

**MARK SCHEME for the May/June 2014 series**

**0606 ADDITIONAL MATHEMATICS**

**0606/13**

Paper 1, 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.

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<p><b>1 (i)</b></p> <p><math>y = 3(x - 1)^2 + 2</math> <math>a = 3, b = 1, c = 2</math></p> <p><b>(ii)</b></p> <p>(1, 2)</p>	<p><b>B1, B1, B1</b></p> <p><b>√B1</b></p>	<p><b>B1</b> for each, may be given in the form <math>y = 3(x - 1)^2 + 2</math></p> <p>Follow through on their answers to <b>(i)</b> If using differentiation, follow through on their <math>x</math> only.</p>
<p><b>2</b></p> <p><math>2^{4x} \times 4^y \times 8^{x-y} = 1</math> Considering powers of either 2, 4 or 8 <math>7x - y = 0</math></p> <p><math>3^{x+y} = \frac{1}{3}</math></p> <p>Considering powers of 3 <math>x + y = -1</math></p> <p>Solving both simultaneously gives <math>x = -\frac{1}{8}, y = -\frac{7}{8}</math></p>	<p><b>M1</b></p> <p><b>B1</b></p> <p><b>M1</b></p> <p><b>A1</b></p>	<p><b>M1</b> for considering powers of either 2, 4 or 8 and forming an equation using these powers</p> <p><b>B1</b> for equation considering powers of 3</p> <p><b>M1</b> for attempt to solve their equations <b>A1</b> for both</p>
<p><b>3 (i)</b></p> <p><math>f(-3) = -27 + 9p - 3p^2 + 21</math> <math>= 9p - 3p^2 - 6</math></p> <p><b>(ii)</b></p> <p><math>9p - 3p^2 - 6 &lt; 0</math> <math>(p - 1)(p - 2) &gt; 0</math> Critical values 1 and 2 <math>p &lt; 1, p &gt; 2</math></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><b>M1</b> for substitution of <math>x = -3</math> <b>A1</b> answer must be simplified</p> <p><b>M1</b> for attempt to factorise</p> <p><b>A1</b> for critical values <b>A1</b> for correct range</p>
<p><b>4 (i)</b></p> <p><math>V = x(24 - 2x)^2</math> <math>= x(576 - 96x + 4x^2)</math> <math>= 4x^3 - 96x^2 + 576x</math></p> <p><b>(ii)</b></p> <p><math>\frac{dV}{dx} = 12x^2 - 192x + 576</math></p> <p>When <math>\frac{dV}{dx} = 0, 12x^2 - 192x + 576 = 0</math></p> <p>leading to <math>(x - 4)(x - 12) = 0</math> with <math>x = 4</math> the only possible solution <math>V = 1024</math></p>	<p><b>M1</b></p> <p><b>A1</b></p> <p><b>M1</b></p> <p><b>DM1</b></p> <p><b>A1</b></p> <p><b>A1</b></p>	<p><b>M1</b> for attempt at a product of 3 lengths, 2 of which must be the same <b>A1</b> for expansion to reach given answer</p> <p><b>M1</b> for attempt to differentiate</p> <p><b>DM1</b> for equating <math>\frac{dV}{dx}</math> to zero and attempt to solve</p> <p><b>A1</b> for <math>x = 4</math> <b>A1</b> for <math>V = 1024</math></p>

