IB Mathematics AA HL - Prediction Exams
May 2025 - Paper 2

Paper 2

12 questions | 120 mins | 110 marks

Filters | Go to Question

Question Type: All | Difficulty: Easy | Medium | Hard

Section A

Question 1

Easy

[Maximum mark: 5]

Find the equations of the two tangents to the curve $y = 2x^2 - x + \frac{9}{2}$ that pass through the origin.

Revisit | Complete

Mark Scheme

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Question 2

Easy

[Maximum mark: 5]

Chun Li has a bag with five 6-sided dice.

Four of them are normal fair dice and one of them is biased with a 6 showing on each of its faces.

She draws two out at random and rolls them.

(a) Find the probability a six shows on both dice. [3]

(b) Given a six shows on both dice find the probability one of the dice is the biased dice. [2]

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Question 3

Easy

[Maximum mark: 7]

A cyclist leaves town A on a bearing of $240°$ and rides 11 kilometers to town B.

The cyclist then travels d km on a bearing of $090°$ until he is exactly 6 km from town A.

Find the possible values of d.

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Question 4

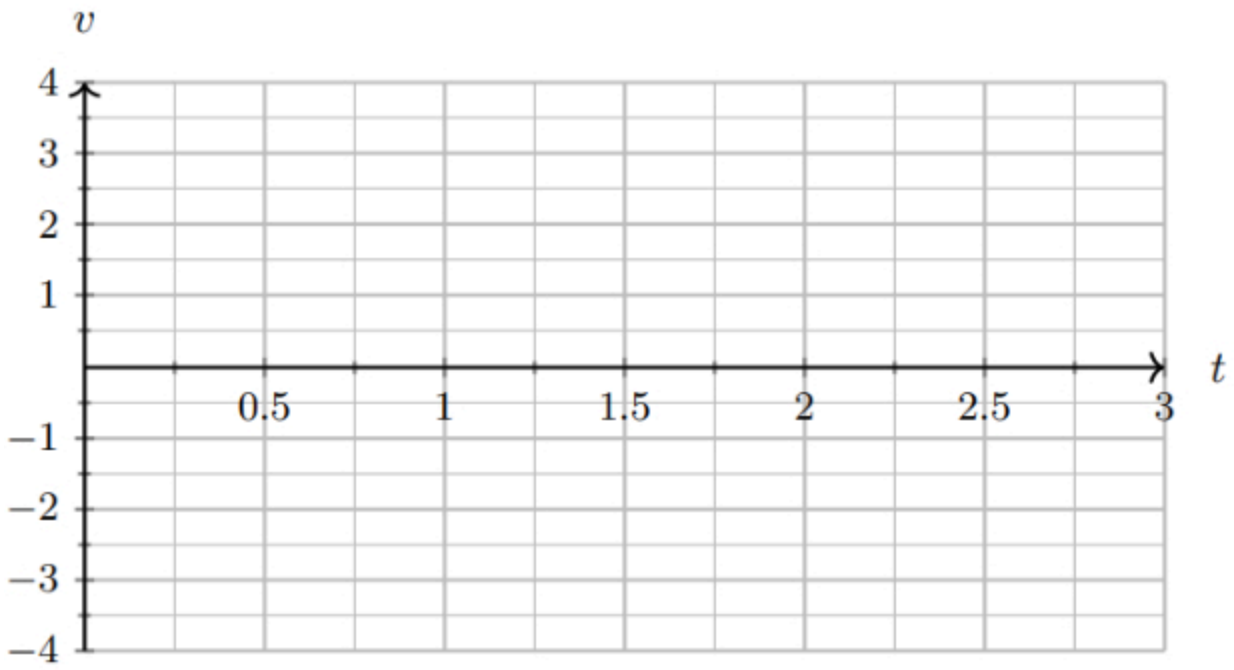
Medium

[Maximum mark: 6]

A particle P moves along a straight line such that its displacement, in metres, after t seconds, from a fixed point O is given by

$$s(t) = 3e^{-(t+1)} \sin(4t + 4), \quad 0 \leq t \leq 2$$

(a) Sketch the graph of the velocity of P against t on the axes below. [2]



P reaches its maximum speed when $t = a$ seconds.

