CAMBRIDGE INTERNATIONAL EXAMINATIONS

Cambridge International General Certificate of Secondary Education

MARK SCHEME for the October/November 2014 series

0606 ADDITIONAL MATHEMATICS

0606/13   Paper 1, maximum raw mark 80

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1	$a = 3$	**B1**	
	$b = 2$	**B1**	
	$c = 4$	**B1**	

2	$x^2 = 16$ or $y^2 - 4y + 3 = 0$	**M1**	for correct elimination of one variable and attempt to form a quadratic equation in x or y.
	$x = \pm 4$	**A1**	
	$y = 1, 3$	**A1**	
	Points $(-4, 1)$ and $(4, 3)$		
	Line $AB = \sqrt{8^2 + 2^2}$	**M1**	for use of Pythagoras theorem
	$= \sqrt{68}$ or $2\sqrt{17}$	**A1**	allow either form

3	(i)	$n(A) = 2$	**B1**	
		$n(B) = 3$	**B1**	**B0** for n(2), {2},{0}, $\varnothing$, {} etc.
		$n(C) = 0$	**B1**	
	(ii)	$A \cup B = \{-1, -2, -3, 3\}$	**B1**	
	(iii)	$A \cap B = \{-2\}$	**B1**	
	(iv)	ξ, 'the universal set', R, 'real numbers', $\{x : x \in \quad \}$	**B1**	

4	(a)	$\tan x = -\dfrac{5}{3}$	**M1**	Correct statement or $\tan x = -1.67$
		$x = 121.0°, \ 301.0°$	**A1** **A1ft**	**A1** for either correct solution **ft** from *their* first solution
	(b)	$\sin\left(3y + \dfrac{\pi}{4}\right) = \dfrac{1}{2}$	**M1**	for dealing correctly with cosec and attempt to solve subsequent equation
		$3y + \dfrac{\pi}{4} = \dfrac{\pi}{6}, \ \dfrac{5\pi}{6}, \ \dfrac{13\pi}{6}, \ \dfrac{17\pi}{6}$	**A1**	for $\dfrac{\pi}{6}, \ \dfrac{5\pi}{6},$ or $\dfrac{13\pi}{6},$ or $\dfrac{17\pi}{6}$
		$3y = -\dfrac{\pi}{12}, \ \dfrac{7\pi}{12}, \ \dfrac{23\pi}{12}, \ \dfrac{31\pi}{12}$	**DM1**	for correct order of operations
		$y = \dfrac{7\pi}{36}, \ \dfrac{23\pi}{36}, \ \dfrac{31\pi}{36}$ (0.611, 2.01 and 2.71)	**A1, A1**	**A1** for one correct solution **A1** for both the other correct solutions and no others in range.

5	(a)	(i)	$\begin{pmatrix} 12 & 2 & 1 \\ 9 & 3 & 0 \\ 8 & 5 & 1 \\ 11 & 2 & 0 \end{pmatrix}\begin{pmatrix} 0.5 \\ 0.4 \\ 0.45 \end{pmatrix} = \begin{pmatrix} 7.25 \\ 5.70 \\ 6.45 \\ 6.30 \end{pmatrix}$	**M1**	for correct compatible matrices in the correct order. Allow 1 error in each matrix. Allow if done in cents
			or $\begin{pmatrix} 0.5 & 0.4 & 0.45 \end{pmatrix}\begin{pmatrix} 12 & 9 & 8 & 11 \\ 2 & 3 & 5 & 2 \\ 1 & 0 & 1 & 0 \end{pmatrix}$	**DM1**	for a correct method for multiplying their matrices to obtain an appropriate 4 by 1 or 1 by 4 matrix.
			$= \begin{pmatrix} 7.25 & 5.70 & 6.45 & 6.30 \end{pmatrix}$	**A2,1,0**	**A2** all correct or **A1** 3 correct elements.
		(ii)	25.70	**B1**	Allow 25.7
	(b)		$\mathbf{Y} = \mathbf{X}^{-1}$ or $\mathbf{Y} = \mathbf{X}^{-1}\mathbf{I}$	**M1**	for matrix algebra
			$\mathbf{Y} = \dfrac{1}{22}\begin{pmatrix} 1 & -4 \\ 5 & 2 \end{pmatrix}$ or $\begin{pmatrix} \dfrac{1}{22} & -\dfrac{4}{22} \\ \dfrac{5}{22} & \dfrac{2}{22} \end{pmatrix}$	**A1**	for $\dfrac{1}{22}\begin{pmatrix} & \\ & \end{pmatrix}$
				A1	for $k\begin{pmatrix} 1 & -4 \\ 5 & 2 \end{pmatrix}$
			Alternative method: $\begin{pmatrix} 2 & 4 \\ -5 & 1 \end{pmatrix}\begin{pmatrix} a & b \\ c & d \end{pmatrix} = \begin{pmatrix} 1 & 0 \\ 0 & 1 \end{pmatrix}$ $2a + 4c = 1,\ 2b + 4d = 0$ $-5a + c = 0,\ -5b + d = 1$	**M1**	for a complete method using simultaneous equations
				A1	$a = \dfrac{1}{22}$ and $c = \dfrac{5}{22}$ or $b = -\dfrac{4}{22}$ and $d = \dfrac{2}{22}$
			leading to $= \dfrac{1}{22}\begin{pmatrix} 1 & -4 \\ 5 & 2 \end{pmatrix}$ oe	**A1**	for correct matrix

