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 your rules for significant figures.

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

\[
\frac{0.17 \text{ ft.}}{3,264.76 \text{ ft.}} \Rightarrow N = \frac{3,264.76 \text{ ft.}}{0.17 \text{ ft.}} = 19,204.470...
\]

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?

\[
E_{\text{Total}} = \pm \sqrt{n} = \pm 0.005 \text{ ft.} \sqrt{28} = \pm 0.026457... \text{ ft.}
\]

\[
= \pm 0.03 \text{ ft.}
\]

Introduction to Measurements

Group Problem #3
Estimate the total error if 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.

\[
E_{\text{Total}} = \pm \sqrt{E_1^2 + E_2^2 + \ldots + E_n^2}
\]

\[
E_1 = \pm 0.04 \text{ ft.} \sqrt{5.1133} = \pm 0.09045... \text{ ft.} = \pm 0.09 \text{ ft.}
\]

\[
E_2 = \pm 0.04 \text{ ft.} \sqrt{7.2632} = \pm 0.1078... \text{ ft.} = \pm 0.1 \text{ ft.}
\]
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.

\[ E_{\text{Total}} = \pm \sqrt{E_1^2 + E_2^2 + \ldots + E_n^2} \]

\[ E_{\text{Total}} = \sqrt{(\pm0.09 \text{ ft.})^2 + (\pm0.1 \text{ ft.})^2 + (\pm0.1 \text{ ft.})^2 + (\pm0.2 \text{ ft.})^2} \]

\[ = \sqrt{0.008 \text{ ft.}^2 + 0.01 \text{ ft.}^2 + 0.01 \text{ ft.}^2 + 0.04 \text{ ft.}^2} \]

\[ = \pm0.2 \text{ ft.} \]

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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.

\[ E_{\text{Total}} = \frac{E_1}{\sqrt{n}} = \frac{\pm0.04 \text{ ft.}}{\sqrt{4}} \frac{3,602.62 \text{ ft}}{100 \text{ ft}} \]

\[ = \frac{\pm0.04 \text{ ft.}}{\sqrt{36.0262}} = \pm0.2 \text{ ft.} \]

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?

\[ E_{\text{Total}} = \pm E \sqrt{n} = \pm0.014 \text{ ft.} \sqrt{42} = \pm0.09073... \text{ ft.} \]

\[ = \pm0.091 \text{ ft.} \]

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?

\[ E_{\text{Total}} = \pm E \sqrt{n} \Rightarrow \pm E = \frac{E_{\text{Total}}}{\sqrt{n}} \]

\[ = \pm0.025 \text{ ft.} \sqrt{16} = \pm0.0063 \text{ ft.} \]

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.?

\[ E_{\text{Total}} = \pm E \sqrt{n} \Rightarrow \pm E = \frac{E_{\text{Total}}}{\sqrt{n}} \]

\[ = \pm0.18 \text{ ft.} \sqrt{25} = \pm0.036 \text{ ft.} \]
### 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?

\[ E_{\text{total}} = \pm E \sqrt{n} \quad \Rightarrow \quad \pm E = \frac{E_{\text{total}}}{\sqrt{n}} \]

\[ = \pm \frac{60''}{\sqrt{18}} = \pm 14'' \]

#### 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** = \( LWT \)

\[ = 100 \text{ ft.} \times \left( \frac{12 \text{ in.}}{1 \text{ ft.}} \right) \times \left( \frac{1 \text{ in.}}{40 \text{ in.}} \right) \times \left( \frac{5 \text{ in.}}{16 \text{ in.}} \right) = 9.375 \text{ in.}^3 \]

\[ = 9.375 \text{ in.}^3 \]

#### 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?

\[ \tan(36.541667...) = \frac{h}{500.00 \text{ ft.}} \]

\[ h = (500.00 \text{ ft.}) \tan(36.541667...) = 370.04 \text{ ft.} \]

#### 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.\(^2\)?

\[ \text{Area} = \frac{150,123.0 \text{ ft.}^2}{43,560 \text{ ft.}^2/\text{acre}} = 3.446350 \]

\[ + \left( \frac{3.446350}{15.667350} \right) = 19.7 \text{ acres} \]
Any Questions?