(b) Find a. [1]

(c) Hence or otherwise, find the distance travelled whilst the acceleration of P is negative. [3]

Question 5

Medium

[Maximum mark: 5]

The amount, in milligrams, of a medicinal drug in the body t hours after it is injected is given by

$$D(t) = 240e^{-kt}$$

Where $k > 0$ and $t \geq 0$. Before the injection, it is assumed the amount of drug in the body is zero.

A patient is to be injected with the drug and, for this patient, it is known that it takes 5 hours for the amount of drug remaining in the body to have decreased by 65% of the initial dose.

The patient is regularly checked and is allowed to go home when the amount of drug remaining in the body is 10%, or less, of the initial dose.

The initial dose is given to the patient at 9 : 00 am.

Use this model to estimate, to the nearest hour, the earliest time the patient will be allowed to go home.

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Question 6

Medium

[Maximum mark: 7]

(a) Write $\frac{3x-7}{3x^2+x-2}$ in form $\frac{A}{x+1} + \frac{B}{3x-2}$, where $x \neq -1, \frac{3}{2}$. [2]

(b) Hence determine the first three terms of the binomial expansion of $\frac{3x-7}{3x^2+x-2}$. [5]

Revisit | Complete

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Question 7

Medium

[Maximum mark: 7]

Consider the real polynomial

$$p(z) = 2z^3 + az^2 + bz - 75$$

One of the roots of $p(z)$ is $3 + 4i$.

(a) Find the remaining roots of $p(z)$. [4]

(b) Hence determine the values of a and b. [3]

Revisit | Complete

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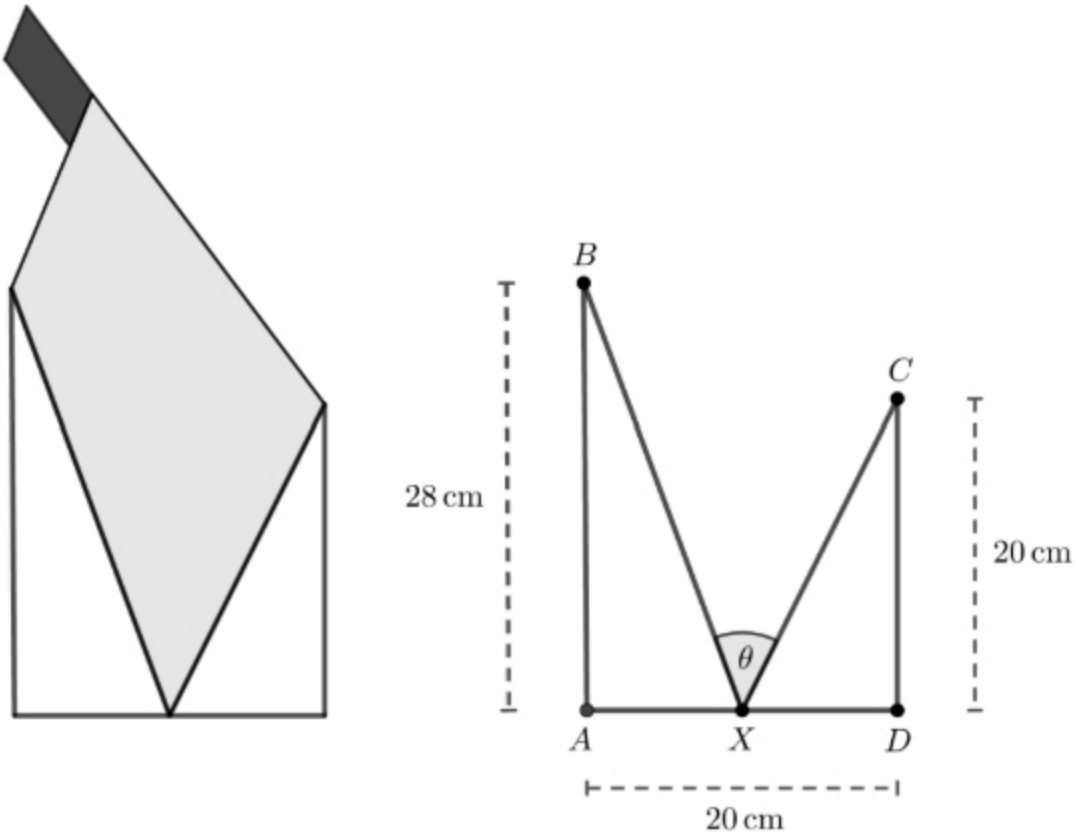
Question 8

