

**Faculty of the Professions**

**Cover Sheet for Individual Assignments**

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 Name: Shenglan Liu a1157950 Address: 18, Matilda Street, Eastwood, 5063

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| **Student ID: 1157950** |
| **Family Name: Liu**  | **Given Name: Shenglan** |
| **Course Name:**[Maths Curriculum and Methodology B (Combined)](https://myuni.adelaide.edu.au/webapps/portal/frameset.jsp?tab_tab_group_id=_2_1&url=/webapps/blackboard/execute/launcher?type=Course&id=_296770_1&url=) |
| **Tutor Name:**Pauline Carter & Carol Moule | **Tutorial: Friday 4-6** |

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 DECLARATION

 *This declaration must be signed before a mark can be awarded.*

I declare the following to be my own work as understood by the University’s Policy on Plagiarism (see *Statement and Definition of Plagiarism and related forms of cheating*, www.adelaide.edu.au/policies/230).

I give permission for my assignment to be scanned for electronic checking of plagiarism.

Signed:Shenglan Liu Date: 31/10/2014



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**Name: \_\_\_\_Shenglan Liu 1157950\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_**

**Directed Investigation:**

**Relationship between Similar Triangles and Trigonometry.**

**Overall Aim:** To recognise the connections between similarity and the trigonometric ratios.

You have learnt about similar triangles and have discovered how the concept of similar triangles can be used to solve for unknown sides.

You have also learnt ideas and concepts that are used when solving trigonometry problems.

This task will involve you coming to the understanding that a knowledge of similar triangles is necessary when comprehending trigonometry.

 

**Big Question:**  **How tall is the tallest building? How does a knowledge of similar triangles enable trigonometry to be used to solve real life problems, and is there a more accurate method of solving an unknown height?**

That question troubled the Greek mathematician Thales of Miletus (my-LEE-tus) 2,600 years ago. He wanted to measure the largest pyramid in Egypt. Like many tourists, Thales wanted to know the height of the Great Pyramid. He couldn’t find anyone to answer his question, so he set out to measure it himself. His method was so clever that people still talk about it.

But Thales had a problem. What time was the right time to measure the shadow?

Thales used a stick to answer that question. He pushed it partway into the ground so that it stood up straight, and he measured the height of the stick. He reasoned that when the length of the stick’s shadow equalled the height of the stick, the height of the pyramid would equal the length of its shadow. Measuring the shadow would be like measuring the height, only easier.

Thales waited until the stick’s shadow was as long as the stick was tall. At that special time, Thales measured the pyramid’s shadow. And he had the answer to his question.

Trigonometry dates back to the early ages of Egypt and Babylon and has had many mathematicians involved in the development of the idea including Hipparchus, Ptolemy and Isaac Newton. After hundreds of years mathematicians realised that ratios could be used to find an unknown side when the angle and another side is known. Trigonometry came about mainly as a function for astronomy and to keep time.

**Introduction:**

Read through the task and write a short introductory paragraph (2 sentences) which explains the task.

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What mathematical concept did Thales use to measure the height of the pyramid? Does this work when the shadow of the stick does not equal the height of the stick? Please select two times that are not suitable for this measurement and explain the reason.

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**Mathematical Investigations:**

***Similar triangles:*** On a sunny day, or several sunny days, you need to complete the following:

1. Measure you height and record in the table below
2. Go outside and measure the length of your shadow on flat ground. Record results in the table below.
3. Choose two objects outside that are too tall to measure. Measure the length of the object’s shadow and record in the table below.

|  |  |  |
| --- | --- | --- |
| **Type of measurement** | **\_\_\_\_\_\_\_\_\_\_\_(Day) and time \_\_\_\_\_\_\_\_\_\_** | **\_\_\_\_\_\_\_\_\_\_\_(Day) and time \_\_\_\_\_\_\_\_\_\_** |
| *Your height* |  |
| *Your shadow* |  |  |
| *Object 1 \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ shadow length* |  |  |
| *Object 2 \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ shadow length* |  |  |

Draw a labelled diagram to show the similar triangles you have measured (an example is below). **Calculate the objects unknown height using similar triangles**. Show all working.



