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Mathematics: applications and interpretation
Higher level
Paper 1

Friday 6 May 2022 (afternoon)

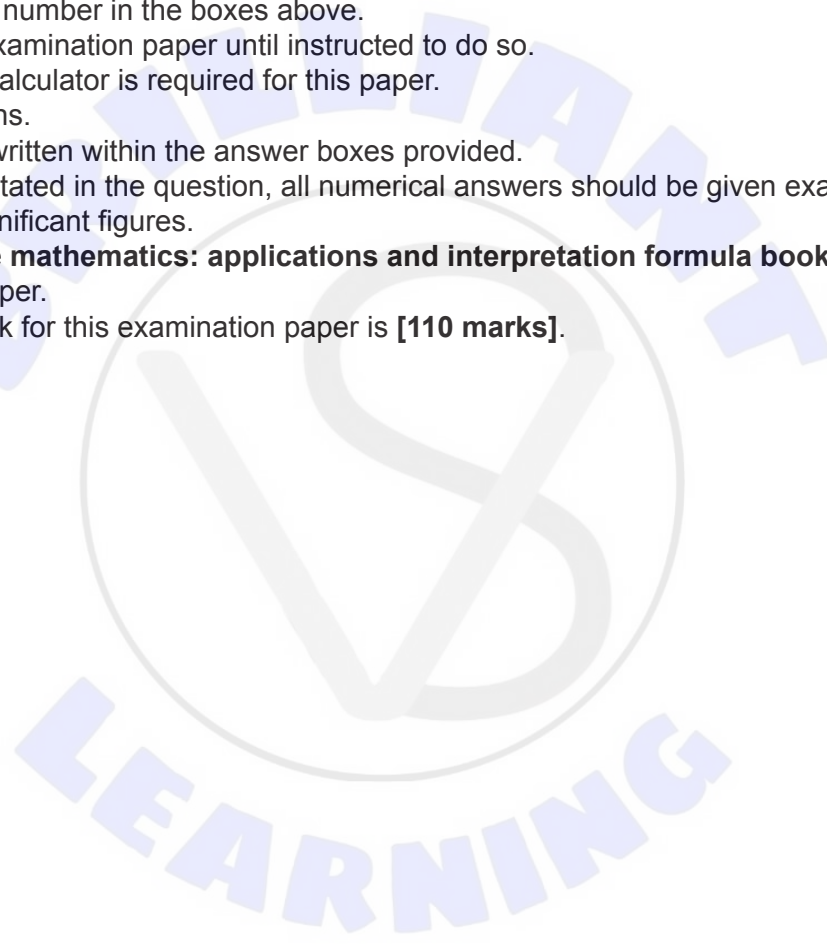
Candidate session number

2 hours

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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 formula booklet** is required for this paper.
- The maximum mark for this examination paper is **[110 marks]**.



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 group of 130 applicants applied for admission into either the Arts programme or the Sciences programme at a university. The outcomes of their applications are shown in the following table.

	Accepted	Rejected
Arts programme	17	24
Sciences programme	25	64

- (a) Find the probability that a randomly chosen applicant from this group was accepted by the university. [1]

