



Mathematics: applications and interpretation Higher level Paper 1

10 November 2025

Zone A afternoon | Zone B afternoon | Zone C afternoon

Candidate session number

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2 hours

Instructions to candidates

- Write your session number in the boxes above.
- Do not open this examination paper until instructed to do so.
- A graphic display calculator is required for this paper.
- Answer all questions.
- Answers must be written within the answer boxes provided.
- Unless otherwise stated in the question, all numerical answers should be given exactly or correct to three significant figures.
- A clean copy of the **mathematics: applications and interpretation HL formula booklet** is required for this paper.
- The maximum mark for this examination paper is **[110 marks]**.

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Answers must be written within the answer boxes provided. Full marks are not necessarily awarded for a correct answer with no working. Answers must be supported by working and/or explanations. Solutions found from a graphic display calculator should be supported by suitable working. For example, if graphs are used to find a solution, you should sketch these as part of your answer. Where an answer is incorrect, some marks may be given for a correct method, provided this is shown by written working. You are therefore advised to show all working.

1. [Maximum mark: 7]

Under controlled driving conditions, Jacob investigated the fuel efficiency of his car when using premium fuel compared to standard fuel.

Jacob recorded the distance travelled per litre (km L^{-1}) using standard fuel for six days and then using premium fuel for seven days. This information is shown in the following tables.

	Standard fuel						
Distance travelled per litre (km L^{-1})	8.1	8.2	7.9	8.2	7.9	8.0	

	Premium fuel						
Distance travelled per litre (km L^{-1})	8.3	8.4	8.1	8.3	8.2	8.0	8.2

At the 5% significance level, Jacob performs a t -test to determine whether there is sufficient evidence that his car travels further using premium fuel compared to standard fuel.

- (a) State one mathematical assumption made for this test to be valid. [1]
- (b) Write down the
 - (i) null hypothesis.
 - (ii) alternative hypothesis. [2]
- (c) (i) Find the p -value.
- (ii) State your conclusion to the test in context. Justify your answer. [4]

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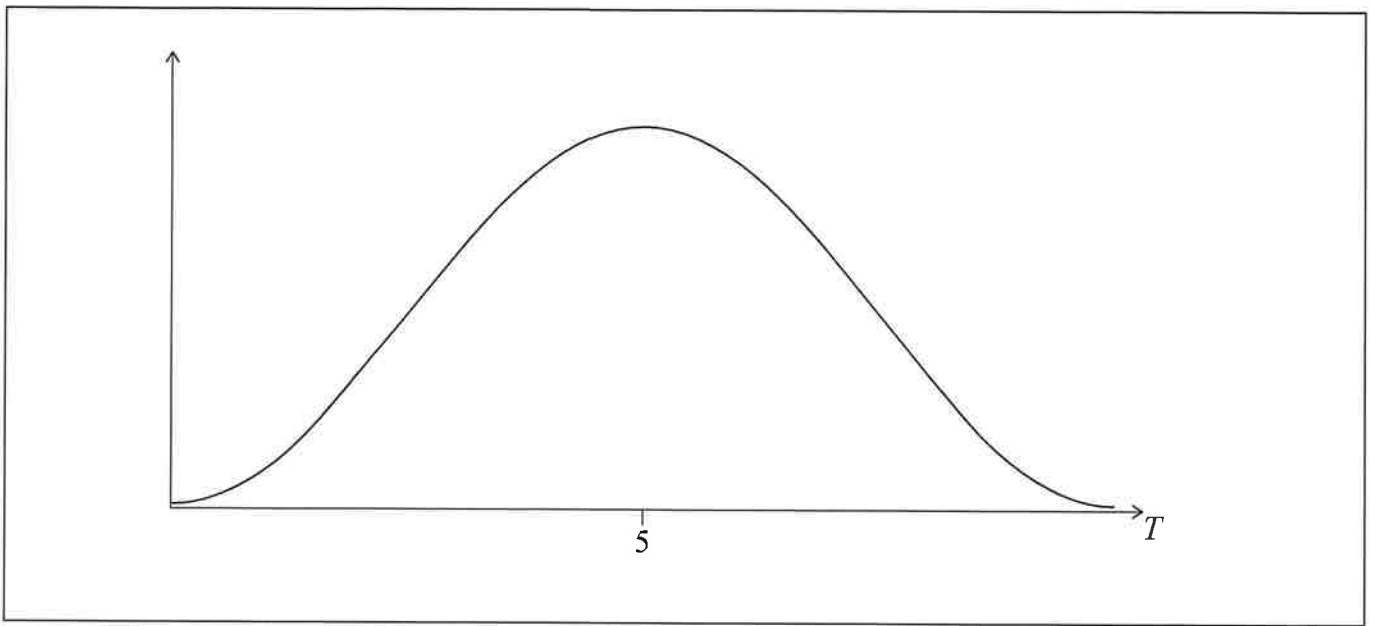
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3. [Maximum mark: 5]

