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Name

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3 Exp

ADDITIONAL MATHEMATICS**4047**

[80 marks]

SEMESTER ONE EXAMINATION

Thursday 07 May 2015

2 hours

Candidates answer on the writing paper provided
 Additional material: Electronic calculator

INSTRUCTIONS TO CANDIDATES**Do not open this booklet until you are told to do so.**

Write your name, register number and class on all the work you hand in.

Write in dark blue or black pen.

You may use a pencil for any diagrams or graphs.

Do not use staples, paper clips, highlighters, glue or correction fluid.

Answer **ALL** questions.

Write your answers on the writing paper provided.

Show all working clearly.

Omission of essential working will result in loss of marks.

Write the brand and model of your calculator in the space provided below.

INFORMATION FOR CANDIDATES

You are expected to use an electronic calculator to evaluate explicit numerical expressions.

If the degree of accuracy is not specified in the question, and if the answer is not exact, the answer should be given to **three** significant figures. Answers in degrees should be given 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 **80**.*For Examiner's Use*

Brand / Model of Calculator

This question paper consists of 5 printed pages.

3 |

Setter: Mr Chio Kah Leong

Vetter: Mrs Quek Ai Jee

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

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

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

2. TRIGONOMETRY

Identities

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

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

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

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

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Formulae for $\triangle ABC$

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- 1 Find the coordinates of the points of intersection of the line $2x + y = 3$ and the curve $3x^2 - y^2 + 4xy - 6 = 0$. [4]
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[Turn over]

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 $9^{x+1} - 28(3^x) + 3 = 0$. [4]

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END OF PAPER

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34

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Setter: Mr Chio Kah Leong

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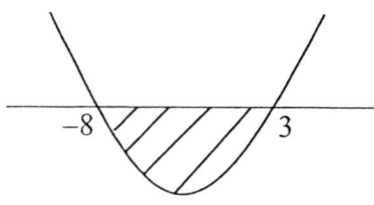
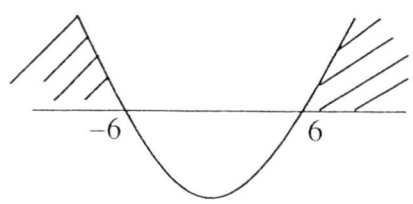
(b) $\lg(x+4) - \lg(x-3) = 3\lg 2$, [3]

(c) $\log_2 x + 8\log_x 2 = 9$. [4]