*h*

Tree’s shadow length

Your shadow length

Your height

***Trigonometry:***

You will work in pairs or individually to make a clinometer, as instructed below:

1. Sticky tape a straw to the hypotenuse of the geoliner
2. Sticky tape a piece of string to the middle of the hypotenuse. Attach a weight (e.g. a washer) to the other end of the string. (This must be done so that the string hangs perpendicular to the hypotenuse, refer to the diagram to the right).

To take your measurements, go outside and find the same objects you measured in your shadows task.

1. Stand away from the object (the same object you used for the shadow similar triangles task) so that you can see the top of the object. Measure this distance accurately and record the measurement in the table below.
2. Look through the straw at the top of the chosen object (the same object you used for the shadow similar triangles task)
3. Hold steady while you get a partner to note where the string is hanging down (be sure to measure the angles the correct way e.g. from the zero). Record the angle in the table below.
4. Measure your height up to eyelevel (when you calculate the height of the object you will need to add the eyelevel height onto your calculated answer.
5. Repeat steps 1 – 4 for the second object which you used in the shadow similar triangles task.

|  |  |  |
| --- | --- | --- |
| **Measurements** | **Object 1 - \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_** | **Object 2 - \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_** |
| **Height of the person’s eyes (which will be added to the height calculated)** |  |  |
| **Angle when looking at the top of the object** |  |  |
| **Distance from base of object to person’s feet** |  |  |

Draw a labelled diagram to show the situations you have measured (an example is below). Calculate the objects unknown height using the correct trigonometry ratio. Show all working.

**Object 1:**

*374 cm*

67o

*h*

**Object 2:**

**Analysis and Interpretation:**

Considering the following points, write an analysis of what you have found by completing this investigation.

* How do you know that the triangle formed by the object and its shadow and the triangle formed by you and your shadow are similar triangles?
* Does a triangle have to be similar to be able to use trigonometry to solve a problem with it? Explain why or why not.
* How did your results from the similar triangles calculations compare to the results from the trigonometry calculations? E.g. were they relatively close or quite different?
* How accurate do you believe the method of using **similar triangles** is for determining the heights of the tall objects? Explain your reasoning.
* How accurate do you believe the method of using **trigonometry** is for determining the heights of the tall objects? Explain your reasoning.
* What problems did you encounter while performing this investigation (for both the similar triangles and trigonometry methods)? How did/could you overcome these? What changes, if any, would you make to this investigation to make the measurements and findings more accurate?
* Which method would you chose to calculate the unknown heights of the objects given the choice.
* Any other thoughts/analysis of this task?

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**Conclusion:**

Write a paragraph (2 or more sentences) summarising the task and showing your understanding of similar triangles and how they are related to the concept of trigonometry (make sure that you refer to the Big Question).

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**Assessment Rubric:**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | **Limited** | **Emerging** | **Developed** | **Advanced** |
| **Understanding** | I did not show understanding of how similarity is related to trigonometric ratios. (ACMMG223)  | I showed some understanding of how similarity is related to trigonometric ratios. (ACMMG223)  | I showed solid understanding of how similarity is related to trigonometric ratios. (ACMMG223)  | I showed consistent and deep understanding of how similarity is related to trigonometric ratios.(ACMMG223) |
| **Fluency** | Parts (or very few) of my calculations were correct e.g. correct substitution. | Some of my calculations were correct; correct methods were chosen. | I generally used appropriate calculations; correct methods were chosen. | I completed all calculations correctly; correct methods were chosen. |
| No logical sequence of working out. Units were not included. | Some logic was followed in working out, units may or may not be included. | Logic was observed in the working out and units were included for the majority of time. | Working out was complete, correct and showed clear logic. Units were included for all results. |
| **Problem Solving** | The Big Question is not addressed. | The Big Question has been referred to vaguely. | The Big Question has been addressed in a superficial manner regarding the relationship between similar triangles and trigonometry. | The Big Question has been answered with a clear understanding shown of the relationship between similar triangles and trigonometry. |
| **Reasoning** | My discussion did not refer to the relevant points. | My discussion vaguely referred to the relevant points, but failed to go into depth, about the similarity and differences between similar triangles and trigonometry. My reasoning was not justified. | My discussion considered the relevant points and went into some detail about the similarity and differences between similar triangles and trigonometry. My reasoning was briefly justified. | My discussion considered the relevant points and went into extensive detail about the similarity and differences between similar triangles and trigonometry. My reasoning was soundly justified. |
| **Presentation** | My assignment is poorly presented. | My assignment is sometimes neat but diagrams are unlabelled. | My assignment is neat for the majority of the time, and the diagrams are mostly neat and labelled. | My assignment is very neat all of the time and all of the diagrams are fully labelled. |

