

**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

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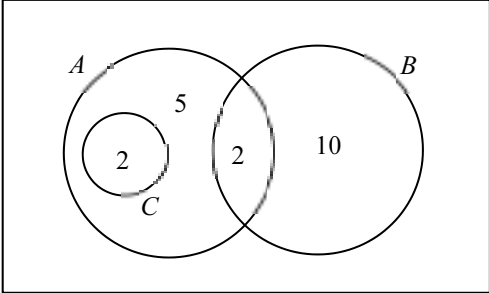
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Page 2	Mark Scheme	Syllabus	Paper
	Cambridge IGCSE – March 2016	0606	22

### 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 $5 \times -\frac{1}{2}$
1 (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	<p>B2 for C as a proper subset of A A and B with an intersection B and C mutually exclusive</p> <p>Or B1 for any two of the these and B1 for the number of elements correctly placed</p>
3	<p>Integrates <math>9x^2 - 3x^{-2}</math></p> <p><math>(y =) \frac{9x^3}{3} - \frac{3x^{-1}}{-1} (+c)</math></p> <p>Substitute <math>x = 1</math> and <math>y = 7</math> into <i>their</i> expression with 'c'</p> <p><math>y = 3x^3 + 3x^{-1} + 1</math> oe isw</p>	<p>M1</p> <p>A1</p> <p>M1</p> <p>A1</p>	<p>condone one rearrangement error</p> <p><i>their</i> expression must be from an attempt to integrate</p> <p>condone <math>y = 3x^3 + 3x^{-1} + c</math> and <math>c = 1</math> seen, isw</p>



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 $-\frac{1}{2} \begin{pmatrix} & \\ & \end{pmatrix}$ and 1 mark for $k \begin{pmatrix} 1 & 0 \\ -4 & -2 \end{pmatrix}$
(ii)	Valid method	M1	$\mathbf{XD}^{-1}\mathbf{D} = \mathbf{CD}$
	$\begin{pmatrix} -8 & -6 \\ 13 & 7 \end{pmatrix}$	A2,1,0	-1 each error
			If M0 then SC1 for $\mathbf{DC} = \begin{pmatrix} 4 & 3 \\ -14 & -5 \end{pmatrix}$
8 (i)	Eliminate $x$ (or $y$ )	M1	$3(2y-2)^2 + (2y-2)y - y^2 = 12$
	$13y^2 - 26y = 0$ 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 <i>their</i> $x$ or $y$ values to find <i>their</i> $y$ or $x$ values; or A1 for $(-2, 0)$ and $(2, 2)$
(ii)	$\text{their } m_{AB} = \frac{1}{2}$ or $\text{their } m_{BC} = -2$ 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

Page 5	Mark Scheme	Syllabus	Paper
	Cambridge IGCSE – March 2016	0606	22

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	M1	
	correct completion to given answer $A = 1 - \frac{\operatorname{cosec} \theta}{2}$	A1	
(iii)	$\operatorname{cosec} \theta = \frac{2\sqrt{3}}{3}$ oe	M1	equivalent must be exact
	$\theta = \frac{\pi}{3}$ cao	A1	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 $2\alpha - 24 = -20$
	$\alpha = 2$ $\beta = 13$	A1 A1	
(ii)	$\sqrt{(\text{their } \alpha + \text{their } \beta)^2 + (-20)^2}$ oe	M1	
	$\frac{15\mathbf{i} - 20\mathbf{j}}{25}$ oe	A1FT	FT <i>their</i> $\alpha + \beta$ provided non-zero
(b)	$\overline{OC} = \overline{OA} + \lambda \overline{AB}$ or $\overline{OC} = \overline{OB} + (1 - \lambda)\overline{BA}$	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 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

Question	Answer	Marks	Guidance
11 (i)	$\frac{dy}{dx} = \frac{(x^2 + 1)(1) - (x)(2x)}{(x^2 + 1)^2}$ oe	<b>M1*</b>	Attempts to differentiate using the quotient rule
	$their(1 - x^2) = 0$ $x = 1, x = -1$ $y = 0.5, y = -0.5$ oe	<b>A1</b>  <b>M1 dep*</b>  <b>A1</b>  <b>A1</b>	correct; allow unsimplified  from correct working only  from correct working only  or <b>A1</b> for each of (1, 0.5), (-1, -0.5) oe from correct working;
(ii)	$\frac{d}{dx}((x^2 + 1)^2) = 2(x^2 + 1)(2x)$ soi	<b>B1</b>	$\frac{d}{dx}(x^4 + 2x^2 + 1) = 4x^3 + 4x$
	$\frac{d^2y}{dx^2} = (x^2 + 1) \frac{(x^2 + 1)(their - 2x) - (their(1 - x^2))2(2x)}{(x^2 + 1)^4}$	<b>M1</b>	Applies quotient rule and factors out
	Correct completion to given answer $\frac{d^2y}{dx^2} = \frac{2x^3 - 6x}{(x^2 + 1)^3}$	<b>A1</b>	
	When $x = 1$ $their \frac{d^2y}{dx^2} \Big _{x=1} = \frac{2(1)^3 - 6(1)}{(1^2 + 1)^3}$ oe $< 0$ therefore <div style="text-align: center;">maximum</div>	<b>B1FT</b>	Complete method including comparison to 0; <b>FT</b> <i>their</i> first or second derivative
When $x = -1$ $their \frac{d^2y}{dx^2} \Big _{x=-1} = \frac{2(-1)^3 - 6(-1)}{((-1)^2 + 1)^3}$ oe $> 0$ <div style="text-align: center;">therefore minimum</div>	<b>B1FT</b>	Complete method including comparison to 0; <b>FT</b> <i>their</i> first or second derivative	

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	