Hard

[Maximum mark: 6]

A group of designers are creating a knife holder.

The diagram on the left shows a knife inside the holder and the diagram on the right shows the empty holder.



The lengths of the holder, $AB = 28$, $AD = 20$ and $CD = 20$ are measured in centimeters and $\angle CXB = \theta$ radians.

The designers can move the vertex X anywhere along the line AD.

Market research suggests that the most appealing design is such that the value of θ is maximised.

Find the length AX which maximises the value of θ.

Revisit | Complete

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Question 9

Hard

[Maximum mark: 8]

Consider the differential equation

$$\frac{\mathrm{d}^2y}{\mathrm{d}x^2} = -10xe^{-x^2}$$

Where $y = -1$ and $\frac{\mathrm{d}y}{\mathrm{d}x} = 2$ when $x = 0$.

(a) Find $\frac{\mathrm{d}y}{\mathrm{d}x}$ in terms of x. [2]

(b) Use Euler's method with a step length of 0.1 to estimate a value for y when $x = 0.5$. [4]

(c) Hence justify whether your answer to part (b) is an overestimate or an underestimate. [2]

Revisit | Complete

Mark Scheme

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Section B

Question 10

Hard

[Maximum mark: 17]

Juanita wants to borrow some money to buy an apartment.

She finds an offer allowing her to borrow \$480,000 over 10 years with an interest rate of $r\%$ P.A. compounded monthly. She repays the loan with a fixed amount p every month.

Juanita takes the loan out at the beginning of the month. At the end of the month, the interest is added **and then** she makes the monthly payment of p.

This continues until after 10 complete years, she has repaid the loan in its entirety.

Juanita wants to analyse three different scenarios in which she could repay the loan.

(a) In the first scenario her monthly payment is $p = \$5\,000$.

If $k = 1 + \dfrac{r}{1200}$

(i) Write down the number of payments that will be made over the entire 10 year term of the loan.

(ii) Show that

$$96k^{120} = \frac{k^{120} - 1}{k - 1}$$

(iii) Hence, or otherwise, find r. [6]

(b) In the second scenario Juanita uses the same values for p and r as part (a). She makes the monthly payments of p for 7 years and 4 months.

She then makes a final payment to clear the remaining balance of the loan.

(i) Find the number of payments she makes **before** the final payment.

(ii) Hence, find the final payment required to clear the remaining balance to 4 significant figures. [3]

(c) In the third scenario Juanita pays p per month for 5 complete years and then she increases her monthly loan repayment to $2p$ for the remaining 5 years.

Find the value of p, to the nearest dollar, for the third scenario. [8]

Revisit Complete

Mark Scheme

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Question 11

Medium

[Maximum mark: 21]

A continuous random variable, X, has a probability density function defined by

$$f(x) = \begin{cases} \frac{1}{4}x, & 0 \leq x \leq a \\ \frac{2}{7} - \frac{1}{28}x, & a \leq x \leq 8 \\ 0, & \text{otherwise} \end{cases}$$

(a) It is known that $\mathrm{P}(X \leq a) = 0.125$.

(i) Show that $a = 1$.

