

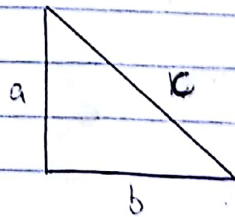
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17/ENG061018

ENG 281

Mechanical Engineering

The hypotenuse of a right-angled triangle is denoted as c , and the other two sides are denoted as a and b . If the possible error of measuring each of a and b is $\pm 1.5\%$, find the maximum possible error in calculating:
a, the area of the triangle, and
b, the length of the hypotenuse.



$$\text{Recall, } A = \frac{1}{2} ba$$
$$c = \sqrt{a^2 + b^2}$$

$$\text{a) } \delta A = \frac{\partial A}{\partial a} \cdot \delta a + \frac{\partial A}{\partial b} \cdot \delta b$$
$$= \frac{b}{2} \cdot \delta a + \frac{a}{2} \cdot \delta b$$

$$\delta b = \pm \frac{1.5}{100} \times b$$

$$\delta a = \pm \frac{1.5}{100} \times a$$

$$= \pm \frac{3b}{200}$$

$$= \pm \frac{3a}{200}$$

$$= \frac{b}{2} \cdot \pm \frac{3b}{200} + \frac{a}{2} \cdot \pm \frac{3a}{200}$$

$$= \frac{3ab}{2} \left(\pm \frac{1}{200} + \pm \frac{1}{200} \right)$$

$$= \frac{3ab}{2} \left(\pm \frac{1}{100} \right)$$

$$\text{Area} = \frac{ab}{2}$$

$$= 3A \left(\pm \frac{1}{100} \right) \text{ (divide both sides by 3)}$$

$$= A \left(\pm \frac{3}{100} \right)$$

= A increases / decreases by 3%

$$b, \delta h = \frac{\partial h}{\partial a} \cdot \delta a + \frac{\partial h}{\partial b} \cdot \delta b$$

$$h = (a^2 + b^2)^{1/2}$$

$$u = a^2 + b^2$$

$$h = u^{1/2}$$

$$\frac{\partial h}{\partial a} = \frac{\partial h}{\partial u} \times \frac{\partial u}{\partial a}$$

$$= \frac{1}{2} u^{-1/2} \times 2a$$

$$= \frac{a}{\sqrt{a^2 + b^2}}$$

$$\frac{\partial h}{\partial b} = \frac{\partial h}{\partial u} \times \frac{\partial u}{\partial b}$$

$$= \frac{1}{2} u^{-1/2} \cdot 2b$$

$$= \frac{b}{\sqrt{a^2 + b^2}}$$

$$= \frac{a}{\sqrt{a^2 + b^2}} \cdot \frac{\pm 3a}{200} + \frac{b}{\sqrt{a^2 + b^2}} \cdot \frac{\pm 3b}{200}$$

$$= \frac{\cancel{a}^2}{\sqrt{a^2 + b^2}} \cdot \frac{\pm 3}{200} + \frac{\cancel{b}^2}{\sqrt{a^2 + b^2}} \cdot \frac{\pm 3}{200}$$

$$= \frac{a^2 + b^2}{\sqrt{a^2 + b^2}} \left(\frac{\pm 3}{100} \right)$$

$$h = \frac{a^2 + b^2}{\sqrt{a^2 + b^2}}$$

= h increases / decreases by 3%