## MARK SCHEME for the October/November 2015 series

## **0606 ADDITIONAL MATHEMATICS**

0606/13

Paper 1, maximum raw mark 80

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Т

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## Abbreviations

Г

Awrt	answers which round to
Cao	correct answer only
dep	dependent
FT	follow through after error
isw	ignore subsequent working
oe	or equivalent
rot	rounded or truncated
SC	Special Case
soi	seen or implied
www	without wrong working

1 (i)		B1	
(ii)		B1	
(iii)		B1	
2	$\cos\left(3x - \frac{\pi}{4}\right) = (\pm)\frac{1}{\sqrt{2}} \text{ oe}$	M1	division by 2 and square root
	$3x - \frac{\pi}{4} = -\frac{\pi}{4}, \ \frac{\pi}{4}, \ \frac{3\pi}{4}$		
	$x = \left(-\frac{\pi}{4} + \frac{\pi}{4}\right) \div 3, \ \left(\frac{\pi}{4} + \frac{\pi}{4}\right) \div 3, \ \left(\frac{3\pi}{4} + \frac{\pi}{4}\right) \div 3 \text{ oe}$	DM1	correct order of operations in order to obtain a solution
	$x = 0$ and $\frac{\pi}{6}$ (or 0 and 0.524)	A2/1/0	A2 for 3 solutions and no extras in the range
	$x = \frac{\pi}{3}$ (or 1.05)		A0 for one solution or no solutions

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3	(a)	$\begin{pmatrix} 12 & 16 & 4 \\ 30 & 32 & 10 \end{pmatrix}$	B2,1,0	B2 for 6 elem B1for 5 elem	nents correct, ents correct		
	(b)	$ \begin{pmatrix} 28 & -24 \\ -8 & 76 \end{pmatrix} = m \begin{pmatrix} 4 & 6 \\ 2 & -8 \end{pmatrix} + n \begin{pmatrix} 1 & 0 \\ 0 & 1 \end{pmatrix} $	B2,1,0	B2 for 4 corr B1 for 3 corr	ect elements ect elements	in $\mathbf{X}^2$ in $\mathbf{X}^2$	
		-24 = 6m or $-8 = 2m$ giving $m = -4$	B1	For $m = -4$ using correct I			
		28 = 4m + n or $76 = -8m + nn = 44$	M1 A1	complete met	hod to obtain	n <i>n</i>	
	(c)	$a^2 - 6 = 0$ so $a = \pm \sqrt{6}$	B2,1,0	B2 for $a = \pm -$ incorrect state or B1 for $a = \pm -$ or B1 for $a = \sqrt{6}$	$\sqrt{6}$ or $a = \pm 2$ ements seen $\sqrt{6}$ or $a = \pm 2$ and no inco	.45, with no 2.45 seen prrect working	5
4	(i)	$\frac{1}{2}\left(4\sqrt{3}+1\right) \times BC = \frac{47}{2}$	B1	correct use of	f the area		
		$BC = \frac{47}{(4\sqrt{3}+1)} \times \frac{(4\sqrt{3}-1)}{(4\sqrt{3}-1)}$ $BC = 4\sqrt{3}-1$	M1 A1	correct ration Dependent or	alisation 1 all method	being seen	
		Alternative method					
		$\frac{1}{2}\left(4\sqrt{3}+1\right) \times BC = \frac{47}{2}$ $\left(4\sqrt{3}+1\right)\left(a\sqrt{3}+b\right) = 47$	B1				
		Leading to $12a + b = 47$ and $a + 4b = 0$ Solution of simultaneous equations	M1				
		$BC = 4\sqrt{3-1}$	A1	Dependent or solution of si	n all method multaneous e	seen including	5
	(ii)	$\left(4\sqrt{3}+1\right)^2+\left(4\sqrt{3}-1\right)^2$					
		$= (48 + 8\sqrt{3} + 1) + (48 - 8\sqrt{3} + 1)$	B1FT	6 correct FT	terms seen		
		$AC^2 = 98$ $AC = 7\sqrt{2}$ or $p = 7$	B1cao	98 and $7\sqrt{2}$	or 98 and <i>p</i> =	= 7	