**Achievement Standard:** Use [similarity](http://www.australiancurriculum.edu.au/glossary/popup?a=M&t=Similarity) to investigate the constancy of the [sine](http://www.australiancurriculum.edu.au/glossary/popup?a=M&t=Sine), [cosine](http://www.australiancurriculum.edu.au/glossary/popup?a=M&t=Cosine) and [tangent](http://www.australiancurriculum.edu.au/glossary/popup?a=M&t=Tangent) ratios for a given [angle](http://www.australiancurriculum.edu.au/glossary/popup?a=M&t=Angle) in right-angled triangles [(ACMMG223)](http://www.australiancurriculum.edu.au/Curriculum/ContentDescription/ACMMG223)

This folio task is for year 9 students and the specific content covered in the task is the relationship between trigonometry and similar triangles.

The Australian Curriculum includes seven general capabilities:

[Literacy](http://www.australiancurriculum.edu.au/GeneralCapabilities/Literacy)

[Numeracy](http://www.australiancurriculum.edu.au/GeneralCapabilities/Numeracy)

[Information and communication technology (ICT) capability](http://www.australiancurriculum.edu.au/GeneralCapabilities/Information-and-Communication-Technology-capability)

[Critical and creative thinking](http://www.australiancurriculum.edu.au/GeneralCapabilities/Critical-and-creative-thinking)

[Personal and social capability](http://www.australiancurriculum.edu.au/GeneralCapabilities/Personal-and-social-capability)

[Ethical understanding](http://www.australiancurriculum.edu.au/GeneralCapabilities/Ethical-understanding)

[Intercultural understanding](http://www.australiancurriculum.edu.au/GeneralCapabilities/Intercultural-understanding)

**Australian Curriculum Content Descriptions:**

Use [similarity](http://www.australiancurriculum.edu.au/glossary/popup?a=M&t=Similarity) to investigate the constancy of the [sine](http://www.australiancurriculum.edu.au/glossary/popup?a=M&t=Sine), [cosine](http://www.australiancurriculum.edu.au/glossary/popup?a=M&t=Cosine) and [tangent](http://www.australiancurriculum.edu.au/glossary/popup?a=M&t=Tangent) ratios for a given [angle](http://www.australiancurriculum.edu.au/glossary/popup?a=M&t=Angle) in right-angled triangles [(ACMMG223)](http://www.australiancurriculum.edu.au/curriculum/contentdescription/ACMMG223) .

Critical and creative thinking:

* The particular elements of Critical and creative thinking addressed by this content description

Inquiring – identifying, exploring and organising information and ideas:

* Identify and clarify information and ideas
* Organise and process information

Generating ideas, possibilities and actions:

* Seek solutions and put ideas into action

Reflecting on thinking and processes

* Reflect on processes

Literacy:

* The particular elements of Literacy addressed by this content description

Comprehending texts through listening, reading and viewing:

* Comprehend texts
* Navigate, read and view learning area texts
* Interpret and analyse learning area texts

Composing texts through speaking, writing and creating:

* Compose texts
* Compose spoken, written, visual and multimodal learning area texts

Word Knowledge:

* Understand learning area vocabulary

Apply trigonometry to solve right-angled triangle problems [(ACMMG224)](http://www.australiancurriculum.edu.au/curriculum/contentdescription/ACMMG224). That includes:

* understanding the terms 'adjacent' and 'opposite' sides in a right-angled triangle
* selecting and accurately using the correct trigonometric ratio to find unknown sides (adjacent, opposite and hypotenuse) and angles in right-angled triangles

