### Quantity

<table>
<thead>
<tr>
<th>Definition or Expression</th>
<th>Excel Function</th>
</tr>
</thead>
<tbody>
<tr>
<td>mean — your best guess for the quantity you measured</td>
<td>$\bar{y} = \frac{1}{N} \sum_{n=1}^{N} y_n$</td>
</tr>
<tr>
<td>standard deviation — a measure of the width of the distribution of your data points</td>
<td>$\sigma_y = \left[ \frac{1}{N-1} \sum_{n=1}^{N} (y_n - \bar{y})^2 \right]^{1/2}$</td>
</tr>
<tr>
<td>standard deviation of the mean (aka standard error) — your best guess for the random uncertainty of the measurement</td>
<td>$\sigma_{\bar{y}} = \frac{\sigma_y}{\sqrt{N}}$</td>
</tr>
<tr>
<td>weighted average — this is how to combine several measurements of the same thing that have different uncertainties</td>
<td>$\bar{x} = \frac{\sum_i x_i / \sigma_i^2}{\sum_i 1 / \sigma_i^2}$, $\sigma = \left[ \sum_i 1 / \sigma_i^2 \right]^{-1/2}$</td>
</tr>
</tbody>
</table>

### Error Propagation

**general uncorrelated errors**

$z = z(x, y)$

$\delta z = \left[ \left( \frac{\partial z}{\partial x} \delta x \right)^2 + \left( \frac{\partial z}{\partial y} \delta y \right)^2 \right]^{1/2}$

**sum**

$z = x + y$

$\delta z = \sqrt{(\delta x)^2 + (\delta y)^2}$

**product**

$z = xy$

$\frac{\delta z}{z} = \left[ \left( \frac{\delta x}{x} \right)^2 + \left( \frac{\delta y}{y} \right)^2 \right]^{1/2}$

**generalized product**

$z = x^m y^n$

$\frac{\delta z}{z} = \sqrt{ \left( m \frac{\delta x}{x} \right)^2 + \left( n \frac{\delta y}{y} \right)^2}$

### Plotting and Analyzing Results

#### Residuals
- Do they appear random?
- Are about 2/3 of the points within one error bar from the zero line?

#### Fit Results
- Does the curve describe the data trends well?
- Are the parameter values reasonable?
- Is the reduced value of $\chi^2$ approximately equal to 1?