Title:

Trigonometric Measurement

Laboratorial Report 3

Created to fulfill the assignment for Mechanic and heat EN222 subject

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Abstract

Basically the height of a tall object cold be measured without measuring the height of the object from the top to the bottom of the indicated object; it is by applying the principle of the trigonometric theory. Therefore, in this experiment the student use the trigonometric principle to calculate the height of a door. In the observation part, the student measure the angle that given by the protractor in respect to the distance of the student from the chosen door. By varying the distance, the experiment is expected to produce a perfect-close data in which the data itself is not singular to each other. In line with the experiment, in order to enhance the knowledge about trigonometric principle, the student answer some questions given in the end of the discussion. To conclude the experiment, the conclusion, recommendation, and reference list is given in the end of the report.

Keywords: height, angle, protractor, singularity, contribution.
CHAPTER I

OBJECTIVES

1.1 The objectives:

1. To review basic trigonometric functions
2. To measure the height of a building using trigonometry
CHAPTER II
METHODOLOGY

2.1 Materials:

In the experiment, the material used are listed in the table below:

<table>
<thead>
<tr>
<th>MATERIALS FROM:</th>
<th>LABEL OR BOX/BAG:</th>
<th>QTY</th>
<th>ITEM DESCRIPTION:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Student provides</td>
<td></td>
<td>1</td>
<td>Masking or Scotch® tape</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1</td>
<td>Computer and spreadsheets program</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1</td>
<td>A lab partner (optional)</td>
</tr>
<tr>
<td>From Lab Paq</td>
<td></td>
<td>1</td>
<td>Protractor</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1</td>
<td>Straw, drinking</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1</td>
<td>Tape measure, 3 m</td>
</tr>
<tr>
<td>String &amp; weight bag</td>
<td>String &amp; weight bag</td>
<td>1</td>
<td>String – Qty- 4.0 meters</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1</td>
<td>Weight, ½ oz</td>
</tr>
</tbody>
</table>

2.3 Procedures:

In order create an orderly experiment, the procedure used is as follow:

1. Prepare the measure the height of any tall building on campus or in your neighborhood. This is best done with a partner. You will use a protractor fitted with a drink straw and weighted string as previously shown. Do not forget to describe the building your report.

2. Move some distance away from the building (at least 5 to 10 meters, or if possible, a distance equal to the height of the building). Sight trough the straw to a point on the top of the building. When the top is sighted the second person should read the elevation angle “Θ” theta from the protractor. Record the elevation angle “theta” on your data sheet.

3. Using the tape measure, measure the distance “a” in meters from the sighting position to the wall of the building and record this value on your data sheet.

4. Measure the vertical distance \( h_o \) from the ground to your eyes in meters and record this value in your data sheets.

5. Calculate the height \( b \) and record it in your data sheet.

6. Calculate the height \( h \) of the record value in meters on your data sheet.
7. Repeat the step of 2 through 6 two different distances (not less than 5 meters) from the building.

8. Using the data from step 7 calculate the average height $h$ of the building.
CHAPTER III
RESULT AND DISCUSSION

3.1 Theory: The Principle of Trigonometric

A right triangle have basically been used by the Rome and Greek to develop their architecture or geometry application; by using what it is called as trigonometry, both Greek and Rome has been becoming a great developed countries among the others, one hundred years ago. Trigonometry by its three sides (hypotenuse, horizontal, and vertical side) can, in fact, be used to determine the height of an object without measure the object directly; this principle that surprisingly have been being used by Rome and Greek to help determining their perfect architecture technology. However, today, by the development of mathematics concept in the science application, the trigonometric principle and its beneficial result is not being enjoyed by Greek and Rome only; it is, now, used by every human in every aspect of theirs.

