



CATHOLIC SECONDARY SCHOOLS  
ASSOCIATION OF NSW

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Centre Number

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Student Number

DO NOT REMOVE PAPER FROM EXAM ROOM

**2020**  
TRIAL HIGHER SCHOOL  
CERTIFICATE EXAMINATION

# Mathematics Advanced

Morning Session  
Thursday, 20 August 2020

## General Instructions

- Reading time – 10 mins
- Working time – 3 hours
- Write using black pen
- Use Multiple Choice Answer Sheet provided
- NESA-approved calculators may be used
- A reference sheet is provided on a SEPARATE sheet
- For questions in Section II, show relevant mathematical reasoning and/or calculations
- Write your Centre Number and Student Number at the top of this page

## Total marks - 100

**Section I** Pages 2-6

### 10 marks

- Attempt Questions 1-10
- Allow about 15 minutes for this section

**Section II** Pages 7-26

### 90 marks

- Attempt Questions 11-37
- Allow about 2 hours and 45 minutes for this section

## Disclaimer

Every effort has been made to prepare these 'Trial' Higher School Certificate Examinations in accordance with the NESA documents, Principles for Setting HSC Examinations in a Standards-Referenced Framework and Principles for Developing Marking Guidelines Examinations in a Standards Referenced Framework. No guarantee or warranty is made or implied that the 'Trial' Examination papers mirror in every respect the actual HSC Examination question paper in any or all courses to be examined. These papers do not constitute 'advice' nor can they be construed as authoritative interpretations of NESA intentions. The CSSA accepts no liability for any reliance use or purpose related to these 'Trial' question papers. Advice on HSC examination issues is only to be obtained from the NESA.

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## Section I

10 marks

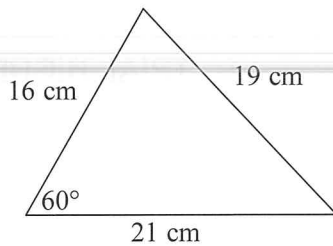
Attempt Questions 1-10

Allow about 15 minutes for this section

Use the Multiple-Choice Answer Sheet for Questions 1-10.

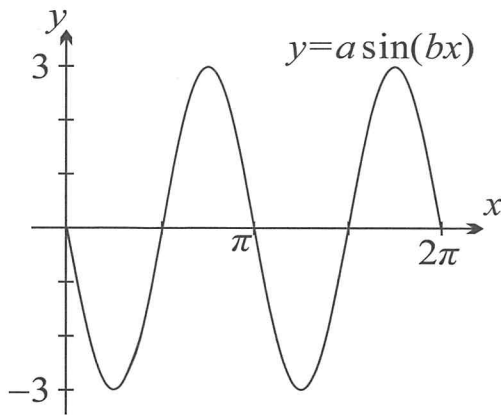
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- 1 Which of the following expressions gives the area of the triangle below?



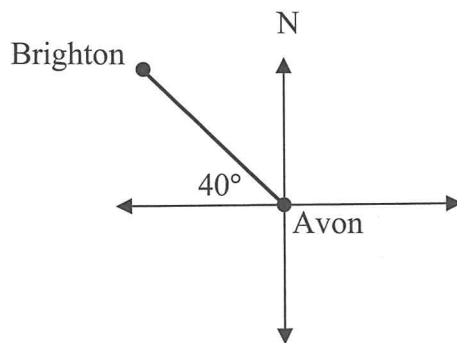
- (A)  $\text{Area} = \frac{1}{2} \times 16 \times 19 \times \cos 60^\circ$
- (B)  $\text{Area} = \frac{1}{2} \times 16 \times 21 \times \cos 60^\circ$
- (C)  $\text{Area} = \frac{1}{2} \times 16 \times 19 \times \sin 60^\circ$
- (D)  $\text{Area} = \frac{1}{2} \times 16 \times 21 \times \sin 60^\circ$
- 2 Which of the following is equal to  $\frac{1}{3\sqrt{2}-\sqrt{5}}$  ?
- (A)  $3\sqrt{2}-\sqrt{5}$
- (B)  $3\sqrt{2}+\sqrt{5}$
- (C)  $\frac{3\sqrt{2}-\sqrt{5}}{13}$
- (D)  $\frac{3\sqrt{2}+\sqrt{5}}{13}$

- 3 The diagram below is a graph of  $y = a \sin(bx)$  in the domain  $[0, 2\pi]$ .



What is the equation of the curve?

- (A)  $y = 3 \sin 2x$
- (B)  $y = 2 \sin 3x$
- (C)  $y = -3 \sin 2x$
- (D)  $y = -2 \sin 3x$
- 4 What is the compass bearing of Avon from Brighton in the diagram shown?



- (A) S50°E
- (B) S40°W
- (C) N40°E
- (D) N50°W

5 What is the value of  $(\log a)^2 \div \log(a^2)$ ?

- (A) 1
- (B)  $\frac{\log a}{2}$
- (C)  $\log a$
- (D)  $2 \log a$

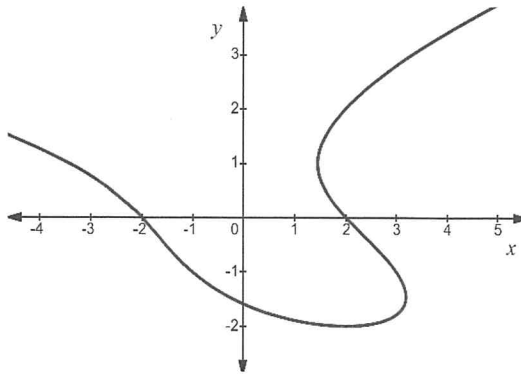
6 Which of the following is equal to  $\frac{4^n - 1}{2^n - 1}$  ?

- (A)  $2^n + 1$
- (B)  $2^n - 1$
- (C)  $2^2$
- (D) 2

7 For a normally distributed set of scores, which of the following statements is FALSE?

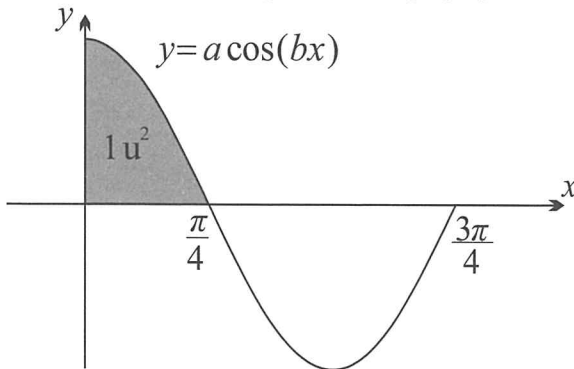
- (A) A z-score more than 2 has a higher probability than a z-score more than 1.
- (B) The frequency distribution is symmetrical about the mean.
- (C) The z-score of a score describes how far that score is from the mean.
- (D) The mean and the median are equal.

- 8 Below is a graph of  $x^2 + 2xy - y^3 = 4$ .



What type of relation is this?

- (A) one-to-one  
 (B) one-to-many  
 (C) many-to-one  
 (D) many-to-many
- 9 The diagram shows part of the graph  $y = a \cos bx$ .



The area of the shaded region is equal to 1 unit<sup>2</sup>. What is the value of  $\int_0^{\frac{3\pi}{4}} f(x) dx$ ?

- (A) -2  
 (B) -1  
 (C) 1  
 (D) 3

- 10 The graph of  $y = \frac{3}{x+1}$  is translated 4 units right and dilated vertically by a factor of  $\frac{1}{2}$ . Which of the following gives the equation of the new function?