**Achievement Standards:**

By the end of Year 9, students solve problems involving [simple interest](http://www.australiancurriculum.edu.au/glossary/popup?a=M&t=Simple+interest). They interpret [ratio](http://www.australiancurriculum.edu.au/glossary/popup?a=M&t=Ratio) and scale factors in [similar](http://www.australiancurriculum.edu.au/glossary/popup?a=M&t=Similar) figures. Students explain similarity of triangles. They recognise the connections between [similarity](http://www.australiancurriculum.edu.au/glossary/popup?a=M&t=Similarity) and the [trigonometric ratios](http://www.australiancurriculum.edu.au/glossary/popup?a=M&t=Trigonometric+ratios).

They use trigonometry to find unknown sides of right-angled triangles.

**Technology:**

Height measuring instruments, measuring tape, scissors, sticky tape, straw, geoliner, string, etc.

**Intended Learning being assessed and Learning experiences that might have supported it**

This task is designed to help students investigate the relationship between similar triangles and trigonometry and provides students with an opportunity to solve the unknown side of a triangle using two methods. Learning experiences include measurements of height, eye-level height, shadow length, the distance between a person and the base of an object, etc. From this, students can have the hand-on experiences useful for their understanding trigonometry and similar triangles. It is also designed to assess students’ ability to apply the theory into the real context where they can be engaged in doing the measurement. Moreover, it is expect that advanced students can explain the difference between the two methods and hence come up with some improvements on the measurement. In theory, the two methods should give the same answer, but in reality, the two answers are different (should be close to each other anyway). This means that students should identify and analyse the difficulties and random errors encountered in the measurement based on the full understanding of similar triangles and trigonometry. Students with low levels can find an opportunity to participate and most students should be able to calculate the unknown side (the height of an object) provided that a diagram is correctly sketched and labelled.

**Sample Solution**

**Introduction:**

*Read through the task and write a short introductory paragraph (2 sentences) which explains the task.*

*Thales was able to determine the heights of the Egyptian Pyramids using his knowledge of similar triangles.*

*Trigonometry can also be used to find the height of an object.*

**This question: Students have the opportunity to show their literacy skills. They need to read the background introduction prior to the understanding of this folio task.**

*What mathematical concept did Thales use to measure the height of the pyramid? Does this work when the shadow of the stick does not equal the height of the stick? Please select two times that are not suitable for this measurement and explain the reason.*

Thales was able to determine the heights of the Egyptian Pyramids using his knowledge of similar triangles. He realised that when the length of his shadow was the same as his height, and the same was true for all objects nearby. Similar triangle concepts can also be used when heights and shadows are not exactly the same. The times that are not suitable are midday and sunset or dawn. When the Sun was near the horizon, the pyramid’s shadow was long. The shadow shortened as the Sun rose in the sky.

**This question tests students’ understanding of similar triangles and how this concept is used. It does not require for the shadow to be the same as the height for the measurement to work. It involves a little bit reasoning, as students need to know that it is actually much easier to estimate the height when the shadow is the same as the height.**

**Most students should be able to finish Introduction. If students are struggling with the last part (reasoning), teachers may give a hint or teachers may let students do the measurement at different times of a day.**

**Mathematical Investigations:**

***Similar triangles:*** On a sunny day, or several sunny days, you need to complete the following:

1. Measure you height and record in the table below
2. Go outside and measure the length of your shadow on flat ground. Record results in the table below.
3. Choose two objects outside that are too tall to measure. Measure the length of the object’s shadow and record in the table below.

|  |  |  |
| --- | --- | --- |
| **Type of measurement** | **\_\_\_\_\_\_\_\_\_\_\_(Day) and time \_\_\_\_9:34\_\_\_\_\_\_** | **\_\_\_\_\_\_\_\_\_\_\_(Day) and time \_\_\_15:05** |
| *Your height* | 170 cm |
| *Your shadow* | 145 cm | 200 cm |
| *Object 1 \_\_\_\_\_\_\_\_\_tree\_\_\_\_\_\_\_\_ shadow length* | 250 cm | 310 cm |
| *Object 2 \_\_\_\_\_\_Flag\_\_\_\_\_\_\_\_\_\_\_ shadow length* | 350 cm | 400 cm |

*Draw a labelled diagram to show the similar triangles you have measured (an example is below).* ***Calculate the objects unknown height using similar triangles****. Show all working.*



*h*

Tree’s shadow length

Your shadow length

Your height

Tree:

At 9:34 am:

The height of the tree is 250/145\*170 = 293 cm

At 15:05

The height of the tree is 310/200\*170 = 264 cm

The calculation for the flag is similar.

