2016-DSE MATH EP M2

HONG KONG EXAMINATIONS AND ASSESSMENT AUTHORITY
HONG KONG DIPLOMA OF SECONDARY EDUCATION EXAMINATION 2016

MATHEMATICS Extended Part Module 2 (Algebra and Calculus) Question-Answer Book

8.30 am - 11.00 am (2½ hours)
This paper must be answered in English

INSTRUCTIONS

- (1) After the announcement of the start of the examination, you should first write your Candidate Number in the space provided on Page 1 and stick barcode labels in the spaces provided on Pages 1, 3, 5, 7, 9 and 11.
- (2) This paper consists of TWO sections, A and B.
- (3) Attempt ALL questions in this paper. Write your answers in the spaces provided in this Question-Answer Book. Do not write in the margins. Answers written in the margins will not be marked.
- (4) Graph paper and supplementary answer sheets will be supplied on request. Write your Candidate Number, mark the question number box and stick a barcode label on each sheet, and fasten them with string INSIDE this book.
- (5) Unless otherwise specified, all working must be clearly shown.
- (6) Unless otherwise specified, numerical answers must be exact.
- (7) No extra time will be given to candidates for sticking on the barcode labels or filling in the question number boxes after the 'Time is up' announcement.

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FORMULAS FOR REFERENCE

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

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

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

$$2\sin A\cos B = \sin (A+B) + \sin (A-B)$$

$$2\cos A\cos B = \cos(A+B) + \cos(A-B)$$

$$2\sin A\sin B = \cos(A-B) - \cos(A+B)$$

$$\sin A + \sin B = 2\sin\frac{A+B}{2}\cos\frac{A-B}{2}$$

$$\sin A - \sin B = 2\cos\frac{A+B}{2}\sin\frac{A-B}{2}$$

$$\cos A + \cos B = 2\cos\frac{A+B}{2}\cos\frac{A-B}{2}$$

$$\cos A - \cos B = -2\sin\frac{A+B}{2}\sin\frac{A-B}{2}$$

SECTION A (50 marks)

in the margins will not be marked.	1.	Expand $(5+x)^4$. Hence, find the constant term in the expansion of $(5+x)^4 \left(1-\frac{2}{x}\right)^3$.	(5 marks)
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Prove that	$\frac{1}{\sqrt{x}}$	$-\frac{1}{\sqrt{x+h}}$	$=\frac{h}{(x+h)\sqrt{x}+x\sqrt{x+h}}$. Hence, find	$\frac{\mathrm{d}}{\mathrm{d}x}\sqrt{\frac{3}{x}}$	from first principles.	(5
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(b) If P moves along C such that OQ increases at a constant rate of 6 units per second, for rate of change of the area of $\triangle OPQ$ when $u=4$.	(a)	Express the area of $\triangle OPQ$ in terms of u .
	(b)	If P moves along C such that OQ increases at a constant rate of 6 units per second, find
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4.	Prove that $x+1$ is a factor of $4x^3 + 2x^2 - 3x - 1$.	
(b)	Express $\cos 3\theta$ in terms of $\cos \theta$.	
(c)	Using the results of (a) and (b), prove that $\cos \frac{3\pi}{5} = \frac{1-\sqrt{5}}{4}$.	
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8.	Let i	n be a positive integer.	
	(a)	Define $A = \begin{pmatrix} 1 & 0 \\ 1 & 1 \end{pmatrix}$. Evaluate	
		(i) A^2 ,	
		(ii) A^n ,	
		(iii) $(A^{-1})^n$.	
	(b)	Evaluate	
		$(i) \qquad \sum_{k=0}^{n-1} 2^k \ ,$	
		(ii) $\begin{pmatrix} 1 & 0 \\ 1 & 2 \end{pmatrix}^n$.	
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SECT	TION B	3 (50 marks)	
9.		a and b be constants. Define $f(x) = x^3 + ax^2 + bx + 5$ for all real numbers x. Denote the $y = f(x)$ by C. It is given that $P(-1, 10)$ is a turning point of C.	
	(a)	Find a and b . (3 marks)	
	(b)	Is P a maximum point of C ? Explain your answer. (2 marks)	
	(c)	Find the minimum value(s) of $f(x)$. (2 marks)	***************************************
	(d)	Find the point(s) of inflexion of C . (2 marks)	
	(e)	Let L be the tangent to C at P . Find the area of the region bounded by C and L . (4 marks)	
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10.	(a)	Let $f(x)$ be a continuous function defined on the interval $[0, a]$, where a is a positive constant.	
		Prove that $\int_0^a f(x) dx = \int_0^a f(a-x) dx$ (3 marks)	
	(b)	Prove that $\int_0^{\frac{\pi}{4}} \ln(1 + \tan x) dx = \int_0^{\frac{\pi}{4}} \ln(\frac{2}{1 + \tan x}) dx$. (3 marks)	
	(c)	Using (b), prove that $\int_0^{\frac{\pi}{4}} \ln(1 + \tan x) dx = \frac{\pi \ln 2}{8}$ (3 marks)	
	(d)	Using integration by parts, evaluate $\int_0^{\frac{\pi}{4}} \frac{x \sec^2 x}{1 + \tan x} dx$ (3 marks)	
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11.	(a)	Consider the system of linear equations in real variables x , y , z
		(E): $\begin{cases} x + y - z = 3 \\ 4x + 6y + az = b \\ 5x + (1-a)y + (3a-1)z = b-1 \end{cases}$, where a and b are real numbers.
		(E): $\begin{cases} 4x + 6y + az = b \\ \end{cases}$, where a and b are real numbers.
		(5x + (1-a)y + (3a-1)z = b-1
		(i) Assume that (E) has a unique solution.
		(1) Prove that $a \neq -2$ and $a \neq -12$.
		(2) Solve (E) .
		(ii) Assume that $a = -2$ and (E) is consistent.
		(1) Find b .
		(2) Solve (E). (9 marks)
	a >	
	(b)	Is there a real solution of the system of linear equations
		$\begin{cases} x + y - z = 3 \end{cases}$
		$\begin{cases} x + y - z = 3 \\ 2x + 3y - z = 7 \\ 5x + 3y - 7z = 13 \end{cases}$
		satisfying $x^2 + y^2 - 6z^2 > 14$? Explain your answer. (3 marks)
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