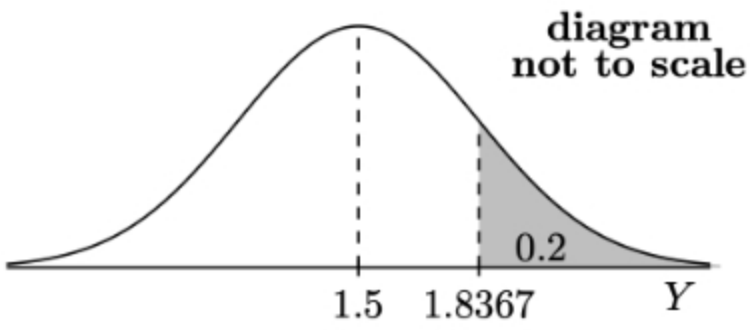
(ii) Hence show that $\mathrm{E}(X) = 3$. [4]

(b) Find $\mathrm{P}(0.5 \leq X \leq 2)$. [3]

(c) Given that $\mathrm{E}(X^2) = \frac{73}{6}$ find $\mathrm{Var}(X)$. [1]

Another continuous random variable, Y, is normally distributed with a mean of 1.5 and a standard deviation of σ_Y .

For this distribution it is known that $\mathrm{P}(Y \geq 1.8367) = 0.2$. This information is shown below



(d) Find σ_Y. [3]

(e) Hence find $\mathrm{P}(0.5 \leq Y \leq 2)$. [1]

A water utility company serves a large number of households. 90% of their households are classed as **regular** households. The rest are classed as **premium** households.

The water usage per day, in m^3, of the regular households is modeled by the random variable X.

The water usage per day, in m^3, of the premium households is modeled by the random variable Y.

If a household uses between $0.5\,\mathrm{m}^3$ and $2\,\mathrm{m}^3$ of water per day they are eligible for a special deal.

(f) A household is chosen at random. It is found that they are eligible for a special deal. What is the probability they are a premium household? [3]

The water company charges the households a daily fee based on how much water is used in that day.

The charge per day, C_X, in \$US, for the regular households is calculated using the following formula

$$C_X = 1.5X + 0.5$$

(g) Find

(i) $\mathrm{E}(C_X)$.

(ii) $\mathrm{Var}(C_X)$. [3]

Premium households are charged in a different way to regular households.

The charge per day, C_Y, in \$US, for the premium households is calculated using the following formula

$$C_Y = sY + t \qquad \text{where } s, t \in \mathbb{R}.$$

If the value of $\mathrm{E}(C_Y)$ is \$1 less than the value of $\mathrm{E}(C_X)$ and $\mathrm{Var}(C_Y) = \frac{32}{57}\mathrm{Var}(C_X)$ then

(h) Given that $s > 0$, find s and t. [3]

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Question 12

Hard

[Maximum mark: 16]

Consider the planes Π_1, Π_2 and Π_3 with the following equations.

$$\begin{aligned} \Pi_1: &\quad x - y + z = -4 \\ \Pi_2: &\quad 2x + y - z = -1 \\ \Pi_3: &\quad -x + y + kz = -3 \end{aligned}$$

Where $k \in \mathbb{R}$.

The system of equations that represents the three planes is inconsistent.

(a) (i) Find k.

(ii) Describe the geometrical relationship of the three planes. [3]

L is the line of intersection between Π_1 and Π_2 and it crosses the $xy-$plane at point D.

(b) (i) Verify that the vector equation of L can be written as

$$\boldsymbol{r} = \begin{pmatrix} -\frac{5}{3} \\ 0 \\ -\frac{7}{3} \end{pmatrix} + \lambda \begin{pmatrix} 0 \\ 1 \\ 1 \end{pmatrix}$$

(ii) Hence find the coordinates of point D. [4]

A fourth plane, Π_4, is created by reflecting Π_1 in Π_3.

(c) Find the Cartesian equation of Π_4. [9]

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