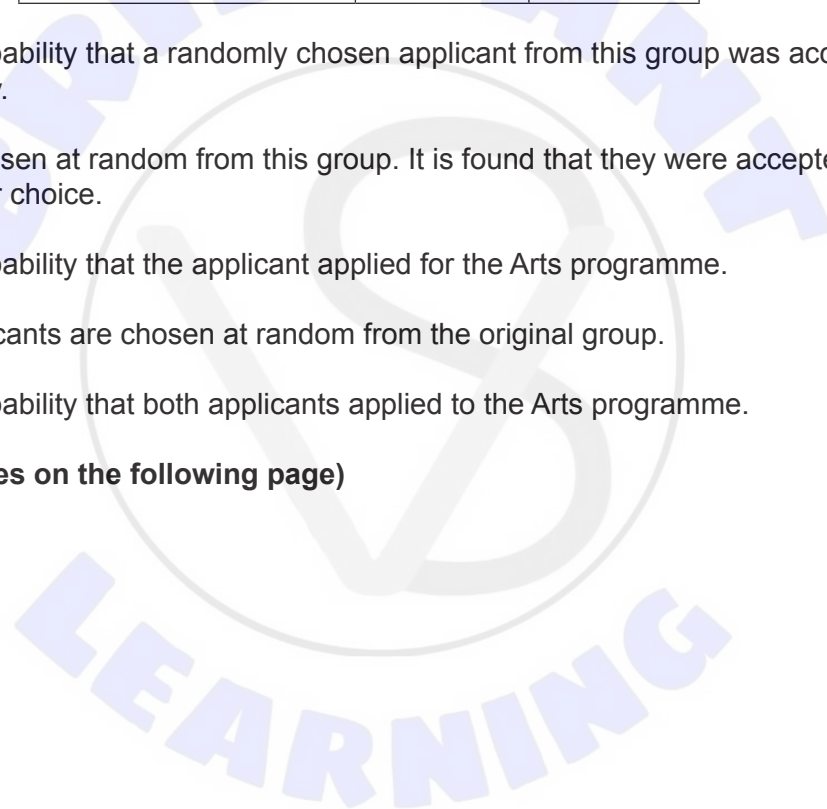
An applicant is chosen at random from this group. It is found that they were accepted into the programme of their choice.

- (b) Find the probability that the applicant applied for the Arts programme. [2]

Two different applicants are chosen at random from the original group.

- (c) Find the probability that both applicants applied to the Arts programme. [3]

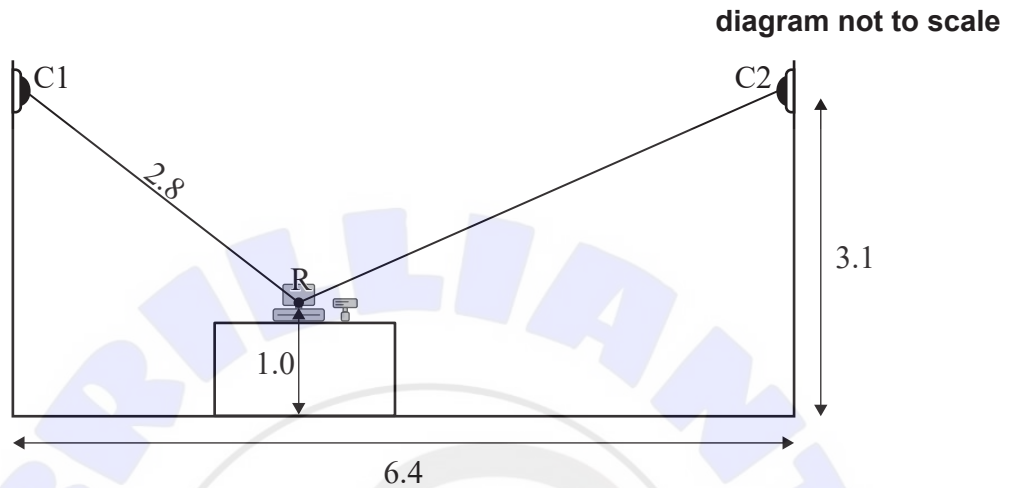
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2. [Maximum mark: 8]

The owner of a convenience store installs two security cameras, represented by points C1 and C2. Both cameras point towards the centre of the store's cash register, represented by the point R.

The following diagram shows this information on a cross-section of the store.



The cameras are positioned at a height of 3.1 m, and the horizontal distance between the cameras is 6.4 m. The cash register is sitting on a counter so that its centre, R, is 1.0 m above the floor.

The distance from Camera 1 to the centre of the cash register is 2.8 m.

