Name: _____

Teacher: _____

Due date: _____

10MA1 Mathematics
Assignment 1
2024

Outcomes Assessed		
This assignment will address many outcomes from the Stage 5 syllabus, with particular focus on: • Calculates the surface areas of right prisms, cylinders and related composite solids MA5.2-11MG. • Applies formulas to calculate the volumes of composite solids composed of right prisms and cylinders MA5.2-12MG • uses and interprets formal definitions and generalisations when explaining solutions and/or conjectures MA5.3-1WM • generalises mathematical ideas and techniques to analyse and solve problems efficiently MA5.3-2WM • applies formulas to find the volumes of right pyramids, right cones, spheres and related composite solids MA5.3-14MG • applies Pythagoras' Theorem, trigonometric relationships, the sine rule, the cosine rule and the area rule to solve problems, including problems involving three dimensions MA5.3-15MG		
Content Assessed		
Refer to the attached assignment booklet and instructions. All activities are based around the Measurement and Working Mathematically Units, which have been studied in class.		
Weighting	**20%**	**Due Date: Tuesday Week 6 – 5/3/24**
Penalties as per assessment booklet		

Task

Mathematics is an essential tool to analyse sustainability issues including predicted energy use and how we can reduce it using alternative energy sources such as solar cells. Through measurement and the reasoned use of data, we can predict and evaluate our impact on energy use and develop a deeper appreciation of the use of Earth's resources.

In this task, you will utilise your understanding of the various measurement applications, including your knowledge of surface area, volume and capacity, to answer a variety of questions. You will also be required to research the efficiency of solar panels and calculate energy usage based on the size of panels and the output of energy.

Instructions:

Students are required to complete the questions in the space provided. Separate A4 sheets of paper can be used if additional space is required. All working out must be shown for each question.

Total /43

Part 1

1. When installing solar panels on the roof of a building, it is important that they face a specific direction and have a recommended tilt angle to maximise their energy output. Research the optimum aspect and tilt angle if a set of solar panels were installed in Sydney NSW. Write up to 5 sentences about your findings, making sure that you reference your source of information. **(3 marks)**

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2. Using Google Earth, locate the building that has the following coordinates

33˚49’ 42.2”S, 151˚05’ 04.3”E.

a. Measure the dimensions of the roof of the building, using the Ruler Tool correct to the nearest 0.5m. **(1 mark)**

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b. Calculate the area of the roof you have just measured. **(1 mark)**

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c. A single solar panel has the dimensions of 1.6m x 80cm. Calculate the area of one solar panel in m^2, and hence, how many panels could theoretically be placed on the roof? **(2 marks)**

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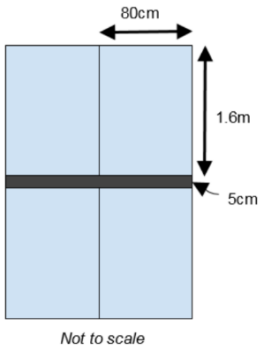
d. In order to operate effectively, the solar panel installer has informed you that there must be a 5cm space between each row of panels, as shown in the diagram to the right. Given this new information, draw two different diagrams of the layout of your panels, and determine how many full panels can actually fit on the roof.



(3 marks)

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e. List at least two reasons why your answer to part (c) and part (d) are not the same. **(2 marks)**

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3. The solar system installed in question 2 is a 0.72 Megawatt system.

a. Convert 0.72MW to kW. **(1 mark)**

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b. Using the table below, predict how many kWh this system will produce each day for a building located in Sydney. **(2 marks)**

City	1 kW system	1.5 kW system	2.0 kW system	3.0 kW system	4.0 kW system
Adelaide	4.2 kWh	6.3 kWh	8.4 kWh	12.6 kWh	16.8 kWh
Alice Springs	5.0 kWh	7.5 kWh	10.0 kWh	15.0 kWh	20.0 kWh
Brisbane	4.2 kWh	6.3 kWh	8.4 kWh	12.6 kWh	16.8 kWh
Cairns	4.2 kWh	6.3 kWh	8.4 kWh	12.6 kWh	16.8 kWh
Canberra	4.3 kWh	6.45 kWh	8.6 kWh	12.9 kWh	17.2 kWh
Darwin	4.4 kWh	6.6 kWh	8.8 kWh	13.2 kWh	17.6 kWh
Hobart	3.5 kWh	5.25 kWh	7.0 kWh	10.5 kWh	14.0 kWh
Melbourne	3.6 kWh	5.4 kWh	7.2 kWh	10.8 kWh	14.4 kWh
Perth	4.4 kWh	6.6 kWh	8.8 kWh	13.2 kWh	17.6 kWh
Sydney	3.9 kWh	5.85 kWh	7.8 kWh	11.7 kWh	15.6 kWh

The rated output is that achieved in perfect laboratory conditions. The Clean Energy Council design summary software takes these de-ratings into account when predicting averages for any given system.

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4. The building from question 2 and 3 uses three fifths of the energy produced by the solar panels and feeds the remaining energy back to the grid. An electricity provider is willing to buy back power at the rate of 6 cents/kWh. How much money, in dollars, will the building receive from the provider in the month of January? **(2 marks)**

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5. The house at 33°49'46"S 151°05'16"E has decided to also install solar panels.

a. Measure the dimensions of the roof of the building, using the Ruler Tool, correct to the nearest m.