6	(i)	$\cos 0.9 = \dfrac{6}{OC}$ or $\dfrac{OC}{\sin 0.9} = \dfrac{12}{\sin(\pi - 1.8)}$ $OC = \dfrac{6}{\cos 0.9} = 9.652...$ or $OC = \dfrac{12\sin 0.9}{\sin(\pi - 1.8)} = 9.652...$	**M1** **A1**	for correct use of cosine, sine rule, cosine rule or any other valid method for manipulating correctly to $OC = 9.652(35…)$ Must have 4th figure (or more) for rounding
	(ii)	Perimeter $= (0.9 \times 12) + 9.652 + (12 - 9.652)$ $= 22.8$	**B1** **M1** **A1**	for arc length for attempt to add the correct lengths
	(iii)	Area $= \left(\dfrac{1}{2} \times 12^2 \times 0.9\right) - \left(\dfrac{1}{2} \times 9.652^2 \sin(\pi - 1.8)\right)$ $64.8 \; - \; 45.36$ $\qquad = \; 19.4 \text{ to } 19.5$ Alternative Method: $\dfrac{1}{2}(12 - 9.652) \times 9.652 \times \sin 1.8$ $\dfrac{1}{2}12^2(0.9 - \sin 0.9)$ $11.04 + 8.40$ Area $= 19.4 \text{ to } 19.5$	**B1** **B1** **B1** **B1** **B1** **B1**	for area of sector, allow unsimplified for area of isosceles triangle $\dfrac{1}{2}(9.65(2...))^2 \sin(\pi - 1.8)$ or $\dfrac{1}{2}(12 \times 6 \tan 0.9)$ or $\dfrac{1}{2}(12 \times 9.65(2...) \times \sin 0.9)$, allow unsimplified. for answer in range 19.4 to 19.5 for area of triangle *ACB*, unsimplified for area of segment, unsimplified answer in range 19.4 to 19.5
7		$1 + 2\log_5 x = \log_5(18x - 9)$ $\log_5 5 + \log_5 x^2 = \log_5(18x - 9)$ $5x^2 = 18x - 9$ $(5x - 3)(x - 3) = 0$ $x = \dfrac{3}{5}, \; 3$	**B1, B1** **M1** **DM1** **A1**	**B1** for dealing with '1', **B1** for dealing with '2' for a correct use of addition or subtraction of logarithms for elimination of logarithms to form a 3 term quadratic and for solution of quadratic for both *x* values

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8	(i)	$f'(x) = \left(x \times \dfrac{3x^2}{x^3}\right) + \left(\ln x^3\right)$	**M1** **B1**	for differentiation of a product for differentiation of $\ln x^3$
		$= 3 + 3\ln x, \;= 3(1 + \ln x)$	**A1**	for simplification to gain <u>given answer</u>
		or $f(x) = 3x\ln x$	**B1**	for use of $\ln x^3 = 3\ln x$
		$f'(x) = \left(3x \times \dfrac{1}{x}\right) + 3\ln x,$	**M1**	for differentiation of a product
		$= 3(1 + \ln x)$	**A1**	for simplification to gain <u>given answer</u>
	(ii)	$\int 3(1 + \ln x)\,dx = x\ln x^3 \;$ or $\; 3x\ln x$	**M1**	for realising that differentiation is the reverse of integration and using **(i)**
		$\int 1 + \ln x\,dx = \dfrac{1}{3}x\ln x^3 \;$ or $\; x\ln x$	**A1**	
	(iii)	$x\ln x - \int 1\,dx \;$ or $\; \left[\dfrac{1}{3}x\ln x^3\right] - \int 1\,dx$	**DM1**	for using answer to **(ii)** and subtracting $\int 1\,dx$ dependent on M mark in **(ii)**
		$\left[x\ln x - x\right]_1^2 \;$ or $\; \left[\dfrac{1}{3}x\ln x^3 - x\right]_1^2$	**DM1**	for correct application of limits
		$= 2\ln 2 - 2 + 1$ $= -1 + \ln 4$	**A1**	from correct working
9	(a)	$5^p = 625$, so $p = 4$	**B1**	
		${}^4C_1 5^{p-1}(-q) = -1500$ $4 \times 125(-q) = -1500$ $q = 3$	**M1** **A1**	*their p* substituted in ${}^PC_1 5^{p-1}(-q)$ or in ${}^PC_1 5^{p-1}(-qx)$ unsimplified
		${}^4C_2 5^{p-2}q^2 = r$	**M1**	*their p* and *q* substituted in ${}^PC_2 5^{p-2}(-q)^2$ or ${}^PC_2 5^{p-2}(-qx)^2$ unsimplified
		$r = 1350$	**A1**	
	(b)	${}^{12}C_3 (2x)^9 \left(\dfrac{1}{4x^3}\right)^3$	**M1**	for identifying correct term
			DM1	for attempt to evaluate correct expression
		Term is 1760	**A1**	must be evaluated

