Data Processing

1. Averaging multiple trials: report the mean value ± ½ range

The following measurements were made for the height of the classroom door. (What's wrong with the data table?)

- Data Table Title - matched the
- listed uncertainty place value

Trial	Height (m) ± .002m
1	2.152
2	2.200
3	2.180
4	2.213

What final value should be reported?

$2.18625\,m \pm \frac{1}{2}(2.213\,m - 2.152\,m)$

$2.19m \pm 0.03m$

2. Measuring several cycles: reduces the uncertainty
divide total and the uncertainty by the # of cycles

A mass bounced up and down 5 times in 7.63 seconds as measured on a stopwatch.

How should the total time be recorded? $7.6\,s \pm 0.2\,s$

How much time did one full bounce take? $7.6s \div 5 \pm 0.2s \div 5$ $1.52s \pm 0.04s$

3. Mathematical operations: "+" or "−" then you add the uncertainties

a) To find the volume of an irregular object by water displacement, the following data were taken. How should the volume of the object be reported?

Volume of water in graduated cylinder: 22.5 ml ± 0.1 ml

Volume of water plus object: 83.7 ml ± 0.1 ml

Volume of object:

$83.7mL - 22.5mL = 61.2mL$

$61.2ml \pm 0.2mL$

$\pm \frac{1}{2}(61.4mL - 61.0mL)$

Determining uncertainty:

Maximum volume:

$83.8\,ml - 22.4\,ml = 61.4\,mL$

Minimum volume:

$83.6\,mL - 22.6\,mL = 61.0\,mL$

"×" or "÷" add % uncertainties

b) To find the area of his desktop, a student took the following data. How should the area be reported?

Length of desktop: 38.4 cm ± 0.3 cm

Width of desktop: 72.9 cm ± 0.3 cm

Area of desktop:

$2799.36\ cm^2$

$2800\ cm^2 \pm 30\ cm^2$

$\pm \frac{1}{2}(2832.84\ cm^2 - 2766.06\ cm^2) = 33.37\ cm^2$

Determining uncertainty:

Maximum area:

$38.7\ cm \times 73.2\ cm = 2832.84\ cm^2$

Minimum area:

$38.1\ cm \times 72.6\ cm = 2766.06\ cm^2$

c) To find the speed of a toy car, the following data were taken. How should the speed be reported?

Distance traveled: 4.23 m ± 0.05 m $\frac{0.05\ m}{4.23\ m} \times 100$

Time taken: 8.7 s ± 0.2 s $\frac{0.2\ s}{8.7\ s} \times 100 = 2.3\%$

$1.18\% + 2.3\% = 3.48\%$

Speed:

$\frac{4.23\ m}{8.7\ s} = 0.4862\ \frac{m}{s}$

3.48% of $0.4862\ \frac{m}{s}$

rounds

$0.49\ \frac{m}{s} \pm 0.02\ \frac{m}{s}$

Determining uncertainty:

Maximum speed:

$\frac{4.28\ m}{8.5\ s} = 0.5035\ \frac{m}{s}$

Minimum speed:

$\frac{4.18\ m}{8.9\ s} = 0.470\ \frac{m}{s}$

$\pm \frac{1}{2}(0.5035\ \frac{m}{s} - 0.470\ \frac{m}{s})$

d) What is the area of a circle whose radius is measured to be 6.2 cm ± 0.1 cm?

Area: $\pi r^2 = \pi r \cdot r$

$\pi (6.2\ cm)^2$

$121\ cm^2 \pm 4\ cm^2$

$\pm \frac{1}{2}(125\ cm^2 - 117\ cm^2) = 4\ cm^2$

Determining uncertainty:

Maximum area:

$\pi (6.3\ cm)^2 = 125\ cm^2$

Minimum area:

$\pi (6.1\ cm)^2 = 117\ cm^2$