(A)  $\frac{y}{2} = \frac{3}{x-3}$

(B)  $2y = \frac{3}{x-4}$

(C)  $2y = \frac{3}{x-3}$

(D)  $\frac{y}{2} = \frac{3}{x-4}$

**End of Section I**

**The paper continues over the page**

## Section II

90 marks

Attempt Questions 11-37

Allow about 2 hours and 45 minutes for this section

- Answer the questions in the spaces provided. These spaces provide guidance for the expected length of your response.
- Your responses should include relevant mathematical reasoning and/or calculations.

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### Question 11 (2 marks)

Solve  $|2x - 3| \leq 1$ .

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### Question 12 (2 marks)

Differentiate  $\frac{e^x}{x^2 + 1}$ .

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**Question 13** (2 marks)

Evaluate  $\int_{-1}^0 x(3x-4) dx$ .

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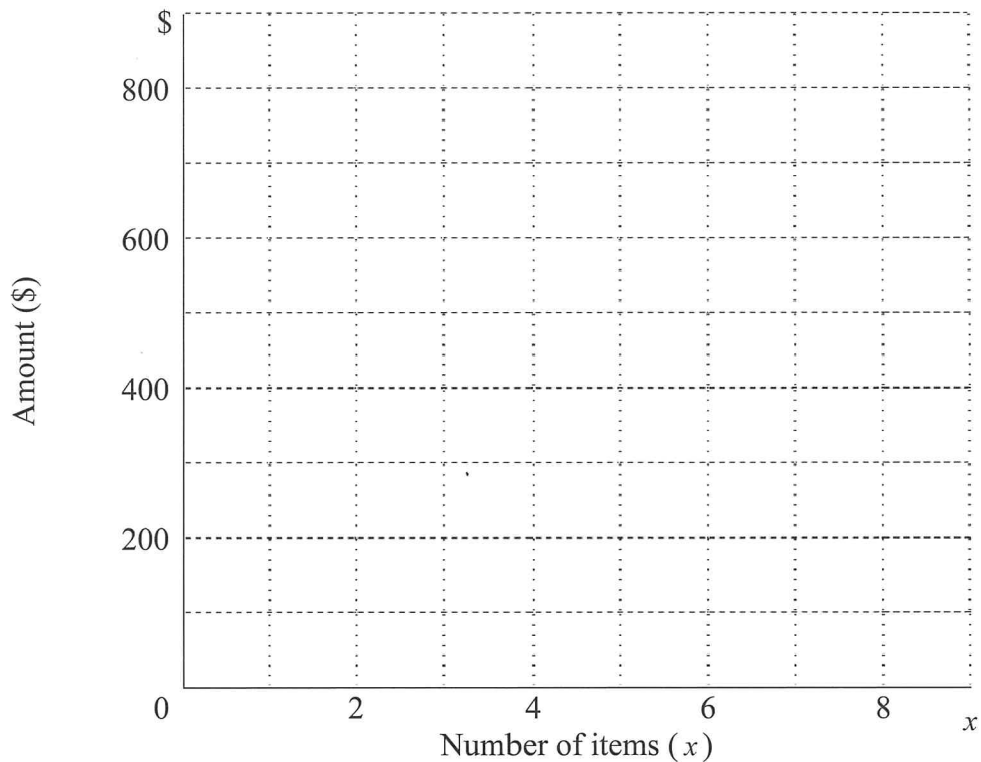
**Question 14** (3 marks)

Michael has a small manufacturing business.

The cost of manufacturing is given by the equation  $C = 50x + 200$  and the income earned is given by the equation  $I = 100x$ , where  $x$  is the number of items that the business has manufactured.

- (a) Graph each of the two equations on the grid below.

2



- (b) How many items need to be manufactured for the business to break even?

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**Question 15** (2 marks)

Find the gradient of the tangent to the curve  $y = e^x \sin x$  as it passes through the origin.

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**Question 16** (2 marks)

Two ordinary 6-sided dice, one red and one blue, are rolled and the numbers on the uppermost face are recorded. The blue die shows a number less than five. What is the probability that the sum of the two numbers is greater than seven?

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**Question 17** (2 marks)

A set of scores is normally distributed. A score of 12 has z-score of  $-2$  while a score of 21 has a z-score of  $+1$ .

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Calculate the mean of the scores.

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**Question 18** (4 marks)

A cup of coffee is cooling according to the following exponential formula

$C = 21 + (74 \times 3^{-0.2t})$ , where  $C$  is the temperature in degrees Celsius and  $t$  is the time in minutes since the coffee was poured.

- (a) Calculate the initial temperature of the coffee. 1

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- (b) Calculate the temperature of the coffee after 10 minutes, correct to the nearest degree. 1

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- (c) After how many minutes, to the nearest minute, will the coffee first reach  $50^\circ\text{C}$ ? 2

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**Question 19** (2 marks)

Show that  $\frac{\sec \theta - \sec \theta \cos^4 \theta}{1 + \cos^2 \theta} = \sin \theta \tan \theta$ .

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**Question 20** (3 marks)

The sum of the first  $n$  terms of an arithmetic series is given by

$$S_n = \frac{n(3n+7)}{2}.$$

- (a) Find the first three terms of the sequence.

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- (b) Find an expression for the  $n$ -th term of the sequence.

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**Question 21** (3 marks)

Solve  $\sin\left(x + \frac{\pi}{6}\right) = -\frac{\sqrt{3}}{2}$  for  $0 \leq x \leq 2\pi$ .

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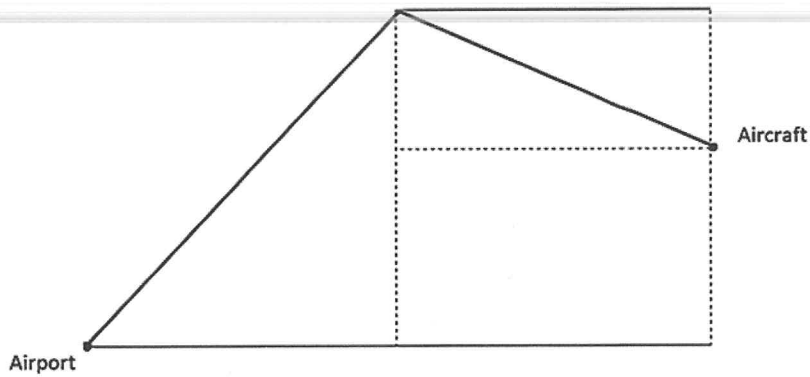
**Question 22** (5 marks)

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An aircraft took off from an airport on an angle of elevation of  $30^\circ$  until it reached a maximum height of 12 000 metres.

The aircraft then descended on an angle of depression of  $20^\circ$  to a new height of 9000 metres.

Find the straight-line distance of the aircraft to the airport when it first reaches the new height of 9000 metres, correct to the nearest metre.



