**Math Lesson (Suitable for Years 11 and 12)**
**Precision and accuracy of calculated quantities**
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## Precision and accuracy

Many quantities are measured directly with instruments. The precision and accuracy of a measured quantity depend on the instrument employed.

When a measurement is expressed in standard form, e.g. $3.0010\times10^3$ kg, the place value of the *last* figure in the decimal part multiplied by the power of 10 and the unit kg give the **precision**, and the number of figures (called **significant figures**) in the decimal part is the **accuracy** of the measurement.

The precision of $3.0010\times10^3$ kg is $0.0001\times10^3$ kg, i.e. $0.1$ kg, and the accuracy of the measurement is 5.

Some quantities are derived from measured quantities. They are called calculated quantities. There are certain procedures to follow in determining the precision and accuracy of a calculated quantity.

## Calculated quantities from addition and/or subtraction of measured quantities

Firstly change the measured quantities to the same unit.

After adding and/or subtracting the measured quantities, the resulting quantity has a *precision* same as the *least* precise measured quantity.

Example 1 Find the total of the following measured quantities: $0.05218$ km, $12.3$ m, $350.00$ cm, $12300$ mm

A suitable unit to change to is m. Among the four measurements, 12.3 m is the least precise and 12300 mm is the most precise.
(Note: A whole number is considered to be the most precise. Unless specified, it is taken to have infinitely many decimal places.)

$52.18\text{ m}+12.3\text{ m}+3.5000\text{ m}+12.3000000...\text{ m}$
$=80.28000000...\text{ m}$ (incorrect way to present answer)
$\approx 80.3\text{ m}$ (correct answer)

## Calculated quantities from multiplication and/or division of measured quantities

After multiplying and/or dividing the measured quantities, the resulting quantity has an *accuracy* same as the *least* accurate measured quantity.

Example 1 A journey consists of 3 parts of the same distance 123.9 km. The time taken to complete the journey is 5.3 hours. Calculate the average speed in $\text{kmh}^{-1}$.

There are three measurements. The measurement, 3 parts, is the most accurate. A measurement in whole number is 100% accurate and has an accuracy of infinity, (i.e. infinite number of significant figures).

The measurement, 5.3 hours, has 2 significant figures (i.e. accuracy of 2). It is the least accurate.

By definition, average speed $=\dfrac{\text{total distance}}{\text{time taken}}$

$=\dfrac{3\times123.9\text{ km}}{5.3\text{ h}}$
$=70.13207547......\text{ kmh}^{-1}$ (incorrect answer)
$\approx 7.0\times10^1\text{ kmh}^{-1}$ (correct answer)

Note: The average speed was expressed in standard form in order to show an accuracy of 2. Writing it as $70\text{ kmh}^{-1}$ requires a statement of the number of significant figures. By itself, $70\text{ kmh}^{-1}$, would imply it is $100\%$ accurate.

## Exercise

1) Evaluate $3451.0\text{ mg}-0.004860\text{ kg}+3.32\text{ g}$

2) Find the volume of concrete (in $m^3$) required to make 10 rectangular slabs of identical dimensions, $3.60$ m, $180.0$ cm and $600.0$ mm.

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