

CAMBRIDGE INTERNATIONAL EXAMINATIONS

Cambridge International General Certificate of Secondary Education

MARK SCHEME for the March 2016 series

0606 ADDITIONAL MATHEMATICS

0606/22

Paper 22, maximum raw mark 80

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.

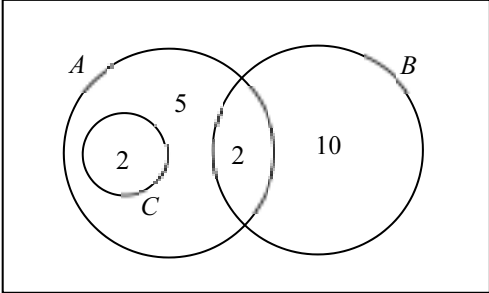
Cambridge is publishing the mark schemes for the March 2016 series for most Cambridge IGCSE® and Cambridge International A and AS Level components.

® IGCSE is the registered trademark of Cambridge International Examinations.

Page 2	Mark Scheme	Syllabus	Paper
	Cambridge IGCSE – March 2016	0606	22

Abbreviations

awrt	answers which round to
cao	correct answer only
dep	dependent
FT	follow through after error
isw	ignore subsequent working
nfww	not from wrong working
oe	or equivalent
rot	rounded or truncated
SC	Special Case
soi	seen or implied
www	without wrong working

Question	Answer	Marks	Guidance
1 (i)	$\frac{dy}{dx} = k(x-9)^{-\frac{3}{2}}$	M1	If M0 then SC1 for the correct answer with an extra term.
	$k = -\frac{5}{2}$ isw	A1	condone $5 \times -\frac{1}{2}$
	(ii) $\delta y = \text{their} \left(\frac{dy}{dx} \Big _{x=13} \right) \times h$	M1	
	$-0.3125h$ oe	A1	
2	 <p>5</p>	B3,2,1,0	B2 for <i>C</i> as a proper subset of <i>A</i> <i>A</i> and <i>B</i> with an intersection <i>B</i> and <i>C</i> mutually exclusive Or B1 for any two of the these and B1 for the number of elements correctly placed B1FT FT <i>their</i> 5
3	Integrates $9x^2 - 3x^{-2}$ $(y =) \frac{9x^3}{3} - \frac{3x^{-1}}{-1} (+c)$ Substitute $x = 1$ and $y = 7$ into <i>their</i> expression with ' <i>c</i> ' $y = 3x^3 + 3x^{-1} + 1$ oe isw	M1 A1 M1 A1	condone one rearrangement error <i>their</i> expression must be from an attempt to integrate condone $y = 3x^3 + 3x^{-1} + c$ and $c = 1$ seen, isw

Page 4	Mark Scheme	Syllabus	Paper
	Cambridge IGCSE – March 2016	0606	22

Question	Answer	Marks	Guidance
7 (a)	$\begin{pmatrix} 4 & 6 & 8 \\ -2 & 0 & 4 \end{pmatrix} - \begin{pmatrix} 18 & 3 & 6 \\ 21 & -6 & 3 \end{pmatrix}$	M1	for attempt to multiply and subtract
	$\begin{pmatrix} -14 & 3 & 2 \\ -23 & 6 & 1 \end{pmatrix}$	A1	
(b) (i)	$-\frac{1}{2} \begin{pmatrix} 1 & 0 \\ -4 & -2 \end{pmatrix} \text{ oe}$	B1 + B1	1 mark for $-\frac{1}{2} \begin{pmatrix} \quad & \quad \\ \quad & \quad \end{pmatrix}$ and 1 mark for $k \begin{pmatrix} 1 & 0 \\ -4 & -2 \end{pmatrix}$
(ii)	Valid method	M1	XD⁻¹D = CD
	$\begin{pmatrix} -8 & -6 \\ 13 & 7 \end{pmatrix}$	A2,1,0	-1 each error
			If M0 then SC1 for DC = $\begin{pmatrix} 4 & 3 \\ -14 & -5 \end{pmatrix}$
8 (i)	Eliminate x (or y)	M1	$3(2y-2)^2 + (2y-2)y - y^2 = 12$
	$13y^2 - 26y = 0$ or $\frac{13}{4}x^2 - 13 = 0$ oe	A1	$3x^2 + x\left(\frac{x+2}{2}\right) - \left(\frac{x+2}{2}\right)^2 = 12$
	$13y(y-2)$ or $x^2 = 4$	M1	
	$x = -2,$ $x = 2$	A1	or for $(-2, 0)$ or $(2, 2)$ from correct working
	$y = 0$ $y = 2$ isw	+ A1FT	FT their x or y values to find their y or x values; or A1 for $(-2, 0)$ and $(2, 2)$
(ii)	<i>their</i> $m_{AB} = \frac{1}{2}$ or <i>their</i> $m_{BC} = -2$ soi	M1	may be unsimplified or Pythagoras' theorem correctly applied to <i>their</i> $(0, -2)$, <i>their</i> $(2, 2)$ and $(0, 6)$
	use of $(m_{AB}) \times (m_{BC}) = -1$ and conclusion	A1	or use of $h^2 = a^2 + b^2$ and conclusion

