

### measurement result

The outcome of an analytical measurement (application of the *chemical measurement process*), or value attributed to a *measurand*. This may be the result of direct observation, but more commonly it is given as a statistical estimate derived from a set of observations. The distribution of such estimates (estimator distribution) characterizes the chemical measurement process, in contrast to a particular estimate, which constitutes an experimental result.

Additional characteristics become evident if we represent  $\hat{x}$  as follows:

$$\hat{x} = \tau + \underbrace{e}_{\mu} = \tau + \Delta + \delta = \mu + \delta$$

The *true value*,  $\tau$ , is the value  $x$  that would result if the chemical measurement process were error-free.

The *error*,  $e$ , is the difference between an observed (estimated) value and the true value; i.e.  $e = \hat{x} - \tau$  (signed quantity). The total error generally has two components, bias ( $\Delta$ ) and *random error* ( $\delta$ ), as indicated above. The limiting mean,  $\mu$ , is the asymptotic value or population mean of the distribution that characterizes the measured quantity; the value that is approached as the number of observations approaches infinity. Modern statistical terminology labels this quantity the expectation value or expected value,  $E(\hat{x})$ .

The bias,  $\Delta$ , is the difference between the limiting mean and the true value; i.e.  $\Delta = \mu - \tau$  (signed quantity).

The random error,  $\delta$ , is the difference between an observed value and the limiting mean; i.e.  $\delta = \hat{x} - \mu$  (signed quantity).

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