Diploma Programme
Programme du diplôme
Programa del Diploma

Mathematics: applications and interpretation
Higher level
Paper 1

14 May 2026

Zone A afternoon | **Zone B** afternoon | **Zone C** afternoon

Session number

2 hours

Instructions to students

- 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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29 pages

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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: 6]

A mathematics teacher surveys her 200 students. She asks each student if they are left-handed or right-handed and whether they prefer geometry or algebra. The results are shown in the following table.

	Geometry	**Algebra**
Left-handed	16	6
Right-handed	67	111

A student is randomly selected from this group.

(a) Write down the probability that the student is left-handed and prefers geometry. [1]

(b) Find the probability that the student prefers geometry, given that they are left-handed. [2]

The teacher randomly selects two students from the 200 students to be the class leaders.

(c) Find the probability that at least one of the selected students is left-handed. [3]

(This question continues on the following page)

(Question 1 continued)

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2. [Maximum mark: 6]

A group of friends want to rent a beach house for their vacation. The cost per person, c, varies inversely with the total number of people, n, who will be sharing the cost.

If four people share the cost equally, then the cost per person is $\$187.50$.

(a) Determine an equation for c in terms of n. [2]

The group wants the cost per person to be less than $\$100.00$.

(b) (i) Find the minimum number of people needed to share the cost to meet this requirement.

(ii) Find the cost per person for this number of people. [4]

(This question continues on the following page)

(Question 2 continued)

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616

A001

3. [Maximum mark: 7]

Carboys are containers used to hold chemical waste in laboratories. Shaud wants to buy some carboys for his laboratory. He finds one on a store's website, shown in the following diagram.

diagram not to scale

The store states that the carboy has height $299\,\text{mm}$, length $218\,\text{mm}$ and width $318\,\text{mm}$. Shaud models the shape of this carboy as a cuboid and uses these dimensions to find the volume of one container.

(a) Calculate the volume that Shaud finds, to the nearest cubic millimetre. [2]

The store states that the actual volume of the container is 20 litres.

(b) Given that $1\,\text{mm}^3$ is equal to $0.001\,\text{ml}$, calculate the percentage error in Shaud's calculation. [4]

(c) State one reason why Shaud's calculation might overestimate the volume. [1]

(This question continues on the following page)

(Question 3 continued)

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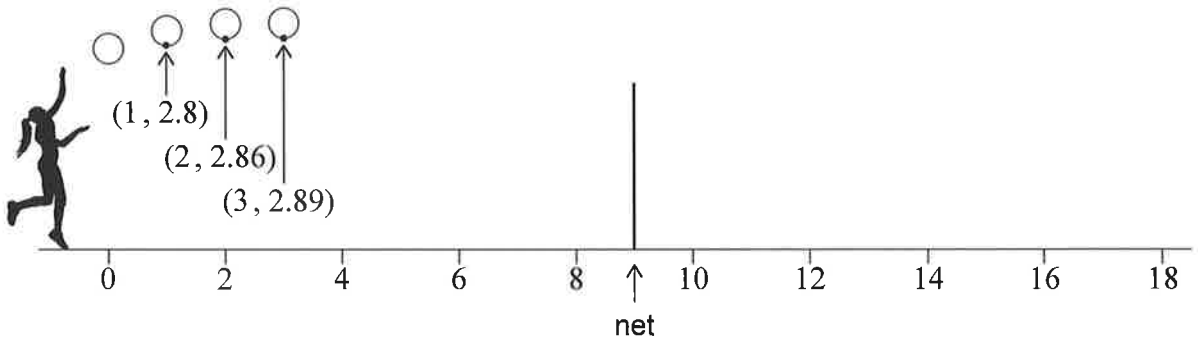
A001

4. [Maximum mark: 10]

Emily practices serving a volleyball directly towards the net. A high-speed camera is positioned on the side of the volleyball court. After Emily hits the ball, the camera records that the lowest point of the ball passes through the points $(1, 2.8)$, $(2, 2.86)$ and $(3, 2.89)$.

