



**Cambridge International Examinations**  
Cambridge International General Certificate of Secondary Education

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**ADDITIONAL MATHEMATICS**

**0606/12**

Paper 1

**October/November 2016**

MARK SCHEME

Maximum Mark: 80

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**Published**

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This document consists of **6** printed pages.

<b>Page 2</b>	<b>Mark Scheme</b>	<b>Syllabus</b>	<b>Paper</b>
	<b>Cambridge IGCSE – October/November 2016</b>	<b>0606</b>	<b>12</b>

### Abbreviations

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

Question	Answer	Marks	Part Marks
<b>1 (a) (i)</b>	10	<b>B1</b>	
<b>(ii)</b>	22	<b>B1</b>	
<b>(iii)</b>	4	<b>B1</b>	
<b>(b) (i)</b>	$Q \subset R$	<b>B1</b>	
<b>(ii)</b>	$P \cap Q = \emptyset$ , or $\{ \}$	<b>B1</b>	
<b>2</b>	$a = 1, b = -3, c = -1$	<b>B3</b>	<b>B1</b> for each
<b>3</b>	$3y^2 + 5y - 2 = 0$ $y = \frac{1}{3}, y = -2$ $x = 3^{\frac{1}{3}}, x = 3^{-2}$ $x = 1.44, x = \frac{1}{9}$	<b>B1, B1</b> <b>M1</b> <b>M1</b> <b>A1, A1</b>	<b>B1</b> for $5y$ or $5\log_3 x$ , <b>B1</b> for $-2$ for correct attempt at the solution of <i>their</i> quadratic equation for dealing with one base 3 logarithm correctly <b>A1</b> for each
<b>4 (i)</b>	$32x^{10} - \frac{80}{3}x^7 + \frac{80}{9}x^4$	<b>B3</b>	<b>B1</b> for each term, powers of $x$ must be simplified
<b>(ii)</b>	Coefficients needed: $\left(3 \times \text{their} - \frac{80}{3}\right) + (1 \times \text{their } 32)$ $= -48$	<b>M1</b> <b>A1</b>	for dealing with 2 terms Allow <b>A1</b> for $-48x^7$

Page 3	Mark Scheme	Syllabus	Paper
	Cambridge IGCSE – October/November 2016	0606	12

Question	Answer	Marks	Part Marks
5 (i)	$\frac{dy}{dx} = \frac{3}{2(3x+2)}$	<b>B1</b>	for correct derivative of log function
	When $x = -\frac{1}{3}$ , $y = 0$ , $\frac{dy}{dx} = \frac{3}{2}$ Equation of normal: $y = -\frac{2}{3}\left(x + \frac{1}{3}\right)$	<b>B1</b> <b>M1</b> <b>A1</b>	for $y = 0$ <b>M1</b> for attempt at a gradient of a perpendicular from differentiation and the equation of the normal
(ii)	$Q\left(0, -\frac{2}{9}\right)$ or $(0, 0.22)$ or better	<b>B1 ft</b>	Follow through on <i>their c</i> from part (i)
	$R\left(0, \frac{1}{2}\ln 2\right)$ or $(0, 0.35)$ or better	<b>B1</b>	
	Area of $PQR = \frac{1}{2}\left(\frac{1}{2}\ln 2 + \frac{2}{9}\right) \times \frac{1}{3}$ $= 0.0948$	<b>B1</b>	Allow 0.095
6 (a)	<b>YX, XZ</b>	<b>B2</b>	<b>B2</b> for both with no extras <b>B1</b> for 1 correct with or without extras <b>B1</b> for both correct with extras <b>B0</b> for anything else
(b) (i)	$\frac{1}{18}\begin{pmatrix} 7 & 1 \\ -4 & 2 \end{pmatrix}$	<b>B1, B1</b>	<b>B1</b> for $\frac{1}{18}$ , <b>B1</b> for $\begin{pmatrix} 7 & 1 \\ -4 & 2 \end{pmatrix}$
	(ii) $\mathbf{C} = \mathbf{A}^{-1}\mathbf{B}$ $= \frac{1}{18}\begin{pmatrix} 7 & 1 \\ -4 & 2 \end{pmatrix}\begin{pmatrix} -4 & 2 \\ 10 & 4 \end{pmatrix}$ $= \begin{pmatrix} -1 & 1 \\ 2 & 0 \end{pmatrix}$	<b>M1</b> <b>A1, A1</b>	for pre-multiplication <b>A1</b> for any correct pair of elements, but must be from correct matrices

