

Uncertainty Calculations

IB PHYSICS | SCIENCE SKILLS

Uncertainty Review



Absolute Uncertainty	$0.385 \pm 0.001 \text{ V}$
Fractional Uncertainty	$\frac{0.001}{0.385} = 0.0026$
Percentage Uncertainty	$0.0026 \times 100\% = 26\%$

Uncertainty in Calculations

Adding or Subtracting

Always Add

If $y = a \pm b$ then $\Delta y = \Delta a + \Delta b$

Absolute Uncertainty

To find the **uncertainty in a sum or difference** you just add the uncertainties of all the ingredients.

Try This

A 5.0 ± 0.7 meter ladder propped vertically next to a 8.5 ± 0.3 meter wall. How far between the top of the ladder and the top of the wall?

$$8.5 - 5.0 = 3.5 \text{ m}$$

$$0.7 + 0.3 = 1.0 \text{ m}$$

$$3.5 \pm 1.0 \text{ m}$$



Uncertainty in Calculations

Multiplying or Dividing

Always Add

If $y = a \times b \div c$ then $\Delta y/y = \Delta a/a + \Delta b/b + \Delta c/c$

Percent or Fractional Uncertainty

To find the **uncertainty in a product or quotient** you just add the percentage or fractional uncertainties of all the ingredients.

Try This

A car travels 64.7 ± 0.5 meters in 8.65 ± 0.05 seconds.
What is its speed?

$$v = \frac{d}{t} = \frac{64.7}{8.65} = 7.48 \text{ m s}^{-1}$$



$$\frac{0.5}{64.7} \times 100\% = 0.77\%$$

$$\frac{0.05}{8.65} \times 100\% = 0.58\%$$

$$0.77\% + 0.58\% = 1.35\%$$

$$7.48 \text{ m s}^{-1} \pm 1.35\%$$

$$7.48 \times 0.0135 = 0.1 \text{ m s}^{-1}$$

$$7.48 \pm 0.1 \text{ m s}^{-1}$$

This is in the Data Booklet ☺

Uncertainties

if: $y = a \pm b$	then: $\Delta y = \Delta a + \Delta b$
if: $y = \frac{ab}{c}$	then: $\frac{\Delta y}{y} = \frac{\Delta a}{a} + \frac{\Delta b}{b} + \frac{\Delta c}{c}$
if: $y = a^n$	then: $\frac{\Delta y}{y} = \left n \frac{\Delta a}{a} \right $

Example IB Question

2. The current I through a resistor is measured with a digital ammeter to be 0.10A. The uncertainty in the calculated value of I^2 will be

A. 1%.

B. 2%.

C. 5%.

D. 20%.

$$0.10 \pm 0.01 \text{ A}$$

$$\frac{0.01}{0.10} \times 100\% = 10\%$$

$$2 \times 10\% = 20\%$$

Example IB Questions

1. The radius of a sphere is measured with an uncertainty of 2%. What is the uncertainty in the volume of the sphere?

- A. 2%
 B. 4%
 C. 6%
 D. 8%

$$4\pi r^3$$

Exact Values

$$3 \times 2 = 6\%$$

1. The length of the side of a cube is 10.0 ± 0.3 cm. What is the uncertainty in the volume of the cube?

- A. ± 0.027 cm³
 B. ± 2.7 cm³
 C. ± 9.0 cm³
 D. ± 90 cm³

$$\frac{0.3}{10.0} \times 100\% = 3\%$$

$$3 \times 3\% = 9\%$$

$$10^3 = 1000 \text{ cm}^3$$

$$1000 \times 0.09 = 90 \text{ cm}^3$$

Lesson Takeaways

- I can calculate uncertainty from added or subtracted values
- I can calculate uncertainty from multiplied or divided values