The x-coordinate represents the ball's horizontal distance, in metres (m), from the point at which Emily hits the ball. The y-coordinate represents the height, h metres, of the lowest point of the ball above the ground.

diagram not to scale



The height, h, can be modelled with an equation in the form $h(x) = ax^2 + bx + c$.

(a) Use the coordinates of the points to write down three equations in terms of a, b and c. [2]

(b) Find the equation of $h(x)$. [2]

(c) Comment on the meaning of the value of c in context. [1]

For the serve to be in play, the ball must pass over the net, which is $9\,\text{m}$ horizontally from where Emily hits the ball and $2.24\,\text{m}$ in height. The ball must also hit the court on the other side before the end line, which is $18\,\text{m}$ horizontally from where Emily hits the ball.

(d) Determine whether Emily's serve will be in play. [5]

(This question continues on the following page)

(Question 4 continued)

616

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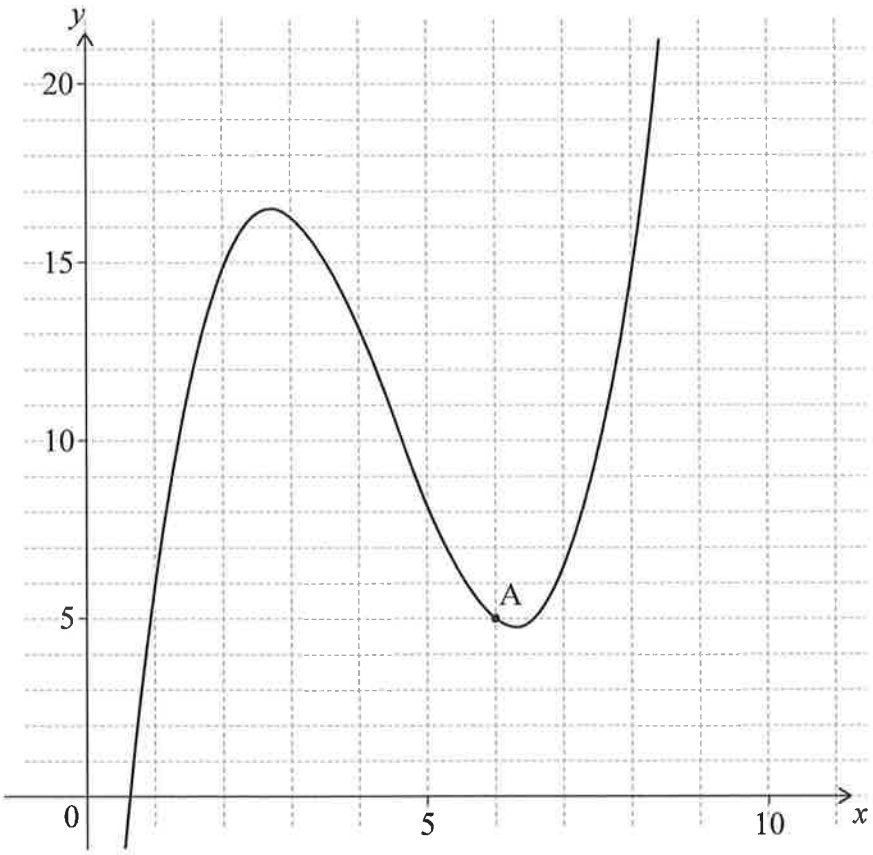
5. [Maximum mark: 9]

The graph of $f(x)=\frac{1}{2}x^3-\frac{27}{4}x^2+\frac{51}{2}x-13$ is shown on the following axes.

Point A is on the curve and has coordinates $(6, 5)$.



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(a) Find the gradient of the normal to $f(x)$ at point A. [2]

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(b) Write down the equation of the normal to $f(x)$ at point A. [1]

(c) Draw the normal line on the axes given above. [2]

(d) Find the coordinates of the point(s), other than point A, where the normal line intersects the graph of $f(x)$. [2]

The function $g(x)$ is defined as $g(x)=-f(3x)+4$.

