PHY151H1F Practicals 1 Intro Video Slides

- Almost every time you make a measurement, the result will not be an exact number, but it will be a *range* of possible values.
- The range of values associated with a measurement is described by the **uncertainty**, sometimes called the error.

Exactly 3 apples (no uncertainty)

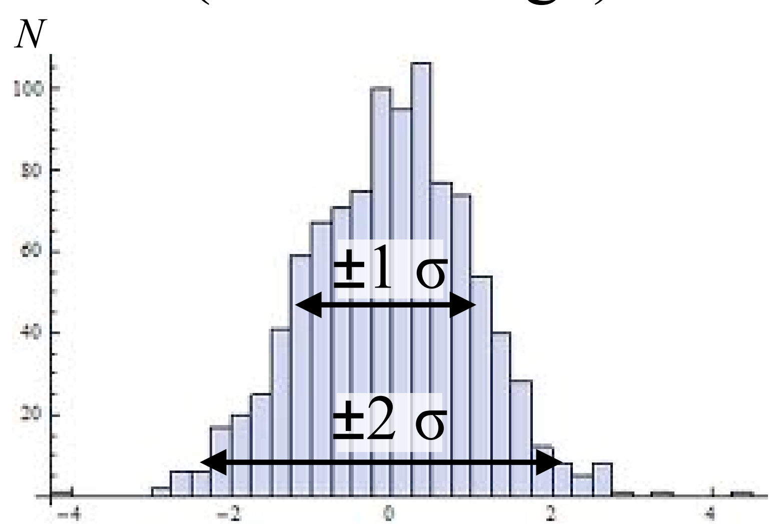
1600 ± 100 apples:

1600 is the **value**
100 is the **uncertainty**

Uncertainties

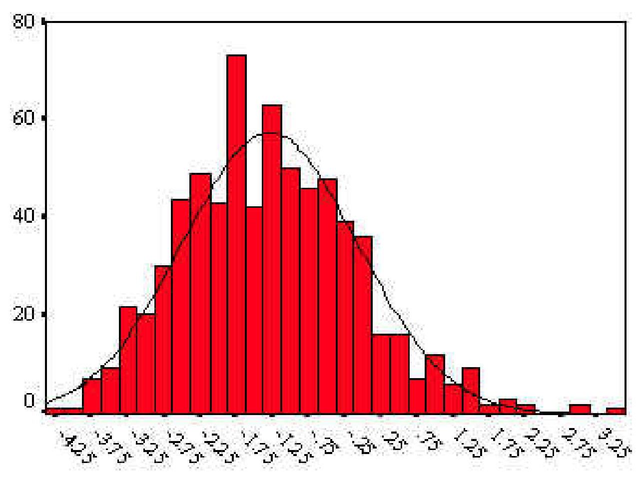
- Uncertainties **eliminate** the need to report measurements with vague terms like "approximately" or "≈".
- Uncertainties give a *quantitative* way of stating your confidence level in your measurement.
- Saying the answer is 10 ± 2 means you are 68% confident that the actual number is between 8 and 12.
- It also implies that you are 95% confident that the actual number is between 6 and 14 (the 2-σ range).

A histogram of many, many measurements of the same thing:



