 Year 11 mathematics advanced

All outcomes referred to in this unit come from [Mathematics Advanced](http://educationstandards.nsw.edu.au/wps/portal/nesa/11-12/stage-6-learning-areas/stage-6-mathematics/mathematics-advanced-2017) Syllabus  
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**Assessment:** MA-T1 Trigonometry and measure of angles

**Driving question:** How are outdoor concert spaces designed?

Outcomes:

* **MA11-3** uses the concepts and techniques of trigonometry in the solution of equations and problems involving geometric shapes
* **MA11-8** uses appropriate technology to investigate, organise, model and interpret information in a range of contexts
* **MA11-9** provides reasoning to support conclusions which are appropriate to the context

Learning across the curriculum

General capabilities

* Critical and creative thinking
* Information and communication technology capability
* Literacy
* Numeracy

Context:

There is to be an outdoor concert held in NSW. You are required to find a vacant piece of land to host it. The land is to be designed to include a stage, which is a shaped as a sector in one corner. The chosen piece of land must be in the shape of an irregular quadrilateral, which will encompass seating and standing areas for the crowd. **Note:** the quadrilateral must not be a rectangle or a square.

Task:

1. Find a vacant piece of land in NSW using Google Maps ([www.google.com.au/maps](https://www.google.com.au/maps)), this piece of land must be able to fit an irregular quadrilateral that has a total area between 5000 and 15 000m2. You can assume that the piece of land you chose is completely level (flat).
2. Using the measure distance tool on Google Maps, outline the shape of the quadrilateral, clearly determining the distance of each of the 4 edges, one diagonal length and the area of the quadrilateral, ensuring that this area meets the given requirements.  
   (Google Maps Support page provides instruction for this tool: [support.google.com/maps/answer/1628031?co=GENIE.Platform%3DDesktop&hl=en](https://support.google.com/maps/answer/1628031?co=GENIE.Platform%3DDesktop&hl=en))
3. Create a scale diagram of the chosen quadrilateral using Geogebra ([www.geogebra.org/](https://www.geogebra.org/)), desmos ([www.desmos.com/](https://www.desmos.com/)) or another graphing tool, being sure to mark in the one diagonal length.
4. Confirm the area of your quadrilateral using the trigonometric formula for the area of a triangle. You will need to use your scale diagram that you created to determine the interior angles. You must show all working for this.
5. Determine the location and size of the stage for your concert. The stage must be in one of the corners of your quadrilateral, should take up no more than 15% of the total area and be in the shape of a sector. The area of the stage is to be found using formula for the area of a sector. You will need to show all of the measurements required for this formula on your diagram. You must also show all working to confirm that the stage meets the given requirements.
6. Confirm the area of your stage, by adding the stage to your scale diagram. Verify the area of the stage using the graphing software.
7. Investigate a different corner for your stage. This stage must be of the same area as the one created in Step 5. Find the radius of the stage and justify your answer with appropriate mathematical reasoning.
8. If lights are to be placed along the curved perimeter, determine the number of lights required on the stage of your choice if one light is positioned every 30cm along the perimeter. Compare and contrast the two stages with consideration for the location, shape and lighting requirements.
9. A big screen is to be positioned behind the stage to display the artists during the concert and each audience member must be able to view the screen. The dimensions of the screen are 5m by 3m. On your scale diagram, using a single interval, construct the positioning of the big screen on your stage
10. The audience for the concert is to be arranged into a seating section and a standing section. The seating section will be closest to the stage and extends the sector formed by the stage. The standing section is located behind the seating section and extends another 20 metres beyond the seating section.   
      
    Consider an audience member towards the back of the seated section and another towards the back of the standing section. Clearly represent these audience members as points on the scale diagram, so that both points are collinear with a point at the centre of the base of the screen.

If the angle of elevation to the bottom of the screen for each seated audience member is less than 15°, their view is distorted by the audience members in front.   
Similarly, if the angle of elevation for the standing audience members is less than 8°, their view is distorted by the audience members in front.   
  
By considering each of the audience members above make informed decisions regarding the size of the seated section and the height at which the bottom of the screen must be above the ground to allow for the above conditions. You may assume that the eye-level of a seated audience member is 1.4 metres and a standing member is 1.7 metres.   
  
Fully justify your answer with supporting mathematics.