(e) Write down the coordinates of the point on the curve of $g(x)$ that corresponds to point A on the curve of $f(x)$. [2]

(This question continues on the following page)

(Question 5 continued)

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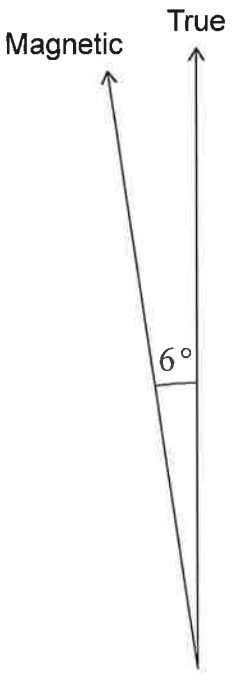
6. [Maximum mark: 8]

Bearings are measured from true north, which is the direction towards the geographic North Pole. A compass points to magnetic north. There is a small difference between true north and magnetic north.

Scotty is hiking in a location where magnetic north is 6 degrees from true north, as shown in the following diagram.

diagram not to scale



He is at a point, A, and wants to hike to a second point, B, which is 5 kilometres (km) away in the direction of true north. Scotty uses his compass as a guide and travels in the direction of magnetic north.

(a) Write down the bearing on which Scotty is travelling towards magnetic north. [1]

Scotty hikes a straight path on this bearing for $5\,\mathrm{km}$ and stops at a point, C, to check his position.

(b) Find angle $\mathrm{A\hat{C}B}$. [2]

(c) Calculate the distance from point C to point B. [3]

Scotty hikes a straight path from point C to point B. In total, he hikes for 2 hours and 15 minutes.

(d) Calculate Scotty's average speed for the total hike, in $\mathrm{km\,h^{-1}}$. [2]

(This question continues on the following page)

(Question 6 continued)

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7. [Maximum mark: 7]

Krauss works at a coffee shop and finds that this month, 65% of customers ordered regular coffee and 35% of customers ordered decaf coffee. This information can be displayed as the following column vector.

$$C = \begin{pmatrix} 0.65 \\ 0.35 \end{pmatrix}$$

Krauss believes that customers change their choices each month according to the following transition matrix.

$$T = \begin{pmatrix} 0.8 & 0.3 \\ 0.2 & 0.7 \end{pmatrix}$$

(a) Use Krauss' transition matrix to predict the proportion of customers who ordered regular coffee and decaf coffee **in the previous month**. [3]

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(b) Show that the only steady state vector is $\begin{pmatrix} 0.6 \\ 0.4 \end{pmatrix}$. [4]

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(Question 7 continued)

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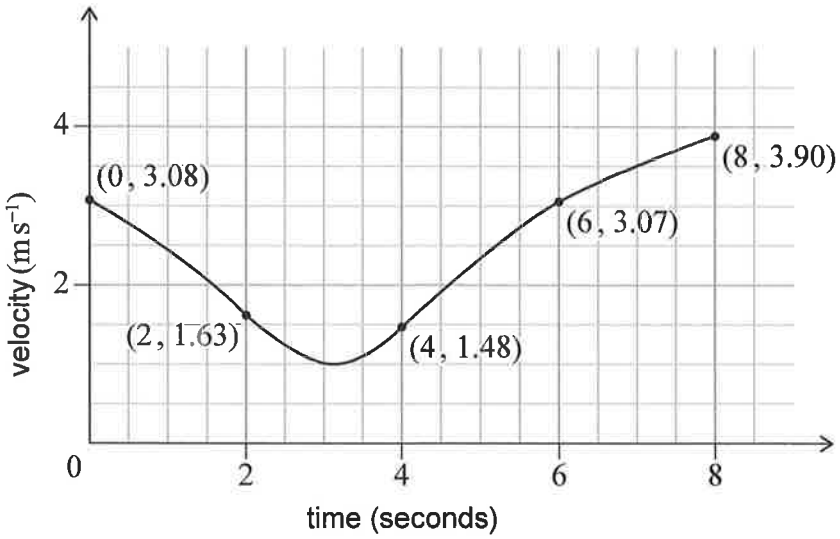
8. [Maximum mark: 6]

The following graph shows the velocity of an object, in metres per second, over an 8-second period. The function $x(t)$ gives the displacement of the object from its initial position at time t.