**It is expected that students should finish the table and the calculation, as this part is mainly understanding and fluency. Most students should be able to sketch a diagram whereas the bottom students may not do the calculations or have difficulty sketching the diagram. Understanding involves similar triangles whereas fluency is whether students can do the calculations. Students also should note the answers would be different, though they are measuring the same object, but at different times. This is due to the sun, measuring error, etc.**

***Trigonometry:***

You will work in pairs or individually to make a clinometer, as instructed below:

1. Sticky tape a straw to the hypotenuse of the geoliner
2. Sticky tape a piece of string to the middle of the hypotenuse. Attach a weight (e.g. a washer) to the other end of the string. (This must be done so that the string hangs perpendicular to the hypotenuse, refer to the diagram to the right).

To take your measurements, go outside and find the same objects you measured in your shadows task.

1. Stand away from the object (the same object you used for the shadow similar triangles task) so that you can see the top of the object. Measure this distance accurately and record the measurement in the table below.
2. Look through the straw at the top of the chosen object (the same object you used for the shadow similar triangles task)
3. Hold steady while you get a partner to note where the string is hanging down (be sure to measure the angles the correct way e.g. from the zero). Record the angle in the table below.
4. Measure your height up to eyelevel (when you calculate the height of the object you will need to add the eyelevel height onto your calculated answer.
5. Repeat steps 1 – 4 for the second object which you used in the shadow similar triangles task.

|  |  |  |
| --- | --- | --- |
| **Measurements** | **Object 1 - \_\_\_\_\_\_\_\_Tree\_\_\_\_\_\_\_** | **Object 2 - \_\_\_\_\_Flag\_\_\_\_\_\_\_\_\_\_\_** |
| **Height of the person’s eyes (which will be added to the height calculated)** | 155 cm |  |
| **Angle when looking at the top of the object** | 330 |  |
| **Distance from base of object to person’s feet** | 200 cm |  |

*Draw a labelled diagram to show the situations you have measured (an example is below). Calculate the objects unknown height using the correct trigonometry ratio. Show all working.*

**Object 1:**

*200 cm*

33o

*h*

**Object 2:**

The height of the tree = 155 +200 \* tan 33 = 285 cm

**Students are required to make a clinometer. Students work in pairs and all the groups should make a clinometer which the teacher should show them how to make one. While making a clinometer and measuring can be fun, the calculation is a little bit harder than the first part. Students need to realize the height of an object is the sum of their eye-level height and the length of the opposite side of a right-angled triangle as shown above. This again is understanding and fluency, possibly some problem solving. It makes sense that students cannot get exactly the same height as the first part where they used similar triangles to find the answer even though they are measuring the same object. However, if measured correctly, the three answers (two from the previous part at two different times) should be within a reasonable range.**

**Analysis and Interpretation:**

Considering the following points, write an analysis of what you have found by completing this investigation.

* *How do you know that the triangle formed by the object and its shadow and the triangle formed by you and your shadow are similar triangles?*

If you are doing the measurement at the same time on a sunny day provided that if the two measurements are done quickly enough, these two right-angled triangles are always the similar triangles, as we can assume the sun is at the same spot and the angles of elevation are the same for the two.

**Understanding of similar triangles and the ability to reason and apply the concept in reality**

* *Does a triangle have to be similar to be able to use trigonometry to solve a problem with it? Explain why or why not.*

The two triangles (the triangle formed by the object and its shadow and the triangle formed by you and your shadow are similar triangles) must be similar (they must be measured at the same time) so that we can use trigonometry to estimate the height of the object.

