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

Page	3 Mark Scheme		Syllabus Paper
	Cambridge IGCSE – March 2016		0606 22
Question	Answer	Marks	Guidance
4 (a)	a = 10 b = 6 c = 4 or $10\cos 6x + 4$	B2,1,0	for <b>B1</b> allow correct FT of <i>c</i> from <i>a</i> e.g. <i>their</i> $c = 14 - their a$
(b)	y 1 0 $45^{\circ}$ $90^{\circ}$ $135^{\circ}$ $180^{\circ}$ x -2 -5	B3,2,1,0	Correct shape; two cycles; both maximum at 1 and minimum at $-5$ ; starting at $(0, -2)$ and ending at $(180, -2)$
5 (i)	$2187 + 5103kx + 5103k^2x^2$	<b>B3</b>	1 for each term; ignore extra terms
(ii)	$2(5103k) = 5103k^2$	M1	must not include $x$ , $x^2$
	<i>k</i> = 2	A1	<b>A0</b> if $k = 0$ also given as a solution
6	$\frac{x}{1+3\sqrt{3}} = \frac{5-\sqrt{3}}{6+2\sqrt{3}}$ oe soi	M1	
	$(x=)\frac{-4+14\sqrt{3}}{6+2\sqrt{3}}$ oe	M1	
	$(x=)\frac{-4+14\sqrt{3}}{6+2\sqrt{3}} \times \frac{6-2\sqrt{3}}{6-2\sqrt{3}}$	M1	
	p = -27, q = 23 isw	A1 + A1	allow $(x =) \frac{-27 + 23\sqrt{3}}{6}$

	Page 4 Mark Scheme			Syllabus Paper	
		Cambridge IGCSE – March 2016		0606 22	
				_	
Qu	lestion	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} -2 & 0 & 4 \end{pmatrix}  \begin{pmatrix} 21 & -6 & 3 \end{pmatrix} $ $ \begin{pmatrix} -14 & 3 & 2 \\ -23 & 6 & 1 \end{pmatrix} $ $ -\frac{1}{2} \begin{pmatrix} 1 & 0 \\ -4 & -2 \end{pmatrix} oe $	A1		
	(b) (i)	$-\frac{1}{2} \begin{pmatrix} 1 & 0 \\ -4 & -2 \end{pmatrix}$ oe	B1 + B1	1 mark for $-\frac{1}{2}$ and 1 mark	
				for $k \begin{pmatrix} 1 & 0 \\ -4 & -2 \end{pmatrix}$	
	(ii)	Valid method	M1	$\mathbf{X}\mathbf{D}^{-1}\mathbf{D}=\mathbf{C}\mathbf{D}$	
		$\begin{pmatrix} -8 & -6 \\ 13 & 7 \end{pmatrix}$	A2,1,0	-1 each error	
				If M0 then <b>SC1</b> for	
				$\mathbf{DC} = \begin{pmatrix} 4 & 3 \\ -14 & -5 \end{pmatrix}$	
8	(i)	Eliminate $x$ (or $y$ )	M1	$3(2y-2)^{2} + (2y-2)y - y^{2} = 12$	
				$3x^{2} + x\left(\frac{x+2}{2}\right) - \left(\frac{x+2}{2}\right)^{2} = 12$	
		$13y^2 - 26y = 0$ or $\frac{13}{4}x^2 - 13 = 0$ oe	A1		
		$13y(y-2)$ or $x^2 = 4$	M1		
		$x = -2, \qquad x = 2$	A1	or for $(-2, 0)$ or $(2, 2)$ from correct	
		y = 0 $y = 2$ isw	+ A1FT	working <b>FT</b> <i>their x</i> or <i>y</i> values to find <i>their</i> <i>y</i> or <i>x</i> values; or <b>A1</b> for (-2, 0) and (2, 2)	
	(ii)	their $m_{AB} = \frac{1}{2}$ or their $m_{BC} = -2$ 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	

Cambridge IGCSE - March 2016060622QuestionAnswerMarksGuidance9 (i) $RT = \frac{1}{\tan \theta}$ B1or $RT = \cot \theta$ $RS = \frac{1}{\sin \theta}$ B1or $RT = \cot \theta$ B1 $x = 1 - \frac{1}{2 \tan \theta} - \frac{1}{2 \sin \theta}$ ocB1FTFT their RT and their RS, provided both are functions of ratios(ii) $A = x + \frac{1}{2} \cot \theta$ oe soiM1 $correct$ completion to given answer $A = 1 - \frac{\csc \theta}{2}$ A1(iii) $cosec \theta = \frac{2\sqrt{3}}{3}$ ocM1 $\theta = \frac{\pi}{3}$ caoA1(iii) $(\alpha + \beta)i - 20j = 15i + (2\alpha - 24)j$ M1 $\alpha = 2$ A1 $\beta = 13$ A1(iii) $\sqrt{(their \alpha + their \beta)^2 + (-20)^2}$ oeM1 $\frac{15i - 20j}{25}$ ocA1FT $(iii)$ $\overline{OC} = \overline{OA} + \lambda \overline{AB}$ or $\overline{OC} = OB + (1 - \lambda)\overline{BA}$ B1 $(\overline{OC} = 1 + \lambda(b - a)$ or $(\overline{OC} = 1 (1 - \lambda)a + \lambda b$ A1(c) $\frac{2}{\mu + 3} = \frac{\mu}{9}$ M1or multiplies one of the vector a general scale factor and find par of simultanceus equations solveSolves $\mu^2 + 3\mu - 18 = 0$ M1		Page 5	Mark Scheme		Syllabus Paper
9 (i) $RT = \frac{1}{\tan \theta}$ $RS = \frac{1}{\sin \theta}$ $x = 1 - \frac{1}{2\tan \theta} - \frac{1}{2\sin \theta}$ oc $rx = 1 - \frac{\cos \theta}{2} - \frac{\cos c \theta}{2}$ oe (ii) $A = x + \frac{1}{2}\cot \theta$ oc soi correct completion to given answer $A = 1 - \frac{\csc \theta}{2}$ (iii) $c \csc \theta - \frac{2\sqrt{3}}{3}$ oe $\theta = \frac{\pi}{3}$ cao $A = \frac{\pi}{3}$ cao		Ŭ			
9 (i) $RT = \frac{1}{\tan \theta}$ $RS = \frac{1}{\sin \theta}$ $x = 1 - \frac{1}{2\tan \theta} - \frac{1}{2\sin \theta}$ oc $\sigma r x = 1 - \frac{\cot \theta}{2} - \frac{\csc \theta}{2}$ oe (ii) $A = x + \frac{1}{2}\cot \theta$ oc soi $correct completion to given answer A = 1 - \frac{\csc \theta}{2}(iii) \cos \cos \theta = \frac{2\sqrt{3}}{3} oe\theta = \frac{\pi}{3} cao10 (a) (i) (\alpha + \beta)i - 20j = 15i + (2\alpha - 24)j\alpha = 2\beta = 13(ii) \frac{15i - 20j}{2} oe(b) \overline{OC} = \overline{OA} + \lambda \overline{AB} or \overline{OC} = OB + (1 - \lambda)\overline{BA}(ii) \frac{15i - 20j}{(\overline{OC} = 1)} = 1 + (1 - \lambda)(\alpha - b)(\overline{OC} = 1 + (1 - \lambda)(\alpha - b)(\overline{OC} = \frac{2}{(1 - \lambda)\alpha + \lambda - b}(c) \frac{2}{\mu + 3} = \frac{\mu}{9}Solves \mu^2 + 3\mu - 18 = 0MI or RT = \cot \thetaB1 implies M1implies M1$					C '1
$RS = \frac{1}{\sin\theta}$ B1or $RS = \csc\theta$ $x = 1 - \frac{1}{2\tan\theta} - \frac{1}{2\sin\theta}$ oeB1FTFT their RT and their RS, provided both are functions of ratios(ii) $A = x + \frac{1}{2}\cot\theta$ oc soiM1correct completion to given answer $A = 1 - \frac{\csc\theta}{2}$ A1(iii) $\cos \theta = \frac{2\sqrt{3}}{3}$ ocM1equivalent must be exact $\theta = \frac{\pi}{3}$ caoA1implies M1implies M110(a) $(a + \beta)i - 20j = 15i + (2\alpha - 24)j$ M1 $\mu = 2$ A1 $\beta = 13$ A1(ii) $\sqrt{(thetra + their \beta)^2 + (-20)^2}$ oeM1 $\frac{15i - 20j}{25}$ oeA1 $\frac{10}{(CC} = j a + \lambda(A = a) \text{ or } (CC = OB + (1 - \lambda)BA$ B1 $(C)$ $\frac{2}{\mu + 3} = \frac{\mu}{9}$ M1(c) $\frac{2}{\mu + 3} = \frac{\mu}{9}$ M1solves $\mu^2 + 3\mu - 18 = 0$ M1or multiplies one of the vector a general scale factor and find heir scale factor and find pair of simultaneous equation find their scale factor and find	Qu	estion	Answer	Marks	Guidance
$ \begin{array}{c c c c c c c c c c c c c c c c c c c $	9	(i)	$RT = \frac{1}{\tan \theta}$	<b>B</b> 1	or $RT = \cot \theta$
