Chapter 0: Significant Figures and Uncertainty

Significant Figures

Significant figures (or digits) are important when you are working with data that has been measured. It is important to consider them when you are doing some calculations using numbers obtained from measurements.

What is the point of sig figs? Knowing about sig figs allows you to ROUND your answer properly.

What are significant figures?

For any given measurement, some digits (or figures) are significant, while some are non-significant. Significant figures always indicate precision.

Here are some rules for determining whether or not digits are significant:

1. Digits from 1-9 are always significant. (not zero)

Examples:

a. 5 843 has _____ significant figures

b. 23 has _____ significant figures

2. Zeros between two other significant digits are always significant.

Examples:

a. 6008 has _____ significant figures

b. 20 564 302 has _____ significant figures

3. One or more additional zeros to the right of both the decimal place and another significant digit are significant.

Examples:

a. 23.0 has _____ significant figures

b. 860.00 has _____ significant figures

4. Zeros used solely for spacing the decimal point (placeholders) are not significant.

i.e. zeros at the right of a large number are not significant.

zeros at the left of a small number (<1) are not significant

Examples:

a. 0.0025 has _____ significant figures

b. 6 500 has _____ significant figures

c. 2.31×10^4 has _____ significant figures

5. Numbers that are not measurements (for example, constants in a formula or values that have been counted) have a infinite number of significant figures). We basically ignore them when we are trying to decide how many significant figures we need to round to.

Examples:

a. There are 41 bunnies in a cage.

b. Near the surface of the Earth, the acceleration due to gravity is 9.8 m/s^2

The rule for addition and subtraction with significant figures

When adding or subtracting round the answers to the least number of decimal places.

Examples:

a. 32.3 + 51 = _____ → _____

b. 6.235 – 2.54 = _____ → _____

c. 452.99 + 0,120005 = _____ → _____

The rule for multiplication and division with significant figures

When multiplying or dividing with numbers round the answer to the least number of sig figs i.e round off your answer to match the same number of significant figures as your measurement with the least number of significant figures.

Examples:

a. $0.0025 \times 3568 =$ _____ → _____

b. $101 \times 6.0 =$ _____ → _____

c. $4525 \div 320 =$ _____ → _____

d. $6.35 \times 3098 \times 25 =$ _____ → _____

e. $\frac{(1.234 \times 10^{4}) \times (83.4 \times 10^{-2})}{3.0} =$ _____ → _____

f. The base of a triangle measures 2.39 cm and its height measures 8.53 cm. What is the area of a triangle?

g. What is the area of a circle that has a radius of 3.9.cm?

h. What is the weight of a 7.4 kg mass?

Multi –Step Problems

When a problem involves both addition and multiplication, each rule has to be applied separately.

Examples:

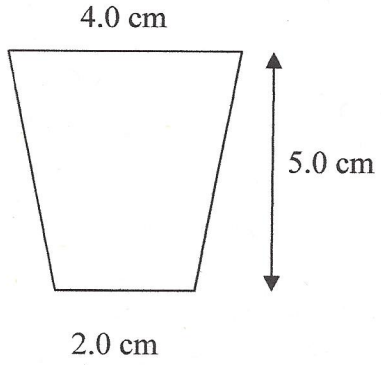
1. (4.56 + 12.678)(3.99)

2. 12.98 x 2.75 – 7.39

3. $\frac{600.3 - 45}{3.987}$

4. 35.98 x 34.09 x 107.9 x 8.09

5. Find the area of this trapezoid



Uncertainty

Uncertainty is present when a quantity has been measured with an instrument. The uncertainty in the measurement is a result of the uncertainty of the instrument used, or of the skill of the person taking the measurement.

There are two ways to express uncertainty:

Absolute uncertainty: is expressed in the same units as the measurement itself.

Ex: 5.9 cm ± 0.3 cm

Relative uncertainty: is expressed as a percentage of the measurement.

Ex: 5.9 cm ± 5 %

$$\text{Relative uncertainty} = \frac{\text{Absolute uncertainty}}{\text{Value of measurement}} \times 100$$

There are two ways of determining the uncertainty of a measurement:

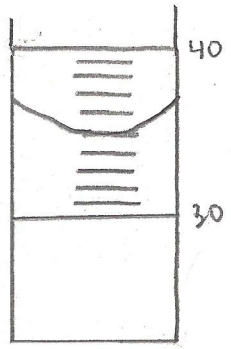
1. Sometimes the uncertainty is written on the instrument itself

Example: on a balance, it may say that the mass indicated has an uncertainty of 0.01 g.

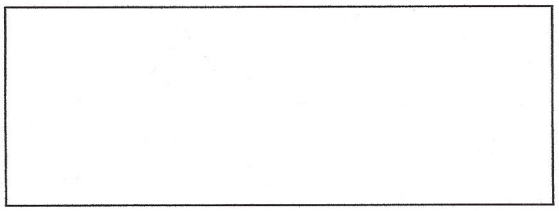
2. When the instrument does not indicate a specific uncertainty, the uncertainty is equal to one half of the smallest measurement provided by the instrument.

Examples:

a. Read the volume of the liquid in the graduated cylinder. The volume is in millilitres.



b. Measure the length and width of the rectangle below using a regular ruler. Give both the absolute and relative uncertainty.



c. Express the temperature reading taken from a thermometer at 36.8° C using absolute and relative uncertainty.