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5		When $x = \frac{\pi}{4}$ , $y = 2$	B1	<i>y</i> = 2			
		$\frac{\mathrm{d}y}{\mathrm{d}x} = 5\mathrm{sec}^2 x$	B1	$5 \sec^2 x$			
		When $x = \frac{\pi}{4}$ , $\frac{dy}{dx} = 10$	B1	10 from diffe	rentiation		
		Equation of normal $y - 2 = -\frac{1}{10}\left(x - \frac{\pi}{4}\right)$	M1	y - their 2 = -	$-\frac{1}{their10}\left(x-\frac{1}{10}\right)$	$-\frac{\pi}{4}$	
		$10y + x - 20 - \frac{\pi}{4} = 0$ or $10y + x - 20.8 = 0$ oe	A1	allow unsimp	lified		
6	(i)	-4 -2 2 4 6 8	B1 B1 B1	shape intercepts on intercept on y maximum an	<i>x-</i> axis <sup>2-</sup> axis for a c d two arms	urve with a	
	(ii)	(2,16)	M1 A1	$(2, \pm 16)$ seen (2, 16) or $x =$	or $(2, k)$ wh 2 and $y = 10$	here $k > 0$ 5 only	
	(iii)	k = 0	B1				
		<i>k</i> >16	B1				
1				1			

