

---

**ADDITIONAL MATHEMATICS****4037/22**

Paper 2

**May/June 2016**

MARK SCHEME

Maximum Mark: 80

---

**Published**

This mark scheme is published as an aid to teachers and candidates, to indicate the requirements of the examination. It shows the basis on which Examiners were instructed to award marks. It does not indicate the details of the discussions that took place at an Examiners' meeting before marking began, which would have considered the acceptability of alternative answers.

Mark schemes should be read in conjunction with the question paper and the Principal Examiner Report for Teachers.

Cambridge will not enter into discussions about these mark schemes.

Cambridge is publishing the mark schemes for the May/June 2016 series for most Cambridge IGCSE<sup>®</sup>, Cambridge International A and AS Level components and some Cambridge O Level components.

<b>Page 2</b>	<b>Mark Scheme</b>	<b>Syllabus</b>	<b>Paper</b>
	<b>Cambridge O Level – May/June 2016</b>	<b>4037</b>	<b>22</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	Guidance
<b>1 (i)</b>	$(2k)^2 - 4(1)(4k - 3) [< 0]$ Correct completion to given inequality $k^2 - 4k + 3 < 0$ isw	<b>M1</b> <b>A1</b>	clear attempt at $b^2 - 4ac$
	<b>(ii)</b> Critical values 1 and 3 soi $1 < k < 3$ as final answer	<b>M1</b> <b>A1</b>	May be implied by incorrect inequalities
<b>2 (i)</b>	Clear attempt at quotient rule or equivalent product rule $\left[ \frac{dy}{dx} = \right] \frac{14}{(3-x)^2}$ or $\left[ \frac{dy}{dx} = \right] \frac{14}{x^2 - 6x + 9}$ cao or correct simplified equivalent	<b>M1</b>  <b>A1</b>	condone omission of brackets  allow recovery from bracketing errors or omissions if implied in correct work to the correct answer
	<b>(ii)</b> $[y = 9]_{x=2}$ $\frac{0.07}{\delta x} \approx \left( \textit{their} \frac{dy}{dx} \Big _{x=2} \right)$ oe 0.005 oe	<b>B1</b> <b>M1</b> <b>A1</b>	condone $\frac{0.07}{\delta x} = \left( \textit{their} \frac{dy}{dx} \Big _{x=2} \right)$ not from wrong working; answer only does not score
<b>3</b>	Any one of: $[{}^6C_0 \times] {}^7C_3 + {}^6C_1 \times {}^7C_2$ or $35 + 126$ or ${}^{13}C_3 - {}^6C_2 \times {}^7C_1 - {}^6C_3$ or $286 - 105 - 20$  161	<b>M2</b>      <b>A1</b>	<b>M1</b> for $[{}^6C_0 \times] {}^7C_3$ or ${}^6C_1 \times {}^7C_2$ or ${}^{13}C_3 - {}^6C_2 \times {}^7C_1$ or ${}^{13}C_3 - {}^6C_3$ or ${}^6C_2 \times {}^7C_1 + {}^6C_3$ or for the numerical equivalent of one of these calculations If <b>M0</b> then <b>B3</b> for answer only of 161

Page 3	Mark Scheme	Syllabus	Paper
	Cambridge O Level – May/June 2016	4037	22

Question	Answer	Marks	Guidance
4 (i)	$2(2)^3 - 3(2)^2 + 2q + 56 = 0$ with one correct interim step leading to $q = -30$	<b>B1</b>	allow for only $16 - 12 + 2q + 56 = 0$ $q = -30$  NB $= 0$ must be seen or may be implied by e.g. $-60 = 2q$ or $60 = -2q$ ;  or convincingly showing $2(2)^3 - 3(2)^2 - 30(2) + 56 = 0$ ; allow for only $16 - 12 + 2(-30) + 56 = 0$  or correct synthetic division at least as far as $\begin{array}{r rrrr} 2 & 2 & -3 & q & 56 \\ & & 4 & 2 & 2q+4 \\ \hline & 2 & 1 & q+2 & 0 \end{array}$ then $q = -30$
(ii)	$2x^2 + x - 28$ $(x-2)(2x-7)(x+4)$  $x = 2, x = -4, x = 3.5$ oe	<b>B2</b> <b>M1</b>  <b>A1</b>	<b>B1</b> for any two terms correct For factorising the correct equation; condone $= 0$ ; condone $(2x-7)(x+4)$ only for <b>M1</b> but for <b>A1</b> <b>must see</b> all 3 factors in this part; do not allow $\left(x - \frac{7}{2}\right)$  not from wrong working; answers only do not score
5 (i)	(2, 8)	<b>B1, B1</b>	
(ii)	$\frac{\text{their } 8 - 0}{\text{their } 2 - p} = -2$ or better  [p =] 6	<b>M1</b>  <b>A1</b>	Condone $\frac{\text{their } 8 - 0}{\text{their } 2 - p} = \frac{-1}{\text{their gradient } AB}$ oe