In a reaction test, the time, T seconds, taken to complete the test can be modelled by a normal distribution with a mean of 5 seconds and a standard deviation of 1 second.

- (a) Find the probability that a randomly selected person completes the reaction test in less than 4 seconds. [2]

The graph of the distribution of T is shown in the following diagram.



The slowest 15% of participants will be given training to reduce their time to complete the test.

- (b) (i) Shade the region on the given diagram that corresponds to these participants.
- (ii) Find the least time taken to complete the test by a person who will be given training. [3]

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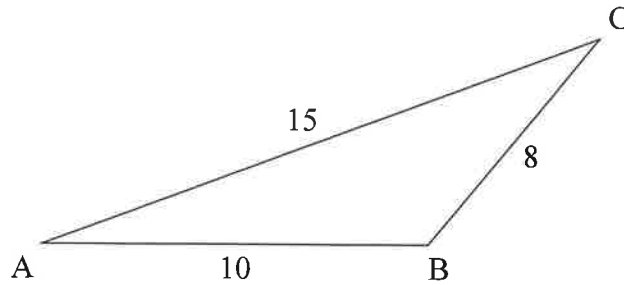
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4. [Maximum mark: 8]

Triangle ABC has sides of length $AB = 10$ cm, $BC = 8$ cm and $AC = 15$ cm, as shown in the diagram.

diagram not to scale

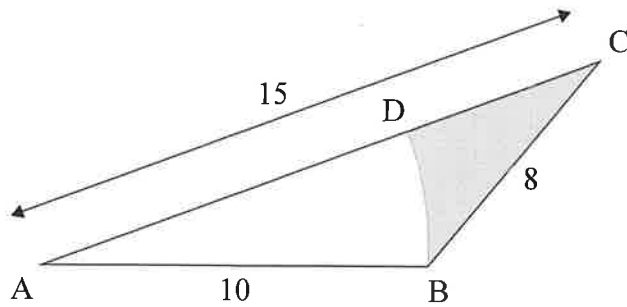


(a) Find the size of \hat{BAC} .

[3]

The circular arc BD, with centre A, is drawn inside the triangle, such that D lies on AC.

diagram not to scale



(b) Find the area of the shaded region.

[5]

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6. [Maximum mark: 7]

At 12:05 pm, Navam starts draining water from a small reservoir into an empty pond.