Cambridge IGCSE – October/November 2015         0606         13           7 $\frac{dy}{dx} = 2\sin 3x$ (+c) $4\sqrt{3} = 2\frac{\sqrt{3}}{2} + c$ B1 $2\sin 3x$ M1         finding constant using $\frac{dy}{dx} = k\sin 3x + c$ making use of $\frac{dy}{dx} = 4\sqrt{3}$ and $x = \frac{\pi}{9}$ A1 $\frac{dy}{dx} = 2\sin 3x + 3\sqrt{3}$ A1         Allow with $c = 5.20 \text{ or } \sqrt{27}$ $y = -\frac{2}{3}\cos 3x + 3\sqrt{3}x$ (+d)         B1FT         FT integration of their k sin 3x $-\frac{1}{3} = -\frac{2}{3}\cos \frac{\pi}{3} + 3\sqrt{3}\left(\frac{\pi}{9}\right) + d$ M1         finding constant d for $k\cos 3x + cx + d$ $y = -\frac{2}{3}\cos 3x + 3\sqrt{3}x - \frac{\sqrt{3}}{3}\pi$ A1         Allow $y = -0.667\cos 3x + 5.20x - 0.577\pi$ or better         A1           8         (a) $(2 + kx)^8 = 256 + 1024kx + 1792k^2x^2 + 1792k^3x^3$ $k = \frac{1}{4}$ B1 P = 112 q = 28         B1 B1FT         FT 1792 multiplied by their $k^2$ (b) ${}^9C_3x^6\left(-\frac{2}{x^2}\right)^3$ $84x^6\left(-\frac{8}{x^6}\right)$ leading to -672         DM1 A1         correct term seen		Page 5	Mark Scheme			Syllabus	Paper	
7 $\frac{dy}{dx} = 2\sin 3x + c$ BI $2\sin 3x$ $4\sqrt{3} = 2\frac{\sqrt{3}}{2} + c$ M1       Inding constant using $\frac{dy}{dx} = k\sin 3x + c$ making use of $\frac{dy}{dx} = 4\sqrt{3}$ and $x = \frac{\pi}{9}$ $\frac{dy}{dx} = 2\sin 3x + 3\sqrt{3}$ A1       Allow with $c = 5.20 \text{ or } \sqrt{27}$ $y = -\frac{2}{3}\cos 3x + 3\sqrt{3}x + (+d)$ B1FT       FT integration of their k sin 3x $-\frac{1}{3} = -\frac{2}{3}\cos \frac{\pi}{3} + 3\sqrt{3}\left(\frac{\pi}{9}\right) + d$ M1       finding constant d for $k\cos 3x + cx + d$ $y = -\frac{2}{3}\cos 3x + 3\sqrt{3}x - \frac{\sqrt{3}}{3}\pi$ A1       Allow $y = -0.667\cos 3x + 5.20x - 0.577\pi$ 8       (a) $(2 + kx)^8 = 256 + 1024kx + 1792k^2x^2 + 1792k^3x^3$ B1 $k = \frac{1}{4}$ B1FT       FT 1792 multiplied by their $k^2$ $p = 112$ B1FT       FT 1792 multiplied by their $k^2$ $q = 28$ B1FT       FT 1792 multiplied by their $k^2$ (b) ${}^9C_3x^6\left(-\frac{2}{x^2}\right)^3$ M1       correct term seen $84x^6\left(-\frac{8}{x^6}\right)$ leading to       DM1       Term selected and 2^3 and ${}^9C_3$ correctly evaluated			Cambridge IGCSE – October/Nove	ember 20	15	0606	13	J
7 $\frac{dy}{dx} = 2\sin 3x$ (+c)       B1 $2\sin 3x$ $4\sqrt{3} = 2\frac{\sqrt{3}}{2} + c$ M1       finding constant using $\frac{dy}{dx} = k\sin 3x + c$ making use of $\frac{dy}{dx} = k\sin 3x + c$ making use of $\frac{dy}{dx} = 4\sqrt{3}$ and $x = \frac{\pi}{9}$ $\frac{dy}{dx} = 2\sin 3x + 3\sqrt{3}$ A1       Allow with $c = 5.20 \text{ or } \sqrt{27}$ $y = -\frac{2}{3}\cos 3x + 3\sqrt{3}x$ (+d)       B1FT       FT integration of their k sin 3x $-\frac{1}{3} = -\frac{2}{3}\cos \frac{\pi}{3} + 3\sqrt{3}\left(\frac{\pi}{9}\right) + d$ M1       finding constant d for $k\cos 3x + cx + d$ $y = -\frac{2}{3}\cos 3x + 3\sqrt{3}x - \frac{\sqrt{3}}{3}\pi$ A1       Allow $y = -0.667\cos 3x + 5.20x - 0.577\pi$ 8       (a) $(2 + kx)^8 = 256 + 1024kx + 1792k^2x^2 + 1792k^3x^3$ B1 $k = \frac{1}{4}$ B1       B1FT       FT 1792 multiplied by their k^2 $q = 28$ B1FT       B1FT       FT 1792 multiplied by their k^2         (b) ${}^{9}C_{3}x^6\left(-\frac{2}{x^2}\right)^3$ M1       correct term seen $84x^6\left(-\frac{8}{x^6}\right)$ leading to       DM11       Term selected and 2^3 and ${}^{9}C_3$ correctly evaluated								
$4\sqrt{3} = 2\frac{\sqrt{3}}{2} + c$ $M1$ finding constant using $\frac{dy}{dx} = k\sin 3x + c$ making use of $\frac{dy}{dx} = 4\sqrt{3} \text{ and } x = \frac{\pi}{9}$ $\frac{dy}{dx} = 2\sin 3x + 3\sqrt{3}$ $y = -\frac{2}{3}\cos 3x + 3\sqrt{3}x  (+d)$ $H1$ $M1$ $M1$ $M1$ $M1$ $M1$ $M1$ $M1$ $M$	7		$\frac{\mathrm{d}y}{\mathrm{d}x} = 2\sin 3x  (+c)$	B1	$2\sin 3x$			
$\frac{dy}{dx} = 2\sin 3x + 3\sqrt{3}$ A1 Allow with $c = 5.20 \text{ or } \sqrt{27}$ $y = -\frac{2}{3}\cos 3x + 3\sqrt{3}x  (+d)$ B1FT FT integration of <i>their</i> $k \sin 3x$ $-\frac{1}{3} = -\frac{2}{3}\cos \frac{\pi}{3} + 3\sqrt{3}\left(\frac{\pi}{9}\right) + d$ M1 finding constant $d$ for $k \cos 3x + cx + d$ $y = -\frac{2}{3}\cos 3x + 3\sqrt{3}x - \frac{\sqrt{3}}{3}\pi$ A1 Allow $y = -0.667\cos 3x + 5.20x - 0.577\pi$ or better $\frac{8  (a)}{y = -28}$ (b) $\frac{(2 + kx)^8 = 256 + 1024kx + 1792k^2x^2 + 1792k^3x^3}{k = \frac{1}{4}}$ B1 B1 B1FT FT 1792 multiplied by <i>their</i> $k^2$ B1FT FT 1792 multiplied by <i>their</i> $k^3$ (b) $\frac{^9C_3x^6\left(-\frac{2}{x^2}\right)^3}{84x^6\left(-\frac{8}{x^6}\right)}$ leading to $-672$ A1 Allow with $c = 5.20 \text{ or } \sqrt{27}$ A1 Correct term seen DM1 Term selected and $2^3$ and $\frac{^9C_3}{c_3}$ correctly evaluated			$4\sqrt{3} = 2\frac{\sqrt{3}}{2} + c$	M1	finding const $\frac{dy}{dx} = k \sin 3x$ $\frac{dy}{dx} = 4\sqrt{3} \text{ an}$	ant using + c making und $x = \frac{\pi}{9}$	ise of	
$y = -\frac{2}{3}\cos 3x + 3\sqrt{3}x  (+d)$ $B1FT$ $FT integration of their k sin 3x -\frac{1}{3} = -\frac{2}{3}\cos \frac{\pi}{3} + 3\sqrt{3}\left(\frac{\pi}{9}\right) + d y = -\frac{2}{3}\cos 3x + 3\sqrt{3}x - \frac{\sqrt{3}}{3}\pi A1 A1 A1 ow  y = -0.667\cos 3x + 5.20x - 0.577\pi or better k = \frac{1}{4} p = 112 q = 28 B1FT B1FT FT 1792 \text{ multiplied by their k2}  B1FT FT 1792 \text{ multiplied by their k2} FT 1792 \text{ multiplied by their k2} FT 1792 \text{ multiplied by their k2}  FT 1$			$\frac{\mathrm{d}y}{\mathrm{d}x} = 2\sin 3x + 3\sqrt{3}$	A1	Allow with $c = 5.20 \text{ or } \sqrt{27}$			
$\begin{array}{c c c c c c c c c c c c c c c c c c c $			$y = -\frac{2}{3}\cos 3x + 3\sqrt{3}x  (+d)$	B1FT	FT integration of <i>their</i> $k \sin 3x$			
$y = -\frac{2}{3}\cos 3x + 3\sqrt{3}x - \frac{\sqrt{3}}{3}\pi$ A1 Allow $y = -0.667\cos 3x + 5.20x - 0.577\pi$ or better 8 (a) $(2 + kx)^8 = 256 + 1024kx + 1792k^2x^2 + 1792k^3x^3$ $k = \frac{1}{4}$ B1 p = 112 $q = 28$ B1 B1FT B1FT B1FT FT 1792 multiplied by <i>their</i> k^2 FT 1792 multiplied by <i>their</i> k^3 (b) ${}^9C_3x^6\left(-\frac{2}{x^2}\right)^3$ M1 correct term seen $84x^6\left(-\frac{8}{x^6}\right)$ leading to $-672$ M1 Term selected and 2^3 and {}^9C_3 correctly evaluated			$-\frac{1}{3} = -\frac{2}{3}\cos\frac{\pi}{3} + 3\sqrt{3}\left(\frac{\pi}{9}\right) + d$	M1	finding constant <i>d</i> for $k \cos 3x + cx + cx$			d
8 (a) $(2 + kx)^8 = 256 + 1024kx + 1792k^2x^2 + 1792k^3x^3$ $k = \frac{1}{4}$ p = 112 $q = 28$ B1FT FT 1792 multiplied by <i>their</i> $k^2$ B1FT FT 1792 multiplied by <i>their</i> $k^3$ (b) ${}^9C_3x^6\left(-\frac{2}{x^2}\right)^3$ $84x^6\left(-\frac{8}{x^6}\right)$ leading to $-672$ DM1 Term selected and 2 <sup>3</sup> and ${}^9C_3$ correctly evaluated			$y = -\frac{2}{3}\cos 3x + 3\sqrt{3}x - \frac{\sqrt{3}}{3}\pi$	A1	Allow y = -0.667 co or better	$5x^{3}x + 5.20x$	$-0.577\pi$	
$k = \frac{1}{4}$ $p = 112$ $q = 28$ B1 B1FT B1FT FT 1792 multiplied by <i>their</i> k <sup>2</sup> FT 1792 multiplied by <i>their</i> k <sup>3</sup> M1 correct term seen $84x^{6}\left(-\frac{8}{x^{6}}\right)$ leading to $-672$ DM1 Term selected and 2 <sup>3</sup> and <sup>9</sup> C <sub>3</sub> correctly evaluated	8	(a)	$(2+kx)^8 = 256 + 1024kx + 1792k^2x^2 + 1792k^3x^3$					
(b) $ \begin{array}{c} p = 112 \\ q = 28 \end{array} \\ \begin{array}{c} B1FT \\ B1FT \end{array} \\ \begin{array}{c} FT & 1792 \text{ multiplied by their } k^2 \\ FT & 1792 \text{ multiplied by their } k^3 \end{array} \\ \begin{array}{c} M1 \\ evaluated \end{array} \\ \begin{array}{c} correct \text{ term seen} \\ A1 \end{array} \\ \begin{array}{c} Term \text{ selected and } 2^3 \text{ and } {}^9C_3 \text{ correctly} \\ evaluated \end{array} \\ \end{array} $			$k = \frac{1}{4}$	B1				
(b) ${}^{9}C_{3}x^{6}\left(-\frac{2}{x^{2}}\right)^{3}$ $84x^{6}\left(-\frac{8}{x^{6}}\right)$ leading to -672 M1 correct term seen DM1 Term selected and 2 <sup>3</sup> and ${}^{9}C_{3}$ correctly evaluated			p = 112 $q = 28$	B1FT B1FT	FT 1792 mu FT 1792 mu	ltiplied by <i>th</i> ltiplied by <i>th</i>	eir k <sup>2</sup> eir k <sup>3</sup>	
$\begin{vmatrix} 84x^6 \left(-\frac{8}{x^6}\right) \text{ leading to} \\ -672 \end{vmatrix} \qquad $		(b)	${}^{9}C_{3}x^{6}\left(-\frac{2}{x^{2}}\right)^{3}$	M1	correct term seen			
			$84x^6\left(-\frac{8}{x^6}\right)$ leading to -672	DM1 A1	Term selected evaluated	d and 2 <sup>3</sup> and	${}^{9}C_{3}$ correctly	У