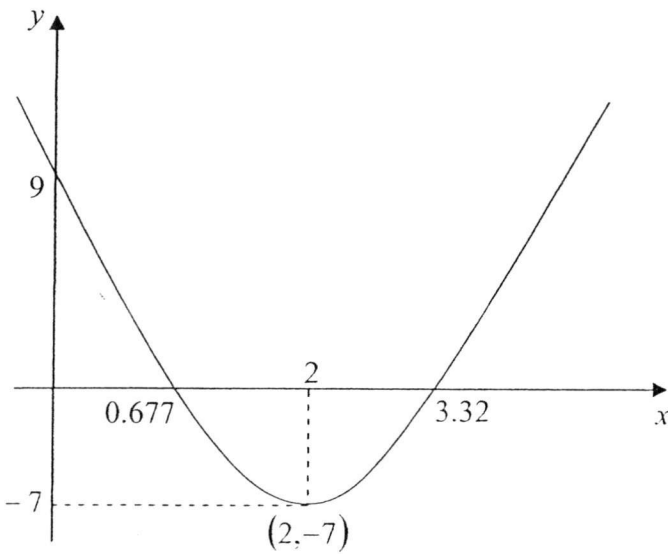
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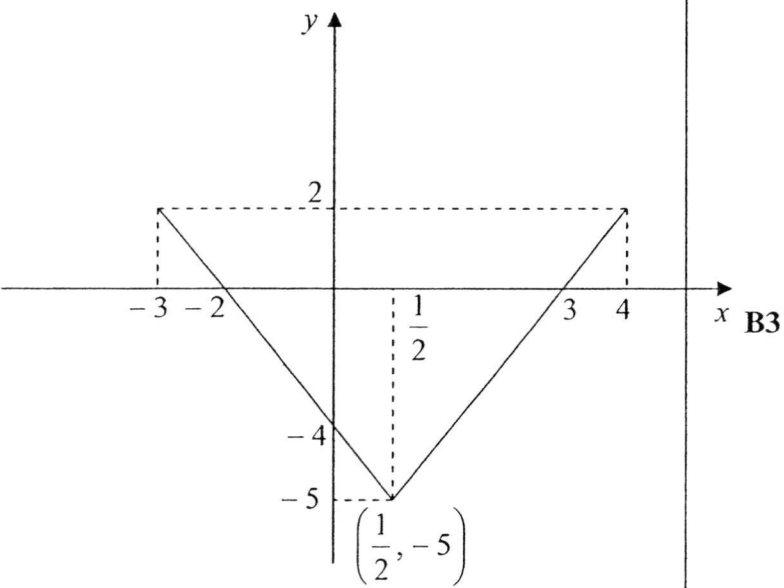
3(a)	$2x^2 - 6x - 5 = 0$ $\alpha + \beta = 3,$ $\alpha\beta = -\frac{5}{2}$ Sum of new roots $= \frac{\alpha}{2\beta} + \frac{\beta}{2\alpha}$ $= \frac{\alpha^2 + \beta^2}{2\alpha\beta}$ $= \frac{(\alpha + \beta)^2 - 2\alpha\beta}{2\alpha\beta}$ $= \frac{3^2 - 2\left(-\frac{5}{2}\right)}{2\left(-\frac{5}{2}\right)}$ $= -\frac{14}{5}$ Product of new roots $= \frac{\alpha}{2\beta} \times \frac{\beta}{2\alpha} = \frac{1}{4}$ The new equation is $x^2 + \frac{14}{5}x + \frac{1}{4} = 0 \quad \text{or} \quad 20x^2 + 56x + 5 = 0$	M1 M1 M1 A1	77.8% of the candidates are able to apply $\alpha^2 + \beta^2 = (\alpha + \beta)^2 - 2\alpha\beta$ to find the sum of the new roots. But many made the following mistake: $= \frac{\alpha}{2\beta} + \frac{\beta}{2\alpha}$ $= \frac{2\alpha^2 + 2\beta^2}{2\alpha \times 2\beta}$ $= \frac{2(\alpha + \beta)^2 - 2\alpha\beta}{2\alpha\beta}$ This seems to be one of the most difficult questions. Only 34.9% of the candidates are able to solve it. M1 M1 A1
3(b)	$x^2 = 1 - 2x$ Since α is a root, $\alpha^2 = 1 - 2\alpha$ $\alpha^4 = (1 - 2\alpha)^2$ $\alpha^4 = 1 - 4\alpha + 4\alpha^2$ $\alpha^4 = 1 - 4\alpha + 4(1 - 2\alpha)$ $\alpha^4 = 1 - 4\alpha + 4 - 8\alpha$ $\alpha^4 + 12\alpha - 5 = 0 \quad (\text{shown})$	M1 M1 A1	