- (a) Determine the angle of depression from Camera 1 to the centre of the cash register. Give your answer in degrees. [2]
- (b) Calculate the distance from Camera 2 to the centre of the cash register. [4]
- (c) Without further calculation, determine which camera has the largest angle of depression to the centre of the cash register. Justify your response. [2]

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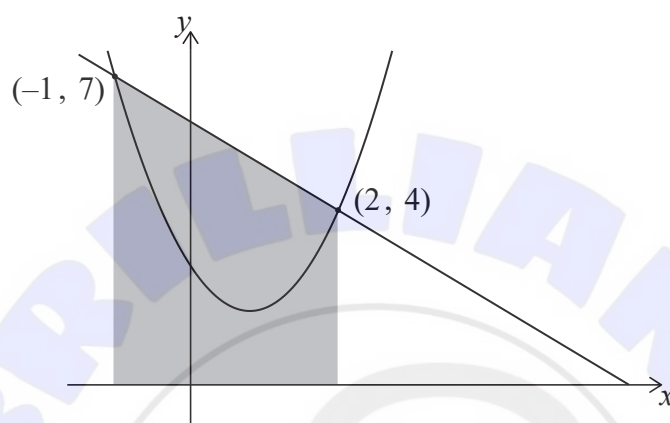
4. [Maximum mark: 7]

The graphs of $y = 6 - x$ and $y = 1.5x^2 - 2.5x + 3$ intersect at $(2, 4)$ and $(-1, 7)$, as shown in the following diagrams.

In **diagram 1**, the region enclosed by the lines $y = 6 - x$, $x = -1$, $x = 2$ and the x -axis has been shaded.

diagram not to scale

Diagram 1



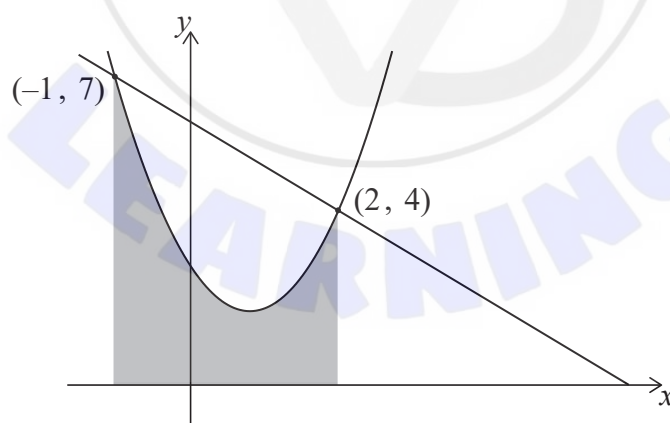
(a) Calculate the area of the shaded region in **diagram 1**.

[2]

In **diagram 2**, the region enclosed by the curve $y = 1.5x^2 - 2.5x + 3$, and the lines $x = -1$, $x = 2$ and the x -axis has been shaded.

diagram not to scale

Diagram 2



(b) (i) Write down an integral for the area of the shaded region in **diagram 2**.

(ii) Calculate the area of this region.

[3]

(c) Hence, determine the area enclosed between $y = 6 - x$ and $y = 1.5x^2 - 2.5x + 3$.

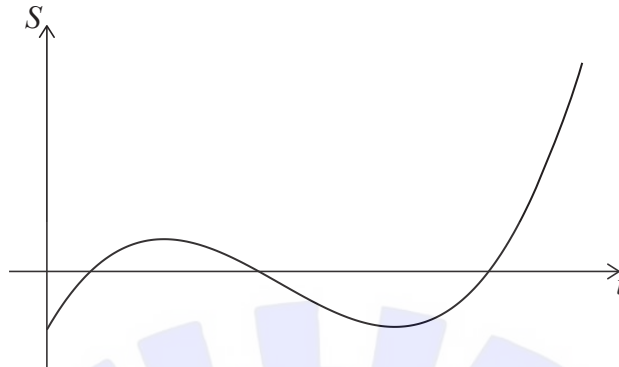
[2]

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5. [Maximum mark: 8]

The graph below shows the average savings, S thousand dollars, of a group of university graduates as a function of t , the number of years after graduating from university.



(a) Write down one feature of this graph which suggests a cubic function might be appropriate to model this scenario.

[1]

The equation of the model can be expressed in the form $S = at^3 + bt^2 + ct + d$, where a , b , c and d are real constants.

The graph of the model must pass through the following four points.

t	0	1	2	3
S	-5	3	-1	-5

(b) (i) Write down the value of d .