(ii) $A = x + \frac{1}{2} \cot \theta$ oc soi (ii) $A = x + \frac{1}{2} \cot \theta$ oc soi (iii) $Correct completion to given answer A = 1 - \frac{\csc \theta}{2}(iii) Cosec \theta = \frac{2\sqrt{3}}{3} oe\theta = \frac{\pi}{3} cao(iii) Cosec \theta = \frac{2\sqrt{3}}{3} oe\theta = \frac{\pi}{3} cao(iv) Cosec \theta = \frac{2\sqrt{3}}{3} oe\theta = \frac{\pi}{3} cao(iv) Cosec \theta = \frac{2\sqrt{3}}{2} oeA = 2\beta = 13(iv) \sqrt{(their\alpha + their\beta)^2 + (-20)^2} oe(iv) \frac{15i - 20j}{25} oe(iv) 15i - 2$			$RS = \frac{1}{\sin \theta}$	B1	or $RS = \csc \theta$
(iii) $2$ correct completion to given answer $A = 1 - \frac{\csc \theta}{2}$ (iii) $\cos c \theta = \frac{2\sqrt{3}}{3}$ oc $\theta = \frac{\pi}{3}$ cao A1 implies M1 implies M1 implied by $\alpha + \beta = 15$ or $2\alpha - 24 = -20$ A1 A1 (i) $(\alpha + \beta)\mathbf{i} - 20\mathbf{j} = 15\mathbf{i} + (2\alpha - 24)\mathbf{j}$ $\alpha = 2$ $\beta = 13$ (ii) $\sqrt{(their\alpha + their\beta)^2 + (-20)^2}$ oc A1 $\frac{15\mathbf{i} - 20\mathbf{j}}{25}$ oe (b) $\overline{OC} = \overline{OA} + \lambda \overline{AB}$ or $\overline{OC} = OB + (1 - \lambda)\overline{BA}$ $[\overline{OC} = \mathbf{j} + \lambda(\mathbf{b} - \mathbf{a})$ or $[\overline{OC} = \mathbf{j} + \lambda(\mathbf{b} - \mathbf{a})$ or $[\overline{OC} = \mathbf{j} + (1 - \lambda)(\mathbf{a} - \mathbf{b})]$ $[\overline{OC} = \mathbf{j} (1 - \lambda)\mathbf{a} + \lambda \mathbf{b}$ (c) $\frac{2}{\mu + 3} = \frac{\mu}{9}$ Solves $\mu^2 + 3\mu - 18 = 0$ A1 A1 A1 A1 A1 A1 A1 A1 A1 A1			$x = 1 - \frac{1}{2\tan\theta} - \frac{1}{2\sin\theta}$ oe or $x = 1 - \frac{\cot\theta}{2} - \frac{\csc\theta}{2}$ oe	B1FT	provided both are functions of trig
(iii) $\cos cose \theta = \frac{2\sqrt{3}}{3}$ oeM1equivalent must be exact $\theta = \frac{\pi}{3}$ caoA1implies M110 (a) (i) $(\alpha + \beta)\mathbf{i} - 20\mathbf{j} = 15\mathbf{i} + (2\alpha - 24)\mathbf{j}$ M1implied by $\alpha + \beta = 15$ or $2\alpha - 24 = -20$ $\alpha = 2$ A1 $\beta = 13$ A1(ii) $\sqrt{(their \alpha + their \beta)^2 + (-20)^2}$ oeM1 $\frac{15\mathbf{i} - 20\mathbf{j}}{25}$ oeA1FT $\frac{15\mathbf{i} - 20\mathbf{j}}{25}$ oeA1FT $\frac{10}{CC} = \mathbf{i} + \lambda (\mathbf{b} - \mathbf{a})$ or $[\overline{OC} = ] \mathbf{b} + (1 - \lambda)(\mathbf{a} - \mathbf{b})$ B1 $(\mathbf{c})$ $\frac{2}{\mu + 3} = \frac{\mu}{9}$ (c) $\frac{2}{\mu + 3} = \frac{\mu}{9}$ M1or multiplies one of the vector a general scale factor and find pair of simultaneous equations solveSolves $\mu^2 + 3\mu - 18 = 0$ M1or solves their correct equation find their scale factor and atter	(	ii)	$A = x + \frac{1}{2}\cot\theta  \text{oe soi}$	M1	