4(a)	$(x+7)(2-x) \geq -10$ $2x - x^2 + 14 - 7x \geq -10$ $-x^2 - 5x + 24 \geq 0$ $x^2 + 5x - 24 \leq 0$ $(x+8)(x-3) \leq 0$  $\therefore -8 \leq x \leq 3$	M1	57.1% of the candidates are able to solve the quadratic inequality with the correct presentation.
		M1	Common Mistake: $(x+8)(x-3) \leq 0$ $(x+8) \leq 0$ or $(x-3) \leq 0$
		A1	
4(b)	For $mx^2 - 5x + 2 > 0$ for all real values of x, $\Rightarrow b^2 - 4ac < 0$ $\Rightarrow 25 - 4(m)(2) < 0$ $\Rightarrow 25 - 8m < 0$ $\Rightarrow 8m > 25$ $\Rightarrow m > \frac{25}{8} \text{ or } m > 3\frac{1}{8}$	M1	50% of the candidates are able to solve it correctly.
		M1	Common Mistake: $b^2 - 4ac > 0$
		A1	
4(c)	$y = 3x + k \rightarrow (1)$ $2x^2 - xy = 9 \rightarrow (2)$ Sub. (1) into (2): $2x^2 - x(3x + k) = 9$ $-x^2 - kx - 9 = 0$ $x^2 + kx + 9 = 0$ For the line to meet the curve at two real & distinct points, $b^2 - 4ac > 0$ $k^2 - 4(1)(9) > 0$ $k^2 - 36 > 0$ $(k-6)(k+6) > 0$  $\therefore k < -6 \text{ or } k > 6$	M1	80.2% of the candidates are able to link the question to $b^2 - 4ac > 0$
		M1	
		M1	Common Mistake: $k^2 > 36$ $\Rightarrow k > \pm 6$
		A1	

5(a)	$x^3 + ax^2 - 5x + 23 \equiv (x - b)(x^2 - 4x + 7) + c$ Comparing coeff. of, x: $-5 = 7 + 4b$ $4b = -12$ $b = -3$ x^2: $a = -4 - b$ $a = -4 + 3$ $a = -1$ x^0: $23 = -7b + c$ $23 = 21 + c$ $c = 2$	B1 B1 B1	73.0% of the candidates are able to use the best method "Comparing Coefficients" to solve the problem.
5(b)	Let $f(x) = 2x^3 + px^2 - 18x + q$		
(i)	Given that $f(2) = 0$ and $f(-1) = 27$ $\Rightarrow 2(2)^3 + p(2)^2 - 18(2) + q = 0$ and $-2 + p + 18 + q$ $\Rightarrow 4p + q = 20 \rightarrow (1)$ and $p + q = 11 \rightarrow (2)$ (1) - (2): $3p = 9$ $p = 3$ $\therefore q = 11 - 3 = 8$	M1+M1 M1 A1 for both correct answers	84.1% of the candidates are able to apply the Remainder & Factor Theorems to form the 2 equations correctly.
(ii)	$f(x) = (x - 2)(2x^2 + Bx - 4)$ Comparing coeff. of, x: $-18 = -4 - 2B$ $2B = 14$ $B = 7$	M1 A1	
(iii)	Now, $f(x) = (x - 2)(2x^2 + 7x - 4)$ $= (x - 2)(2x - 1)(x + 4)$		77.8% of the candidates are able to factorise a cubic equations

	If $f(x-1) = 0$, $\Rightarrow 2(x-1)^3 + 3(x-1)^2 - 18(x-1) + 8 = 0$ $\Rightarrow x-1 = 2 \quad \text{or} \quad x-1 = \frac{1}{2} \quad \text{or} \quad x-1 = -4$ $\Rightarrow x = 3 \quad \text{or} \quad x = 1\frac{1}{2} \quad \text{or} \quad x = -3$	M1 A1 for all 3 correct answers	This seems to be another difficult question. Only 31.7% of them are able to solve it correctly.
6(i) $y = 4x^2 - 16x + 9$ $= 4\left(x^2 - 4x + \frac{9}{4}\right)$ $= 4\left[(x-2)^2 - 4 + \frac{9}{4}\right]$ $= 4\left[(x-2)^2 - \frac{7}{4}\right]$ $= 4(x-2)^2 - 7$ (ii) $(2, -7)$ (iii) x-intercepts : Let $y = 0$, $4(x-2)^2 - 7 = 0$ $x = 0.677 \quad \text{or} \quad 3.32$ y-intercept : Let $x = 0$, $y = 9$  B1 – Correct shape B1 – Correct x/y-intercepts B1 – Correct turning point	M1 A1 B1 B3	42.9% of the candidates are able to convert $ax^2 - bx + c$ into $a(x-h)^2 + k$ Careless mistakes made in algebraic Manipulation Majority of the candidates are weak in sketching.	

