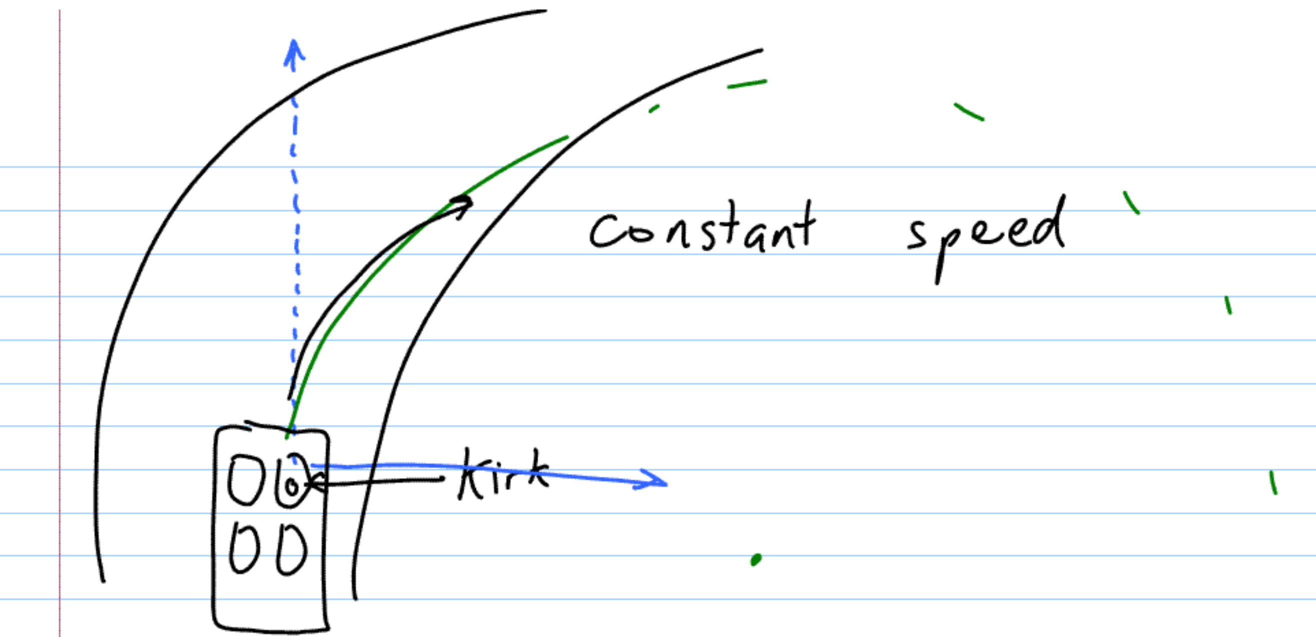

Exact

Approximate.

~~$t_4 = 5.38$~~ s woops.

$t_5 = 7.53$ s

7.38 s

7.47 s

7.43 s

~1800 Gauss discovered repeated measurements produce a <u>distribution</u> of answers.

Histogram looks like a bell.

$$N(x) = A\, e^{\left[-(x-\bar{x})^2/2\sigma^2\right]}$$

where $N(x)$ = number of measurements whose value is near x.

A = arbitrary constant

$e = 2.7182\ldots$

$\bar{x}$ = mean or average

σ = standard deviation

} these can be estimated from the data.

Error propagation.

Sum Rule

Product Rule

Multiply by an exact constant rule

Example: 5 oscillations take 7.53 ± 0.06 seconds

What is the period? 1.506

error?

→ multiplying by exact constant $\frac{1}{5}$

error: 0.012

or 1.51 ± 0.01

answer: $T = 1.506 \pm 0.012$

Error in mean of n measurements

$$\bar{x} = \frac{(x_1 \pm \Delta x) + (x_2 \pm \Delta x) + \cdots}{n}$$

sum: $x_{sum} = x_1 + x_2 + \cdots + x_n$

Mean: $\bar{x} = x_{sum}/n$

$$\Delta x_{sum} = \sqrt{\Delta x^2 + \Delta x^2 + \cdots}$$

n times

$$\Delta x_{sum} = \sqrt{n \Delta x^2}$$

$$= \sqrt{n}(\Delta x)$$

Error in mean:

$$\Delta \bar{x} = \frac{\sqrt{n}}{n}(\Delta x)$$

$$\Delta \bar{x} = \frac{\Delta x}{\sqrt{n}}$$

← error in mean

Error in a "quoted value" is ± half last digit ie $c = 3.00 \times 10^8$ m/s

$\pm\ 0.005 \times 10^8$ m/s

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calculation: $7.0\cancel{5}\cancel{6} \pm 0.705$ → 0.7

tenths place is most significant

7.1 ± 0.7