# Calculating Percentage Uncertainties when you have repeats

| Reading 1 | Reading 2 | Reading 3 | Average Reading |
|---|---|---|---|
| 5.00 | 5.17 | 5.09 | 5.09 |

$$\text{Uncertainty} = \text{Half the Range} = \frac{5.17 - 5.00}{2} = \pm 0.09$$

$$\%\text{Uncertainty} = \frac{\text{Half the Range}}{\text{Average Reading}} \times 100$$

$$\%\ \text{Uncertainty} = (0.09/5.09) \times 100 = 1.8\ \%$$

# Calculating Percentage Uncertainties when there are NO repeat measurements


Reading on meter = 12.6 V

Resolution = 0.2 V

Uncertainty = HALF the Resolution = ± 0.1V

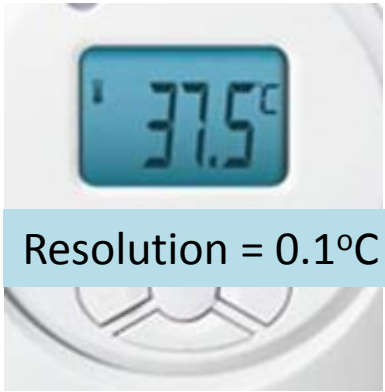
$$\%\text{Uncertainty} = \frac{\textbf{HALF}\ \text{Resolution}}{\text{Reading Taken}} \times 100$$

% Uncertainty = (0.1/12.6) x 100 = 0.8 %

# Task

Calculate the percentage uncertainties for the following measurements:

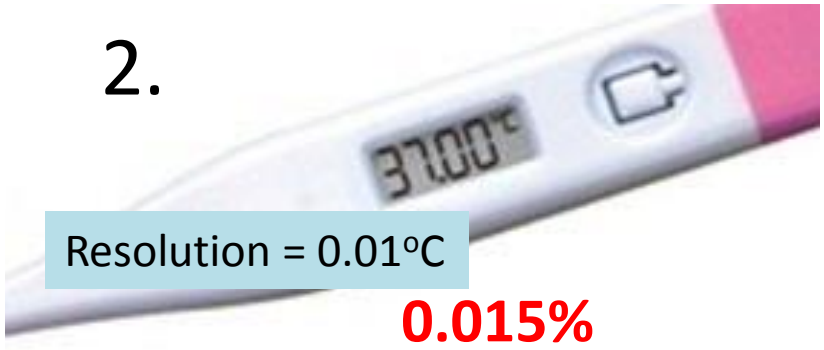
1.




Resolution = 0.1°C

**0.13%**

2.




Resolution = 0.01°C

**0.015%**

3. 100m record of 9.6 s (resolution = 0.1s)

**0.5%**

4. Extension of 0.0020m (resolution = 0.0001m)

**2.5%**

5. Extension of 0.045m (resolution = 0.001m)

**1%**

# Combining Uncertainties

Suppose I want to work out the density of the block…

$$\text{Density} = \frac{\text{Mass (kg)}}{\text{Volume (m}^3\text{)}}$$

Mass = 0.500 ± 0.001 kg

Volume = (6.25 ± 0.25) x $10^{-5}$ $m^3$

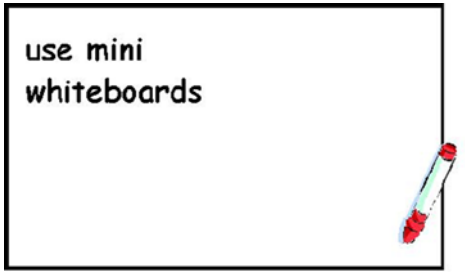
To work out the percentage uncertainty in the density, I have to combine the percentage uncertainty in the mass with the percentage uncertainty in the volume

# How do we do it?

1. **Work out the Percentage Uncertainty in the volume and the mass.**

2. **Then add these together.**

# Work it out…




$$\text{Density} = \frac{\text{Mass (kg)}}{\text{Volume (m}^3\text{)}}$$

Mass = 0.500 ± 0.001 kg

Volume = (6.25 ± 0.25) x $10^{-5}$ $m^3$

**4.2%**

Extension: Work out the **uncertainty** in the density

# THE RULES

| What happens in the formula | What to do to calculate percentage uncertainties |
|---|---|
| $A \times B$ or $A \div B$ | Add percentage uncertainty of A with percentage uncertainty in B |
| $A^2$ | Double the percentage uncertainty of A |
| $A^n$ | Multiply the percentage uncertainty by n |

# Want More Practise?

- See the worksheets in OneNote and email Miss Kent for answers (kenta@salesian.hants.sch.uk)