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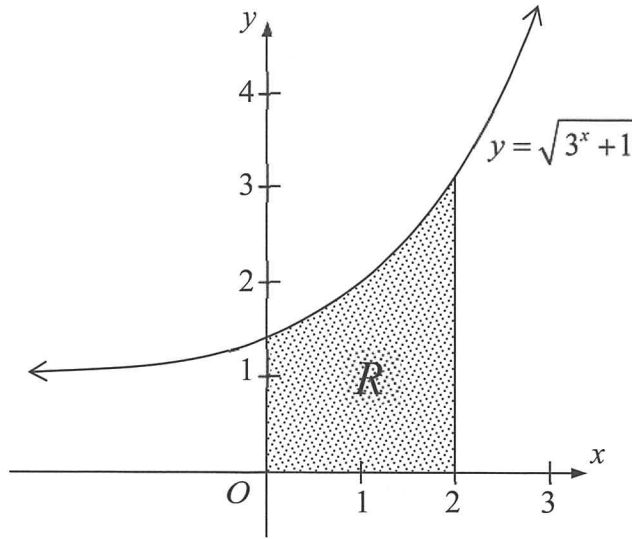
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**Question 23** (3 marks)

The diagram below shows the region  $R$  which is bounded by  $y = \sqrt{3^x + 1}$ , the  $x$ -axis and the lines  $x = 0$  and  $x = 2$ .



- (a) Use the Trapezoidal Rule with five function values to find an approximation for the area  $R$ . Give your answer to two decimal places. 2

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- (b) With reference to the curve, give a reason whether your approximation is an over-estimation or underestimation. 1

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**Question 24 (5 marks)**

Seven students, who are still on their Learner’s Permit, recorded the number of driving hours they have logged so far and the mark they scored in their Visual Art assessment task.

The results are recorded in the table below:

Name	Ally	Bree	Cain	Dan	Elle	Frank	Guy
Hours of driving ( $x$ )	63	68	72	76	82	84	91
Visual Art mark ( $y$ )	73	71	71	85	92	80	81

- (a) Calculate Pearson's correlation coefficient for the data, correct to two decimal places. 1

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- (b) Calculate the value, to two decimal places, of the gradient and the  $y$ -intercept. Use these values to write the equation of the least-squares line of best fit. 2

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- (c) Another student, who has logged 55 hours of driving and who scored 94 in Visual Art, is added to the data. 1

Describe the impact this addition to the data will have on Pearson’s correlation coefficient.

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- (d) A student made the statement, “Doing well in Visual Art depends on how much driving you have done.” 1

Based on the data, justify whether you agree or disagree with the statement.

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**Question 25** (4 marks)

The displacement of a particle moving along the  $x$ -axis is given by  $x = t + e^{-2t}$ , where  $x$  is the displacement from the origin in metres and  $t$  is the time in seconds, for  $t \geq 0$ .

- (a) Find an expression, in terms of  $t$ , for the velocity of the particle.

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- (b) Find the time when the particle is closest to the origin.

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**Question 26** (2 marks)

Let  $f(x) = 5x - 2$  and  $g(x) = \frac{1}{\sqrt{x}}$ . State the domain of  $g(f(x))$ .

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**Question 27** (7 marks)

Consider the curve  $y = (x + 1)^2(x - 5)$ .

- (a) Find the stationary points and determine their nature.

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- (b) Given that the point  $(1, -16)$  lies on the curve, show that it is a point of inflection.

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**Question 27 continues over the page**



**Question 27 (continued)**

- (c) Sketch the curve  $y = (x+1)^2(x-5)$ , showing the stationary points and the point of inflection.

2

**Question 28** (3 marks)

Consider the circle given by the equation  $x^2 + 8x + y^2 - 4y - 29 = 0$ .

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Give the equation of the circle in the form  $(x - h)^2 + (y - k)^2 = r^2$ , if it is translated up by three units and right by five units.

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**Question 29** (6 marks)

The time  $t$  minutes that a customer spends waiting in a queue has a probability density function:

$$f(x) = \begin{cases} \frac{x(k-x)}{36} & \text{for } 0 \leq x \leq k \\ 0 & \text{otherwise} \end{cases}$$

- (a) Show that the value of  $k$  is 6.

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- (b) Write down the value of  $E(X)$ .

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- (c) Calculate  $\text{Var}(X)$ .

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**Question 30** (3 marks)

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Chickens are sized according to their weight. For example, a size 16 chicken weighs 1.6 kg. At a particular farm, the chickens they sell as size 15 have weights which are normally distributed with a mean of 1.56 kg and a standard deviation of 0.025 kg. Chickens that weigh less than 1.5 kg should be classified size 14 and chickens that weigh more than 1.6 kg should be classified size 16.

The following table gives the probability of scores with a z-score less than the given value.

z	<i>first decimal place</i>									
	.0	.1	.2	.3	.4	.5	.6	.7	.8	.9
0.	0.500	0.540	0.579	0.618	0.655	0.692	0.726	0.758	0.788	0.816
1.	0.841	0.864	0.885	0.903	0.919	0.933	0.945	0.955	0.964	0.971
2.	0.977	0.982	0.986	0.989	0.992	0.994	0.995	0.997	0.997	0.998
3.	0.999	0.999	0.999	1.000	1.000	1.000	1.000	1.000	1.000	1.000

For example, the probability of a score with a z-score of less than 2.6 is 0.995, as highlighted above.

What is the probability that a randomly selected size 15 chicken has been incorrectly classified? Give your answer correct to the nearest 3 decimal places.

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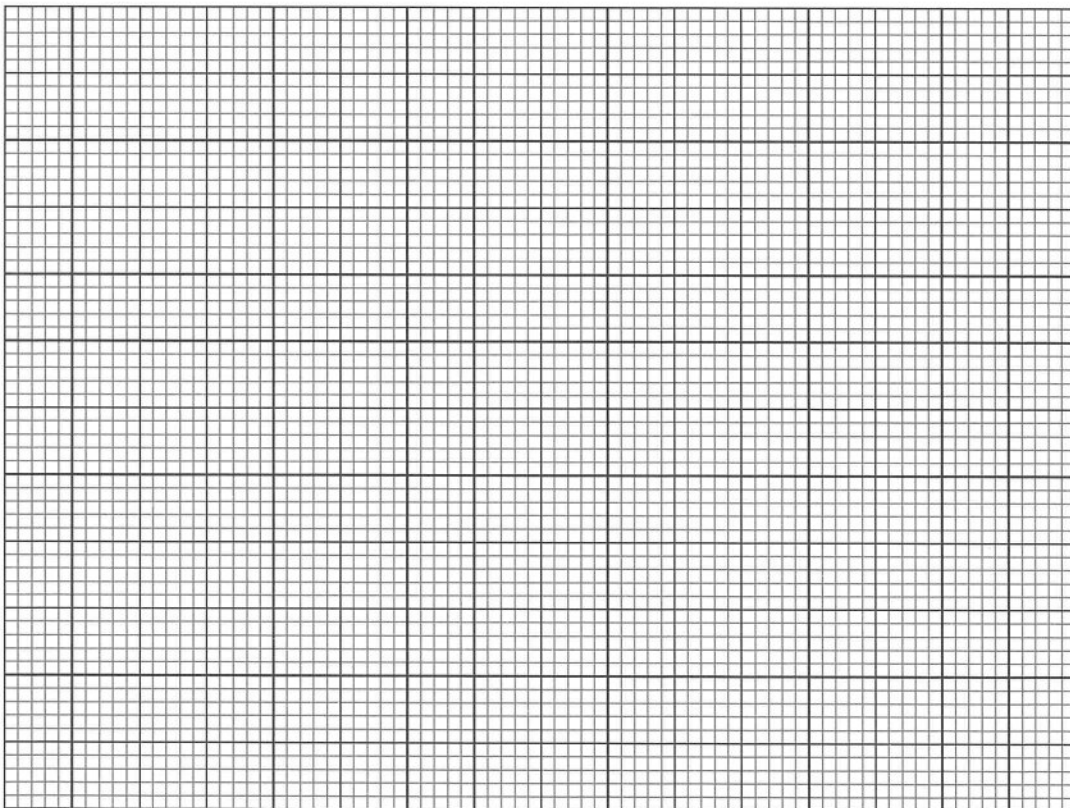
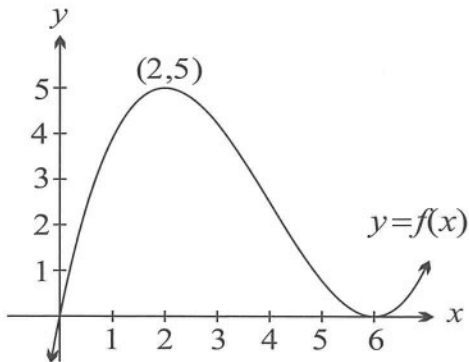
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**Question 31** (2 marks)

The sketch shows  $y = f(x)$ . Draw a sketch of  $f(2-x)$ .

