buildings for a year if the buildings were airtight?

Optional Extra

Explore how practical it would be to express numbers in the form $a \times 3^n$ where n is an integer and $1 \leq a < 3$. Show by example that it is possible to do this, but explain carefully why it is not a very useful method in practice. Would using a value other than 3 (or 10) make any more sense?



Multiplying the number of electrons moving throughout the worldwide web by their mass gives the total mass of the internet.