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4E/5N

ADDITIONAL MATHEMATICS 4049/01

Paper 1 [90 marks]

PRELIMINARY EXAMINATION

20 August 2024

2 hours 15 minutes

Candidates answer on the question paper.

READ THESE INSTRUCTIONS FIRST

Do not open this booklet until you are told to do so.
Write your name, index number and class on all the work you hand in.
Write in dark blue or black pen.
You may use an HB pencil for any diagrams or graphs.
Do not use staples, paper clips, glue or correction fluid.

Answer **ALL** questions.
If working is needed for any question it must be shown with the answer.
Omission of essential working will result in loss of marks.
The use of an approved scientific calculator is expected, where appropriate.
If the degree of accuracy is not specified in the question, and if the answer is not exact, give the answer to three significant figures. Give answers in degrees to one decimal place.
For π, use either your calculator value or 3.142, unless the question requires the answer in terms of π.
The number of marks is given in brackets [ ] at the end of each question or part question.
The total of the marks for this paper is **90**.
Write the brand and model of your calculator in the space provided below.

Brand/Model of Calculator	For Examiner's Use	
	Total	90

This question paper consists of **16** printed pages and **2** blank pages.

Setter: Ms Shen Sirui Vetter: Mr. Narayanan

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Mathematical Formulae

1. ALGEBRA

Quadratic Equation

For the equation $ax^2 + bx + c = 0$,

$$x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$$

Binomial expansion

$$(a+b)^n = a^n + \binom{n}{1}a^{n-1}b + \binom{n}{2}a^{n-2}b^2 + \ldots + \binom{n}{r}a^{n-r}b^r + \ldots + b^n,$$

where n is a positive integer and $\binom{n}{r} = \frac{n!}{r!(n-r)!} = \frac{n(n-1)\ldots(n-r+1)}{r!}$

2. TRIGONOMETRY

Identities

$$\sin^2 A + \cos^2 A = 1$$

$$\sec^2 A = 1 + \tan^2 A$$

$$\operatorname{cosec}^2 A = 1 + \cot^2 A$$

$$\sin(A \pm B) = \sin A \cos B \pm \cos A \sin B$$

$$\cos(A \pm B) = \cos A \cos B \mp \sin A \sin B$$

$$\tan(A \pm B) = \frac{\tan A \pm \tan B}{1 \mp \tan A \tan B}$$

$$\sin 2A = 2 \sin A \cos A$$

$$\cos 2A = \cos^2 A - \sin^2 A = 2\cos^2 A - 1 = 1 - 2\sin^2 A$$

$$\tan 2A = \frac{2\tan A}{1 - \tan^2 A}$$

Formulae for ΔABC

$$\frac{a}{\sin A} = \frac{b}{\sin B} = \frac{c}{\sin C}$$

$$a^2 = b^2 + c^2 - 2bc\cos A$$

$$\text{Area of } \Delta = \frac{1}{2}ab\sin C$$

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1 Given that $4(5^{x+3}) = 20^{3-x}$, evaluate 10^x **without using a calculator**. [4]

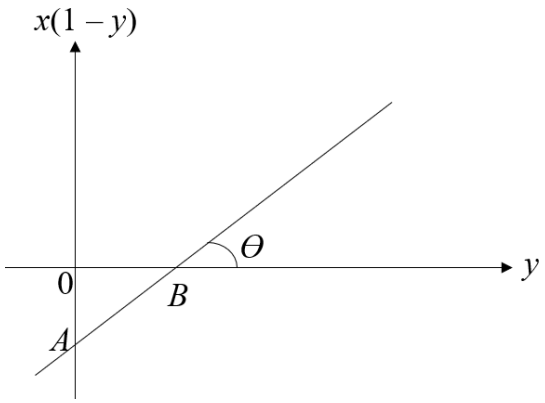
2 Solve the equations.

(a) $\log_2(x+4) = 2\log_2 x - 1$ [4]

(b) $10\log_y 5 + 3 = \log_5 y$ [4]

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3 The variables x and y are related by $y = \dfrac{2x+8}{2x+1}$. When values of $x(1-y)$ are plotted against y, a straight line is obtained. The straight line intersects the vertical and horizontal axes at A and B respectively.