$\theta = \frac{\pi}{3} \text{ cao}$ A1 implies M1 implies M1 implied by $\alpha + \beta = 15$ or $2\alpha - 24 = -20$ A1 $\beta = 13$ (i) $(\alpha + \beta)i - 20j = 15i + (2\alpha - 24)j$ A1 $\beta = 13$ (ii) $\sqrt{(their\alpha + their\beta)^2 + (-20)^2}$ oe M1 $\frac{15i - 20j}{25}$ oe M1 $\frac{15i - 20j}{25}$ oe M1 $\frac{15i - 20j}{25}$ oe M1 $\frac{16i}{CC} = ] \mathbf{a} + \lambda (\mathbf{b} - \mathbf{a})$ or $\overline{CC} = OB + (1 - \lambda)\overline{BA}$ B1 $\overline{(OC} = ] \mathbf{a} + \lambda (\mathbf{b} - \mathbf{a})$ or $\overline{(OC} = ] \mathbf{b} + (1 - \lambda)(\mathbf{a} - \mathbf{b})$ $\overline{(OC} = ] (1 - \lambda)\mathbf{a} + \lambda \mathbf{b}$ A1 (c) $\frac{2}{\mu + 3} = \frac{\mu}{9}$ Solves $\mu^2 + 3\mu - 18 = 0$ M1 or solves their correct equations solve			correct completion to given answer $A = 1 - \frac{\csc \theta}{2}$	A1	
<b>10</b> (a) (i) $(\alpha + \beta)\mathbf{i} - 20\mathbf{j} = 15\mathbf{i} + (2\alpha - 24)\mathbf{j}$ $\alpha = 2$ $\beta = 13$ (ii) $\sqrt{(their\alpha + their\beta)^2 + (-20)^2}$ oe <b>M1</b> $\frac{15\mathbf{i} - 20\mathbf{j}}{25}$ oe <b>M1</b> <b>M1</b> (c) $\frac{12}{QC} = \mathbf{i} + \lambda(\mathbf{b} - \mathbf{a})$ or $[\overline{OC} = \mathbf{OA} + \lambda \overline{AB}$ or $\overline{OC} = OB + (1 - \lambda)\overline{BA}$ <b>B1</b> $[\overline{OC} = \mathbf{i} + (1 - \lambda)(\mathbf{a} - \mathbf{b})$ $[\overline{OC} = \mathbf{i} (1 - \lambda)\mathbf{a} + \lambda \mathbf{b}$ <b>A1</b> <b>M1</b> (c) $\frac{2}{\mu + 3} = \frac{\mu}{9}$ <b>M1</b> Solves $\mu^2 + 3\mu - 18 = 0$ <b>M1</b> or solves their correct equations solve	(i	ii)	$\csc \theta = \frac{2\sqrt{3}}{3}$ oe	M1	equivalent must be exact
(i) $\alpha = 2$ $\beta = 13$ (ii) $\sqrt{(their \alpha + their \beta)^2 + (-20)^2}$ oe $\frac{15i - 20j}{25}$ oe (b) $\overline{OC} = \overline{OA} + \lambda \overline{AB}$ or $\overline{OC} = OB + (1 - \lambda)\overline{BA}$ $[\overline{OC} = ] \mathbf{a} + \lambda(\mathbf{b} - \mathbf{a})$ or $[\overline{OC} = ] \mathbf{b} + (1 - \lambda)(\mathbf{a} - \mathbf{b})$ $[\overline{OC} = ] (1 - \lambda)\mathbf{a} + \lambda \mathbf{b}$ (c) $\frac{2}{\mu + 3} = \frac{\mu}{9}$ Solves $\mu^2 + 3\mu - 18 = 0$ M1 or solves their correct equations solve M1 or solves their correct equations for the vector and attern their scale factor and scale factor and attern their scale factor and attern their scale factor and scale facto			$\theta = \frac{\pi}{3}$ cao	A1	implies M1
(ii) $ \begin{array}{c c} \beta = 13 \\ \hline \hline \hline \hline \hline \\ \sqrt{(their\alpha + their\beta)^2 + (-20)^2} & \text{oe} \\ \hline \hline \\ 15i - 20j \\ 25 & \text{oe} \\ \hline \\ 15i - 20j \\ 25 & \text{oe} \\ \hline \\ 15i - 20j \\ 25 & \text{oe} \\ \hline \\ 15i - 20j \\ 25 & \text{oe} \\ \hline \\ 15i - 20j \\ 25 & \text{oe} \\ \hline \\ \hline \\ 15i - 20j \\ 25 & \text{oe} \\ \hline \\ $	10 (	(a) (i)	$(\alpha + \beta)\mathbf{i} - 20\mathbf{j} = 15\mathbf{i} + (2\alpha - 24)\mathbf{j}$	M1	