Page 5	Mark Scheme	Syllabus	Paper
	Cambridge O Level – May/June 2016	4037	22

Question	Answer	Marks	Guidance
(iv)	$\left[ \text{triangle area} = \right] \frac{1}{2} \times 5^2 \times \sin \theta = 12.3$ or 12.3 to 12.32 or for $\left[ \frac{1}{2} \times \text{base} \times \text{height} = \right]$ $\frac{1}{2} \times 6.4[4\dots] \times 3.8[2\dots] \text{ oe}$	M1	may be embedded in a difference calculation
	5.18 to 5.2 inclusive	A1	implies M1
7 (i)	$\begin{pmatrix} 12 & 15 \\ 9 & 6 \end{pmatrix} + \begin{pmatrix} 4 & 2 \\ 1 & 3 \end{pmatrix} \text{ soi}$	M1	if no method shown, may be implied by their answer with at least 2 correct elements
	$\begin{pmatrix} 16 & 17 \\ 10 & 9 \end{pmatrix}$	A1	
(ii)	$\det \mathbf{A} = 4 \times 2 - 3 \times 5 = -7$ or $\det \mathbf{B} = 4 \times 3 - 2 \times 1 = 10$	B1	allow for e.g. $(4 \times 2 - 3 \times 5) \times (4 \times 3 - 2 \times 1) = -70$
	$\mathbf{AB} = \begin{pmatrix} 21 & 23 \\ 14 & 12 \end{pmatrix}$	B2	or B1 for two elements correct
	$\det(\mathbf{AB}) = 21 \times 12 - 23 \times 14 = -70$	B1	allow for $\det(\mathbf{AB}) = 252 - 322 = -70$
			For full marks must conclude that $\det \mathbf{AB} = \det \mathbf{A} \times \det \mathbf{B}$ or show the product $-7 \times 10 = -70$
			otherwise max 3 marks
(iii)	$\frac{1}{\text{their } \det \mathbf{AB}} \times \text{their} \begin{pmatrix} 12 & -23 \\ -14 & 21 \end{pmatrix} \text{ isw}$	B2	correct or correct FT; <b>FT</b> their <b>AB</b> and their non-zero <b>det AB</b> ; their <b>AB</b> must be an attempt at a matrix product e.g. $\begin{pmatrix} 16 & 10 \\ 3 & 6 \end{pmatrix}$
			<b>B1</b> for $\frac{1}{\text{their } \det \mathbf{AB}} \times \text{their} \begin{pmatrix} & \\ & \end{pmatrix}$
			or for $k \times \text{their} \begin{pmatrix} 12 & -23 \\ -14 & 21 \end{pmatrix}$

Page 6	Mark Scheme	Syllabus	Paper
	Cambridge O Level – May/June 2016	4037	22

Question	Answer	Marks	Guidance
8	<p>Eliminates <math>y</math> e.g. <math>4 + \frac{5}{15x+10} + \frac{3}{x} = 0</math> or eliminates <math>x</math> e.g. <math>4 + \frac{5}{y} + \frac{3}{(y-10)/15} = 0</math></p> <p>Rearrange to a 3-term quadratic <math>60x^2 + 90x + 30 = 0</math> oe or <math>4y^2 + 10y - 50 = 0</math> oe</p> <p>Factorise or solve 3-term quadratic <math>x = -\frac{1}{2}, x = -1</math> isw <math>y = 2\frac{1}{2}, y = -5</math> isw</p>	<p><b>M1</b></p> <p><b>M1</b></p> <p><b>A1</b></p> <p><b>M1</b></p> <p><b>A1</b></p> <p><b>A1</b></p>	<p>allow even after incorrect rearrangement of the equation of the curve (dependent on resulting equation still in terms of <math>x</math> and <math>y</math>); condone substitution of e.g. <math>\frac{y+10}{15}</math></p> <p>condone sign slips/arithmetic slips</p> <p>or <math>y = 2\frac{1}{2}, y = -5</math> or <math>x = -\frac{1}{2}, x = -1</math></p> <p>If final A marks not awarded then <b>A1</b> for a correct <math>x, y</math> pair</p>
9 (a)	$\frac{x^2}{2} + x - \frac{1}{x} (+c)$ isw	<b>B3</b>	<p><b>B1</b> for each term allow <math>\frac{x^2}{2} + x + \frac{x^{-1}}{-1} (+c)</math> isw for <b>B3</b></p>
(b) (i)	<p><math>k \cos(5x + \pi)</math> where <math>k &lt; 0</math> or <math>\frac{\cos(5x + \pi)}{5}</math> <math>\frac{-\cos(5x + \pi)}{5} (+c)</math></p>	<p><b>M1</b></p> <p><b>A1</b></p>	
(ii)	<p><math>\frac{-\cos(5(0) + \pi)}{5} - \frac{-\cos(5(-\pi/5) + \pi)}{5}</math> or <math>\frac{-\cos(\pi)}{5} - \left( \frac{-\cos(0)}{5} \right)</math> 0.4 oe</p>	<p><b>M1</b></p> <p><b>A1</b></p>	<p>correct substitution of the given limits into <i>their</i> expression of the form <math>k \cos(5x + \pi)</math>, dep on <b>M1</b> in (b)(i) answer only does not score</p>
10 (a)	<p><math>2 = p - q</math> and <math>14 = 4p - 2q</math> oe <math>p = 5</math> <math>q = 3</math></p>	<p><b>M1</b></p> <p><b>A1</b></p> <p><b>A1</b></p>	
(b)	<p>Factorise <math>10^{2x} - 2(10^x) - 24 [= 0]</math> or factorise <math>u^2 - 2u - 24 [= 0]</math>  <math>10^x = 6</math> <math>x = \lg 6</math> cao as final answer</p>	<p><b>M1</b></p> <p><b>A1</b></p> <p><b>A1</b></p>	<p>or applies the formula or completes the square  ignore <math>10^x = -4</math> for this mark or exact equivalent</p>