(i) Find the coordinates of A and of B. [4]

(ii) State the value of $\tan\theta$. [1]

[Turn over

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4 **(i)** Factorise completely $2x^3 - 3x^2 - 5x + 6$. [4]

(ii) **Hence**, solve $2e^{3y} - 3e^{2y} - 5e^{y} + 6 = 0$. [3]

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5 **(i)** Prove that $\dfrac{2-\sec^2\theta}{\sec\theta(\sin\theta+\cos\theta)} = 1-\tan\theta$. [4]

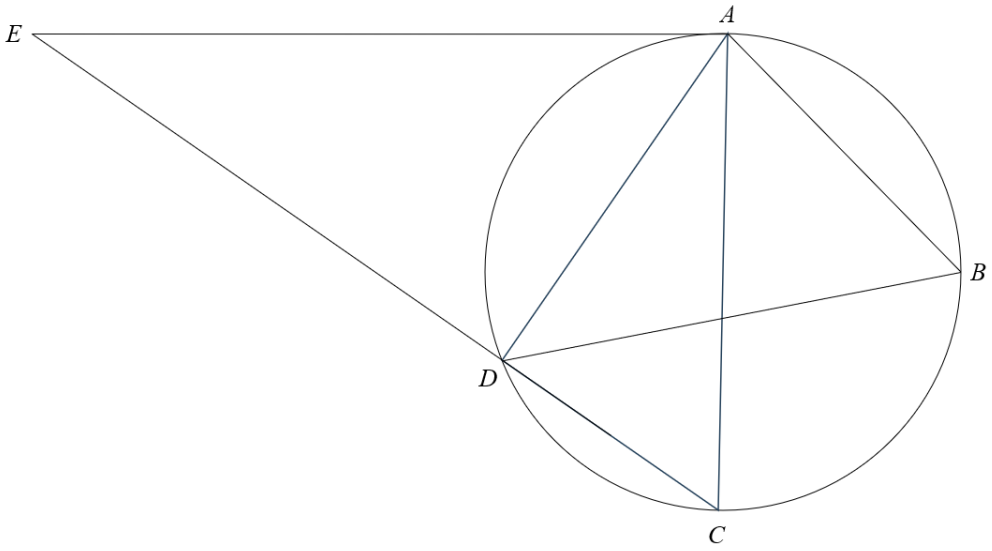
(ii) Hence solve the equation $\dfrac{4-2\sec^2\theta}{\sec\theta(\sin\theta+\cos\theta)} = \sec^2\theta - 2$ for $0 \le \theta \le 2\pi$. [5]

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6 The first two non-zero terms in the expansion of $(1+bx)(1+ax)^6$ in ascending powers of x are 1 and $-\frac{21}{4}x^2$. Find the value of each of the constants a and b, where $a < b$. [7]

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7



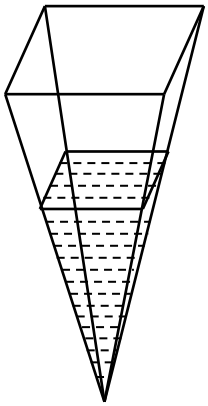
The diagram shows a circle passing through the points *A*, *B*, *C* and *D*. *AC* is a diameter of the circle. The line *EA* is a tangent to the circle and it intersects the straight line *EDC* at *E*.

(i) Show that angle *AED* = angle *DAC*. [2]

(ii) Show that $AD^2 = CD \times DE$. [4]

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8 A vessel in the shape of an inverted right pyramid has a square base of side 12 cm and a height of 30 cm. Water is leaking from the vessel at a constant rate of 5 cm^3/s.



(i) Show that the volume of water in the vessel, V cm^3, is given by $V = \frac{4h^3}{75}$, where h is the depth of the water. [2]

(ii) Find the rate of change of the depth of water when the water is 6 cm deep. [3]

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9 f(x) is such that $\mathrm{f}'(x) = \sin\frac{1}{4}x - \cos 4x$. Given that $\mathrm{f}(2\pi) = 1$, show that

$16\mathrm{f}''(x) + \mathrm{f}(x) = a\sin 4x + b$, where a and b are constants. [6]

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10 **(a)** **(i)** Find the range of values of the constant m for which the curve $y = x^2 - 5x + m$ meets the line $y = mx - 8$. [4]

(ii) Hence state the values of m for which the line is a tangent. [1]

(b) Given that $px^2 + 5x - q$ is always positive, what conditions must apply to the constants p and q? [3]

[Turn over

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11 **(i)** Express $\frac{-x^2+2x+1}{(x-1)(x^2+1)}$ in the form $\frac{A}{x-1}+\frac{Bx+C}{x^2+1}$ where A, B and C are constants.

