How to quote any physical quantity

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Since physical Quantities have errors/uncertainty in them ∴ they are quoted as follows

$L = 25.0 \pm 0.5$ cm

25.0 → Actual value OR True value

0.5 → Actual error or Actual uncertainity.

General form $\boxed{L = x \pm \Delta x}$

fractional error $= \frac{0.5}{25.0}$ OR $\boxed{\frac{\Delta x}{x}}$

% error $= \frac{0.5}{25.0} \times 100$ OR $\boxed{\frac{\Delta x}{x} \times 100}$

$= 2\%$

Rules :: ① errors to be quoted correct to 1 significant figure

② True value must be consistent with the error

eg $x = 25.00$ $\Delta x = 0.50$

$x = 25.0 \pm 0.5$ (1 s.f)

eg $x = 25.000$ $\Delta x = 0.05$

$x = 25.00 \pm 0.05$ (1 s.f)

eg $x = 16.00$ $\Delta x = 0.36$

$x = 16.0 \pm 0.4$ (1 s.f)

① Rules for adding two physical Quantities

- True values must be added
- errors/uncertainity also added

$x = 18.5 \pm 0.5$ ✓
$y = 12.5 \pm 0.5$ ✓

- write down value for $x+y$ (add)

$x+y = 31 \pm 1$

- write down fractional error for $x+y = \frac{1}{31}$

- write down % error in $x+y$

$= \frac{1}{31} \times 100 = 3.2\%$ ✓ or 3.22% ✓ or 3.226% ✗

[rule for percentages :: To be given to a maximum of 2 or 3 s.f]
$= 3.22\%$ or 3.2%

② Rule for Subtracting two physical Quantities

- True values to be subtracted
- Since errors can't get reduced ∴ errors are still added together

$x = 18.5 \pm 0.5$
$y = 12.5 \pm 0.5$

- write down value for $x-y$.

$x-y = 6 \pm 1$

- fractional error in $x-y = \frac{1}{6}$
- % error in $x-y = \frac{1}{6} \times 100$
$= 17\%$ or 16.7%

eg initial velocity = 20 m/s
final velocity = 60 m/s
both values have uncertainity of 0.5 m/s

Cal % error in change in velocity?

Initial 20.0 ± 0.5 m/s
final 60.0 ± 0.5 m/s.

ΔV (Change in velocity) = final − Initial
$= 40 \pm 1$ m/s

% error in $\Delta V = \frac{1}{40} \times 100$
$= 2.5\%$ or 2.50%

③ Rule for multiplying two physical Quantities

- True values to be multiplied
- In multiplication, fractional errors are added together

$L = 5.0 \pm 0.5$
$B = 6.0 \pm 0.5$
} Rectangle

- write down the Actual value for the Area of Rectangle.

$A = 5 \times 6 = 30$ ✓

- write down the error in the area

$A = L \times B$
fractional errors to be added ✓

$\frac{\Delta A}{A} = \frac{\Delta L}{L} + \frac{\Delta B}{B}$ ✓

$\frac{\Delta A}{30} = \frac{0.5}{5.0} + \frac{0.5}{6.0}$ ✓

$\Delta A = 5.5$ ✓

final answer 30 ± 6

eg:: $L = 2.0 \pm 0.5$
$B = 18.0 \pm 0.5$
$H = 16.0 \pm 0.5$
} Rectangular block

Cal its volume along with its uncertainity.

- True value $V = L \times B \times H$
$V = 2 \times 18 \times 16$
$V = 576$

- error in volume
fractional error are added

$\frac{\Delta V}{V} = \frac{\Delta L}{L} + \frac{\Delta B}{B} + \frac{\Delta H}{H}$

$\frac{\Delta V}{576} = \frac{0.5}{2} + \frac{0.5}{18} + \frac{0.5}{16}$

$\Delta V = 178$

600 ± 200

if error is written correct to the nearest 100, than to maintain consistency the true value must also be rounded off to the nearest 100. (hence 576 changed to 600).

Q True value = 327.65
error = 9.8

quote this physical Quantity along with its uncertainity. ?

$x = 330 \pm 10$ Ans.

$327.65 \approx 330$

Q $V = L^2 \times H$

How would you write down this formula in the form of fractional errors ?

$V = L \times L \times H$

~~$\frac{\Delta V}{V} = \frac{\Delta L}{L} + \frac{\Delta L}{L} + \frac{\Delta H}{H}$~~

$\frac{\Delta V}{V} = 2\frac{\Delta L}{L} + \frac{\Delta H}{H}$

- The power with any term can be written down as a multiplying constant.

Q $V = L^3 \times H^2 \times \sqrt{T}$

fractional error would be written as

$\frac{\Delta V}{V} = 3\frac{\Delta L}{L} + 2\frac{\Delta H}{H} + \frac{1}{2}\frac{\Delta T}{T}$.

④ Rule for dividing Physical Quantities

- True values to be divided
- fractional errors to be added

eg
$d = 40.0 \pm 0.1$ m
$t = 2.50 \pm 0.05$ s

Cal speed along with its uncertainity ?

True value $S = \frac{d}{t} = \frac{40}{2.5} = 16$

error in speed

$\frac{\Delta S}{S} = \frac{\Delta d}{d} + \frac{\Delta t}{t}$

$\frac{\Delta S}{16} = \frac{0.1}{40} + \frac{0.05}{2.50}$

$\Delta S = 0.36$

Speed $= 16.0 \pm 0.4$