Page 7	Mark Scheme	Syllabus	Paper
	Cambridge O Level – May/June 2016	4037	22

Question	Answer	Marks	Guidance
(c)	$\frac{x+1}{x} = 2^3$ oe www  $x = \frac{1}{7}$ or 0.143 or 0.1428 to 0.1429	<b>M2</b>  <b>A1</b>	combines logs and anti-logs or <b>B1</b> for one correct log move e.g. $\log_2\left(\frac{x+1}{x}\right) = 3$ or $\log_2(x+1) - \log_2(x) = \log_2 8$ or $\log_2(x+1) - \log_2(x) = 3\log_2 2$
<b>11 (a)</b>	Valid method  when $x = \frac{1}{2}$  [greatest value =] $\frac{1}{4}$	<b>M1</b>  <b>A1</b>  <b>B1</b>	Completing the square as far as e.g. constant $-\left(x - \frac{1}{2}\right)^2$  or calculus as far as $1 - 2x = 0$  or finding roots $x = 0$ and $x = 1$ and using symmetry soi  Implies <b>M1</b> if not clearly from wrong working
<b>(b)</b>	Valid comment e.g. when $x \geq 1$ , $f'$ is always decreasing	<b>B1</b>	Allow e.g. a sketch with a comment such as the curve is one-one [when $x \geq 1$ ] or e.g. the curve is one-one when $x > \frac{1}{2}$
<b>(c) (i)</b>	$k(10) = 8$ or $5 + \sqrt{10-1} = 8$ or stating $h(8)$  $h(8) = 1$ or $\lg(8+2) = 1$ cao	<b>M1</b>  <b>A1</b>	or $[hk(x) =] \lg(7 + \sqrt{x-1})$  $[hk(10) =] \lg(7 + \sqrt{10-1}) = 1$
<b>(ii)</b>	$(y-5)^2 = x-1$ $k^{-1}(x) = (x-5)^2 + 1$ isw or $k^{-1}(x) = x^2 - 10x + 26$ isw $5 < x < 15$	<b>M1</b> <b>A1</b>  <b>B1, B1</b>	or $(x-5)^2 = y-1$  <b>B1</b> for $5 < x$ oe and <b>B1</b> for $x < 15$ oe  allow (5, 15); one mark for each limit of the interval;  if <b>B0</b> then <b>SC1</b> for $5 \leq x \leq 15$ or '5 to 15' or [5, 15] etc.
	$1 < k^{-1}(x) < 101$	<b>B1</b>	allow (1, 101)

Page 8	Mark Scheme	Syllabus	Paper
	Cambridge O Level – May/June 2016	4037	22

Question	Answer	Marks	Guidance
12 (i)	$8(1 - \cos^2 A) + 2 \cos A = 7$ or better Solves or factorises <i>their</i> 3-term quadratic in $\cos A$	<b>B1</b> <b>M1</b>	with no extras in range; not from clearly wrong working but allow recovery from minor slips or <b>A1</b> for either, ignoring extras
	60, 104.477... rounded or truncated to 1 dp or more;	<b>A2</b>	
(ii)	$\sin(3B + 1) = 0.4$ soi	<b>B1</b>	may be implied by $\frac{1}{\sin(3B + 1)} = 2.5$
	$[3B + 1 =] 0.41$ or better	<b>M1</b>	implies <b>B1</b>
	0.577, 1.9[0], 2.67 or 0.57669..., 1.89823..., 2.67108... rounded or truncated to 4 or more sf	<b>A2</b>	with no extras in range; or <b>A1</b> for any one correct ignoring extras  If <b>M0</b> then <b>B2</b> for all 3 correct angles found or <b>B1</b> for 1 or 2 correct angles found