Introduction to Measurements

Group Problem #1

The sides of a closed figure have been measured and found to have a total length of 3,264.76 ft. If the error in the measurements is estimated to be 0.17 ft., what is the precision of the work? Hint: Remember you rules for significant figures.

$$precision = \frac{\text{error of measurement}}{\text{distance measured}}$$

Introduction to Measurements

Group Problem #1

The sides of a closed figure have been measured and found to have a total length of 3,264.76 ft. If the error in the measurements is estimated to be 0.17 ft., what is the precision of the work? Hint: Remember you rules for significant figures.

$$\frac{0.1\overline{7}\text{ ft.}}{3{,}264.76\text{ ft.}} = \frac{1}{N} \Rightarrow N = \frac{3{,}264.76\text{ ft.}}{0.1\overline{7}\text{ ft.}} = 1\overline{9}{,}204.470\ldots$$

$$= \boxed{\frac{1}{1\overline{9}{,}000}}$$

Introduction to Measurements

Group Problem #2

An error of ±0.005 ft. is estimated for each of 28 length measurements (which are to be added together to get the total length.

Estimated total error?

$$E_{Total} = \pm E\sqrt{n} = \pm 0.00\overline{5}\text{ ft.}\sqrt{28} = \pm 0.0\overline{2}6457..\text{ ft.}$$

$$= \boxed{\pm 0.0\overline{3}\text{ ft.}}$$

Introduction to Measurements

Group Problem #2

An error of ±0.005 ft. is estimated for each of 28 length measurements (which are to be added together to get the total length.

Estimate total error if the error is ±0.008 ft. per length?

$$E_{Total} = \pm E\sqrt{n} = \pm 0.00\overline{8}\ ft\sqrt{28} = \pm 0.0\overline{4}233\ldots\text{ ft.}$$

$$= \boxed{\pm 0.0\overline{4}\text{ ft.}}$$

Introduction to Measurements

Group Problem #3

Estimate the total error is the estimated error per 100 ft. is ±0.04 ft. and the measurements are 511.33, 726.32, 954.86, and 1,410.11 ft.

$$E_{Total} = \pm\sqrt{E_1^2 + E_2^2 + \ldots + E_n^2}$$

$$E_1 = \pm 0.0\overline{4}\text{ ft.}\sqrt{5.1133} = \pm 0.0\overline{9}045\ldots\text{ ft.} = \pm 0.0\overline{9}\text{ ft.}$$

$$E_2 = \pm 0.0\overline{4}\text{ ft.}\sqrt{7.2632} = \pm 0.\overline{1}078\ldots\text{ ft.} = \pm 0.\overline{1}\text{ ft.}$$

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$$E_{Total} = \pm\sqrt{E_1^2 + E_2^2 + \ldots + E_n^2}$$

$$E_3 = \pm 0.0\overline{4}\text{ ft.}\sqrt{9.5486} = \pm 0.\overline{1}236\ldots\text{ ft.} = \pm 0.\overline{1}\text{ ft..}$$

$$E_4 = \pm 0.0\overline{4}\text{ ft.}\sqrt{14.1011} = \pm 0.\overline{1}502\ldots\text{ ft.} = \pm 0.\overline{2}\text{ ft.}$$

Introduction to Measurements

Group Problem #3

Estimate the total error is the estimated error per 100 ft. is ±0.04 ft. and the measurements are 511.33, 726.32, 954.86, and 1,410.11 ft.

$$E_{Total} = \pm\sqrt{E_1^2 + E_2^2 + \ldots + E_n^2}$$

$$E_{Total} = \sqrt{\left(\pm 0.0\overline{9}\text{ ft.}\right)^2 + \left(\pm 0.\overline{1}\text{ ft.}\right)^2 + \left(\pm 0.\overline{1}\text{ ft.}\right)^2 + \left(\pm 0.\overline{2}\text{ ft.}\right)^2}$$

$$= \sqrt{0.00\overline{8}\text{ ft.}^2 + 0.0\overline{1}\text{ ft.}^2 + 0.0\overline{1}\text{ ft.}^2 + 0.0\overline{4}\text{ ft.}^2}$$

Introduction to Measurements

Group Problem #3

Estimate the total error is the estimated error per 100 ft. is ±0.04 ft. and the measurements are 511.33, 726.32, 954.86, and 1,410.11 ft.

$$E_{Total} = \pm\sqrt{E_1^2 + E_2^2 + \ldots + E_n^2}$$

$$E_{Total} = \sqrt{\left(\pm 0.0\overline{7}\text{ ft.}^2\right)} = \pm 0.\overline{2}646\text{ ft.}$$

$$= \boxed{\pm 0.\overline{3}\text{ ft.}}$$

Introduction to Measurements

Group Problem #3 – Alternate Solution

Estimate the total error is the estimated error per 100 ft. is ±0.04 ft. and the measurements are 511.33, 726.32, 954.86, and 1,410.11 ft.