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5	(i) $64 - 960x + 6000x^2$  (ii) $(64 - 960x + 6000x^2)(a^3 + 3a^2bx)$ , $64a^3 = 512, a = 2$  $-960a^3 + 3a^2b(64) = 0$  leading to $b = 10$	<b>B1, B1, B1</b>  <b>B1</b> <b>B1</b>  <b>M1</b>  <b>A1</b>	<b>B1</b> for each correct term  <b>B1</b> for first two terms of $(a + bx)^3$  <b>B1</b> for equating constant term to 512 and obtaining $a = 2$  <b>M1</b> for attempt to equate coefficient of $x$ to zero, must have two terms involved  <b>A1</b> for $b = 10$
6	When $x = 2, y = -4$  $\frac{dy}{dx} = x \left( \frac{2x}{3} \right) (x^2 - 12)^{-\frac{2}{3}} + (x^2 - 12)^{\frac{1}{3}}$  When $x = 2, \frac{dy}{dx} = -\frac{4}{3}$ Normal: $y + 4 = \frac{3}{4}(x - 2)$ $(4y = 3x - 22)$	<b>B1</b>  <b>M1, B1</b> <b>A1</b>  <b>M1</b>  <b>A1</b>	<b>B1</b> for $y = -4$  <b>M1</b> for differentiation of a product  <b>B1</b> for $\frac{2x}{3}(x^2 - 12)^{-\frac{2}{3}}$  <b>M1</b> for attempt at normal equation  <b>A1</b> allow unsimplified
7	(a) (i) 15120  (ii) $(5 \times 4) \times (4 \times 3 \times 2)$ 480  (b) (i) 5456  (ii) ${}^{18}C_2 \times 15$ 2295  (iii) 5456 – Number of ways only girls get tickets $5456 - 455 = 5001$  <b>Or</b> 1B 2G 1890 2B 1G 2295 3B 816 Total 5001	<b>B1</b>  <b>M1</b> <b>A1</b>  <b>B1</b>  <b>M1</b> <b>A1</b>  <b>M1</b> <b>A1</b>  <b>M1</b> <b>A1</b>	<b>M1</b> for attempt to multiply number of ways of getting 4 letters by the number of ways of getting 2 digits.  <b>M1</b> for attempt at an appropriate product, at least one term must be correct.  <b>M1</b> for a complete correct method <i>their (i)</i> – number of ways only girls get tickets  <b>M1</b> must be considering at least 2 of the cases shown

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8	(i)	1	<b>B1</b>	
	(ii)	$a = 8e^{-2t}$	<b>M1</b>	<b>M1</b> for attempt to differentiate
		$8e^{-2t} = 6, -2t = \ln \frac{3}{4}$	<b>DM1</b>	<b>DM1</b> for correct attempt to solve equation in the form $e^{-2t} = \text{constant}$
	(iii)	$t = 0.144$	<b>A1</b>	<b>A1</b> must be at least 3 sf
$s = 5t + 2e^{-2t} \quad (+c)$		<b>M1</b>	<b>M1</b> for attempt to integrate	
When $t = 0, s = 0, \text{ so } c = -2$		<b>DM1, A1</b>	<b>DM1</b> for attempt to find $c$ , <b>A1</b> $c$ correct	
		When $t = 1.5, s = 5.60$	<b>M1, A1</b>	<b>M1</b> for substitution of $t = 1.5$
	<b>Alternative:</b>	$s = [5t + 2e^{-2t}]_0^{1.5}$	<b>M1</b>	<b>M1</b> for attempt to integrate
			<b>DM1</b>	<b>DM1</b> for attempt to use limits
			<b>A1</b>	<b>A1</b> all correct
			<b>M1</b>	<b>M1</b> for evaluation of square bracket notation
		Leading to $s = 5.60$	<b>A1</b>	
(iv)		Velocity is always +ve, so no change in direction	<b>B1</b>	Allow any valid argument.
9	(i)	$\cos x (3 \sin x - 2) = 0$	<b>B1</b>	<b>B1</b> for $90^\circ$
		$\cos x = 0, x = 90^\circ$	<b>M1</b>	<b>M1</b> for attempt to solve $\sin x = \frac{2}{3}$
		$\sin x = \frac{2}{3},$	<b>A1, √A1</b>	Follow through on their first answer
		$x = 41.8^\circ, 138.2^\circ$		
(ii)	$10 \sin^2 y + \cos y = 8$	<b>M1</b>	<b>M1</b> for use of correct identity	
	$10(1 - \cos^2 y) + \cos y = 8$	<b>M1</b>	<b>M1</b> for attempt to reduce to a 3 term quadratic and attempt to solve quadratic	
	$10 \cos^2 y - \cos y - 2 = 0$	<b>M1</b>	<b>M1</b> for attempt to solve using factors in terms of cos	
	$(2 \cos y - 1)(5 \cos y + 2) = 0$			
	$\cos y = \frac{1}{2}, \cos y = -\frac{2}{5}$	<b>A1, A1</b>	<b>A1</b> for any 'pair'	
	$y = 60^\circ, 300^\circ$ and $y = 113.6^\circ, 246.4^\circ$			