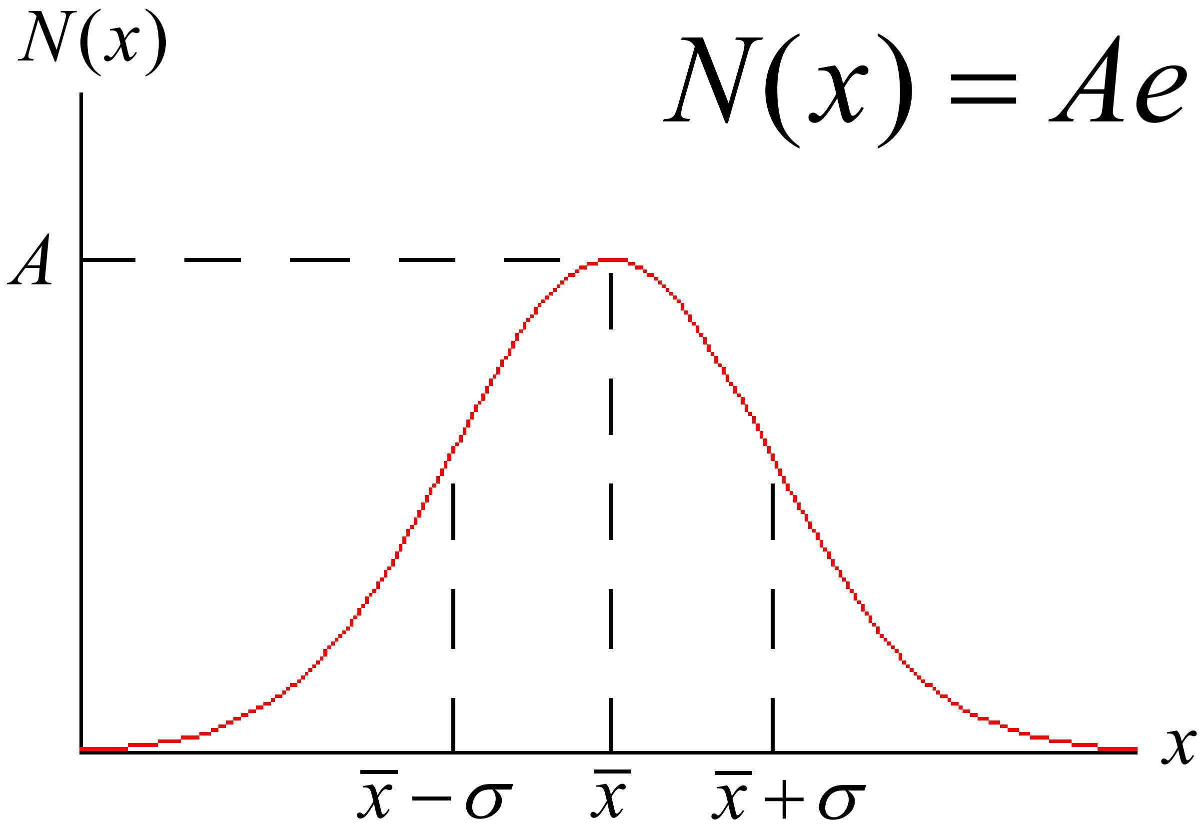
Normal Distribution

- A **probability distribution** is a curve which describes what the probability is for various measurements
- The most important and widely used probability distribution is called the *Normal Distribution*
- It was first popularized by the German mathematician Carl Friedrich Gauss in the early 1800s
- It is also sometimes called the **Gaussian** distribution, or the bell-curve



The Gaussian:

$$N(x) = Ae^{\frac{-(x-\bar{x})^2}{2\sigma^2}}$$



- A is the *maximum amplitude*.
- $\bar{x}$ is the *mean* or *average*.
- σ is the *standard deviation* of the distribution.

Normal Distribution

- σ is the **standard deviation** of the distribution
- Statisticians often call the square of the standard deviation, σ^2, the **variance**
- σ is a measure of the width of the curve: a larger σ means a wider curve
- 68% of the area under the curve of a Gaussian lies between the mean minus the standard deviation and the mean plus the standard deviation
- 95% of the area under the curve is between the mean minus twice the standard deviation and the mean plus twice the standard deviation

When Making Measurements

- There is roughly a 68% chance that any measurement of a sample taken at random will be within one standard deviation of the mean (assuming normal distribution)
- Usually the mean is what we wish to know and each individual measurement almost certainly differs from the true value of the mean by some uncertainty
- There is a 68% chance that any single measurement lies with one standard deviation of this true value of the mean
- The value of σ is often called the *statistical uncertainty*