Calculating Tree Height

Craig Storlie

MTH109 – Mathematical Explorations

Colorado State University – Global Campus

Dr. Al Gebrawiz

September 10, 2013

Calculating Tree Height

The height of tall objects can be difficult to measure using direct measurement. It may also be dangerous and lack accuracy. An alternative to direct measurement is available by incorporating trigonometry and other direct measurements. In this assignment, the height of a large tree was calculated using the trigonometric tangent function.

**Methodology and Discussion**

In this problem, the height of a large tree is unknown. The tree is standing on horizontal ground and is 150 feet from Point A. The angle between the ground and the tip of the tree is 40°, and is measured at Point A (Figure 1). The goal of this problem is to determine the height of the tree using trigonometry.

Point A

40°

150 feet

 *Figure 1*. Dimensions used to calculate tree height.

One portion of trigonometry deals with right angle triangles – those that contain a right, or 90°, angle. The tangent function describes the tangent of an angle as equal to the length of the side opposite of the angle divided by the length of the side adjacent to the angle (not the hypotenuse). This relationship can be used to calculate the height of the tree shown in Figure 1.

$$\tan(40°= \frac{tree height}{150 feet})$$

$$0.84= \frac{tree height}{150 feet}$$

$$tree height=0.84 \left(150 feet\right)$$

$$tree height=126 feet$$

Errors can arise from inaccurate estimates of the angular measurement. Table 1 shows the errors that would occur if incorrect angular estimates were made in the problem solved in this paper. Errors can be significant, and can be minimized through the careful use of a protractor or other accurate sighting device.

Table 1

*Results of Angular Measurement Errors in Calculating Tree Height*

|  |  |  |  |
| --- | --- | --- | --- |
| Angle (degrees) | Estimated Height (feet) | Error (feet) | Error (%) |
| 40 (actual) | 126 | 0 | 0 |
| 45 | 150 | 24 | 19 |
| 50 | 179 | 53 | 42 |

*Note:* Estimated Height is calculated using *Estimated Height = tan Ө (150 feet).*

The method described in this paper provides an accurate estimate of object height if right angle geometry exists and if the horizontal distance and angle measurements are accurately made.

**Conclusions**

Trigonometry is a powerful tool. In this assignment, the height of an object was calculated given the distance an object was from a point and the angle measured between the top of the object and the horizon. This method does not provide an accurate estimate if a right triangle is not formed between the object and the horizontal plane, such as an object standing vertically on sloped ground. However, other simple trigonometric methods exist that can be used for more complicated geometries (Gebrawiz, 2013).

References

Gebrawiz, A. B. (2013). *Trigonometric measurement methodology*. Madison, WI: Bolt Upright Publishing.