2



**Question 32** (6 marks)

Mimi borrows \$650 000 to buy a house at 6 % per annum with interest compounded monthly. The loan is to be repaid with equal monthly repayments of \$4200. Let  $A_n$  be the amount owing after  $n$  months.

- (a) Show that  $A_n = 840\,000 - 190\,000 \times 1.005^n$ . 3

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- (b) After 15 years, the amount owing is \$373 722 to the nearest dollar. At this time Mimi borrows a further \$200 000 to build an extension. She adds this onto her previous mortgage. If the monthly repayments remain the same, what is the minimum remaining number of months it will take her to pay off the balance of the loan? 3

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**Question 33** (6 marks)

- (a) Expand and simplify the expression  $(x + 4)(x - 1)(x - 3)$ .

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- (b) Consider the curves defined by the equations  $y = \frac{12}{x}$  and  $y = 13 - x^2$ .

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Using part (a), or otherwise, find the points of intersection between these two curves and find the exact area enclosed between the two curves in the first quadrant.

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**Question 34** (2 marks)

Solve  $\log_3 x + \log_9 x = 12$ .

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**Question 35** (2 marks)

Sophie rolls two dice and observes that the sum of the uppermost numbers is six.  
What is the probability that the number four has appeared at least once?

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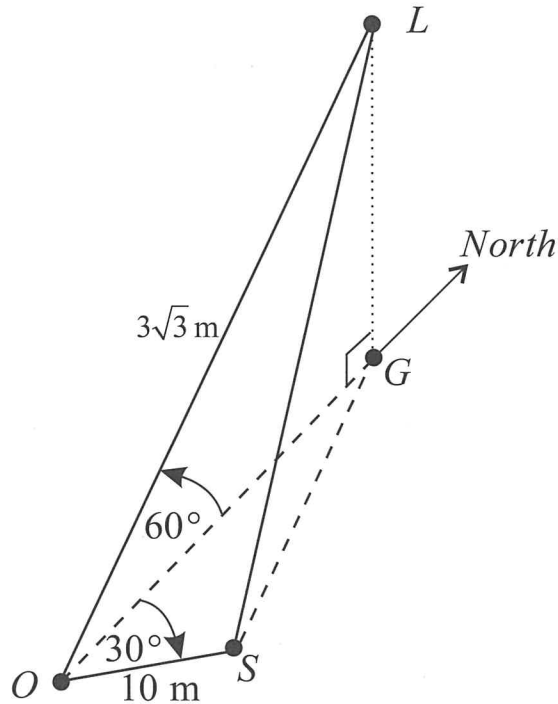


**Question 36** (3 marks)

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During the festival of lanterns Oscar releases a lantern from point  $O$ . It floats up into the sky due north in a straight line with an angle of elevation of  $60^\circ$ . Sarina is located at  $S$ , 10 metres from  $O$  at a bearing of  $N30^\circ E$  from  $O$ .

The lantern has travelled  $3\sqrt{3}$  metres from  $O$  when Sarina first observes it at  $L$ . The point  $G$  is on the ground directly below  $L$ .



Let  $SL$  be  $y$ . Find the distance  $y$ . Give your answer correct to the nearest metre.

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**Question 37** (4 marks)

Two dangerous goods long-haul drivers are contracted to share the driving on one truckload of chemicals over a distance of 1200 km. They are each paid \$55 per hour for

the time spent on the road. The truck consumes fuel at a rate of  $10 + \frac{v^2}{100}$  litres per hour where the average speed of the truck is  $v$  km per hour. Diesel fuel costs \$1.50 per litre.

Show that to complete the journey the cost \$ $C$  of fuel and wages will be given by

$$C = \frac{150\,000}{v} + 18v, \text{ and determine the minimum cost. Give your answer correct to the}$$

nearest dollar.

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**End of Paper**

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## EXAMINERS

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Sue Wymer  
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St Ursula's College, Kingsgrove

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**CATHOLIC SECONDARY SCHOOLS ASSOCIATION  
2020 TRIAL HIGHER SCHOOL CERTIFICATE EXAMINATION  
MATHEMATICS ADVANCED – MARKING GUIDELINES**

These marking guidelines show the criteria to be applied to responses along with the marks to be awarded in line with the quality of responses. These guidelines are suggested and not prescriptive. This is not intended to be an exhaustive list but rather an indication of the considerations that students could include in their responses.

**Section I  
10 Marks**

**Questions 1-10 (1 mark each)**

<b>Question</b>	<b>Answer</b>	<b>Outcomes Assessed</b>	<b>Targeted Performance Bands</b>
1	D	MA11-3	2-3
2	D	MA11-2	2-3
3	C	MA1-4, MA12-5	3-4
4	A	MA11-5	3-4
5	B	MA11-3	3-4
6	A	MA11-2	3-4
7	A	MA11-7	3-4
8	D	MA12-1	4
9	B	MA12-7	4-5
10	C	MA12-1	5-6

**DISCLAIMER**

The information contained in this document is intended for the professional assistance of teaching staff. It does not constitute advice to students. Further it is not the intention of CSSA to provide specific marking outcomes for all possible Trial HSC answers. Rather the purpose is to provide teachers with information so that they can better explore, understand and apply HSC marking requirements, as established by the NESA. No guarantee or warranty is made or implied with respect to the application or use of CSSA Marking Guidelines in relation to any specific trial exam question or answer. The CSSA assumes no liability or responsibility for the accuracy, completeness or usefulness of any Marking Guidelines provided for the Trial HSC papers.