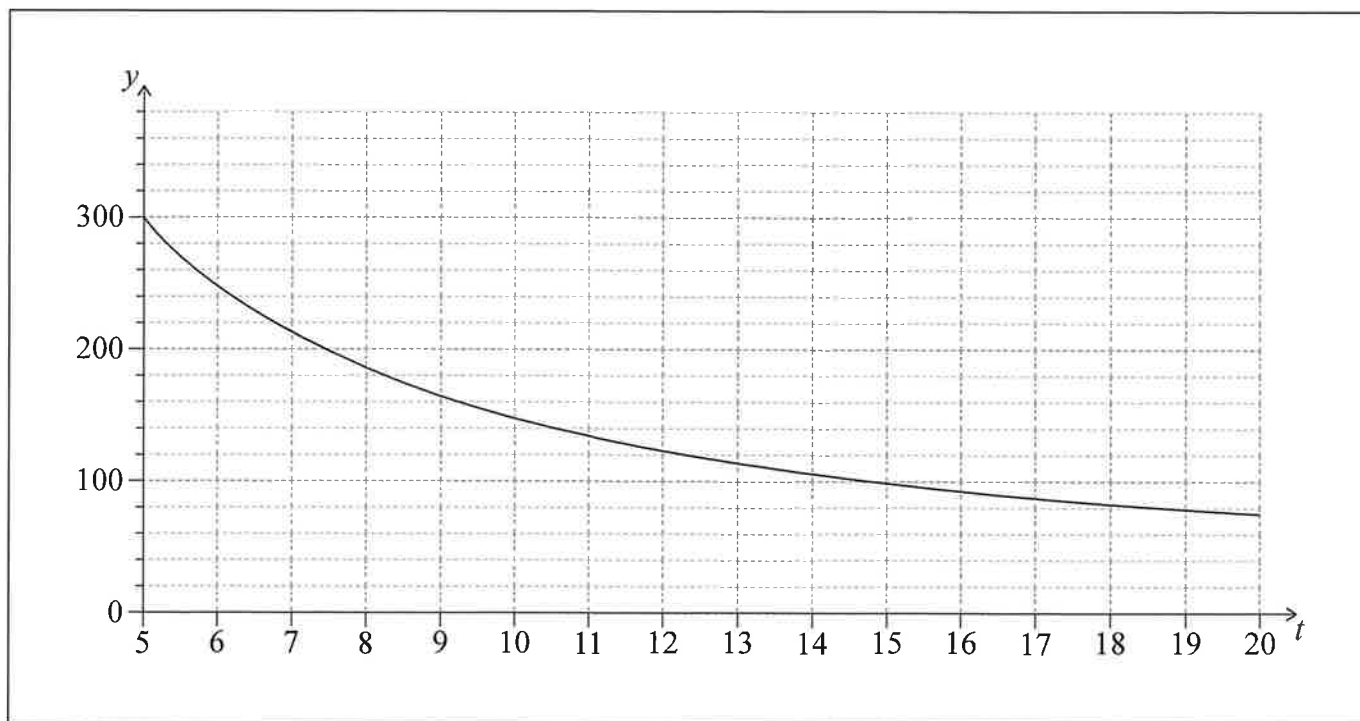
He controls the rate the water is drained so that the volume of water **remaining** in the reservoir, $V\text{m}^3$, varies inversely with the time, t , where t is the number of minutes after 12:00 pm.

At 12:05 pm, the volume of water in the reservoir is 300m^3 .

(a) Show that $V = \frac{1500}{t}$. [2]

(b) Find the value of t when the volume of water remaining in the reservoir equals the volume of water in the pond. [2]

The following diagram shows part of the graph of $y = V(t)$.



(c) On the same diagram, sketch the graph of $y = P(t)$, where P is the volume of water in the pond. [2]

(d) Write down an expression for $P(t)$. [1]

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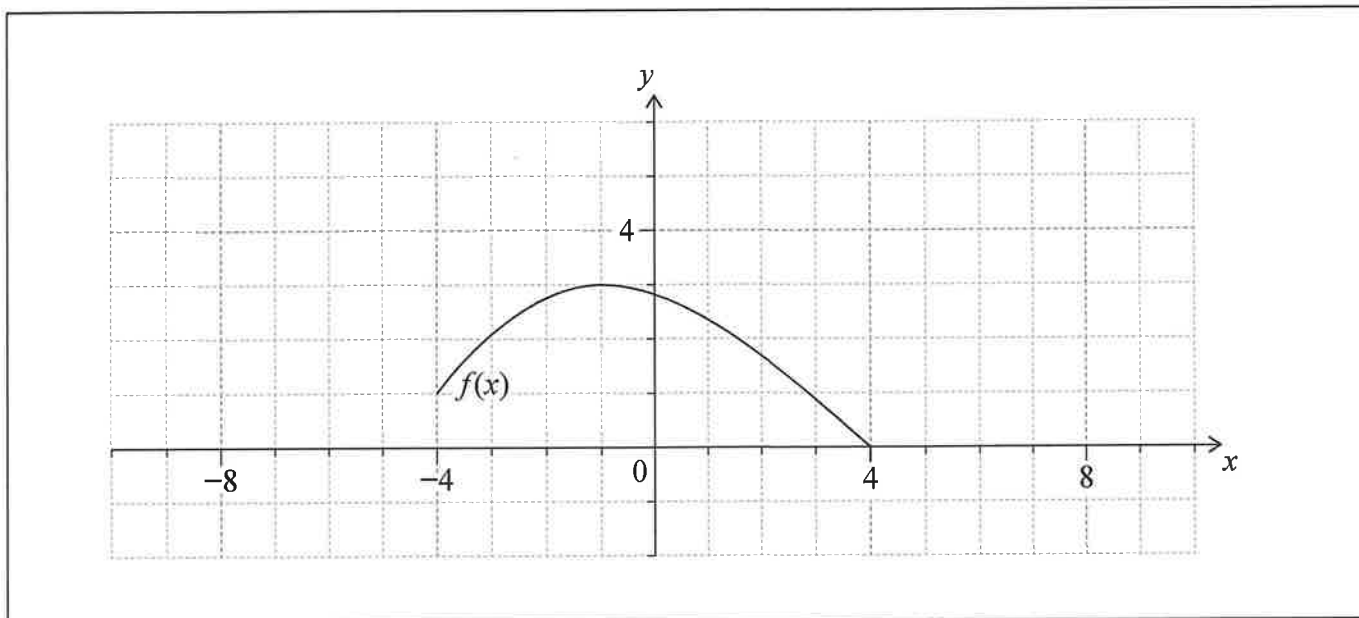