10	(a)	$\dfrac{5^x}{5^{2(3y-2)}} = 1$ or $\dfrac{3^x}{3^{3(y-1)}} = 3^4$ oe	**M1**	for obtaining one correct equation in powers of 5, 3, 25, 27 or 81
		$x = 6y - 4$	**A1**	for $x = 6y - 4$ oe linear equation
		$x = 3y + 1$	**A1**	for $x = 3y + 1$ oe linear equation
			M1	for attempt to solve linear simultaneous equations which have been obtained correctly
		Leads to $x = 6,\ y = \dfrac{5}{3}$	**A1**	for both.
	(b)	Using the cosine rule: $\left(1 + 2\sqrt{3}\right)^2 = \left(2 + \sqrt{3}\right)^2 + 2^2 - 4\left(2 + \sqrt{3}\right)\cos A$	**M1**	for correct substitution in cosine rule, may use in form of $\cos A = ...$
		$\cos A = \dfrac{\left(13 + 4\sqrt{3}\right) - \left(7 + 4\sqrt{3}\right) - 4}{-4\left(2 + \sqrt{3}\right)}$ oe	**DM1**	for attempt to make cos$A$ subject and simplify
		$\cos A = \dfrac{-1}{2\left(2 + \sqrt{3}\right)} \times \dfrac{2 - \sqrt{3}}{2 - \sqrt{3}}$	**DM1**	for rationalisation.
		$\cos A = -1 + \dfrac{\sqrt{3}}{2}$	**A1**	

11	(i)	$\dfrac{\mathrm{d}y}{\mathrm{d}x} = (x+5)2(x-1) + (x-1)^2$	**M1**	for differentiation of a product, allow unsimplified
			A1	correct
		$\dfrac{\mathrm{d}y}{\mathrm{d}x} = (x-1)(3x+9)$		
		When $\dfrac{\mathrm{d}y}{\mathrm{d}x} = 0$	**DM1**	for equating to zero and solution of quadratic
		$x = 1$	**A1**	
		$x = -3$	**A1**	
		Alternative method:		
		$y = x^3 + 3x^2 - 9x + 5$	**M1**	for expansion of brackets and differentiation of each term of a 4 term cubic
		$\dfrac{\mathrm{d}y}{\mathrm{d}x} = 3x^2 + 6x - 9$	**A1**	
		When $\dfrac{\mathrm{d}y}{\mathrm{d}x} = 0$	**DM1**	for equating to zero and solution of 3 term quadratic
		$x = 1$	**A1**	from correct quadratic equation
		$x = -3$	**A1**	from correct quadratic equation
	(ii)	$\displaystyle\int x^3 + 3x^2 - 9x + 5 \,\mathrm{d}x$	**M1**	for correct attempt to obtain and integrate a 4 term cubic
		$= \dfrac{x^4}{4} + x^3 - \dfrac{9x^2}{2} + 5x \ (+c)$	**A2,1,0**	**A2** for 4 correct terms or **A1** for 3 correct terms
	(iii)	$\left[\dfrac{x^4}{4} + x^3 - \dfrac{9x^2}{2} + 5x \right]_{-5}^{1}$	**M1**	for correct substitution of limits 1 and –5 for *their* **(ii)**
		$= \left(\dfrac{1}{4} + 1 - \dfrac{9}{2} + 5 \right) - \left(\dfrac{625}{4} - 125 - \dfrac{225}{2} - 25 \right)$		
		$= 108$	**A1**	
	(iv)	When $x = -3, \ y = 32$	**M1**	for realising that the *y*-coordinate of the maximum point is needed.
		$k > 32$	**A1**	