Question	Answer	Marks	Guidance
9 (i)	$RT = \frac{1}{\tan \theta}$	B1	or $RT = \cot \theta$
	$RS = \frac{1}{\sin \theta}$	B1	or $RS = \operatorname{cosec} \theta$
	$x = 1 - \frac{1}{2 \tan \theta} - \frac{1}{2 \sin \theta}$ oe or $x = 1 - \frac{\cot \theta}{2} - \frac{\operatorname{cosec} \theta}{2}$ oe	B1FT	FT <i>their RT and their RS</i> , provided both are functions of trig ratios
(ii)	$A = x + \frac{1}{2} \cot \theta$ oe soi correct completion to given answer $A = 1 - \frac{\operatorname{cosec} \theta}{2}$	M1 A1	
(iii)	$\operatorname{cosec} \theta = \frac{2\sqrt{3}}{3}$ oe $\theta = \frac{\pi}{3}$ cao	M1 A1	equivalent must be exact implies M1
10 (a) (i)	$(\alpha + \beta)\mathbf{i} - 20\mathbf{j} = 15\mathbf{i} + (2\alpha - 24)\mathbf{j}$	M1	implied by $\alpha + \beta = 15$ or $2\alpha - 24 = -20$
	$\alpha = 2$	A1	
	$\beta = 13$	A1	
	(ii)	$\sqrt{(\text{their } \alpha + \text{their } \beta)^2 + (-20)^2}$ oe $\frac{15\mathbf{i} - 20\mathbf{j}}{25}$ oe	M1 A1FT
(b)	$\overrightarrow{OC} = \overrightarrow{OA} + \lambda \overrightarrow{AB}$ or $\overrightarrow{OC} = \overrightarrow{OB} + (1 - \lambda)\overrightarrow{BA}$	B1	
	$[\overrightarrow{OC} =] \mathbf{a} + \lambda(\mathbf{b} - \mathbf{a})$ or $[\overrightarrow{OC} =] \mathbf{b} + (1 - \lambda)(\mathbf{a} - \mathbf{b})$	M1	
	$[\overrightarrow{OC} =] (1 - \lambda)\mathbf{a} + \lambda \mathbf{b}$	A1	
(c)	$\frac{2}{\mu + 3} = \frac{\mu}{9}$	M1	or multiplies one of the vectors by a general scale factor and finds a pair of simultaneous equations to solve
	Solves $\mu^2 + 3\mu - 18 = 0$	M1	or solves <i>their</i> correct equation to find <i>their</i> scale factor and attempts to use it to find μ
	$\mu = 3$	A1	A0 if -6 not discarded

Page 7	Mark Scheme	Syllabus	Paper
	Cambridge IGCSE – March 2016	0606	22

Question	Answer	Marks	Guidance
12 (i)	$9t^2 - 63t + 90 = 0$ $(9t - 18)(t - 5)$	M1	must see evidence of solving e.g. $t = 5$ and $t = 2$ or factors
	showing that $t = 2$ is smaller value of t	A1	
(ii)	$(a =) \frac{dv}{dt}$ attempted	M1	
	$18(3.5) - 63 = 0$ cao	A1	
(iii)	$\int (9t^2 - 63t + 90) dt$	M1	
	$(s =) \frac{9t^3}{3} - \frac{63t^2}{2} + 90t$ isw	A2,1,0	-1 for each error or for +c left in
(iv) (a)	$(s =) \frac{9(2)^3}{3} - \frac{63(2)^2}{2} + 90(2)$	M1	or $\left[\frac{9t^3}{3} - \frac{63t^2}{2} + 90t \right]_0^2$
	78 [m]	A1	FT their (iii)
(b)	$(s =) \frac{9(3)^3}{3} - \frac{63(3)^2}{2} + 90(3) = 67.5$	M1	FT their (iii)
	their $78 + 10.5 = 88.5$ [m]	A1FT	