Total distance = 511.33 ft. + 726.32 ft. + 954.86 ft. + 1,410.11 ft. = 3,602.62 ft.

$$E_{Total} = E\sqrt{n} = \pm 0.0\overline{4}\,ft\sqrt{\frac{3{,}602.62\,ft}{100\,ft}}$$

$$= \pm 0.0\overline{4}\,ft\sqrt{36.0262} = \pm 0.\overline{2}4009\ldots = \boxed{\pm 0.\overline{2}\text{ ft.}}$$

Introduction to Measurements

Group Problem #4

A surveying crew or party is capable of taping distances with an estimated error of ±0.014 ft. for each 100-ft. distance. Estimated total error if a distance of 4,200 ft. is measured?

$$E_{Total} = \pm E\sqrt{n} = \pm 0.0\overline{14}\text{ ft.}\sqrt{42} = \pm 0.0\overline{9}073\ldots\text{ ft.}$$

$$= \boxed{\pm 0.0\overline{91}\text{ ft.}}$$

Introduction to Measurements

Group Problem #5

It is desired to tape a distance of 1,600 ft. with an estimated total error of not more than ±0.025 ft.

How accurately should each 100-ft. distance be measured so that the permissible value is not exceeded?

$$E_{Total} = \pm E\sqrt{n} \quad \Rightarrow \quad \pm E = \frac{E_{Total}}{\sqrt{n}}$$

$$\pm E = \frac{\pm 0.0\overline{25}\text{ ft.}}{\sqrt{16}} = \pm 0.00\overline{6}250\text{ ft.} = \boxed{\pm 0.00\overline{62}\text{ ft.}}$$

Introduction to Measurements

Group Problem #5

It is desired to tape a distance of 1,600 ft. with an estimated total error of not more than ±0.025 ft.

How accurately should each 100-ft. distance have to be measured so that the estimated total error would not exceed ±0.18 ft. in a total distance of 2,500 ft.?

$$E_{Total} = \pm E\sqrt{n} \quad \Rightarrow \quad \pm E = \frac{E_{Total}}{\sqrt{n}}$$

$$\pm E = \frac{\pm 0.\overline{18}\text{ ft.}}{\sqrt{25}} = \pm 0.0\overline{36}00\text{ ft.} = \boxed{\pm 0.0\overline{36}\text{ ft.}}$$

Introduction to Measurements

Group Problem #6

The 18 interior angles of a polygon are being measured with a theodolite. Specifications require that the estimated total error may not exceed ±60 seconds. How accurately must each angle be measured?

$$E_{Total} = \pm E\sqrt{n} \quad \Rightarrow \quad \pm E = \frac{E_{Total}}{\sqrt{n}}$$

$$\pm E = \frac{\pm\overline{60}"}{\sqrt{18}} = \pm\overline{14}.142..." = \boxed{\pm\overline{14}"}$$

Introduction to Measurements

Group Problem #7

The "exact" measurements of a steel tape are: 100 ft. in length, 1/40 in. thick and 5/16 in. wide. If steel weighs 490.0 lb./ft.^{3}, how much does this tape weigh?

$$Volume = LWT$$

$$= 100\ \text{ft.}\left(\frac{1}{40}\ \cancel{\text{in.}}\right)\left(\frac{1\ \text{ft.}}{12\ \cancel{\text{in.}}}\right)\left(\frac{5}{16}\ \cancel{\text{in.}}\right)\left(\frac{1\ \text{ft.}}{12\ \cancel{\text{in.}}}\right)$$

$$= 0.00542535...\ \text{ft.}^3$$

Introduction to Measurements

Group Problem #7

The "exact" measurements of a steel tape are: 100 ft. in length, 1/40 in. thick and 5/16 in. wide. If steel weighs 490.0 lb./ft.^{3}, how much does this tape weigh?

$$Weight = Volume \times Unit\ Weight$$

$$= 0.00542535...\ \text{ft.}^3\left(\frac{\overline{490.0}\ \text{lb.}}{\text{ft.}^3}\right) = \overline{2.658}420.....$$

$$= \boxed{\overline{2.658}\ \text{lb.}}$$

Introduction to Measurements

Group Problem #8

It is desired to determine the height of a church steeple. Assuming that the ground is level, a 500.00 ft. length is measured out from the base of the steeple and a 36° 30' 15" vertical angle is determined from that point on the ground to the top of the steeple. How tall is the steeple?

$$36^\circ + \frac{30'}{60} + \frac{15"}{(60)^2} = 36.5041666....^\circ$$

$$\tan(36.5041667...^\circ) = \frac{h}{\overline{500.00}\ \text{ft.}}$$

Introduction to Measurements

Group Problem #8

It is desired to determine the height of a church steeple. Assuming that the ground is level, a 500.00 ft. length is measured out from the base of the steeple and a 36° 30' 15" vertical angle is determined from that point on the ground to the top of the steeple. How tall is the steeple?

$$h = \left(\overline{500.00}\ \text{ft.}\right)\tan(36.5041667...^\circ)$$

$$= \overline{370.03}681...\ \text{ft.} = \boxed{\overline{370.04}\ \text{ft.}}$$

Introduction to Measurements

Group Problem #9

What is the total area in acres of three sections of land that are measured as: 11.0 acres, 5.23 acres, 150,123.0 ft.^{2}?

$$Area_3 = \frac{\overline{150,123.0}\ \text{ft.}^2}{43,560\ \text{ft.}^2/\text{acre}} = \overline{3.446350}$$

Introduction to Measurements

Group Problem #9

What is the total area in acres of three sections of land that are measured as: 11.0 acres, 5.23 acres, 150,123.0 ft.^{2}?

$$\begin{array}{r} 11.0 \\ 5.23 \\ +\ 3.446350 \\ \hline 19.676350 \end{array} = \boxed{19.7\,\text{acres}}$$

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Any Questions?