(1 mark)

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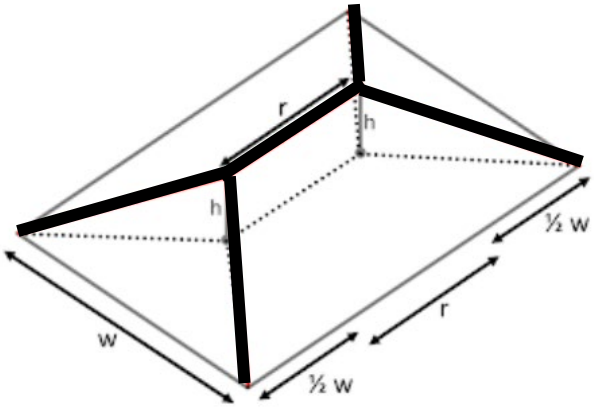
b. The roof of the house has a height of 60cm. The main beams of the house need to be reinforced prior to the installation of panels.



What is the total length of the metal beams required, as indicated by the bold lines on the diagram above? Answer correct to the nearest m. **(3 marks)**

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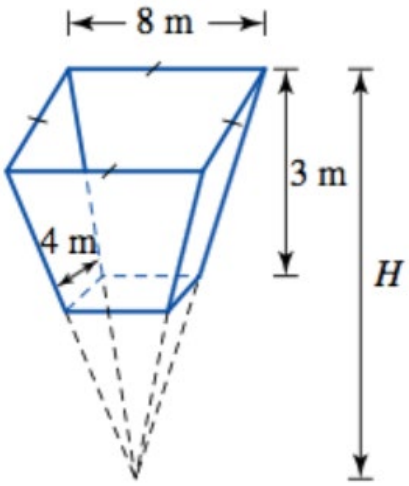
Part 2

1. Johnson High School is about to install a pool. The pool is being constructed so that it is the upper part of an inverted square-based pyramid.



a. Calculate the value of H **(2 marks)**

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b. Calculate the volume of the pool **(2 marks)**

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c. Calculate the cost of tiling the four side walls if they are to be tiled at a cost of \$50p/m^2.

(3 marks)

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2. Johnson High School is located in Cairns. It has been estimated that the pool will consume approximately 0.01 kWh/L each year. The school has already installed a 4kW solar system to supply the electricity demands of their new pool.

a. Using the table from Part 1 question 3b, will the solar system be able to supply enough energy to meet the requirements of the swimming pool? Justify your answer with suitable calculations.

(2 marks)

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b. Outline two advantages of using solar panels to supply some, or all, of the energy requirements of the pool. **(2 marks)**

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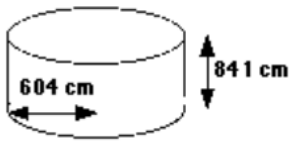
Part 3

A chemical tanker containing Chlorine for swimming pools was driving to a warehouse when it was involved in an accident. The tanker ended up on its side and leaking! The emergency services need to find a way to syphon the Chlorine from inside the damaged tanker.

The full chemical tanker was approximately in the shape of a cylinder and had a diameter of 3.12 m and was 9.04 m long. They found they had two alternatives to remove the Chlorine as quickly as possible.

Method 1:

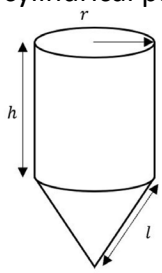
The Chlorine could be syphoned into a bulk storage container (shown below) although it was known that the nearest one was already 80% full. Chlorine could be pumped through the pipe at 200m^3/hr.



Method 2:

The fire brigade had at their immediate disposal three vehicles into which the Chlorine could be syphoned.

Vehicle 1: A trailer in the shape of shown below. The trailer has a total height 3m and is 3m wide. The cylindrical part of the trailer has a height of 2.2m Chlorine could be pumped at a rate of 197 m^3/hr.



Vehicle 2: This was a cylindrical shape.
Unfortunately in the vehicle's manual the page indicating the volume of the vehicle and its length was missing. All that we know about the vehicle was that it had a radius of 1.5 m and the total surface area of the cylindrical container was 80.1 m^2.
Chlorine could be pumped into it at a rate of 203 m^3/hr.

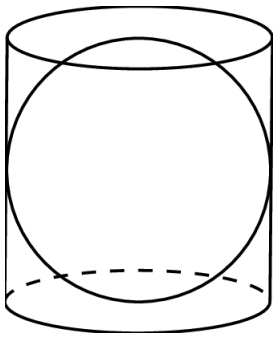
Vehicle 3: This had a volume of 20 000 litres and Chlorine could be pumped into it at a rate of 200 m^3/hr.

Which solution should be used? Show all Mathematical calculations to support your answer. **(7 marks)**

Part 4:

(4 marks)

Archimedes is considered to be one of the greatest mathematicians of all time. He discovered several of the formulae used in Measurement. Inscribed in his tombstone was the diagram of his proudest discovery. It shows a sphere inscribed (fitting exactly) into a cylinder.



Show that:

$$\frac{volume\ of\ the\ cylinder}{volume\ of\ the\ sphere} = \frac{surface\ area\ of\ the\ cylinder}{surface\ area\ of\ the\ sphere}$$

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END OF TASK