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(a) Use the trapezoidal rule with four equal intervals to estimate $x(8)$, the displacement of the object at the end of the 8-second period. [3]

The velocity of the object can be modelled by the equation

$$v(t)=\sqrt{\frac{1}{2}(t-3)^2+2\cos(t)+3}\text{, for } 0\le t\le 8.$$

(b) Find $x(8)$ according to this model. [3]

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(Question 8 continued)

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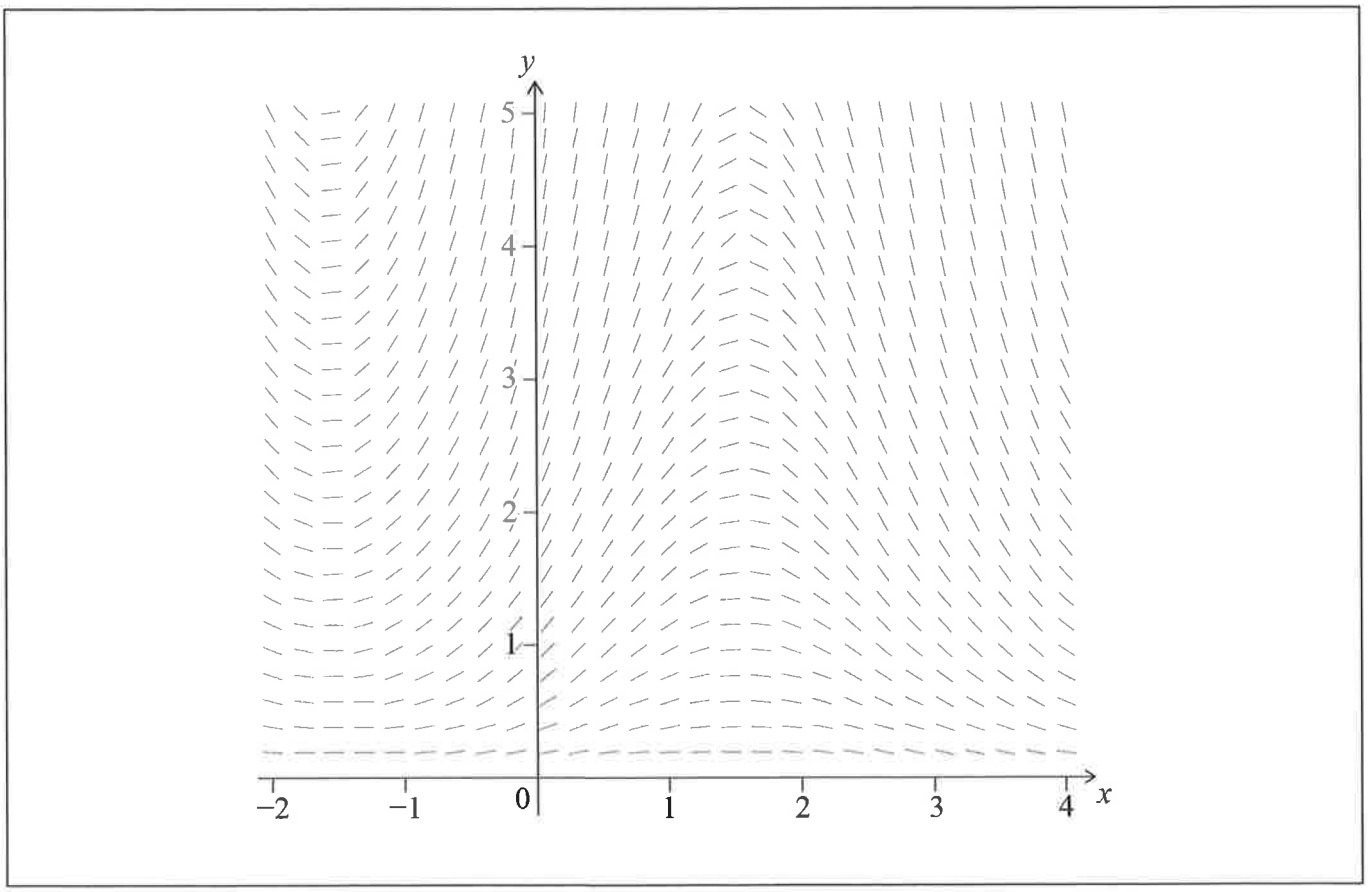
9. [Maximum mark: 7]

The following figure shows the slope field for the differential equation $\frac{dy}{dx} = y\cos x$.