8. [Maximum mark: 4]

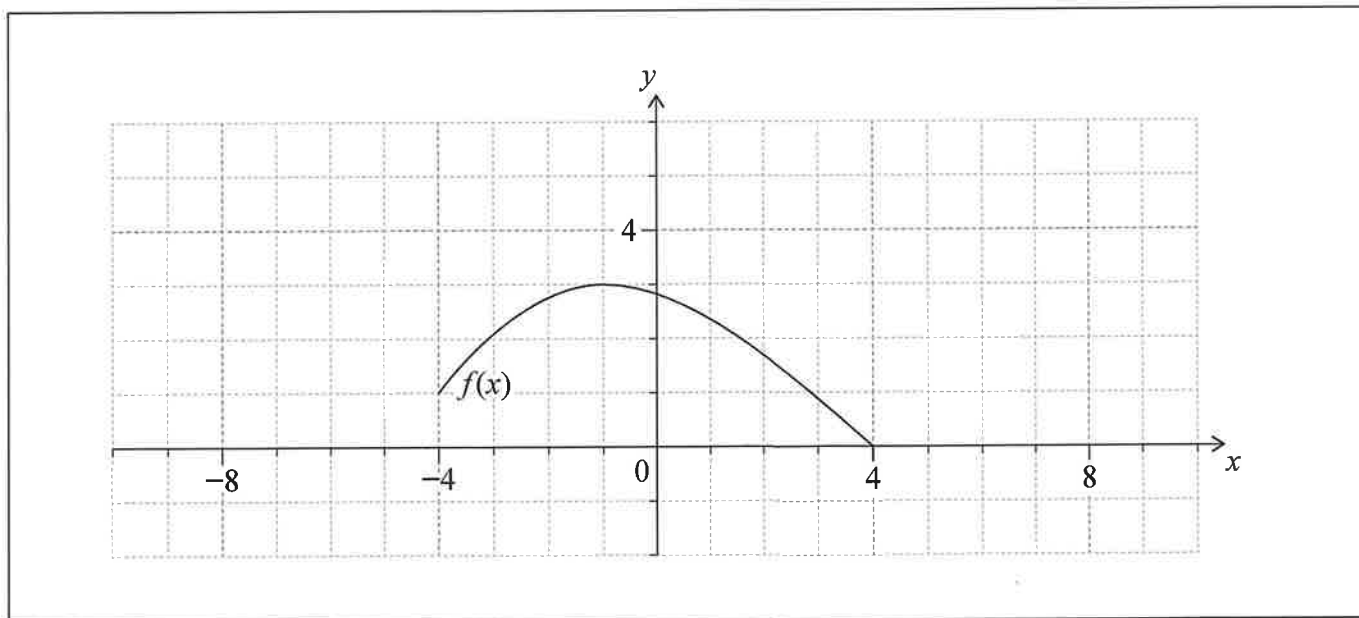
The function f has domain $-4 \leq x \leq 4$.

The graph of $y = f(x)$ has endpoints $(-4, 1)$ and $(4, 0)$, and a local maximum at $(-1, 3)$. This is shown in each of the following diagrams.

- (a) On the axes provided, sketch the graph of $y = 2f(x) - 1$. [2]



- (b) On the axes provided, sketch the graph of $y = f(2x - 2)$. [2]



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Turn over

9. [Maximum mark: 6]

A help desk receives an average of 34 calls each hour. The number of calls received can be modelled by a Poisson distribution.