* 1. Similar triangles have the same trigonometric ratio, so we can use this to find the height of an object. The ration of my height: my shadow length is the same as the ratio of object height: object shadow length.
	2. My height can shadow can be easily measured from which the angle of elevation can be calculated. That angle is also the angle of elevation in the right-angle triangle formed between the object height and its shadow, as these two triangles are similar triangles. That helps solve the unknown which is the object height.

**The relationship between similar triangles and trigonometry is an important part of the Australian Curriculum. Students have the chance to estimate the height using the combination of similar triangles and trigonometry. The important point is that similar triangles have the same trigonometry ratio**

* *How did your results from the similar triangles calculations compare to the results from the trigonometry calculations? E.g. were they relatively close or quite different?*

There were relatively close/They are entirely different.

**Comparison of results.**

* *How accurate do you believe the method of using* ***similar triangles*** *is for determining the heights of the tall objects? Explain your reasoning.*

It is not so accurate, because it is hard to measure the shadow length sometimes due to the cloud or undulating ground. Also, we are required to measure the shadow twice and heavily rely on the weather conditions.

* *How accurate do you believe the method of using* ***trigonometry*** *is for determining the heights of the tall objects? Explain your reasoning.*

As long as the angle of elevation is measured correctly, this measurement is more accurate than similar triangles. It is easier to measure the distance between a person and the object than the shadow length.

Using trigonometry does not require a sunny day, as we do not need to measure shadow length.

**The above two parts are related to reasoning. It does not matter what the maths level students are at, as long as they participate actively in the measurement, they will see the difference between the two measurements as well as the difficulties. Sometimes, students cannot read the clionmeter. Reading a clinometers can be quite tricky; if the angle were wrong, the result would not make sense and would be less accurate than similar triangles.**

* *What problems did you encounter while performing this investigation (for both the similar triangles and trigonometry methods)? How did/could you overcome these? What changes, if any, would you make to this investigation to make the measurements and findings more accurate?*

Problems can potentially include rainy/cloudy days when the sun is not reliable. The ground may not be flat enough to measure the shadow length accurately. The measurement at midday and sunset or dawn is hard, because the shadow is going to be either too short or too long to measure. On a windy day, it may be hard to read the angle of elevation, as the string attaching the weight cannot hang perpendicularly…etc…

Measure the shadow length when the shadow length is close to the height, as it is easier to measure. Try to use flat ground wherever it is possible.

Can use an object whose height is already known or that can be measured using a height measuring instrument as the starting point. Re-estimate/calculate the height using similar triangles to see if the answer is close to the actual height. If so, measure other objects.

Can measure the same object several times at different times using both similar triangles (if it is a sunny day) and trigonometry (it does not matter what the weather conditions are), take the average. When using similar triangles, make sure it is not early in the morning or midday or at sunset.

Can measure the angle elevation again using a ‘professional’ clinometers which makes it easier to read the angle even if the it is windy…

 **This is reasoning and problem-solving. Students need to reflect on their measurement and give reasons why the results are different and come up with improvements.**

* *Which method would you chose to calculate the unknown heights of the objects given the choice.*

I would use trigonometry, because I would not rely on the weather and I do not measure the shadow length. It is easier to measure the distance between the measurer and the object. However, the angle of elevation should be measured as accurately as possible.

**This summarizes the fact that students can solve a mathematical problem using multiple methods. They need to compare the methods and consider which one is better and more effective.-reasoning.**

* Any other thoughts/analysis of this task?

**Conclusion:**

Write a paragraph (2 or more sentences) summarising the task and showing your understanding of similar triangles and how they are related to the concept of trigonometry (make sure that you refer to the Big Question).

We can estimate the height of an object using two mathematical methods, similar triangles and trigonometry.

* The knowledge of similar triangles enables us to find the unknown side which is the height of an object. The two similar triangles are the triangle formed by the object and its shadow and the other triangle formed by you and your shadow. Because similar triangles have the same trig ratio, which we can use to calculate the height of an object.
* Trigonometry is more accurate. However, it can be difficult to measure the angle of elevation. Once the angle of elevation can be accurately measured, the height can be readily calculated.

**An opportunity for students to show their overall understanding of the task.**