Rounding: Snails vs Rockets

Key Learning Content

This film explores how it is possible to accurately record measurements as fast as the speed of light, or as slow as the rate of continental drift. The rules of rounding are illustrated for whole numbers to the nearest thousand, and for speeds to a given number of decimal places or significant figures. The level of accuracy used is presented as a matter of choice. Familiarity with the rules for multiplying decimals is desirable for the lesson.

Core Outcomes

Learning Points

- Be able to round integers to a given power of 10.
- Be able to round to a given number of decimal places or significant figures (SFs).

Suggested Activities

- Practise rounding rules with whole numbers and decimals.
- Explore how rounding errors can occur when rounding too early in a calculation.

Rather than measuring all speeds to the same level of accuracy, a decision must be taken about what information is needed.

Extension Outcomes

Learning Points

- Be able to identify upper and lower bounds where values are given to a degree of accuracy.
- Be able to solve problems using upper and lower bounds where values are given to a degree of accuracy.

Suggested Activities

- Calculate the volume of solids of given dimensions rounded to a given accuracy.
- Work out upper and lower bounds for the range of possible values of actual volumes consistent with the rounded dimensions.

Related Films

To use before the lesson plan:

How Long Is a Metre?

This film tells the story of how the metre came to be defined as the distance light travels in a vacuum in a set period of time.

To use after the lesson plan:

Jai Singh

This film shows how ancient astronomers managed to make incredibly accurate measurements using only very basic instruments.

Heptathlon

This film explains why scoring the seven events in the heptathlon needs a range of metric measurements and a complex algorithm to calculate the winner.

Decimal Places: Photofinish

This film highlights the importance of accurate timing within the context of a closely fought 60m sprint race.

Guide Lesson Plan

Introduction

Start writing the value of Pi (π) on the board to more and more decimal places. Ask the students: how far is it appropriate to go? Check what degree of accuracy calculators use for Pi. Agree that rounding is inevitable, but ask the question: What is the appropriate level of accuracy?

Show Film

Rounding: Snails vs Rockets

Main Activity

Foundation

Practise basic rounding skills, rounding numbers to the nearest power of ten, decimal places and significant figures, paying particular attention to the treatment of zeros when rounding decimals (e.g. 0.003697 to 3sf is 0.00370).

Next, explore what happens if you round too early in a calculation. Ask students to calculate the volume of a cuboid of side 1.2cm, 5.3cm and 6.4cm, giving the answer to 1sf. Then 1.2 x 5.3 x 6.4 = 40.704 = 40 to 1sf, but if dimensions are rounded before multiplying then calculation is 1 x 5 x 6 = 30. Set practice exercises.

Main Activity cont ...

Advanced

Set students problems to do with calculating the range of possible answers consistent with initial input values rounded to a given accuracy.

For example, suppose you were told that a cuboid has dimensions 1.2cm, 5.3cm and 6.4cm, to one decimal place (dp). The volume would then be calculated as $1.2 \times 5.3 \times 6.4 = 40.704 = 40.7$ to 1dp. But then ask: is this the appropriate degree of accuracy for the answer? To answer this, get students to observe that 1.2 to 1dp implies that the actual length L satisfies $1.15 \leq L < 1.25$. So minimum possible volume is given by $1.15 \times 5.25 \times 6.35 = 38.33813$ and maximum volume given by $1.25 \times 5.35 \times 6.45 = 43.13438$, so

$$38.33813 \leq V < 43.13438$$

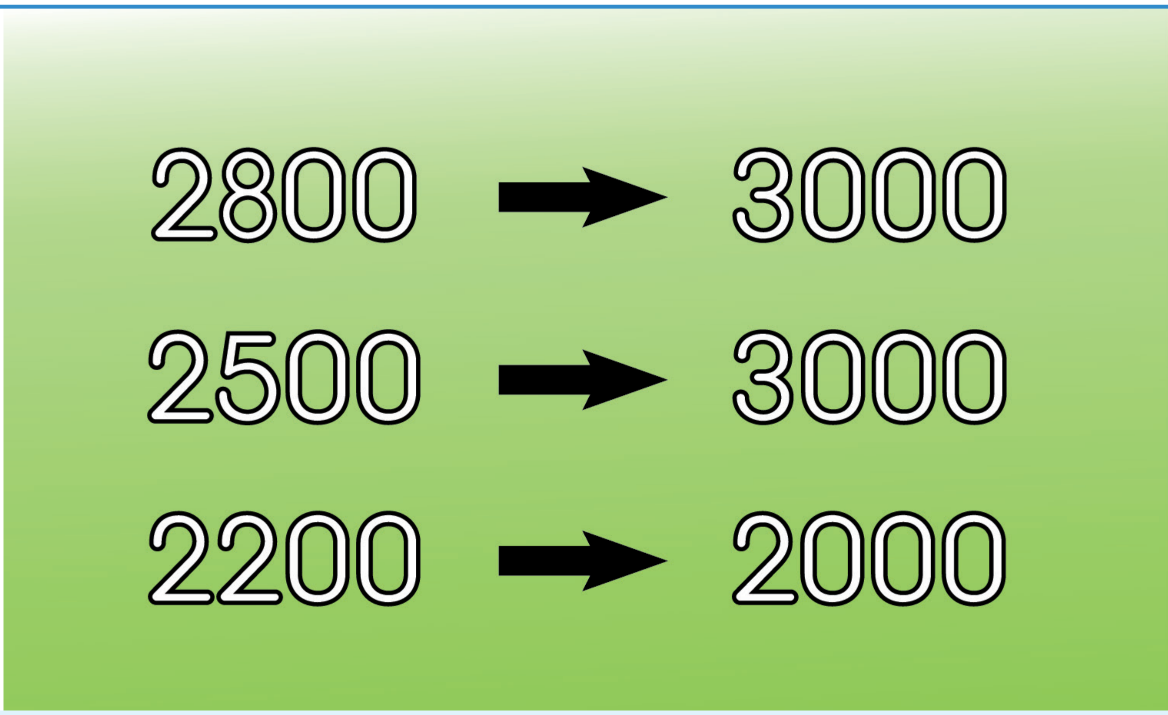
which implies that answer should be given as 40 to 1sf.

Extension Activity

Set similar volume questions involving Pi and using more complex shapes such as spheres and cones. Then set questions involving fractions, pointing out that the maximum value of A/B occurs when A is at a maximum but B is at a minimum.

Optional Extra

The value of Pi has often been approximated using fractions, e.g. Pi ≈ $3\frac{1}{7}$. Research the approximations that are commonly used, and calculate their accuracy.



A number is rounded by looking to the digit to the right of that to be rounded – if it is 5 or above, the rounded number will increase by 1.