The help desk staff can answer a maximum of 22 calls in any 30-minute period.

- (a) Find the probability that some calls are not answered in a 30-minute period. [3]

A supervisor is deciding whether to employ extra staff for the help desk. They monitor the phone calls for a random 30-minute period each day for 10 days.

- (b) Find the probability that all the monitored calls are answered on at least 9 of these 10 days. [3]

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10. [Maximum mark: 5]

The function f is defined by $f(x) = \frac{6}{2x^2 + 5x + 4}$.

- (a) Find $f'(x)$. [2]
- (b) Hence or otherwise, find the x -coordinates of the points of inflexion of f . [3]

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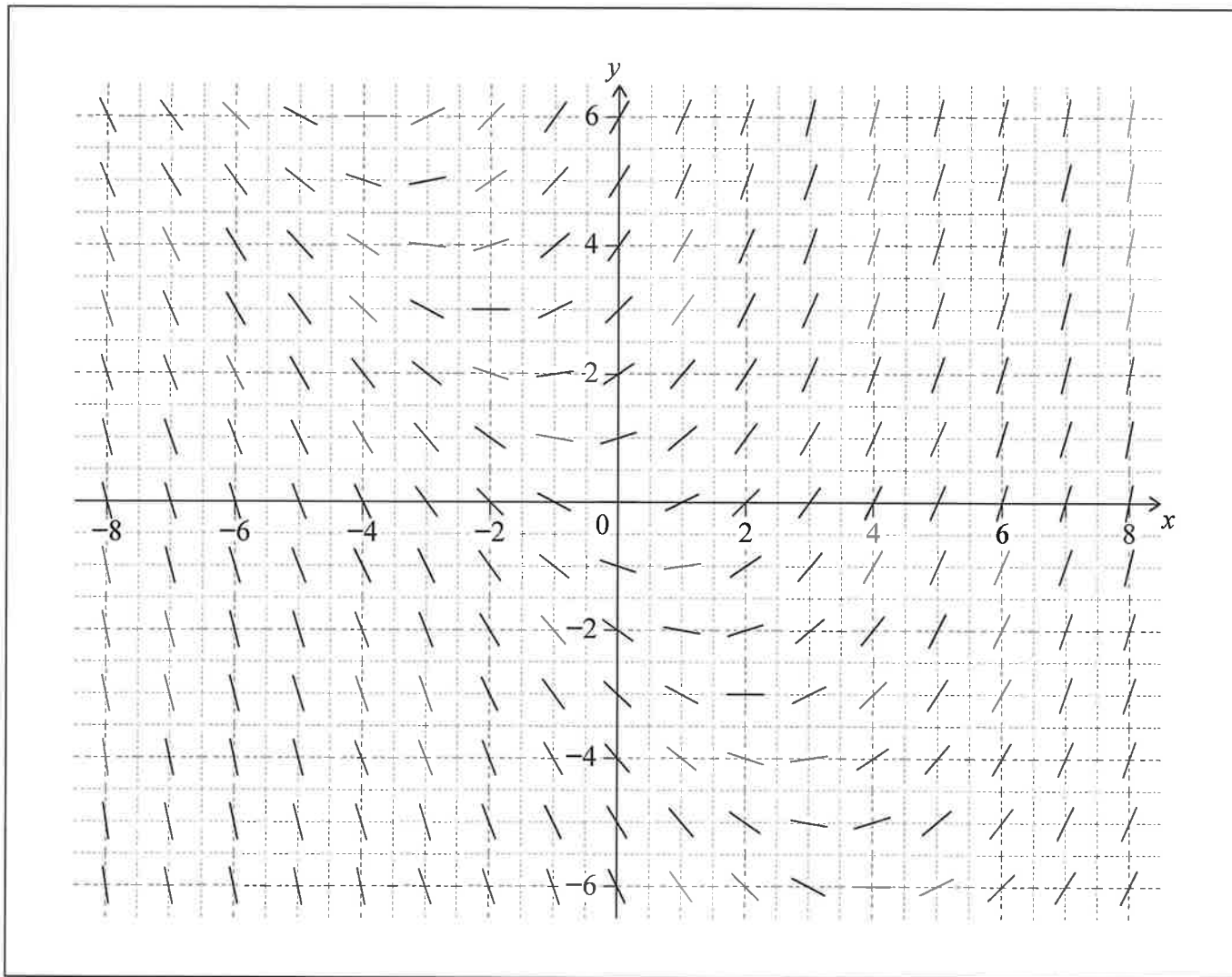
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Turn over

11. [Maximum mark: 4]

Consider the differential equation $\frac{dy}{dx} = \frac{x}{2} + \frac{y}{3}$.