By letting “a” become the name of vertical line; “b” become the name of horizontal line; and “c” become the name of the hypotenuse, the trigonometric faction is, as a result, can be formulated to be as follow:

\[ c^2 = a^2 + b^2 \]

This formula can be further proceeded to result the other three basic formulas which are as follow:

\[ \sin \theta = \frac{a}{c} \]
\[ \cos \theta = \frac{b}{c} \]
\[ \tan \theta = \frac{a}{b} \]
3.2 Result and Discussion: Determining the Height of the Door

Table 2. Result of the Experiment

<table>
<thead>
<tr>
<th>No.</th>
<th>Trial</th>
<th>Length of horizontal line (m)</th>
<th>Angle</th>
<th>Experimental height of the door (m)</th>
<th>Accepted/real Height of the Door (m)</th>
<th>Percent Error</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>I</td>
<td>2</td>
<td>34°</td>
<td>2.74</td>
<td>2.67</td>
<td>2.62%</td>
</tr>
<tr>
<td>2.</td>
<td>II</td>
<td>2.5</td>
<td>28°</td>
<td>2.72</td>
<td>2.67</td>
<td>1.87%</td>
</tr>
<tr>
<td>3.</td>
<td>III</td>
<td>3</td>
<td>24°</td>
<td>2.73</td>
<td>2.67</td>
<td>2.25%</td>
</tr>
</tbody>
</table>

The table above is basically showing the data finding that is needed to calculate the height of the door. In the first trial, it can be shown, the distance measured from the door horizontally forward away is around 2 meter. By using protractor, the angel between the person who stand exactly 2 meter from the door and seeing to the top of the door is around 34°. By using this two variable, the height of the door can be calculated as follow:

\[
\tan \theta = \frac{a}{b}
\]

\[
\tan 34° = \frac{a}{2 \text{ meter}}
\]

\[
0.67 = \frac{a}{2 \text{ meter}}
\]

\[
1.35 \text{ m} = a
\]

By determining the vertical distance from the ground to the eye of the person who making the angle to be 1.39 meter, therefore the experimental height of the object can be determined as follow:

\[
H = 1.39 \text{ m} + a
\]

\[
H = 1.39 \text{ m} + 1.35\text{m}
\]

\[
H = 2.74\text{m}
\]

The value of the first experimental height of the door is actually not precisely match to the real height of the door. By determine the height of the door to be 267m, the percent error of the first experimental height of the door is as follow:
%Error = \left| \frac{\text{Experimental value} - \text{Accepted value}}{\text{Accepted value}} \right| \times 100\%

%Error = \left| \frac{2.74 - 2.67}{2.67} \right| \times 100\%

%Error = 2.62\%

By applying the same calculation to the second data and third data, as a result, the percent error gotten of each trial is as what they are shown in the table.

3.3 Answering Question

1. Based on the Picture above, it can be stated that the longest line which is 14.4 cm is acting as hypotenuse. by using protractor the angle is as follow:
   - \( \theta_1 = 34^\circ \)
   - \( \theta_2 = 56^\circ \)

By using the formula of sin rule, each angle can consequently be determined as follow:

\[
\frac{14.4}{\sin 90} = \frac{12}{\sin \theta_1}
\]

\[
\theta_1 = 33.69^\circ
\]
\[
\frac{14.4}{\sin 90} = \frac{8}{\sin \theta_2} \\
\theta_2 = 56.30^\circ
\]

2. When the wall or building is not perpendicular to the ground, there will be no right triangle that can be used as a basis of the trigonometric function, therefore the calculation cannot be done and finally the height of the building or object cannot be determined.

Like what it is showed in the picture below when the object is perpendicular to the object the right triangle will be formed, however when the object is not perpendicular, the right triangle cannot be formed.

3. The uncertainty that is introduced in the experiment is about accuracy. It is because by using the tape measurement, the accuracy higher than 0.5 cm occurring error.

4. Since the scale of the protractor is up to one degree per scale, therefore the degree of accuracy is about 0.5°
CHAPTER IV
CONCLUSION

1.1 Conclusion

1. Protractor can be the alternative tools to estimate the height of an object.

2. The principle of trigonometric which is the right triangle is needed and useful to know the height using protractor.

3. The object that is not perpendicular to the ground cannot use right triangle principle since it has no right triangle, but it has acute angle or obtuse angle.

1.2 Recommendation

1. More apparatuses that has high precision and accuracy to get accurate result of experiment.

2. Measure the length more than once so the human error can be minimalize.

3. Measure the real height of the object if possible to know the error.

References