(ii) $\sqrt{(their\alpha + their\beta)^2 + (-20)^2}$ oe M1 $\frac{15i - 20j}{25}$ oe A1FT FT their $\alpha + \beta$ provided non-zero (b) $\overline{OC} = \overline{OA} + \lambda \overline{AB}$ or $\overline{OC} = OB + (1 - \lambda)\overline{BA}$ B1 $[\overline{OC} = ] \mathbf{a} + \lambda(\mathbf{b} - \mathbf{a})$ or $[\overline{OC} = ] \mathbf{b} + (1 - \lambda)(\mathbf{a} - \mathbf{b})$ M1 $[\overline{OC} = ] (1 - \lambda)\mathbf{a} + \lambda \mathbf{b}$ A1 (c) $\frac{2}{\mu + 3} = \frac{\mu}{9}$ M1 or multiplies one of the vector a general scale factor and find pair of simultaneous equations solve Solves $\mu^2 + 3\mu - 18 = 0$ M1 or solves their correct equation find their scale factor and attention of the their scale factor and atten			$\alpha = 2$	A1	
(b) $\frac{15i - 20j}{25}$ oe $\frac{15i - 20j}{25}$ oe (b) $\overline{OC} = \overline{OA} + \lambda \overline{AB}$ or $\overline{OC} = OB + (1 - \lambda)\overline{BA}$ $[\overline{OC} = ] \mathbf{a} + \lambda(\mathbf{b} - \mathbf{a})$ or $[\overline{OC} = ] \mathbf{b} + (1 - \lambda)(\mathbf{a} - \mathbf{b})$ $[\overline{OC} = ] (1 - \lambda)\mathbf{a} + \lambda \mathbf{b}$ (c) $\frac{2}{\mu + 3} = \frac{\mu}{9}$ Solves $\mu^2 + 3\mu - 18 = 0$ M1 FT <i>their</i> $\alpha + \beta$ provided non-zero B1 M1 M1 or multiplies one of the vector a general scale factor and finds pair of simultaneous equations solve M1 or solves <i>their</i> correct equations find <i>their</i> scale factor and attent			$\beta = 13$	A1	
(b) $\overrightarrow{OC} = \overrightarrow{OA} + \lambda \overrightarrow{AB} \text{ or } \overrightarrow{OC} = OB + (1 - \lambda) \overrightarrow{BA}$ $\overrightarrow{IOC} = \mathbf{J} \mathbf{a} + \lambda (\mathbf{b} - \mathbf{a}) \text{ or } \overrightarrow{IOC} = \mathbf{J} \mathbf{b} + (1 - \lambda) (\mathbf{a} - \mathbf{b})$ $\overrightarrow{IOC} = \mathbf{J} (1 - \lambda) \mathbf{a} + \lambda \mathbf{b}$ (c) $\frac{2}{\mu + 3} = \frac{\mu}{9}$ Solves $\mu^2 + 3\mu - 18 = 0$ MI $\mathbf{M}$ MI $\mathbf{M}$ MI $\mathbf{M}$ or multiplies one of the vector a general scale factor and finds pair of simultaneous equations solve MI $\mathbf{M}$ or solves their correct equation find their scale factor and atterned to the their scale factor and the their scale factor and atterned to the their scale factor and the their sc		(ii)	$\sqrt{(their\alpha + their\beta)^2 + (-20)^2}$ oe	M1	
$\begin{bmatrix} \overrightarrow{OC} = \mathbf{j} \ \mathbf{a} + \lambda(\mathbf{b} - \mathbf{a}) \text{ or } \\ [\overrightarrow{OC} = \mathbf{j} \ \mathbf{b} + (1 - \lambda)(\mathbf{a} - \mathbf{b}) \\ [\overrightarrow{OC} = \mathbf{j} \ (1 - \lambda)\mathbf{a} + \lambda \ \mathbf{b} \\ [\overrightarrow{OC} = \mathbf{j} \ (1 - \lambda)\mathbf{a} + \lambda \ \mathbf{b} \\ [\overrightarrow{OC} = \mathbf{j} \ (1 - \lambda)\mathbf{a} + \lambda \ \mathbf{b} \\ [\overrightarrow{OC} = \mathbf{j} \ (1 - \lambda)\mathbf{a} + \lambda \ \mathbf{b} \\ [\overrightarrow{OC} = \mathbf{j} \ (1 - \lambda)\mathbf{a} + \lambda \ \mathbf{b} \\ [\overrightarrow{OC} = \mathbf{j} \ (1 - \lambda)\mathbf{a} + \lambda \ \mathbf{b} \\ [\overrightarrow{OC} = \mathbf{j} \ (1 - \lambda)\mathbf{a} + \lambda \ \mathbf{b} \\ [\overrightarrow{OC} = \mathbf{j} \ (1 - \lambda)\mathbf{a} + \lambda \ \mathbf{b} \\ [\overrightarrow{OC} = \mathbf{j} \ (1 - \lambda)\mathbf{a} + \lambda \ \mathbf{b} \\ [\overrightarrow{OC} = \mathbf{j} \ (1 - \lambda)\mathbf{a} + \lambda \ \mathbf{b} \\ [\overrightarrow{OC} = \mathbf{j} \ (1 - \lambda)\mathbf{a} + \lambda \ \mathbf{b} \\ [\overrightarrow{OC} = \mathbf{j} \ (1 - \lambda)\mathbf{a} + \lambda \ \mathbf{b} \\ [\overrightarrow{OC} = \mathbf{j} \ (1 - \lambda)\mathbf{a} + \lambda \ \mathbf{b} \\ [\overrightarrow{OC} = \mathbf{j} \ (1 - \lambda)\mathbf{a} + \lambda \ \mathbf{b} \\ [\overrightarrow{OC} = \mathbf{j} \ (1 - \lambda)\mathbf{a} + \lambda \ \mathbf{b} \\ [\overrightarrow{OC} = \mathbf{j} \ (1 - \lambda)\mathbf{a} + \lambda \ \mathbf{b} \\ [\overrightarrow{OC} = \mathbf{j} \ (1 - \lambda)\mathbf{a} + \lambda \ \mathbf{b} \\ [\overrightarrow{OC} = \mathbf{j} \ (1 - \lambda)\mathbf{a} + \lambda \ \mathbf{b} \\ [\overrightarrow{OC} = \mathbf{j} \ (1 - \lambda)\mathbf{a} + \lambda \ \mathbf{b} \\ [\overrightarrow{OC} = \mathbf{j} \ (1 - \lambda)\mathbf{a} + \lambda \ \mathbf{b} \\ [\overrightarrow{OC} = \mathbf{j} \ (1 - \lambda)\mathbf{a} + \lambda \ \mathbf{b} \\ [\overrightarrow{OC} = \mathbf{j} \ (1 - \lambda)\mathbf{a} + \lambda \ \mathbf{b} \\ [\overrightarrow{OC} = \mathbf{j} \ (1 - \lambda)\mathbf{a} + \lambda \ \mathbf{b} \\ [\overrightarrow{OC} = \mathbf{j} \ (1 - \lambda)\mathbf{a} + \lambda \ \mathbf{b} \\ [\overrightarrow{OC} = \mathbf{j} \ (1 - \lambda)\mathbf{a} + \lambda \ \mathbf{b} \\ [\overrightarrow{OC} = \mathbf{j} \ (1 - \lambda)\mathbf{a} + \lambda \ \mathbf{b} \\ [\overrightarrow{OC} = \mathbf{j} \ (1 - \lambda)\mathbf{a} + \lambda \ \mathbf{b} \\ [\overrightarrow{OC} = \mathbf{j} \ (1 - \lambda)\mathbf{a} + \lambda \ \mathbf{b} \\ [\overrightarrow{OC} = \mathbf{j} \ (1 - \lambda)\mathbf{a} + \lambda \ \mathbf{b} \\ [\overrightarrow{OC} = \mathbf{j} \ (1 - \lambda)\mathbf{a} + \lambda \ \mathbf{b} \\ [\overrightarrow{OC} = \mathbf{j} \ (1 - \lambda)\mathbf{a} + \lambda \ \mathbf{b} \\ [\overrightarrow{OC} = \mathbf{j} \ (1 - \lambda)\mathbf{a} + \lambda \ \mathbf{b} \\ [\overrightarrow{OC} = \mathbf{j} \ (1 - \lambda)\mathbf{a} + \lambda \ \mathbf{b} \\ [\overrightarrow{OC} = \mathbf{j} \ (1 - \lambda)\mathbf{a} + \lambda \ \mathbf{b} \ \mathbf{b} \ (1 - \lambda)\mathbf{c} \ (1 - \lambda)\mathbf{a} \ \mathbf{b} \ (1 - \lambda)\mathbf{c} \ (1 - \lambda)$				A1FT	<b>FT</b> <i>their</i> $\alpha + \beta$ provided non-zero