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		-	-				
9	(a) (i)	Number of arrangements with Maths books as one item = $4!$ or $4 \times 3!$	M1	$4!(\times 2) \text{ or } 4 \times$	$4!(\times 2) \text{ or } 4 \times 3!(\times 2) \text{ oe}$ $2! \times 3!(\times 4) \text{ or } 2 \times 3!(\times 4) \text{ oe}$		
		or Maths books can be arranged 2! ways and History 3! ways = $2! \times 3!$		2!×3!(×4) o			
		$2 \times 4! \text{ or } 2 \times 4 \times 3! \text{ or } 4 \times 2 \times 3! = 48$	A1	A1 for 48			
	(ii)	$5! - 48 \text{ or } 6 \times 2 \times 3!$	M1	5! - their ans			
		72	A1	01101 0 × 2 ×			
	(b) (i)	3003	B1				
	(ii)	3003 - 6 - 135	M1	their answer	to (i) $-6^{-6}$	$C_4 \times 9$	
		2862	B1 A1	135 subtracte	ed		
		or $2M \ 3W = 720$ $3M \ 2W = 1260$	M1	complete cor may be impli	rect method ed by workin	using 4 cases, ng. Must have	
		$4M \ 1W = 756$ 5M = 126 2862	B1 A1	at least one c any 3 correct	orrect		

