Calculating Precision in Parts Per Thousand

General Procedure

Laboratories from CHM 111 and CHM 112 sometimes require students to calculate the "parts per thousand". This is performed as follows. If one has several mesasurements $m_1, m_2, ..., m_n$, the average ($\hat{X}$) is computed as in equation 1.

$$\hat{X} = \frac{m_1 + m_2 + \cdots + m_n}{n} \tag{1}$$

The absolute *deviation* (d) of each of these points from the average is computed as the difference between the average and the measured quantity as indicated in equation 2

$$d_i = \hat{X} - m_i \tag{2}$$

The average deviation ($\hat{d}$) is then computed by simply dividing the sum of the absolute values of the individual deviations (d) by the number of samples.

$$\hat{d} = \sum_{i=1}^{n} \frac{|d_i|}{n} = \frac{|d_1| + |d_2| + \cdots + |d_n|}{n} \tag{3}$$

The parts per thousand (ppt) is then computed by dividing the average deviation ($\hat{d}$) by the average value ($\hat{X}$) and multiplying by 1000.

$$\text{p}pt = \frac{\hat{d}}{\hat{X}} \times 1000 \tag{4}$$

Example

Assume you have six measurements: 43.5, 42.6, 44.1, 43.0, 42.7, and 42.9. The average of these is:

$$\hat{X} = \frac{43.5 + 42.6 + 44.1 + 43.0 + 42.7 + 42.9}{6} = 43.1 \tag{5}$$

The absolute deviations are computed as follows:

$$d_1 = (43.1 - 43.5) = -0.4 \tag{6}$$
$$d_2 = (43.1 - 42.6) = -0.5 \tag{7}$$
$$d_3 = (43.1 - 44.1) = -1.0 \tag{8}$$
$$d_4 = (43.1 - 43.0) = 0.1 \tag{9}$$
$$d_5 = (43.1 - 42.7) = 0.4 \tag{10}$$
$$d_6 = (43.1 - 42.9) = 0.2 \tag{11}$$

The average deviation is therefore:

$$\hat{d} = \frac{|-0.4| + |-0.5| + |-1.0| + |0.1| + |0.4| + |0.2|}{6} = 0.43 \tag{12}$$

Finally, this value is divided by the average and multiplied by 1000.

$$\text{p}pt = \frac{\hat{d}}{\hat{X}} \times 1000 = \frac{0.43}{43.1} \times 1000 = 10 \text{ ppt} \tag{13}$$