$\begin{bmatrix} \overrightarrow{OC} = \mathbf{j} \ \mathbf{a} + \lambda(\mathbf{b} - \mathbf{a}) \text{ or } \\ [\overrightarrow{OC} = \mathbf{j} \ \mathbf{b} + (1 - \lambda)(\mathbf{a} - \mathbf{b}) \\ [\overrightarrow{OC} = \mathbf{j} \ (1 - \lambda)\mathbf{a} + \lambda \ \mathbf{b} \\ [\overrightarrow{OC} = \mathbf{j} \ (1 - \lambda)\mathbf{a} + \lambda \ \mathbf{b} \\ [\overrightarrow{OC} = \mathbf{j} \ (1 - \lambda)\mathbf{a} + \lambda \ \mathbf{b} \\ [\overrightarrow{DC} = \mathbf{j} \ (1 - \lambda)\mathbf{a} + \lambda \ \mathbf{b} \\ [\overrightarrow{DC} = \mathbf{j} \ (1 - \lambda)\mathbf{a} + \lambda \ \mathbf{b} \\ [\overrightarrow{DC} = \mathbf{j} \ (1 - \lambda)\mathbf{a} + \lambda \ \mathbf{b} \\ [\overrightarrow{DC} = \mathbf{j} \ (1 - \lambda)\mathbf{a} + \lambda \ \mathbf{b} \\ [\overrightarrow{DC} = \mathbf{j} \ (1 - \lambda)\mathbf{a} + \lambda \ \mathbf{b} \\ [\overrightarrow{DC} = \mathbf{j} \ (1 - \lambda)\mathbf{a} + \lambda \ \mathbf{b} \\ [\overrightarrow{DC} = \mathbf{j} \ (1 - \lambda)\mathbf{a} + \lambda \ \mathbf{b} \\ [\overrightarrow{DC} = \mathbf{j} \ (1 - \lambda)\mathbf{a} + \lambda \ \mathbf{b} \\ [\overrightarrow{DC} = \mathbf{j} \ (1 - \lambda)\mathbf{a} + \lambda \ \mathbf{b} \\ [\overrightarrow{DC} = \mathbf{j} \ (1 - \lambda)\mathbf{a} + \lambda \ \mathbf{b} \\ [\overrightarrow{DC} = \mathbf{j} \ (1 - \lambda)\mathbf{a} + \lambda \ \mathbf{b} \\ [\overrightarrow{DC} = \mathbf{j} \ (1 - \lambda)\mathbf{a} + \lambda \ \mathbf{b} \\ [\overrightarrow{DC} = \mathbf{j} \ (1 - \lambda)\mathbf{a} + \lambda \ \mathbf{b} \\ [\overrightarrow{DC} = \mathbf{j} \ (1 - \lambda)\mathbf{a} + \lambda \ \mathbf{b} \\ [\overrightarrow{DC} = \mathbf{j} \ (1 - \lambda)\mathbf{a} + \lambda \ \mathbf{b} \\ [\overrightarrow{DC} = \mathbf{j} \ (1 - \lambda)\mathbf{a} + \lambda \ \mathbf{b} \\ [\overrightarrow{DC} = \mathbf{j} \ (1 - \lambda)\mathbf{a} + \lambda \ \mathbf{b} \\ [\overrightarrow{DC} = \mathbf{j} \ (1 - \lambda)\mathbf{a} + \lambda \ \mathbf{b} \\ [\overrightarrow{DC} = \mathbf{j} \ (1 - \lambda)\mathbf{a} + \lambda \ \mathbf{b} \\ [\overrightarrow{DC} = \mathbf{j} \ (1 - \lambda)\mathbf{a} + \lambda \ \mathbf{b} \\ [\overrightarrow{DC} = \mathbf{j} \ (1 - \lambda)\mathbf{a} + \lambda \ \mathbf{b} \\ [\overrightarrow{DC} = \mathbf{j} \ (1 - \lambda)\mathbf{a} + \lambda \ \mathbf{b} \\ [\overrightarrow{DC} = \mathbf{j} \ (1 - \lambda)\mathbf{a} + \lambda \ \mathbf{b} \\ [\overrightarrow{DC} = \mathbf{j} \ (1 - \lambda)\mathbf{a} + \lambda \ \mathbf{b} \\ [\overrightarrow{DC} = \mathbf{j} \ (1 - \lambda)\mathbf{a} + \lambda \ \mathbf{b} \\ [\overrightarrow{DC} = \mathbf{j} \ (1 - \lambda)\mathbf{a} + \lambda \ \mathbf{b} \\ [\overrightarrow{DC} = \mathbf{j} \ (1 - \lambda)\mathbf{a} + \lambda \ \mathbf{b} \\ [\overrightarrow{DC} = \mathbf{j} \ (1 - \lambda)\mathbf{a} + \lambda \ \mathbf{b} \\ [\overrightarrow{DC} = \mathbf{j} \ (1 - \lambda)\mathbf{a} + \lambda \ \mathbf{b} \\ [\overrightarrow{DC} = \mathbf{j} \ (1 - \lambda)\mathbf{a} + \lambda \ \mathbf{b} \ (1 - \lambda)\mathbf{b} \ (1 - \lambda)\mathbf{a} + \lambda \ \mathbf{b} \ (1 - \lambda)\mathbf{b} \ (1 - \lambda)\mathbf{b} \ (1 -$	(	<b>b</b> )	$\overrightarrow{OC} = \overrightarrow{OA} + \lambda \overrightarrow{AB}$ or $\overrightarrow{OC} = OB + (1 - \lambda)\overrightarrow{BA}$	<b>B</b> 1	
