

Tim Hollabaugh	Fresno State Engineering Clinic	3/5	

Q. How does uncertainty differ for analog and digital devices?

Analog devices use one tenth rule

Digital devices use one unit rule

Problems:

1. Estimate measurement with one tenth rule

Ruler $\rightarrow 64.4 \pm 0.1$ Cylinder $\rightarrow 63.5 \pm 0.1$

2. Calculate and determine uncertainty:

a. $3.2 + 6.0 = 9.2 \pm 0.1$

b. $21 \times 8.5 = 120 \pm 1$

c. $(3.5 - 1.0 \div 5) / 55.6 = 0.045 \pm 0.1$

3. Error Propagation

a. Determine $R = A + B$ where $A = 4.5 \pm 0.3$ and $B = 3.7 \pm 0.2$

$R = 8.2$ $U_R = 0.5$

$R = 8.2 \pm 0.5$

b. Determine $R = A \times B$ where $A = 2.0 \pm 0.3$ and $B = 3.0 \pm 0.2$

$R = 6.0$ $U_R = 0.5$

$R = 6.0 \pm 0.5$

c. $R = A \times B - C$ where $A = 3.0 \pm 0.2$ $B = 4.0 \pm 0.2$ $C = 9.15 \pm 0.08$

$R = 3 \pm 0.9$

4. Calculate mean and standard deviation

Trail Measurement

1 11.7 $11.7 + 10.7 + 11.0 + 11.4 + 11.9 + 10.8 + 11.1 + 11.1 + 10.5 + 10.8 + 11.1 + 10.5 + 10.8 + 10.1$

2 10.7 10

3 11.0 $\boxed{= 11} \rightarrow \text{mean}$

4 11.4
$$\text{Std dev} = \sqrt{\frac{\sum_{i=1}^{n-1} (x_i - \bar{x})^2}{(n-1)}}$$

5 11.9

6 10.8
$$\sqrt{\frac{(1.7)^2 + (1.3)^2 + (0)^2 + (1.4)^2 + (1.9)^2 + (1.2)^2 + (1.1)^2 + (1.5)^2 + (1.2)^2 + (1.9)^2}{(n-1)}}$$

7 11.1

8 10.5

9 10.8

10 10.1

$\boxed{= 0.6} \rightarrow \text{Std dev}$