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<p>10 (i)</p>	<table border="1"> <tr> <td><math>x^2</math></td> <td>2.25</td> <td>3.06</td> <td>4</td> <td>5.06</td> </tr> <tr> <td><math>\lg y</math></td> <td>0.59</td> <td>0.92</td> <td>1.29</td> <td>1.71</td> </tr> </table>	$x^2$	2.25	3.06	4	5.06	$\lg y$	0.59	0.92	1.29	1.71	<p><b>B1</b></p>	
$x^2$	2.25	3.06	4	5.06									
$\lg y$	0.59	0.92	1.29	1.71									
<p>(ii)</p>		<p><b>M1</b> <b>A1, 0</b></p>	<p><b>M1</b> for plotting <math>\lg y</math> against <math>x^2</math> –1 each error, poor point plotting, poor line drawing</p>										
<p>(iii)</p>	<p>Gradient: <math>\lg b = 0.4, b = 2.5</math> (allow 2.45 to 2.55)</p> <p>Intercept : <math>\lg A = -0.3, A = 0.5</math> (allow 0.4 to 0.6)</p>	<p><b>M1</b> <b>A1</b></p> <p><b>M1</b> <b>A1</b></p>	<p><b>M1</b> for correct use of gradient</p> <p><b>M1</b> for correct use intercept</p>										
<p>(iv)</p>	<p>2.1 (allow 2 to 2.2)</p>	<p><b>M1, A1</b></p>											

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11	(i)	<p>at A <math>\sqrt{3} \sin 3x + \cos 3x = 0</math></p> <p><math>\tan 3x = -\frac{1}{\sqrt{3}}, 3x = \frac{5\pi}{6} \quad 150^\circ</math></p> <p><math>x = \frac{5\pi}{18} (0.873) \text{ (allow } 50^\circ)</math></p>	M1	M1 for equating to zero and attempt to solve using tan
	(ii)	<p><math>\frac{dy}{dx} = 3\sqrt{3} \cos 3x - 3 \sin 3x</math></p> <p>When <math>\frac{dy}{dx} = 0, \tan 3x = \sqrt{3}, 3x = \frac{\pi}{3} \text{ or } 3x = 60^\circ,</math></p> <p><math>x = \frac{\pi}{9} (0.349) \text{ (allow } 20^\circ)</math></p>	B1, B1	B1 for $\frac{dy}{dx}$
	(iii)	<p>Area = <math>\left[ -\frac{\sqrt{3}}{3} \cos 3x + \frac{1}{3}x + \frac{1}{3} \sin 3x \right]_{\frac{\pi}{9}}^{\frac{5\pi}{18}}</math></p> <p><math>= \left( -\frac{\sqrt{3}}{3} \cos \frac{5\pi}{6} + \frac{1}{3} \sin \frac{5\pi}{6} \right) - \left( -\frac{\sqrt{3}}{3} \cos \frac{\pi}{3} + \frac{1}{3} \sin \frac{\pi}{3} \right)</math></p> <p><math>= \frac{2}{3} \text{ or } 0.667 \text{ or better}</math></p>	M1 A1, A1	M1 for attempt to integrate A1 for each term
			DM1	DM1 for correct application of their limits
			A1	