(c) $\frac{2}{\mu+3} = \frac{\mu}{9}$ Solves $\mu^2 + 3\mu - 18 = 0$ M1 or multiplies one of the vector a general scale factor and finds pair of simultaneous equations solve M1 or solves <i>their</i> correct equation find <i>their</i> scale factor and attention of the solution of the solutio			$[\overrightarrow{OC} =] \mathbf{a} + \lambda(\mathbf{b} - \mathbf{a}) \text{ or}$ $[\overrightarrow{OC} =] \mathbf{b} + (1 - \lambda)(\mathbf{a} - \mathbf{b})$	M1	
Solves $\mu^2 + 3\mu - 18 = 0$ M1 or solves <i>their</i> correct equation find <i>their</i> scale factor and attention				A1	
find <i>their</i> scale factor and atten	(	(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 $\mu$
$\mu = 3$ A1 A0 if -6 not discarded			$\mu = 3$	A1	A0 if -6 not discarded

F	Page 6	Mark Scheme		Syllabus Paper
		Cambridge IGCSE – March 2016		0606 22
Quest	tion	Answer	Marks	Guidance
11 (i)		$\frac{dy}{dx} = \frac{(x^2 + 1)(1) - (x)(2x)}{(x^2 + 1)^2}  \text{oe}$	M1*	Attempts to differentiate using the quotient rule
			A1	correct; allow unsimplified
		$their(1-x^2) = 0$	M1 dep*	
		x = 1, x = -1	A1	from correct working only
		y = 0.5, $y = -0.5$ oe	A1	from correct working only
				or A1 for each of $(1, 0.5)$ , (-1, -0.5) oe from correct working;
				unsupported answers do not score
(ii)		$\frac{d}{dx} \left( \left( x^2 + 1 \right)^2 \right) = 2 \left( x^2 + 1 \right) (2x) \text{ soi}$	B1	$\frac{d}{dx}\left(x^4 + 2x^2 + 1\right) = 4x^3 + 4x$
		$\frac{d^2 y}{dx^2} = (x^2 + 1) \frac{(x^2 + 1)(their - 2x) - (their(1 - x^2))(2x)}{(x^2 + 1)^4}$	M1	Applies quotient rule and factors out
		Correct completion to given answer $\frac{d^2 y}{dx^2} = \frac{2x^3 - 6x}{(x^2 + 1)^3}$	A1	
		When $x = 1$ their $\frac{d^2 y}{dx^2}\Big _{x=1} = \frac{2(1)^3 - 6(1)}{(1^2 + 1)^3}$ oe < 0 therefore maximum	B1FT	Complete method including comparison to 0; <b>FT</b> <i>their</i> first or second derivative
		When $x = -1$ their $\frac{d^2 y}{dx^2}\Big _{x=-1} = \frac{2(-1)^3 - 6(-1)}{((-1)^2 + 1)^3}$ oe > 0 therefore minimum	B1FT	Complete method including comparison to 0; <b>FT</b> <i>their</i> first or second derivative

Page 7	Mark Scheme Cambridge IGCSE – March 2016		Syllabus Paper 0606 22
Question	Answer	Marks	Guidance
12 (i)	$9t^{2} - 63t + 90 = 0$ (9t - 18)(t - 5)	M1	
	showing that $t = 2$ is smaller value of $t$	A1	must see evidence of solving e.g. $t = 5$ and $t = 2$ or factors
(ii)	$(a=)\frac{\mathrm{d}v}{\mathrm{d}t}$ 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)	$18(3.5) - 63 = 0 \text{ cao}$ $\int (9t^2 - 63t + 90) dt$ $(s =) \frac{9t^3}{3} - \frac{63t^2}{2} + 90t \text{ isw}$ $(s =) \frac{9(2)^3}{3} - \frac{63(2)^2}{2} + 90(2)$	M1	or $\left[\frac{9t^3}{3} - \frac{63t^2}{2} + 90t\right]_0^2$ FT their (iii)
	78 [m]	A1	
(b)	$(s=)\frac{9(3)^3}{3} - \frac{63(3)^2}{2} + 90(3) = 67.5$	M1	FT their (iii)
	<i>their</i> 78 + 10.5 = 88.5 [m]	A1FT	