7	Area of triangle = $12 + 7\sqrt{3}$ $\frac{1}{2}(\sqrt{3} + 2) \times h = 12 + 7\sqrt{3}$ $\frac{1}{2}h = \frac{12 + 7\sqrt{3}}{\sqrt{3} + 2} \times \frac{\sqrt{3} - 2}{\sqrt{3} - 2}$ $\frac{1}{2}h = \frac{12\sqrt{3} - 24 + 7(3) - 14\sqrt{3}}{3 - 4}$ $\frac{1}{2}h = \frac{-2\sqrt{3} - 3}{-1}$ $\frac{1}{2}h = 3 + 2\sqrt{3}$ $h = 6 + 4\sqrt{3}$	M1 M1 M1 A1	70.6% of the candidates know how to rationalise the denominator in surd. Mistake: Could not form an expression for h. Did not know how to rationalise the denominator.
8(a)	$\log_a 4 = x$, $\log_a 5 = y$ $\log_{16} a = \frac{1}{\log_a 16}$ $= \frac{1}{2\log_a 4}$ $= \frac{1}{2x}$	M1 A1	63.5% of the candidates are able to solve it. Common Mistakes: $\frac{1}{\log_a 4^2} = \frac{1}{x^2}$ $\frac{1}{\log_a 16} = -\log_a 16$
8(b)	$\log_a (20\sqrt{a})$ $= \log_a 20 + \log_a \sqrt{a}$ $= \log_a 4 + \log_a 5 + \frac{1}{2}\log_a a$ $= x + y + \frac{1}{2}$	M1 M1 A1	This is another difficult question. Only 35.7% of the candidates got it right. Common Mistakes: $\log_a 20a^{\frac{1}{2}} = \frac{1}{2}\log_a 20a$ $\log_a 20a^{\frac{1}{2}} = \log_a 20 \times \log_a a^{\frac{1}{2}}$ $\log_a (4 \times 5)a^{\frac{1}{2}} = \log_a 4a^{\frac{1}{2}} + \log_a 5a^{\frac{1}{2}}$
8(c)	$\log_a \left(\frac{25}{64}\right)^x$ $= x[\log_a 25 - \log_a 64]$ $= x[2\log_a 5 - 3\log_a 4]$ $= x(2y - 3x)$ $= 2xy - 3x^2$	M1 M1 A1	40.5% got it right. Common Mistakes: $\log_a \left(\frac{25}{64}\right)^x = \frac{\log_a 25^x}{\log_a 64^x}$ $\log_a \left(\frac{25}{64}\right)^x = (\log_a 25 - \log_a 64)^x$ $x(\log_a 5^2 - \log_a 4^3) = x(y^2 - x^3)$