(ii) Write down three simultaneous equations for a , b and c .

(iii) Hence, or otherwise, find the values of a , b and c .

[4]

A negative value of S indicates that a graduate is expected to be in debt.

(c) Use the model to determine the total length of time, in years, for which a graduate is expected to be in debt after graduating from university.

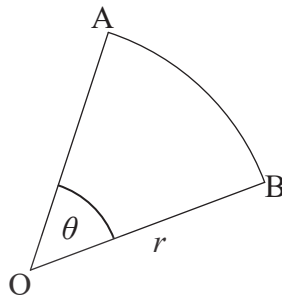
[3]

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8. [Maximum mark: 8]

The diagram shows a sector, OAB, of a circle with centre O and radius r , such that $\hat{AOB} = \theta$.



Sam measured the value of r to be 2 cm and the value of θ to be 30° .

- (a) Use Sam's measurements to calculate the area of the sector. Give your answer to four significant figures. [2]

It is found that Sam's measurements are accurate to only one significant figure.

- (b) Find the upper bound and lower bound of the area of the sector. [3]
- (c) Find, with justification, the largest possible percentage error if the answer to part (a) is recorded as the area of the sector. [3]

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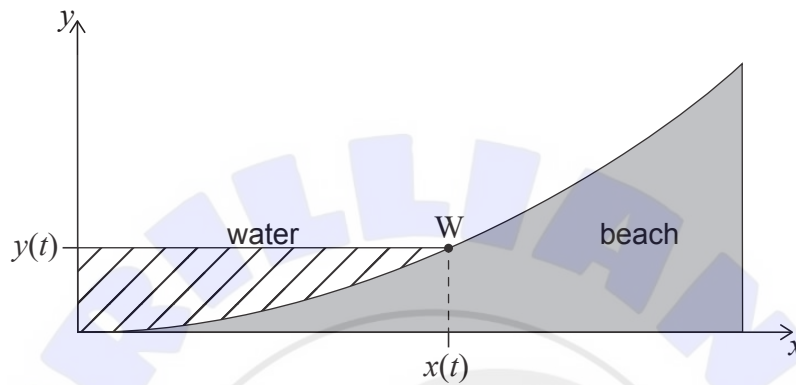
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17. [Maximum mark: 8]

The cross-section of a beach is modelled by the equation $y = 0.02x^2$ for $0 \leq x \leq 10$ where y is the height of the beach (in metres) at a horizontal distance x metres from an origin. t is the time in hours after low tide.

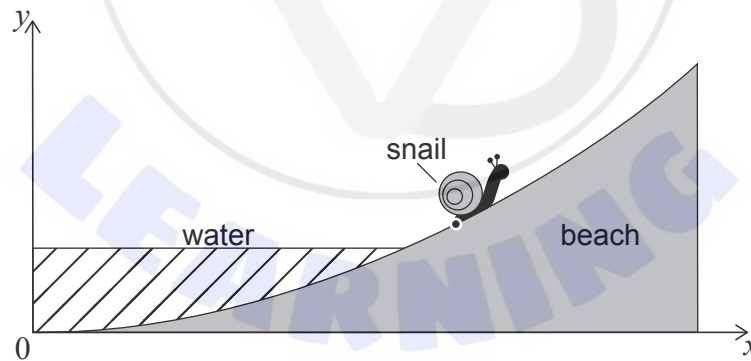
At $t = 0$ the water is at the point $(0, 0)$. The height of the water rises at a rate of 0.2 metres per hour. The point $W(x(t), y(t))$ indicates where the water level meets the beach at time t .



- (a) When W has an x -coordinate equal to 1, find the horizontal component of the velocity of W .

[3]

A snail is modelled as a single point. At $t = 0$ it is positioned at $(1, 0.02)$. The snail travels away from the incoming water at a speed of 1 metre per hour in the direction along the curve of the cross-section of the beach. The following diagram shows this for a value of t , such that $t > 0$.



- (b) (i) Find the time taken for the snail to reach the point $(10, 2)$.
 (ii) Hence show that the snail reaches the point $(10, 2)$ before the water does.

[5]

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