What to submit:

* A screenshot of Google Maps indicating the area of land being used.
* A scale diagram of your design, using graphing software, which includes all measurements.
* All working and calculations required, either written by hand or typed.
* All reasoning and justification, either written by hand or typed.

Success criteria

| Fluency, understanding and communication | Problem solving, reasoning and justification |
| --- | --- |

| Criteria | Working towards developing | Developing | Developed | Well developed | Highly developed |
| --- | --- | --- | --- | --- | --- |
| **1 and 2.** Quadrilateral piece of land for concert using Google Maps tools **(MA11-8)** | Finds vacant piece of land on Google Maps. | Defines and outlines quadrilateral. | Identifies an area that meets the requirements (between 5000 – 15000 square metres). |  |  |
| **3.** Scale Diagram using graphing software **(MA11-8)** | Diagram produced is not to scale and no measurements shown. | Scale diagram is produced showing some measurements required. | Scale diagram is produced showing all measurements required. |  |  |
| **4.** Area of quadrilateral **(MA11-3)** | Makes some attempt towards finding the area of the land using any technique. | Makes some attempt towards finding the area of the land using trigonometric formula. | Uses the trigonometric formula correctly to justify the area of the land, provided by Google Maps. |  |  |
| **5.** Stage calculations **(MA11-3,  MA11-9)** | Determines the location of the stage and makes some attempt towards finding the area of the stage. | Meets area requirements without justifying them mathematically. | Meets area requirements (no more than 15% of the land) and justifies them through mathematics. |  |  |
| **6.** Stage using graphing software **(MA11-8)** | Successfully adds the stage onto their scale diagram and displays some measurements. | Successfully adds the stage onto their scale diagram and displays all measurements. | Confirms the area of stage using graphing software. |  |  |
| **7.** The second stage **(MA11-3)** | Makes some attempt towards finding the radius of the second stage. | Correctly determines the radius of the second stage without reasoning.  OR  Determines the radius of the second stage with minor errors. | Correctly determines the radius of the second stage with all mathematical reasoning shown through working out. |  |  |
| **8.** Lights around arc of stage and comparison of stages  **(MA11-3,  MA11-9)** | Makes some attempt towards finding the arc length. | Determines the arc length with minor errors.  Determines the number of lights required with minor errors. | Correctly determines the arc length.  Correctly determines the number of lights required. | Critically analyses and compares the lighting of the two stages to form a recommendation based on interpreting the results. |  |
| **9.** Represents the big screen  **(MA11-8)** | Appropriately represents the big screen on the stage within the scaled diagram. |  |  |  |  |
| **10.** Height of the stage **(MA11-3,  MA11-9)** |  |  | Provides one correct recommendation and justifies height for the bottom of the stage and the size of the seated section. | Provides a range of suitable heights for the bottom of the stage and justifies them by forming and solving inequalities. | Compares and contrasts more than one suitable recommendation and justifies the choice of one by interpreting the results. |

Note to staff

The success criteria above has been designed for students and staff alike to use. Students should be presented the rubric as part of the assessment task package. Students and staff follow the process of the task downwards through the rubric and the depth of responses, for each element, across the rubric. Students should be encouraged to use the rubric to self-assess their progress as an assessment-as-learning strategy.

The aim of the assessment task is to develop students’ deep content knowledge. This is reflected in the descriptors, **working towards developing** through to **highly developed**. The level of skill and understanding required in each part of the task is different; some parts require **highly developed** or **well-developed** skills, other parts only capture a **developing** skill set.

None of the working mathematically elements are distinct and when demonstrating one element, you are invariably demonstrating another. As an example, communication runs concurrently through all the other working mathematically elements. Students cannot respond to this assessment without communicating in some form. However, it is envisaged that there is a general progression through the working mathematically elements, starting with fluency and leading to understanding, problem solving, reasoning and justification, with increasingly higher levels of communication accompanying each element. Careful consideration has been given to the position of the success criteria statements so they reflect the working mathematically elements demonstrated.

This assessment task has been designed to illuminate the style of questions and the types of responses needed to elicit deep content knowledge, however, staff are encouraged to use and adapt the assessment task and the success criteria to their school context. Staff may like to enhance or amend sections of the task. Staff may like to adapt the rubric to assign marks to the descriptors in order to differentiate between responses that address the same statement. All changes are the responsibility of the staff using the assessment.