Page 4	Mark Scheme	Syllabus	Paper
	Cambridge IGCSE – October/November 2016	0606	12

Question	Answer	Marks	Part Marks
7	(i) $(0, \sqrt{3})$ or $(0, 1.73)$ or better	<b>B1</b>	<b>B1</b> for each  for correct attempt to solve trigonometric equation
	(ii) $\left(\frac{\pi}{6}, 2\right)$ or $(0.524, 2)$ or better	<b>B1, B1</b>	
	(iii) $\cos\left(x - \frac{\pi}{6}\right) = 0$ $x = \frac{2\pi}{3}$ oe or 2.09 or better	<b>M1</b> <b>A1</b>	
	(iv) $2\sin\left(x - \frac{\pi}{6}\right)$ (+c)	<b>B1</b>	
	(v) Area = $\left[2\sin\left(x - \frac{\pi}{6}\right)\right]_0^{\frac{2\pi}{3}}$ = 2 + 1 = 3	<b>M1</b> <b>A1</b>	
8	(i) $47 - 24 = 12\theta$ $\theta = \frac{23}{12}$ , so $\theta = 1.917$ or better $\theta = 1.92$ to 2dp	<b>M1</b> <b>A1</b>	for complete correct method to get $\theta =$ must have evidence of working to more than 2 dp, allow if 1.916 seen (truncated)
	(ii) $\sin\frac{\theta}{2} = \frac{CD/2}{12}$ $CD = \text{awrt } 19.6 \text{ or } 19.7$	<b>M1</b> <b>A1</b>	for a complete method, may use cosine rule to get $CD$
	(iii) Area of sector = awrt 138 Area of triangle $AOB$ = awrt 67 or 68 Area of segment = awrt 70 or 71  $AD \times AB + \text{segment area} = 425$ leading to $AD = \text{awrt } 18.1 \text{ or } 18.0$  <b>Alternative method:</b> Area of sector = awrt 138 Difference in length between $BC$ (or $AD$ ) and $OM$ where $M$ is the midpoint of $CD = 6.88$ , allow awrt 6.9 Remaining area consists of two trapezia each of width 9.85 and each of area 143.4 $\frac{1}{2}(2BC - 6.88) \times 9.85 = 143.4$ oe  leading to $AD = \text{awrt } 18.1 \text{ or } 18.0$	<b>B1</b> <b>M1</b> <b>M1</b> <b>M1</b> <b>A1</b>  <b>B1</b> <b>M1</b>  <b>M1</b> <b>M1</b> <b>A1</b>	for sector area, allow unsimplified for a correct attempt at area for segment area ( <i>their</i> sector area – <i>their</i> triangle area) for complete method to find $AD$ Allow <b>A1</b> for 18  for sector area for attempt to find difference between parallel sides  for area of one trapezium $\frac{1}{2}(2BC - \text{their } 6.88) \times \text{their } 9.85$ oe  for attempt to find either $BC$ or $AD$

Page 5	Mark Scheme	Syllabus	Paper
	Cambridge IGCSE – October/November 2016	0606	12