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(a) Sketch the solution curve that passes through the point $(0, 1.5)$. [2]

(b) By solving the differential equation, find the equation of the solution that passes through the point $(0, 1.5)$. [5]

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(This question continues on the following page)

(Question 9 continued)

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10. [Maximum mark: 5]

The effectiveness, E, of a new drug compared to its concentration within a person is being studied by a company. The concentration, C mg/L, of the new drug within a person can be modelled by the function

$$C(t)=\frac{150}{1+0.35t^2},\ t\geq 0,$$

where t is the number of hours after the drug is given to the person.

(a) Write down the initial concentration of the drug within the person. [1]

The company finds that E can be modelled in terms of C by the function

$$E(C)=\ln(C+1.5)-\frac{1}{C+1},\ C\geq 0.$$

(b) Find the value of t such that $E=2$. [4]

(This question continues on the following page)

(Question 10 continued)

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11. [Maximum mark: 6]

Sutton is investigating the growth of a certain bacterial population and collects the following data.

Time t (hours)	0.2	0.8	1.7	2.5	3.4	4.2	5.1	6.3	7.5	8.0
Population size $N(t)$ (thousands)	0.5	0.6	0.8	1.1	1.5	2.0	2.7	3.6	4.8	6.0

(a) Find the least squares regression line for the data in the form $\ln(N(t)) = at + b$. [3]

Sutton believes that the population growth can be modelled by an exponential equation in the form $N(t) = Ce^{dt}$.

(b) Use your answer to part (a) to estimate the value of C and the value of d. [3]

616

A001

12. [Maximum mark: 8]

The function $g(x)$ is in the form $a\sin x^n + b$ for $x \geq 0$.

The derivative of $g(x)$ is $g'(x) = 6x^2 \cos x^3$, and $g(x)$ has y-intercept $(0, 1)$.

(a) By finding a, b and n, write down the equation of $g(x)$. [3]

A solid is created by rotating the smallest region bounded by $x = 0$, $y = 3$ and $g(x)$ about the x-axis by 2π radians.

(b) (i) Write down the expression that gives the volume of the resulting solid.

(ii) Find the volume of the resulting solid. [5]

616

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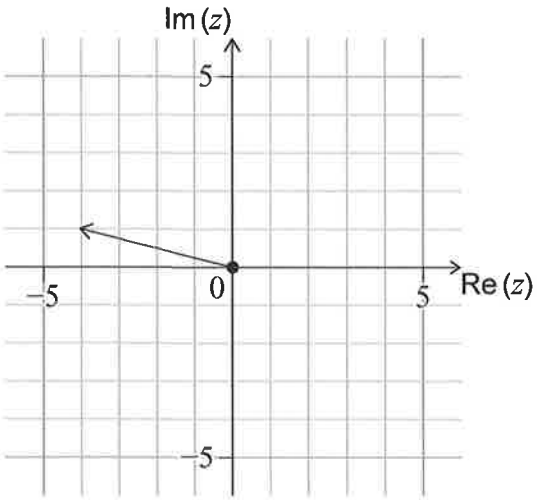
13. [Maximum mark: 7]

The complex number $z = -4 + \left(\sqrt{6} - \sqrt{2}\right)\mathrm{i}$ can be written in the form $z = r\,\mathrm{cis}\theta$, where $0 \leq \theta \leq 2\pi$ and $r \in \mathbb{R}^+$.

(a) Find the value of r. Give your answer in the form $\sqrt{a + b\sqrt{3}}$. [3]

(b) Find the value of θ. [2]

The following Argand diagram shows the vector representation of z.



Consider the vector $w = z^3$.