[4]

(ii) Differentiate $\ln(x^2+1)$ with respect to x. [1]

(iii) Using your results from parts **(i)** and **(ii)**, find $\int \frac{-2x^2+4x+2}{(x-1)(x^2+1)}\,\mathrm{d}x$. [2]

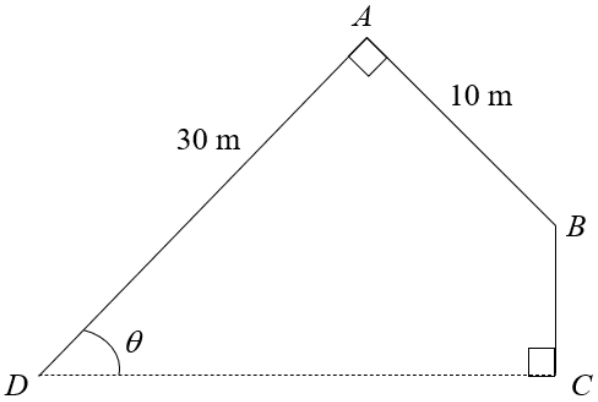
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12



The diagram shows an area that is enclosed by glass panels at *AB*, *BC* and *AD*. *AB* = 10 m, *AD* = 30 m, angle *DAB* = angle *BCD* = $90°$. The glass panel *AD* makes an acute angle θ with *CD*.

(i) Show that *L* m, the length of the glass panels, can be expressed as $40 + 30\sin\theta - 10\cos\theta$. [2]

(ii) Express *L* in the form $40 + R\sin(\theta - \alpha)$ where $R > 0$ and $0° < \alpha < 90°$. [4]

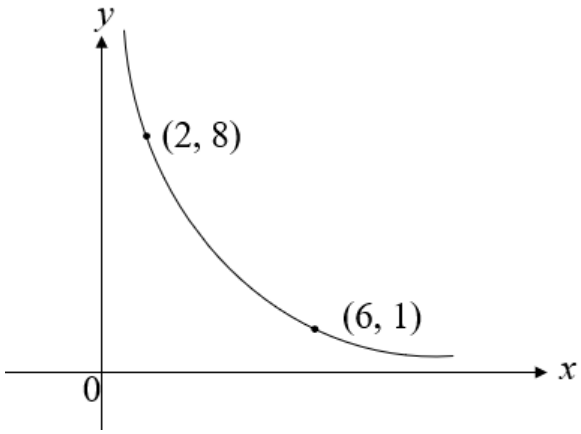
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(iii) The total length of the glass panels is 65 m. Find the value of θ. [2]

(iv) Explain whether it is possible to build an area where the length of the glass panels is 90 m. [1]

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13 **(a)** The figure shows part of the curve $y = g(x)$. (2, 8) and (6, 1) are two points on the curve.

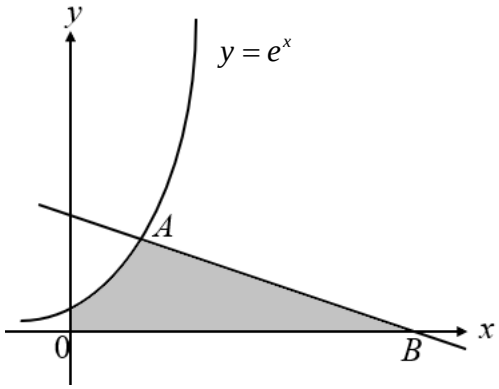


Given that $\int_2^6 y \, dx = 32$, find the value of $\int_1^8 x \, dy$. [2]

[Turn over

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(b)



The diagram shows part of the curve $y = e^x$. The normal to the curve at point *A* where $x = 1$ intersects the *x*-axis at point *B*. Find the area of the shaded region.

Leave your answer in **exact form**. [7]

END OF PAPER

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