Question	Answer	Marks	Part Marks
9 (i)	$p\left(\frac{3}{2}\right): \frac{27a}{8} - \left(4 \times \frac{9}{4}\right) + \frac{3b}{2} + 18 (=0)$	<b>M1</b>	for attempt at $p\left(\frac{3}{2}\right)$
	$p'\left(\frac{3}{2}\right) = \left(3a \times \frac{9}{4}\right) - \left(8 \times \frac{3}{2}\right) + b (=0)$	<b>M1</b>	for differentiation and attempt at $p'\left(\frac{3}{2}\right)$
	leading to $9a + 4b + 24 = 0$ oe and $27a + 4b - 48 = 0$ oe  leading to $a = 4, b = -15$	<b>M1</b> <b>A1</b>	for solution of simultaneous equations, to get either $a$ or $b$ for both
(ii)	$(x+2)(2x-3)^2$ oe	<b>M1, A1</b>	<b>M1</b> for attempt at long division or factorisation
(iii)	$(x+2)(2x-3)^2 = x+2$ $x+2=0, x=-2$	<b>B1</b>	Must be using $(x+2)$ correctly using part (ii) to get $x=-2$
	$(2x-3)^2 = 1$ leading to $x=1, x=2$	<b>M1</b> <b>A1</b>	for solution of the quadratic equation
10 (a) (i)	$20U + \frac{1}{2}\left(U + \frac{U}{2}\right)10 = 165$	<b>M1</b>	for realising that area under the graph is needed and attempt to find an area
	leading to $U = 6$	<b>DM1</b> <b>A1</b>	for equating their area to 165 and attempt to solve
(ii)	Gradient of line: $-0.3$	<b>M1, A1</b>	<b>M1</b> for use of the gradient, must be negative
(b) (i)	27	<b>B1</b>	
(ii)	$t^2 = 8 \ln 4$ $t = 3.33$ or better	<b>M1</b> <b>A1</b>	for a correct attempt to solve $e^{\frac{t^2}{8}} = 4$
(iii)	acceleration = $3 \frac{2t}{8} e^{\frac{t^2}{8}} \left( e^{\frac{t^2}{8}} - 4 \right)^2$	<b>M1, A1</b>	<b>M1</b> for a correct attempt to differentiate using the chain rule
	When $t = 1, a = 6.98$	<b>M1, A1</b>	<b>M1</b> for use of $t = 1$ in their acceleration

Page 6	Mark Scheme	Syllabus	Paper
	Cambridge IGCSE – October/November 2016	0606	12

Question	Answer	Marks	Part Marks
11 (i)	$\ln y = \ln A + x \ln b$ Gradient: $\ln b = -\frac{0.12}{8}, = -0.015$ $b = 0.985$ Intercept: $\ln A = 0.26$ $A = 1.30$	<b>B1</b> <b>M1</b> <b>A1</b> <b>DM1</b>  <b>A1</b>	may be implied, if equation not seen specifically, by correct values for $A$ and $b$ for use of gradient to obtain $\ln b$ Allow <b>A1</b> for $e^{-0.015}$ for use of one of the given points correctly  Allow <b>A1</b> for $e^{0.26}$ or 1.3
	<b>Alternative 1</b> $\ln y = \ln A + x \ln b$ $0.2 = 4 \ln b + \ln A$ $0.08 = 12 \ln b + \ln A$  $A = 1.30$ and $b = 0.985$	<b>B1</b> <b>M1</b> <b>DM1</b>  <b>A1, A1</b>	for one correct equation for attempt to obtain either $\ln A$ or $\ln b$ from simultaneous equations Allow <b>A1</b> for $b = e^{-0.015}$ and $a = e^{0.26}$ or 1.3
	<b>Alternative 2</b> $1.22 = Ab^4$ $1.08 = Ab^{12}$  $A = 1.30$ and $b = 0.985$	<b>B1</b> <b>B1</b> <b>M1</b>  <b>A1, A1</b>	for correct attempt to obtain $b$ or $A$ , must already have <b>B2</b> Allow <b>A1</b> for $b = e^{-0.015}$ and $a = e^{0.26}$ or 1.3
(ii)	When $x = 6$ , $\ln y = 0.17$  $y = 1.19$	<b>M1</b>  <b>A1</b>	for $\ln y = \text{their } \ln A + 6 \text{ their } \ln b$ or $y = \text{their } A \times (\text{their } b)^6$ allow awrt 1.18 to 1.20
(iii)	When $y = 1.1$ , $\ln y = 0.095$  $x = 11$	<b>M1</b>  <b>A1</b>	for $\ln 1.1 = \text{their } \ln A + x \text{ their } \ln b$ or $1.1 = \text{their } A \times (\text{their } b)^x$ allow 10.5 to 11.5