(c) Describe how the vector representation of z is transformed into the vector representation of w. [2]

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(Question 13 continued)

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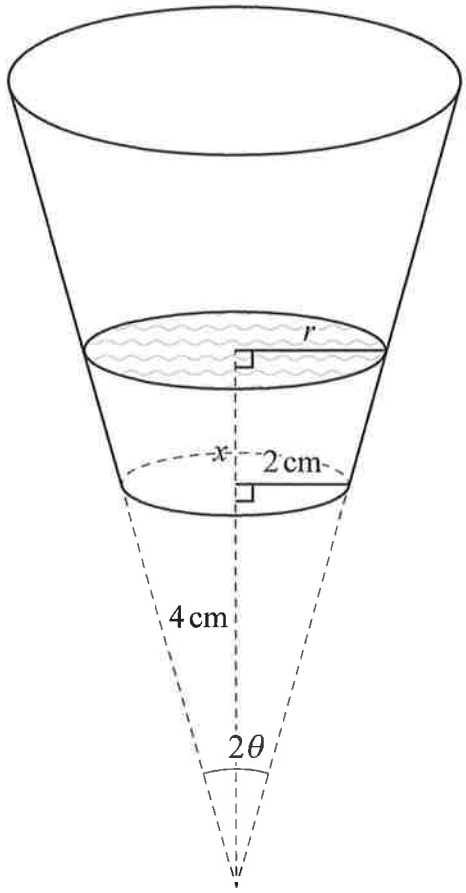
14. [Maximum mark: 10]

Silayan is conducting an experiment in science class that involves pouring water into a cup. The cup is a truncated cone made by removing a cone with a radius of $2\,\text{cm}$ and height of $4\,\text{cm}$ from an existing cone with angle 2θ. A circular base with radius $2\,\text{cm}$ is added.

As water is poured into the truncated cone, both the height, $x\,\text{cm}$, and the radius, $r\,\text{cm}$, of the water surface increase.

This is shown in the following diagram.

diagram not to scale



616

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(a) (i) Write down the exact value of $\tan\theta$.

(ii) Show that $x = 2r - 4$. [3]

(This question continues on the following page)

(Question 14 continued)

The volume of collected water, V, can be found using the equation

$$V = \frac{2}{3}\pi r^3 - a\pi .$$

(b) Find the value of a. [3]

As water is poured into the truncated cone, the rate at which r increases is related to the rate at which V increases according to the equation

$$\frac{\mathrm{d}V}{\mathrm{d}t} = 2\pi r^2 \frac{\mathrm{d}r}{\mathrm{d}t} .$$

Silayan pours water into the truncated cone at a constant rate of $5\,\mathrm{cm}^3$ per second.

(c) Find the height of the water when the radius is increasing at a rate of $0.06\,\mathrm{cm\,s^{-1}}$. [4]

616

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15. [Maximum mark: 8]

Consider the following system of differential equations.

$$\dot{x} = 2x - 5y$$

$$\dot{y} = x - y$$

(a) Find the eigenvalues of this system. [4]

(b) By considering the starting point $(1, 0)$, select which **one** of the following options best describes the trajectory of the system on a phase portrait.

Indicate your choice by placing a tick mark in the second column of the following table.

With reference to your eigenvalues, justify your answer. [4]

Trajectory description	True (✓)
Clockwise spiral towards the origin	
Anticlockwise spiral towards the origin	
Clockwise spiral outwards from the origin	
Anticlockwise spiral outwards from the origin	
Clockwise elliptical path	
Anticlockwise elliptical path	
Saddle point	
None of the above	

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(Question 15 continued)

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References:

3. magann, 2019. *Blue canister*. [image online] Available at: https://www.gettyimages.co.uk/detail/photo/blue-canister-royalty-free-image/1134222586 [Accessed 15 July 2025]. SOURCE ADAPTED.

4. KeithBishop, 2012. *Volleyball players – girls*. [image online] Available at: https://www.gettyimages.co.uk/detail/illustration/volleyball-players-girls-royalty-free-illustration/455440103?adppopup=true [Accessed 8 August 2025]. SOURCE ADAPTED.

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