## Section II

90 Marks

**Question 11** (2 marks)

**Outcomes Assessed:** MA11-1

**Targeted Performance Bands:** 2-3

Criteria	Marks
• Correct answer	2
• Some progress towards the answer	1

*Sample answer:*

$$-1 \leq 2x - 3 \leq 1$$

$$2 \leq 2x \leq 4$$

$$1 \leq x \leq 2$$

**Question 12** (2 marks)

**Outcomes Assessed:** MA11-5

**Targeted Performance Bands:** 2-3

Criteria	Marks
• Correct answer	2
• Some progress towards the answer	1

*Sample answer:*

$$\begin{aligned} \frac{d}{dx} \left( \frac{e^x}{x^2 + 1} \right) &= \frac{e^x(x^2 + 1) - 2x(e^x)}{(x^2 + 1)^2} \\ &= \frac{e^x(x^2 - 2x + 1)}{(x^2 + 1)^2} \end{aligned}$$

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**Question 13** (2 marks)

**Outcomes Assessed:** MA12-7

**Targeted Performance Bands:** 3-4

Criteria	Marks
• Correct answer	2
• Correctly integrates the function	1

**Sample answer:**

$$\begin{aligned}\int_{-1}^0 (3x^2 - 4x) dx &= [x^3 - 2x^2]_{-1}^0 \\ &= (0) - (-1 - 2) \\ &= 3\end{aligned}$$

**Question 14**

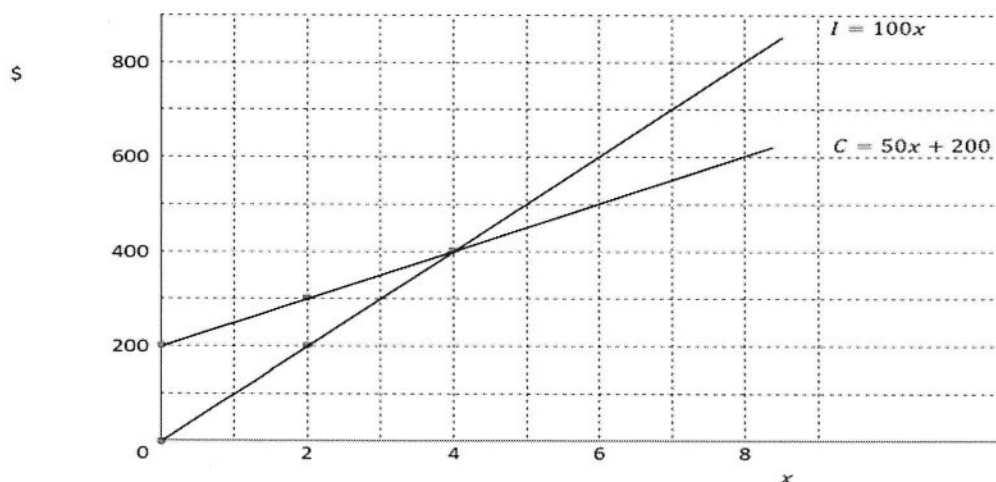
(a) (2 marks)

**Outcomes Assessed:** MA12-1

**Targeted Performance Bands:** 3

Criteria	Marks
• TWO correct lines marked on the graph	2
• ONE correct line marked on the graph	1

**Sample answer:**



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**Question 14**

(b) (1 mark)

**Outcomes Assessed: MA11-1****Targeted Performance Bands: 3**

Criteria	Mark
• Correct answer	1

**Sample answer:**

Break even = 4 items

**Question 15 (2 marks)****Outcomes Assessed: MA11-6****Targeted Performance Bands: 3-4**

Criteria	Marks
• Correct answer	2
• Correctly differentiates the curve	1

**Sample answer:**

$$y' = e^x \times \cos x + e^x \times \sin x$$

$$= e^x (\cos x + \sin x)$$

$$\text{at } x = 0, y' = e^0 (\cos 0 + \sin 0) = 1$$

so the gradient at  $x = 0$  is 1.

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**Question 16** (2 marks)**Outcomes Assessed:** MA11-7**Targeted Performance Bands:** 3-4

Criteria	Marks
• Correct answer	2
• Some progress towards correct answer	1

**Sample answer:**

$$\begin{aligned}
 P(\text{sum} > 7) &= P(2, 6) + P(3, \geq 5) + P(4, \geq 4) \\
 &= \frac{1}{4} \times \frac{3}{6} + \frac{1}{4} \times \frac{2}{6} + \frac{1}{4} \times \frac{1}{6} \\
 &= \frac{1 \times (3 + 2 + 1)}{24} \\
 &= \frac{1}{4}
 \end{aligned}$$

**Question 17** (2 marks)**Outcomes Assessed:** MA12-6**Targeted Performance Bands:** 3-4

Criteria	Marks
• Correct answer and working	2
• Correct calculation of the standard deviation or other progress towards answer	1

**Sample answer:**

-2 to 1 = 3 standard deviations

3 standard deviations = 21 - 12 = 9

So each standard deviation is  $9 \div 3 = 3$  ( $\sigma = 3$ )

$$-2 = \frac{12 - \mu}{3}$$

$$-6 = 12 - \mu$$

$$\mu = 12 + 6$$

$$\mu = 18$$

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**Question 18**

(a) (1 mark)

**Outcomes Assessed: MA12-6****Targeted Performance Bands: 3-4**

Criteria	Mark
• Correct answer	1

**Sample answer:**

$$\begin{aligned} \text{at } t = 0, C &= 21 + (74 \times 3^{-0.2 \times 0}) \\ &= 95^\circ\text{C} \end{aligned}$$

**Question 18**

(b) (1 mark)

**Outcomes Assessed: MA12-6****Targeted Performance Bands: 3-4**

Criteria	Mark
• Correct answer	1

**Sample answer:**

$$\begin{aligned} C &= 21 + (74 \times 3^{-0.2 \times 10}) \\ &= 21 + (74 \times 3^{-2}) \\ &= 29.2222\dots \\ &= 29^\circ\text{C (to the nearest degree)} \end{aligned}$$

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**Question 18**

(c) (2 marks)

**Outcomes Assessed: MA12-6****Targeted Performance Bands: 3-4**

Criteria	Marks
• Correct answer	2
• Progress towards the correct answer	1

**Sample answer:**

$$50 = 21 + (74 + 3^{-0.2t})$$

$$\frac{29}{74} = 3^{-0.2t}$$

$$\log_3\left(\frac{29}{74}\right) = -0.2t$$

$$t = -5 \log_3\left(\frac{29}{74}\right)$$

$$= \frac{-5 \log_{10}\left(\frac{29}{74}\right)}{\log_{10} 3}$$

$$\approx 4 \text{ minutes and } 15 \text{ seconds}$$

$$\approx 4 \text{ minutes (nearest minute)}$$

**Question 19 (2 marks)****Outcomes Assessed: MA12-5****Targeted Performance Bands: 4-5**

Criteria	Marks
• Correct solution	2
• Some progress	1

**Sample answer:**

$$\text{LHS} = \frac{\sec \theta (1 - \cos^4 \theta)}{1 + \cos^2 \theta}$$

$$= \frac{1}{\cos \theta} (1 - \cos^2)$$

$$= \frac{1}{\cos \theta} \times \sin^2 \theta$$

$$= \sin \theta \tan \theta$$

$$= \text{RHS}$$

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**Question 20**

(a) (2 marks)

**Outcomes Assessed: MA12-4****Targeted Performance Bands: 4**

Criteria	Marks
• Correct answer	2
• Some progress towards finding terms or sums	1

**Sample answer:**

$$S_1 = \frac{1 \times 10}{2} = 5$$

$$T_1 = 5$$

$$S_2 = \frac{2 \times 13}{2} = 13$$

$$T_2 = 13 - 5 = 8$$

$$S_3 = \frac{3 \times 16}{2} = 24$$

$$T_3 = 24 - 13 = 11$$

So, the first three terms are 5, 8 and 11.