9(i) 9(ii)	$2x-1 -5=0$ $2x-1 =5$ $2x-1=5$ or $2x-1=-5$ $x=3$ or $x=-2$ <i>When $y=0$, $x=3$ or $x=-2$.</i> <i>When $x=0$, $y=-4$.</i> <i>When $x=-3$, $y=2$.</i> <i>When $x=4$, $y=2$.</i> <i>Vertex: $x = \frac{3+(-2)}{2} = \frac{1}{2}$</i> <i>$y = -5$</i> <i>Coord. of vertex = $\left(\frac{1}{2}, -5\right)$</i>  B1 – Correct x/y-intercepts and end points B1 – Correct vertex B1 – Correct V-shaped	M1 A1 for both correct answers	90.5% of the candidates got it right. This question was badly done. Only 21.4% of the candidates are able to sketch it correctly. Common Mistakes: Cannot see the connection between (i) and (ii). Part (i) gives the x-intercepts. Cannot find the vertex point. Not aware that it is a V-shaped graph.
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10(a)	$16(2^x)^3 = \frac{1}{8^x}$ $2^4 \cdot 2^{3x} = (2^{-3})^x$ $2^{4+3x} = 2^{-3x}$ $\Rightarrow 4 + 3x = -3x$ $\Rightarrow 6x = -4$ $\Rightarrow x = -\frac{2}{3}$	M1	60.3% got it right. Common Mistakes: Cannot apply the Laws of Indices correctly--
10(b)	$3^{2x+1} \times 5^{x-1} = 9^{2x} \times 25^x$ $(3^2)^x \times 3 \times 5^x \times 5^{-1} = 9^{2x} \times 5^{2x}$ $(9 \times 5)^x \times \frac{3}{5} = (9 \times 5)^{2x}$ $45^x \times \frac{3}{5} = 45^{2x}$ $45^{2x-x} = \frac{3}{5}$ $45^x = \frac{3}{5}$	M1	$16(2^x)^3 = 32^{3x}$ $2^4 \times 2^{3x} = 2^{12x}$ $2^{3x} = 2^3 \times 2^x$
10(c)	$9^{x+1} - 28(3^x) + 3 = 0$ $(3^{2x}) \times 9 - 28(3^x) + 3 = 0$ Let $y = 3^x$. $\therefore 9y^2 - 28y + 3 = 0$ $(9y-1)(y-3) = 0$ $y = \frac{1}{9} \quad \text{or} \quad y = 3$ $3^x = 3^{-2} \quad \text{or} \quad 3^x = 3$ $x = -2 \quad \text{or} \quad x = 1$	M1	This is the MOST difficult question. Only 14.3% got it right. <u>Common Mistakes:</u>
		M1	$3^{2x+1} \times 5^{x-1} = 9^{2x} \times 25^x$ $\Rightarrow 3^{2x+1} = 9^{2x} \text{ and } 5^{x-1} = 25^x$
		A1	$\frac{3^{2x+1}}{3^{4x}} = \frac{5^{2x}}{5^{x-1}}$ $\Rightarrow 2x + 1 - 4x = 2x - (x - 1)$ $3^{4x} = 3^4 \times 3^x$ $5^{2x} = 5^2 \times 5^x$
		M1	57.1% of the candidates are able to convert it into a quadratic equation.
		M1	
		A1 for both correct answers	

11(a)	$e^{2+x} = 3$ $2 + x = \ln 3$ $x = \ln 3 - 2$ ≈ -0.901	M1	72.2% got this right.
		A1	Common Mistake: $2 + x = \ln 3$ $\Rightarrow x = \frac{\ln 3}{2}$
11(b)	$\lg(x+4) - \lg(x-3) = 3\lg 2$ $\lg\left(\frac{x+4}{x-3}\right) = \lg 2^3$ $\frac{x+4}{x-3} = 8$ $x+4 = 8x-24$ $7x = 28$ $x = 4$	M1	54.8% got it right. Common Mistakes:
		M1	Apply the Quotient Law, wrongly. Unable to convert from a log equation to a non-log equation.
		A1	
11(c)	$\log_2 x + 8\log_x 2 = 9$ $\log_2 x + \frac{8}{\log_2 x} = 9$ $\text{Let } y = \log_2 x.$ $\therefore y + \frac{8}{y} = 9$ $y^2 - 9y + 8 = 0$ $(y-8)(y-1) = 0$ $y = 8 \quad \text{or} \quad y = 1$ $\log_2 x = 8 \quad \text{or} \quad \log_2 x = 1$ $x = 2^8 = 256 \quad \text{or} \quad x = 2$	M1	This question is difficult. Only 31.0% got it right.
		M1	Common Mistakes: $(\log_2 x)^2 = 2\log_2 x$ $(\log_2 x)^2 = \log_2 x^2$ Not aware that the log equation can be solved by forming a quadratic equation
		M1	
		A1 for both correct answers	