The slope field for the differential equation is shown in the diagram.



All the solutions to $\frac{dy}{dx} = 0$ lie on a straight line.

(a) (i) Find the equation of this line.

(ii) Sketch this line on the slope field.

[2]

One solution to $\frac{dy}{dx} = \frac{x}{2} + \frac{y}{3}$ passes through the point (6, 4).

(b) Sketch this solution on the slope field.

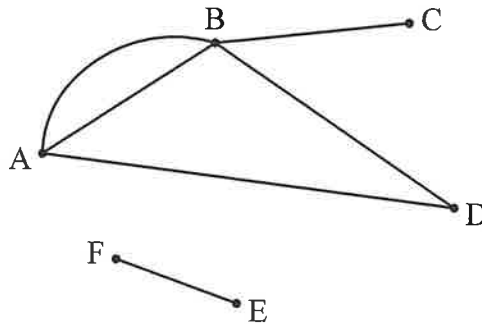
[2]

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12. [Maximum mark: 8]

The graph G has six vertices and is shown in the diagram.



(a) State, giving a reason, whether G is

(i) simple;

(ii) connected.

[2]

(b) Complete the adjacency matrix for G .

[2]

	A	B	C	D	E	F
A	0	<input type="checkbox"/>	0	1	0	0
B	<input type="checkbox"/>	0	<input type="checkbox"/>	1	0	0
C	0	<input type="checkbox"/>	0	0	0	0
D	1	1	0	0	0	0
E	0	0	0	0	0	1
F	0	0	0	0	1	0

(c) Hence, determine the number of walks from A to B with fewer than four edges.

[4]

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14. [Maximum mark: 6]