**Question 20**

(b) (1 mark)

**Outcomes Assessed: MA12-4****Targeted Performance Bands: 3-4**

Criteria	Mark
• Correct answer	1

**Sample answer:**

$$\begin{aligned} T_n &= 5 + (n-1) \times 3 \\ &= 2 + 3n \end{aligned}$$

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**Question 21** (3 marks)

**Outcomes Assessed:** MA12-5

**Targeted Performance Bands:** 4-5

Criteria	Marks
• Correct answer	3
• ONE correct solution	2
• Correctly determines the acute-related angle, or some other progress	1

*Sample answer:*

$$\sin\left(x + \frac{\pi}{6}\right) = -\frac{\sqrt{3}}{2}$$

acute-related angle  $\left(x + \frac{\pi}{6}\right) = \frac{\pi}{3}$

$$x + \frac{\pi}{6} = \frac{4\pi}{3}, \frac{5\pi}{3}$$

$$x = \frac{7\pi}{6}, \frac{3\pi}{2}$$

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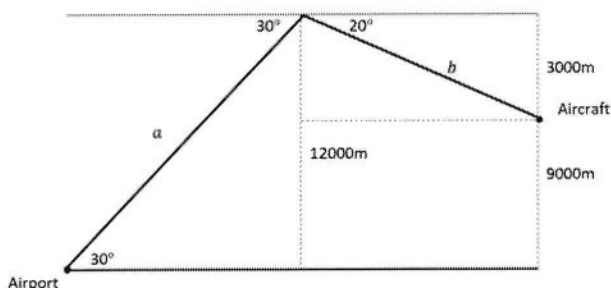
**Question 22** (5 marks)

**Outcomes Assessed:** MA11-4

**Targeted Performance Bands:** 4

Criteria	Marks
• Correct answer and working	5
• Three correct answers for length $a$ , length $b$ , obtuse angle $130^\circ$ AND correct substitution in the cosine rule	4
• Three correct answers for length $a$ , length $b$ , obtuse angle $130^\circ$	3
• Two correct answers for length $a$ , length $b$ , obtuse angle $130^\circ$	2
• One correct answer for length $a$ , length $b$ , obtuse angle $130^\circ$	1

**Sample answer:**



$$\sin 30^\circ = \frac{12\,000}{a}$$

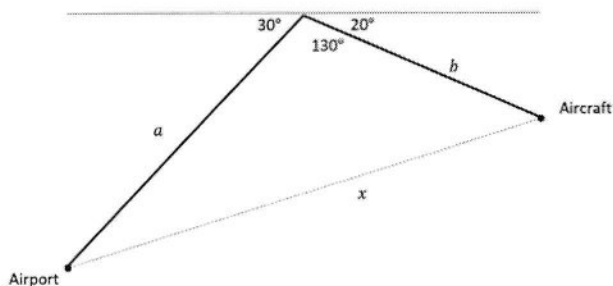
$$a = \frac{12\,000}{\sin 30^\circ}$$

$$a = 24\,000 \text{ m}$$

$$\sin 20^\circ = \frac{3\,000}{b}$$

$$b = \frac{3\,000}{\sin 20^\circ}$$

$$a \approx 8771.14 \text{ m (2 decimal places)}$$



$$x^2 = a^2 + b^2 - 2ab \cos X$$

$$x^2 = 24\,000^2 + 8771.4132^2 - 2 \times 24\,000 \times 8771.4132 \times \cos 130^\circ$$

$$x = 30390 \text{ m (to the nearest metre)}$$

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**Question 23** (3 marks)

(a) (2 marks)

**Outcomes Assessed:** MA12-7

**Targeted Performance Bands:** 4

Criteria	Mark
• Correct answer	2
• Some progress towards the correct answer	1

*Sample answer:*

$x$	0	0.5	1	1.5	2
$\sqrt{3^x + 1}$	1.41421	1.65289	2	2.48920	3.16227

$$R = \frac{0.5}{2} (1.41421 + 2(1.65289 + 2 + 2.48920) + 3.16227)$$
$$\approx 4.215165\dots$$
$$\approx 4.22 \text{ (to 2 decimal places)}$$

(b) (1 mark)

**Outcomes Assessed:** MA12-7, MA12-10

**Targeted Performance Bands:** 4

Criteria	Mark
• Correct answer	1

*Sample answer:*

Overestimation – trapezia are bigger than the curve. i.e. it is concave up.

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**Question 24** (5 marks)

(a) (1 marks)

**Outcomes Assessed: MA12-8**

**Targeted Performance Bands: 3**

Criteria	Mark
• Correct answer	1

**Sample answer:**

$$r = 0.63$$

(b) (2 marks)

**Outcomes Assessed: MA12-8**

**Targeted Performance Bands: 3**

Criteria	Marks
• Correct values and correct equation	2
• Correct gradient and/or correct $y$ -intercept	1

**Sample answer:**

$$m = 0.51$$

$$c = 40.16$$

$$y = 0.51x + 40.16$$

(c) (1 mark)

**Outcomes Assessed: MA12-8**

**Targeted Performance Bands: 3-4**

Criteria	Mark
• Correct gradient and/or correct $y$ -intercept	1

**Sample answer:**

The correlation coefficient will be lower/weaker when the additional student is included in the data.  
The value is now  $r = 0.009$

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(d) (1 mark)

**Outcomes Assessed: MA12-8**

**Targeted Performance Bands: 4-5**

Criteria	Mark
• Correct gradient and/or correct $y$ -intercept	1

**Sample answer:**

Disagree. The original data indicated that there might be a correlation. However, when the additional student is included, it seems that there is almost no correlation between driving hours and marks in Visual Arts.

**Question 25** (4 marks)

(a) (1 mark)

**Outcomes Assessed: MA12-6**

**Targeted Performance Bands: 4**

Criteria	Mark
• Correct answer	1

**Sample answer:**

$$v = \frac{dx}{dt} = 1 - 2e^{-2t}$$

(b) (3 marks)

**Outcomes Assessed: MA12-6**

**Targeted Performance Bands: 4**

Criteria	Marks
• Correct answer with reasoning	3
• Find the correct time	2
• Some progress towards the correct answer	1

**Sample answer:**

Possible min at

$$v = 0$$
$$0 = 1 - 2e^{-2t}$$
$$e^{-2t} = \frac{1}{2}$$
$$e^{2t} = 2$$
$$2t = \ln 2$$
$$t = \frac{1}{2} \ln 2$$

$a = 4e^{-2t}$ , which is positive for all  $t$ . So any turning point is a global minimum.

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**Question 26** (2 marks)**Outcomes Assessed:** MA12-1**Targeted Performance Bands:** 3-4

Criteria	Marks
• Correct solution	2
• Some progress towards the correct answer	1

**Sample answer:**

$$g(f(x)) = \frac{1}{\sqrt{5x-2}}$$

$$\text{so } 5x - 2 > 0$$

$$5x > 2$$

$$x > \frac{2}{5}$$

**Question 27** (7 marks)

(a) (3 marks)

**Outcomes Assessed:** MA12-6, MA11-7**Targeted Performance Bands:** 4

Criteria	Marks
• Correctly determines both stationary points and their nature	3
• Correctly determines one stationary point and its nature	2
• Correctly determines a stationary point	1

**Sample answer:**

$$\begin{aligned} y' &= 2(x+1)(x-5) + (x+1)^2 \\ &= (x+1)[2x-10+x+1] \\ &= 3(x+1)(x-3) \end{aligned}$$

Stationary point at  $x = -1, 3$ 

$$y' = 3(x^2 - 2x - 3)$$

$$y'' = 3(2x - 2) = 6(x - 1)$$

$$\text{at } x = -1, y'' = -12 < 0 \quad \text{so a local MAXIMUM}$$

$$\text{at } x = 3, y'' = 12 > 0 \quad \text{so a local MINIMUM}$$

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(b) (2 marks)

**Outcomes Assessed: MA12-6, MA11-7**

**Targeted Performance Bands: 4**

Criteria	Marks
• Correct solution	2
• Solves $y'' = 0$	1

**Sample answer:**

Possible point of inflection at  $y'' = 0 = 6(x-1)$ , ie when  $x = 1$ .