Γ	Page 7	Mark Scheme			Syllabus	Paper	r
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10	(i)	$10^2 = 6^2 + 6^2 - 2 \times 6 \times 6 \times \cos ABC$	M1	correct cosine rule statement or correct statement for $\sin \frac{ABC}{2}$ or equating are			
		$\sin\left(\frac{ABC}{2}\right) = \frac{5}{6}$		oe	2		
		or $ABC = \pi - \sin^{-1} \frac{10\sqrt{11}}{36}$					
		ABC = 1.9702	A1	1.9702 or bet	ter		
	(ii)	XY = 2	B1	for <i>XY</i> (may be implied by later v allow on diagram)			• <b>•</b>
		Arc length $6\left(\frac{\pi-1.970}{2}\right)$ oe	B1	correct arc le	ngth (unsimp	lified)	
		Perimeter = $2 + 2\left(6\left(\frac{\pi - 1.970}{2}\right)\right)$	M1	<i>their</i> $2 + 2 \times$	$6 \times their$ and	gle C	
		= 9.03	A1				
	(iii)	$\left(\frac{1}{2} \times 6^2 \left(\frac{\pi - 1.970}{2}\right) - \frac{1}{2} \times 5 \times \sqrt{11}\right) \times 2$	M1 M1	sector area us area of $\Delta ABA$ of AC, or ( $\Delta$ s	sing <i>their C</i> M where M is ABY and BX	s the midpoi Ύ) or Δ <i>ABC</i>	nt
		= 4.50 or 4.51 or better	A1	Answers to 3	sf or better		

