"Error" and "Uncertainty" in Measurements

ERROR

The word "error", as used in experimental research, means

> **"The difference between a measured value and the known true value":**
>
> error = measured value − known true value

Example:

Suppose the radius of a circle is measured to be 10.3 cm, and the circumference is measured to be 64.7 cm. Then the measured value of the circle constant, to five significant digits, is:

> circumference/radius = 6.2816

The known true value of the circle constant, to five significant digits, is 6.2832.

Therefore, the error in the measured value of the circle constant is 6.2816 − 6.2832 = −0.0016.

The error can be positive or negative according as the measured value is greater than or less than the known true value.

If the true value of a quantity is unknown, then the error in a measurement of that quantity is also unknown.

However, it may be possible to estimate the possible error in a measurement from the limitations in the method of measurement.

UNCERTAINTY

The word "uncertainty", as used in experimental research, means

> **"The estimated uncertainty in the value of a measurement caused by the limited accuracy of the method of measurement"**

Example:

In the above example, suppose that the measured lengths have an estimated uncertainty 0.05 cm. Then the estimated uncertainty in the measured value of the circle constant is 0.0056.

The estimated uncertainty is always positive because we do not know whether the measurements are greater than or less than the true values.

The true value is expected to be between the measured value minus the uncertainty and the measured value plus the uncertainty. This method is used when the true value is unknown.

Example:

In the above example

> circumference/radius = 6.2816

and the estimated uncertainty in the measured value of the circle constant is 0.0056. Therefore, according to the measurements, the true value of the circle constant is expected to be in the interval from 6.2760 to 6.2872.

RHBE, October 2017.