Consider the system of coupled differential equations given by

$$\frac{dx}{dt} = 2.2x - 2.6y$$

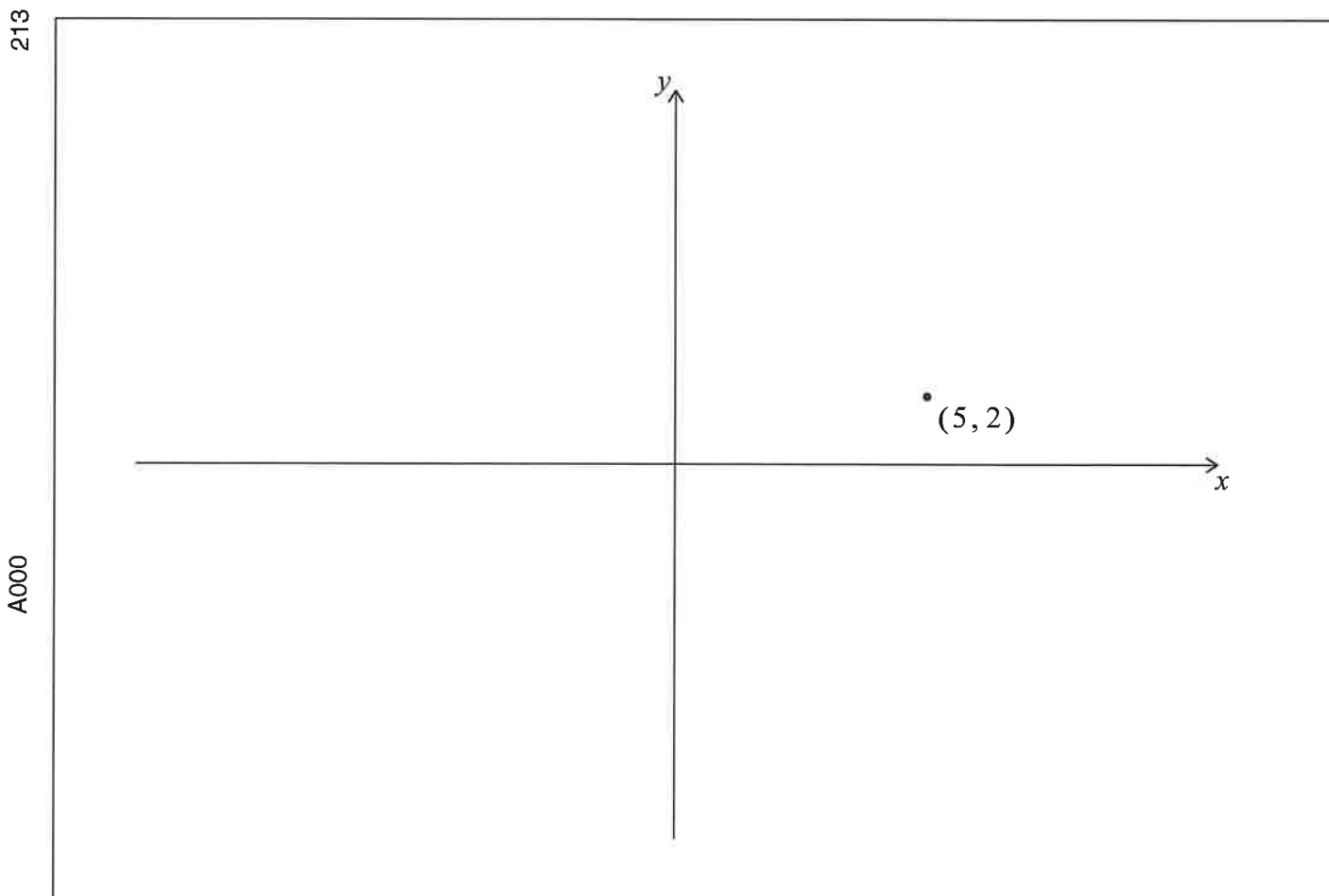
$$\frac{dy}{dt} = 3.4x - 2.2y.$$

When $t = 0$, $x = 5$ and $y = 2$.

(a) Find the value of $\frac{dy}{dx}$ at $t = 0$. [3]

The eigenvalues for this system are $\pm 2i$.

(b) On the following phase portrait, sketch the trajectory that passes through the point $(5, 2)$. Clearly indicate the direction of this trajectory. [3]



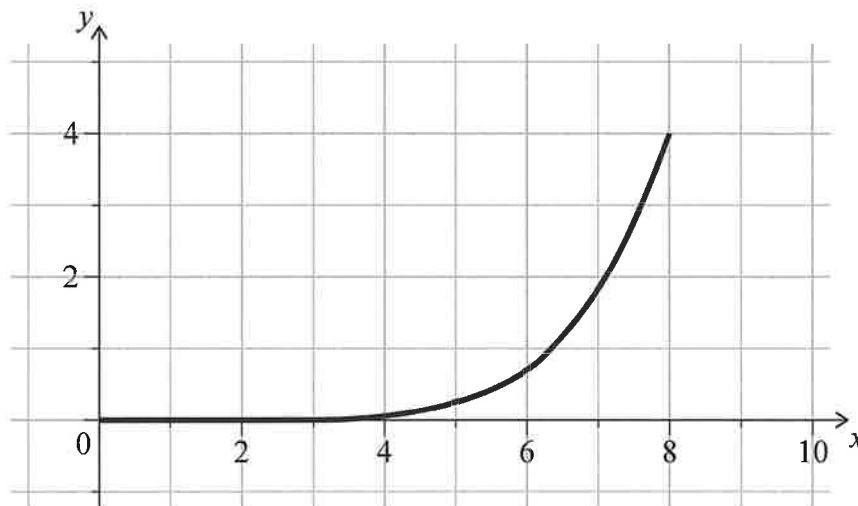
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15. [Maximum mark: 8]

Jun Ho models the cross-section of a bowl, in order to calculate its volume.

His model for part of the cross-section is $y = \frac{x^6}{65536}$, where $0 \leq x \leq 8$, as shown in the following graph. One unit represents one centimetre.



Let R be the region enclosed by this graph, the line $y = 4$ and the line $x = 0$.

He obtains the volume of the bowl by rotating R , 2π radians about the y -axis.

(a) Find the volume of the bowl. [5]

Jun Ho pours 250 cm^3 of water into the bowl.