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11		$x^2 - 2x - 3 = 0$ or $y^2 - 6y + 5 = 0$	M1	substitution a a three term c variable	nd simplifica quadratic equ	ation to obta ation in one	in
		leading to (3, 5) and (-1, 1)	A1,A1	A1 for each ' quadratic equ	pair' from a ation, correc	correct tly obtained	
		Midpoint (1, 3)	B1cao	midpoint			
		(Gradient - 1) Perpendicular bisector $y = 4 - x$ Meets the curve again if $x^{2} + 10x - 15 = 0$ or $y^{2} - 18y + 41 = 0$ leading to $x = -5 \pm 2\sqrt{10}, y = 9 \mp 2\sqrt{10}$	M1 M1 A1,A1	perpendicular their perpend midpoint substitution a a three term c variable. A1 for each '	r bisector, mi icular gradie nd simplifica juadratic equ pair'	ust be using nt and <i>their</i> ation to obta ation in one	in
		$CD^{2} = \left(4\sqrt{10}\right)^{2} + \left(4\sqrt{10}\right)^{2}$ $CD = 8\sqrt{5}$	M1 A1	Pythagoras us solution of se $(x_1 - x_2)^2 + (x_1 - x_2)^2 + (x_2 - x_2)^2$ must be seen coordinates. A1 for $8\sqrt{5}$ ff so far.	sing <i>their</i> con- cond quadra $y_1 - y_2$ <sup>2</sup> if not using or from $\sqrt{320}$ a	ordinates fro tic. correct nd all correc	om

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12	(a)	$2^{2x-1} \times 2^{2(x+y)} = 2^7$ and $\frac{3^{2(2y-x)}}{3^{3(y-4)}} = 1$	M1	expressing 4' $9^{2y-x}$ , $27^{y-4}$ as	<sup>x+y</sup> , 128 as positive s powers of 3	owers of 2 ar	nd
		2x - 1 + 2(x + y) = 7 oe	A 1	Correct equa	tion from cor	rect working	σ
		2(2y-x)=3(y-4) oe	Al	Correct equa	tion from con	rect working	s g
		leading to $x = 4$ , $y = -4$	A1	for both			2
		Example of Alternative method Method mark as above 2x - 1 + 2(x + y) = 7	M1 A1	As before One of the co	orrect equatic	ons in <i>x</i> and <i>y</i>	V
		leading to $y = \frac{(8-4x)}{2}$ Correctly substituted in $\frac{3^{2(2y-x)}}{3^{3(y-4)}} = 1$					
		Leading to $2\left(\frac{2(8-4x)}{2}-x\right) = 3\left(\frac{(8-4x)}{2}-4\right)$ Leading to $x = 4$ and $y = -4$	A1 A1	Correct, unsi only Both answers	mplified, equ	nation in $x$ or	r y
	(b)	$(2(5^z)-1)(5^z+1)=0$ leading to 2.5 <sup>z</sup> = 1 $(5^z = -1)$	M1 A1	solution of que correct solution	uadratic on		
		$5^{z} = 0.5$	DM1	correct attem <i>k</i> is positive	pt to solve 2.	$5^z = k$ , whe	ere
		$z = \frac{\log 0.5}{\log 5}$ or $z = -0.431$ or better	A1	must have on	e solution or	ıly	