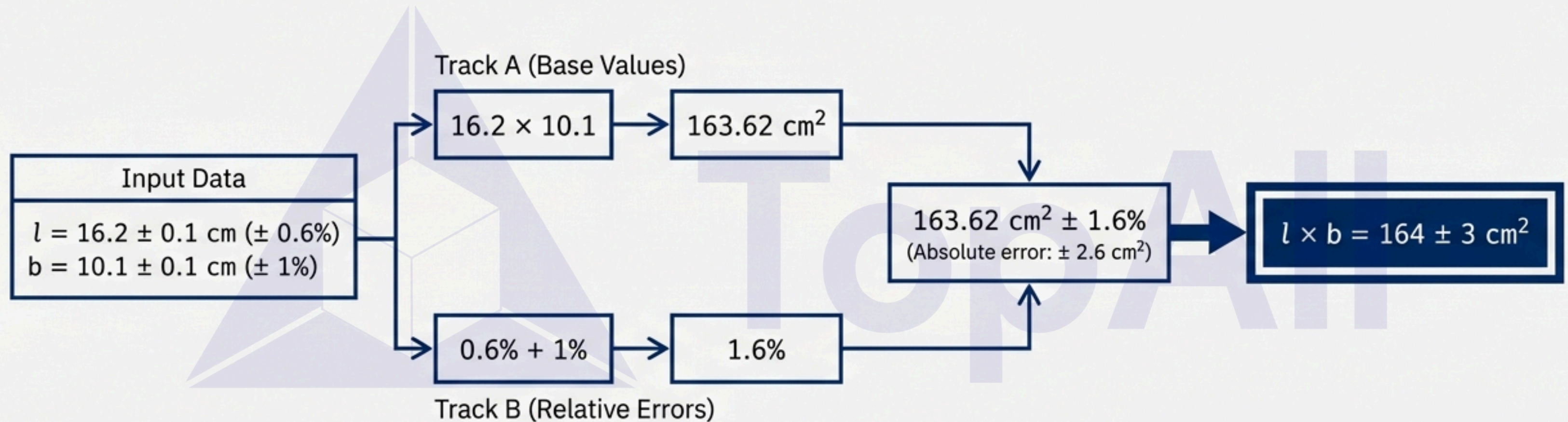


Units and Measurement · Concept 5

Uncertainty in Arithmetic Results — Combining Errors

A diagnostic view of how errors propagate through mathematical operations.

The Multiplication Pipeline



The Subtraction Shredder

$$\begin{array}{r}
 12.9 \text{ g (3 sig figs)} \\
 - 7.06 \text{ g (3 sig figs)} \\
 \hline
 5.84 \text{ g}
 \end{array}
 \rightarrow
 \boxed{5.8 \text{ g}}$$

Even though both inputs have 3 significant figures, the output only survives with 2.



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$$E=mc^2$$



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TRAP ALERT

Equal sig-fig counts do not survive subtraction — decimal places govern, and precision can be lost.

The Magnitude Context Matrix

Small Magnitude Base	Large Magnitude Base
Measurement: 1.02 g $\pm$ 0.01 g	Measurement: 9.89 g $\pm$ 0.01 g
Absolute Uncertainty: $\pm$ 0.01 g	Absolute Uncertainty: $\pm$ 0.01 g
IDENTICAL ABSOLUTE UNCERTAINTY	
Calculation: $(\pm 0.01 / 1.02) \times 100\%$	Calculation: $(\pm 0.01 / 9.89) \times 100\%$
Relative Error Output: $\pm 1\%$	Relative Error Output: $\pm 0.1\%$

Same absolute uncertainty, vastly different relative error.
Magnitude dictates meaning.

Guarding Precision in Multi-Step Computations

Retain **exactly one extra digit** in intermediate steps beyond the least precise measurement.

- 1** Carry the extra digit through all intermediate arithmetic.
- 2** Round off to the proper significant figures **only** at the final result.

Note: Failing to do this allows rounding errors to compound and corrupt the final value.



Key Takeaways

Products: relative errors add.
Sums/differences: decimal places rule, which can cost you a digit.



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