$x$	0	1	2
$y''$	-6	*	6
concavity	down	*	up

Concavity changes so there is a point of inflection at (1,-16)

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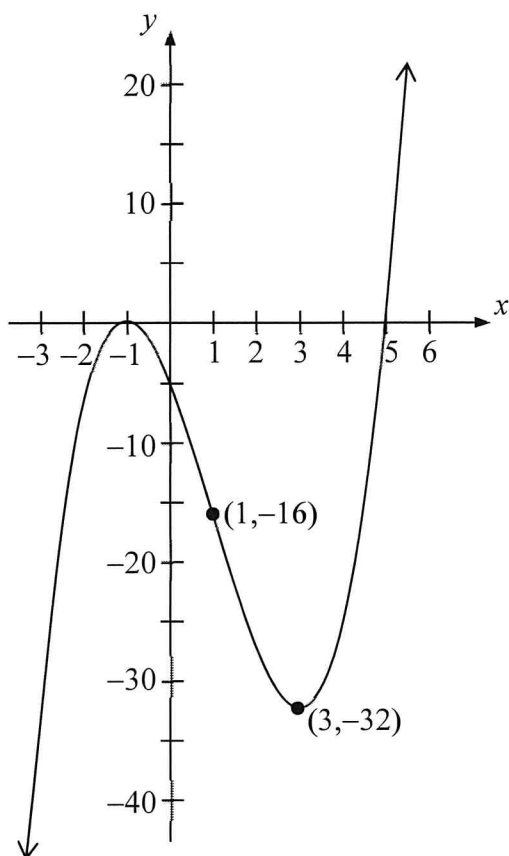
(c) (2 marks)

**Outcomes Assessed:** MA12-6, MA11-7

**Targeted Performance Bands:** 4

Criteria	Marks
• Correct solution	2
• Correct shape, or labels a correct point	1

**Sample answer:**



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**Question 28** (3 marks)**Outcomes Assessed:** MA11-1, MA12-2**Targeted Performance Bands:** 3-4

Criteria	Marks
• Correct solution	3
• TWO correct values of either $h$ , $k$ or $r$ .	2
• ONE correct values of either $h$ , $k$ or $r$ .	1

**Sample answer:**

$$x^2 + 8x + 16 + y^2 - 4y + 4 = 29 + 64 + 4$$

$$(x+4)^2 + (y-2)^2 = 49$$

Translate three units up and five units right

$$(x+4-5)^2 + (y-2-3)^2 = 49$$

$$(x-1)^2 + (y-5)^2 = 7^2$$

**Question 29** (6 marks)

(a) (2 marks)

**Outcomes Assessed:** MA12-8, MA12-7**Targeted Performance Bands:** x

Criteria	Marks
• Correctly shows that $k = 6$	2
• Some progress towards the solution	1

**Sample answer:**

$$\begin{aligned} \frac{1}{36} \int_0^k (kx - x^2) dx &= \frac{1}{36} \left[ \frac{kx^2}{2} - \frac{x^3}{3} \right]_0^k \\ &= \frac{1}{36} \left[ \frac{k^3}{2} - \frac{k^3}{3} \right] = \frac{1}{36} \left[ \frac{3k^3 - 2k^3}{6} \right] = \frac{k^3}{216} \end{aligned}$$

$$\text{so } \frac{k^3}{216} = 1$$

$$k = \sqrt[3]{216}$$

$$k = 6$$

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(b) (1 marks)

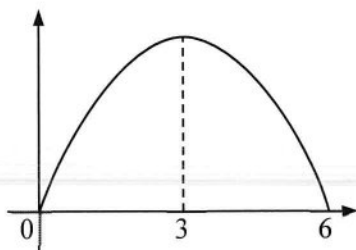
**Outcomes Assessed: MA12-8**

**Targeted Performance Bands: 4-5**

Criteria	Mark
• Correct answer	1

**Sample answer:**

$$E(X) = 3$$



(c) (3 marks)

**Outcomes Assessed: MA12-8**

**Targeted Performance Bands: 4-5**

Criteria	Marks
• Correct answer	3
• Some progress towards the answer	1-2

**Sample answer:**

$$\text{var}(X) = E(X^2) - E(X)^2$$

$$E(X^2) = \frac{1}{36} \int_0^6 x^3(6-x) dx$$

$$= \frac{1}{36} \int_0^6 (6x^3 - x^4) dx$$

$$= \frac{1}{36} \left[ \frac{3x^4}{2} - \frac{x^5}{5} \right]_0^6$$

$$= \frac{1}{36} \left[ 1944 - \frac{7776}{5} \right]$$

$$= 10.8$$

$$\text{var}(X) = 10.8 - 9$$

$$= 1.8$$

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**Question 30** (3 marks)

**Outcomes Assessed:** MA12-8

**Targeted Performance Bands:** 4-5

Criteria	Marks
• Correct answer	3
• Correctly determines z-scores or one of the probabilities	2
• Some progress towards the correct answer.	1

*Sample answer:*

$$\text{Chickens} > 1.6\text{kg}: z = \frac{1.6 - 1.56}{0.025} = 1.6$$

$$\text{Chickens} < 1.5\text{kg}: z = \frac{1.5 - 1.56}{0.025} = -2.4$$

So, the probability of incorrectly classifying a size 15 chicken is:

$$\begin{aligned} 1 - P(-2.4 < z < 1.6) &= P(z < -2.4) + P(z > 1.6) \\ &= 0.0082 + 0.0548 \\ &= 0.063 \end{aligned}$$

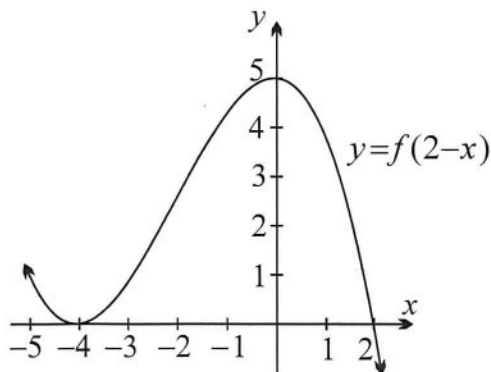
**Question 31** (2 marks)

**Outcomes Assessed:** MA12-1

**Targeted Performance Bands:** 3-4

Criteria	Marks
• Correct diagram with intercepts and maximum turning point labelled	2
• Correct shape, or two correct coordinates.	1

*Sample answer:*



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**Question 32** (6 marks)

(a)(3 marks)

**Outcomes Assessed: MA12-4****Targeted Performance Bands: 4-5**

Criteria	Marks
• Shows the expressions correctly	3
• Finds the sum of the GP	2
• Some progress towards the solution	1