(b) Find the depth of the water in the bowl. [3]

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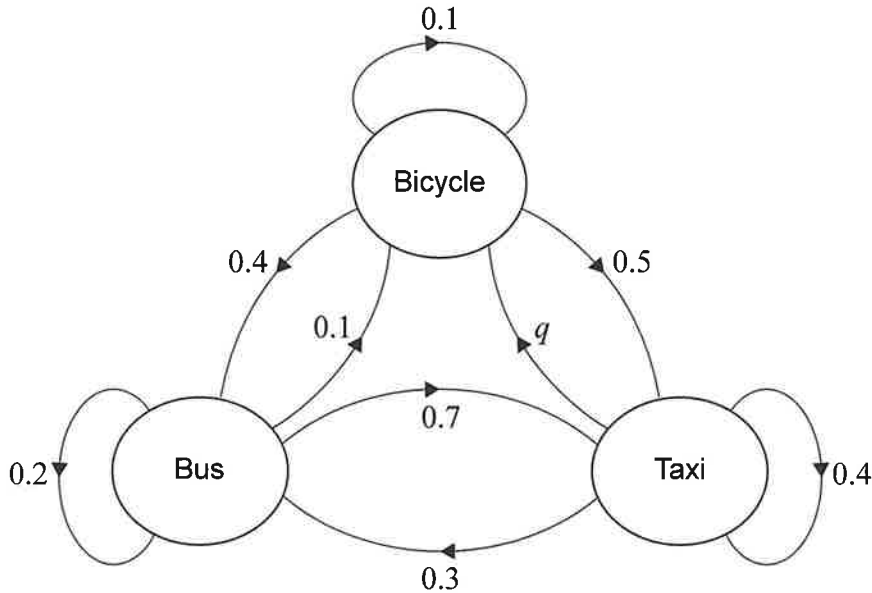
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16. [Maximum mark: 8]

Each day Anirudh goes to work by bus (*B*) or bicycle (*C*) or taxi (*T*). The probability of him using a mode of transport depends on which mode of transport he used the previous day, and is shown in the following transition diagram.



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- (a) Write down the value of q . [1]

On day 1, Anirudh goes to work by bus.

- (b) Write down the probability that he goes to work by taxi on day 2. [1]
- (c) Find the probability that the mode of transport Anirudh uses on day 3 is the same as the one he uses on day 2. [3]
- (d) Complete the following transition matrix. [1]

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$\begin{pmatrix} 0.2 & 0.4 & 0.3 \\ 0.1 & 0.1 & \square \\ 0.7 & \square & \square \end{pmatrix}$

- (e) Hence, find the long-term proportion of days that he goes to work by bicycle. [2]

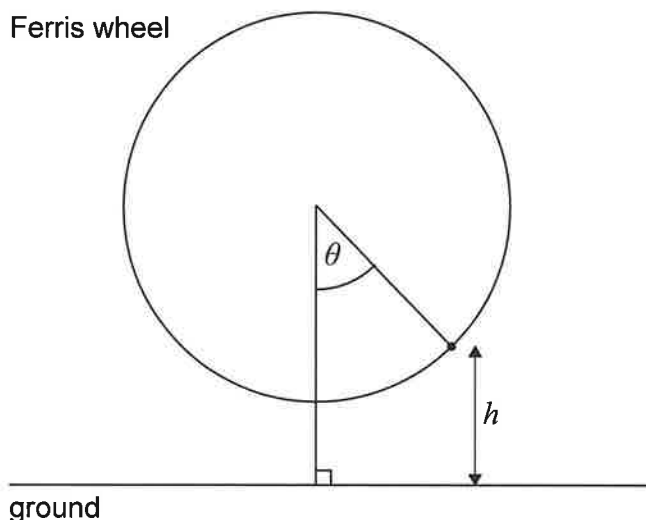
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17. [Maximum mark: 8]

Younsue rides on a Ferris wheel. As the wheel rotates, her height above the ground, h metres, can be modelled in terms of the angle, θ radians, that the wheel has rotated, using $h = 16 - 15 \cos \theta$. The value of θ is measured from Younsue's starting position at the bottom of the wheel.

diagram not to scale



- (a) Write down the radius of the Ferris wheel.

[1]

The speed at which the wheel rotates changes over time and is given by

$$\frac{d\theta}{dt} = \frac{\pi^2}{24} \left| \sin\left(\frac{\pi}{2}t\right) \right|$$

where t is the time, in minutes, after Younsue starts her ride.

- (b) (i) Find the angle rotated by the Ferris wheel between $t = 0$ and $t = 4.5$.

- (ii) Find the value of $\frac{dh}{dt}$, when $t = 4.5$.

[7]

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