**Sample answer:**

$$A_0 = 650\,000$$

$$A_1 = 650\,000(1.005) - 4200$$

$$A_2 = (650\,000(1.005) - 4200) \times 1.005 - 4200$$

$$= 650\,000(1.005)^2 - 4200(1.005 + 1)$$

$$\vdots$$

$$A_n = 650\,000(1.005)^n - 4200(1.005^{n-1} + 1.005^{n-2} + \dots + 1.005 + 1)$$

$$= 650\,000(1.005)^n - 4200 \left( \frac{1.005^n - 1}{1.005 - 1} \right)$$

$$= 650\,000(1.005)^n - 840\,000(1.005^n - 1)$$

$$= 840\,000 - 190\,000 \times 1.005^n$$

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(b)(3 marks)

**Outcomes Assessed: MA11-6, MA12-4**

**Targeted Performance Bands: 4-5**

Criteria	Marks
• Correct answer	3
• Correct expression for $(1.005)^n$	2
• Determines the new balance or some progress towards the answer	1

**Sample answer:**

Let  $B_n$  be the amount owing after  $n$  **further** months ( $B_0 = 573\,722$ )

$$B_n = 573\,722(1.005)^n - 840\,000(1.005^n - 1)$$

Paid off when  $B_n = 0$

$$0 = 573\,722(1.005)^n - 840\,000(1.005^n - 1)$$

$$(1.005)^n = \frac{840\,000}{840\,000 - 573\,722}$$

$$n = \ln\left(\frac{840\,000}{840\,000 - 573\,722}\right) \div \ln(1.005)$$

$$\approx 230.4 \text{ months}$$

Therefore the loan is paid off after an extra **231 months**.

**Question 33** (6 marks)

(a)(1 mark)

**Outcomes Assessed: MA12-7**

**Targeted Performance Bands: 4-5**

Criteria	Mark
• Correct answer	1

**Sample answer:**

$$\begin{aligned}(x^2 + 3x - 4)(x - 3) &= x^3 + 3x^2 - 4x - 3x^2 - 9x + 12 \\ &= x^3 - 13x + 12\end{aligned}$$

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(b)(5 marks)

**Outcomes Assessed: MA12-7**

**Targeted Performance Bands: 4-5**

Criteria	Marks
• Correct answer	5
• Correct area formula AND integrated correctly, with correct bounds	4
• Correct area formula and attempt to integrate correctly	3
• Some progress towards points of intersection	2
• Makes some progress towards the answer	1

**Sample answer:**

$$\frac{12}{x} = 13 - x^2$$

$$12 = 13x - x^3$$

$$x^3 - 13x + 12 = 0$$

$$(x+1)(x-1)(x-3) = 0$$

$$x = 1, 3 \text{ and } 4$$

$$y = 12, 4 \text{ and } -3$$

$$A = \int_1^3 (13 - x^2) - \left(\frac{12}{x}\right) dx$$

$$= \left[ 13x - \frac{x^3}{3} - 12 \ln x \right]_1^3$$

$$= (39 - 9 - 12 \ln 3) - \left( 13 - \frac{1}{3} - 0 \right)$$

$$= 17\frac{1}{3} - 12 \ln 3$$

So the points of intersection are (1, 12), (3, 4) and (-4, -3).

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**Question 34** (2 marks)**Outcomes Assessed:** MA11-6**Targeted Performance Bands:** 4

Criteria	Marks
• Correct solution	2
• Some progress towards correct answer	1

**Sample answer:**

$$\frac{\ln x}{\ln 3} + \frac{\ln x}{\ln 3^2} = 12$$

$$\frac{\ln x}{\ln 3} + \frac{\ln x}{2 \ln 3} = 12$$

$$\frac{2 \ln x + \ln x}{2 \ln 3} = 12$$

$$3 \ln x = 24 \ln 3$$

$$\ln x = 8 \ln 3$$

$$x = 3^8$$

**Question 35** (2 marks)**Outcomes Assessed:** MA11-7**Targeted Performance Bands:** 4-6

Criteria	Marks
• Correct answer	2
• Some progress towards correct answer	1

**Sample answer:**Let  $E = 4$  appears at least onceLet  $F =$  the sum of the numbers is 6

$$E = \{(4,1), (4,2), (4,3), (4,4), (4,5), (4,6), (1,4), (2,4), (3,4), (5,4), (6,4)\}$$

$$F = \{(1,5), (2,4), (3,3), (4,2), (5,1)\}$$

$$E \cap F = \{(2,4), (4,2)\}$$

$$P(E) = \frac{11}{36}, P(F) = \frac{5}{36} \quad \text{and} \quad P(E \cap F) = \frac{2}{36}$$

$$P(E|F) = \frac{P(E \cap F)}{P(F)} = \frac{\frac{2}{36}}{\frac{5}{36}} = \frac{2}{5}$$

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**Question 36** (3 marks)**Outcomes Assessed:** MA11-4, MA12-5**Targeted Performance Bands:** 4-6

Criteria	Marks
• Correct solution	3
• Correct expression for $SG$ or $OG$	2
• Some progress towards correct answer	1

**Sample answer:**Let  $LG = h$ .In  $\triangle OGL$ ,  $OG = 3\sqrt{3} \times \cos \alpha$  and  $OG = \sqrt{(3\sqrt{3})^2 - h^2}$  (By Pythagoras' theorem)In  $\triangle SGL$ ,  $SG = \sqrt{y^2 - h^2}$  (By Pythagoras' theorem)In  $\triangle OSG$ , by the cosine rule:

$$SG^2 = OG^2 + OS^2 - 2 \times OG \times OS \times \cos 30^\circ$$

$$y^2 - h^2 = (3\sqrt{3})^2 - h^2 + 10^2 - 2 \times 3\sqrt{3} \cos \alpha \times 10 \times \frac{\sqrt{3}}{2}$$

$$y^2 = 27 + 100 - \frac{90}{2}$$

$$y = \sqrt{82}$$

$$\approx 9.055385\dots$$

$$\approx 9 \text{ m (to the nearest metre)}$$

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**Question 37 (4 marks)****Outcomes Assessed: MA11-4, MA12-5****Targeted Performance Bands: 4-6**

Criteria	Marks
• Correct solution	4
• Correctly determines the first and second derivative	3
• Makes some progress towards an expression for the cost	2
• Some progress towards correct answer	1

**Sample answer:**

$$S = \frac{D}{T}, \text{ so } T = \frac{1200}{v} \text{ hours}$$

$$\text{Cost of wages} = 55 \times 2 \times \frac{1200}{v} = \frac{132\,000}{v}$$

$$\text{Cost of fuel} = \left(10 + \frac{v^2}{100}\right) \times \frac{1200}{v} \times 1.50$$

$$= \left(10 + \frac{v^2}{100}\right) \times \frac{1800}{v}$$

$$= \frac{18\,000}{v} + 18v$$

$$\text{Total cost} = \frac{150\,000}{v} + 18v$$

$$\frac{dC}{dv} = \frac{-150\,000}{v^2} + 18$$

$$\text{stationary at } \frac{dC}{dv} = 0$$

$$18v^2 = 150\,000$$

$$v^2 = \frac{150\,000}{18}$$

$$v \approx 91.287\dots$$

$$v \approx 91 \text{ km/h}$$

$$\text{so MINIMUM cost} = \frac{150\,000}{91} + 18 \times 91$$

$$\approx 3286.3516\dots$$

$$\approx \$3286 \text{ (to the nearest dollar)}$$

$$\frac{d^2C}{dv^2} = \frac{300\,000}{v^3}$$

$$\text{at } v = 91, \frac{d^2C}{dv^2} = \frac{300\,000}{91^3} > 0 \text{ so a MINIMUM when } v = 91 \text{ km/h}$$

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