CAMBRIDGE INTERNATIONAL EXAMINATIONS

International General Certificate of Secondary Education

MARK SCHEME for the May/June 2014 series

0606 ADDITIONAL MATHEMATICS

0606/11 Paper 1, maximum raw mark 80

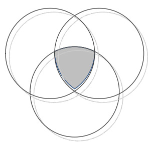
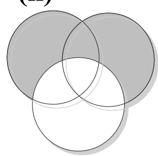
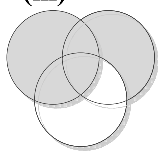
This mark scheme is published as an aid to teachers and candidates, to indicate the requirements of the examination. It shows the basis on which Examiners were instructed to award marks. It does not indicate the details of the discussions that took place at an Examiners' meeting before marking began,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

Cambridge will not enter into discussions about these mark schemes.

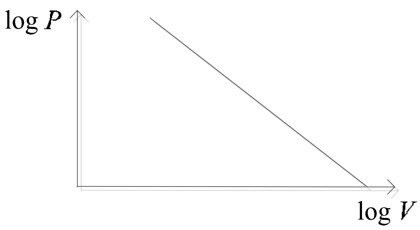
Cambridge is publishing the mark schemes for the May/June 2014 series for most IGCSE, GCE Advanced Level and Advanced Subsidiary Level components and some Ordinary Level components.

1	$\text{LHS} = \dfrac{\sin\ \theta}{\cos\ \theta} + \dfrac{\cos\ \theta}{1+\sin\ \theta}$	**B1**	**B1** for use of $\tan\theta = \dfrac{\sin\theta}{\cos\theta}$
	$= \dfrac{\sin\theta(1+\sin\theta)+\cos^2\theta}{\cos\theta(1+\sin\theta)}$	**M1**	**M1** for attempt to obtain a single fraction
	$= \dfrac{1+\sin\theta}{\cos\theta(1+\sin\theta)}$	**DM1**	**DM1** for use of $\sin^2\theta+\cos^2\theta=1$
	$= \dfrac{1}{\cos\theta}$ leading to $\sec\theta$	**A1**	**A1** for 'finishing off'
	Alternative solution: $\text{LHS} = \dfrac{\sin\theta}{\cos\theta} + \dfrac{\cos\theta\,(1\text{-}\sin\theta)}{(1+\sin\theta)(1\text{-}\sin\theta)}$	**B1**	**B1** for use of $\tan\theta = \dfrac{\sin\theta}{\cos\theta}$
	$= \dfrac{\sin\theta}{\cos\theta} + \dfrac{\cos\theta(1-\sin\theta)}{\cos^2\theta}$	**M1**	**M1** for multiplication by $(1-\sin\theta)$
	$= \dfrac{\sin\theta}{\cos\theta} + \dfrac{(1-\sin\theta)}{\cos\theta}$	**DM1**	**DM1** for use of $\sin^2\theta+\cos^2\theta=1$
	$= \dfrac{1}{\cos\theta}$ leading to $\sec\theta$	**A1**	**A1** for 'finishing off'
	Alternative solution: $\text{LHS} = \dfrac{\tan\theta(1+\sin\theta)+\cos\theta}{1+\sin\theta}$	**M1**	**M1** for attempt to obtain a single fraction
	$= \dfrac{\dfrac{\sin\theta}{\cos\theta}+\dfrac{\sin^2}{\cos\theta}+\cos\theta}{1+\sin\theta}$	**B1**	**B1** for use of $\tan\theta = \dfrac{\sin\theta}{\cos\theta}$
	$= \dfrac{\sin\theta+\sin^2\theta+\cos^2\theta}{\cos\theta(1+\sin\theta)}$		
	$= \dfrac{1+\sin\theta}{\cos\theta(1+\sin\theta)}$	**DM1**	**DM1** for use of $\sin^2\theta+\cos^2\theta=1$
	$= \dfrac{1}{\cos\theta}$ leading to $\sec\theta$	**A1**	**A1** for 'finishing off'

2 (i)	$\lvert\mathbf{a}\rvert = \sqrt{4^2 + 3^2} = 5$ $\lvert\mathbf{b}+\mathbf{c}\rvert = \sqrt{(-3)^2 + 4^2} = 5$	**M1** **A1**	**M1** for finding the modulus of either **a** or **b** + **c** **A1** for completion
(ii)	$\lambda\begin{pmatrix}4\\3\end{pmatrix} + \mu\begin{pmatrix}2\\2\end{pmatrix} = 7\begin{pmatrix}-5\\2\end{pmatrix}$ $4\lambda + 2\mu = -35$ and $3\lambda + 2\mu = 14$ leading to $\lambda = -49$, $\mu = 80.5$	 **M1** **DM1** **A1**	 **M1** for equating like vectors and obtaining 2 linear equations **DM1** for solution of simultaneous equations **A1** for both
3 (a)	**(i)**  **(ii)**  **(iii)** 	**B1** **B1** **B1**	**B1** for each
(b) (i)	2	**B1**	
(ii)	0	**B1**	
4	$k(4x-3) = 4x^2 + 8x - 8$ $4x^2 + x(8-4k) + 3k - 8 = 0$ $b^2 - 4ac = (8-4k)^2 - 16(3k-8)$ $= 16k^2 - 112k + 192$ $b^2 - 4ac < 0$, $k^2 - 7k + 12 < 0$ critical values $k = 3, 4$ $\therefore 3 < k < 4$	**M1** **DM1** **DM1** **A1** **A1**	**M1** for equating the line and the curve and attempt to obtain a quadratic equation in k **DM1** for use of $b^2 - 4ac$ with k **DM1** for solution of a 3 term quadratic equation, dependent on both previous M marks **A1** for both critical values **A1** for the range
5 (i)	$\frac{dy}{dx} = 2xe^{x^2}$	**B1B1**	**B1** for e^{x^2}, **B1** for $2xe^{x^2}$
(ii)	$\frac{1}{2}e^{x^2}$	**M1A1**	**M1** for ke^{x^2} **A1** for $\frac{1}{2}e^{x^2}$
(iii)	$\left(\frac{1}{2}e^4\right) - \left(\frac{1}{2}\right) = 26.8$	**DM1** **A1**	**DM1** for correct use of limits **A1** for 26.8, allow exact value

6	(i)	$\mathbf{AB} = \begin{pmatrix} 10 & 19 \\ 32 & 37 \\ 14 & 14 \end{pmatrix}$	M1 A1	M1 for at least 3 correct elements of a 3×2 matrix A1 for all correct
	(ii)	$\mathbf{B}^{-1} = \frac{1}{7}\begin{pmatrix} 5 & -1 \\ -3 & 2 \end{pmatrix}$	B1 B1	B1 for $\frac{1}{7}$, B1 for $\begin{pmatrix} 5 & -1 \\ -3 & 2 \end{pmatrix}$
	(iii)	$2\begin{pmatrix} 2 & 1 \\ 3 & 5 \end{pmatrix}\begin{pmatrix} x \\ y \end{pmatrix} = \begin{pmatrix} -3 \\ -22 \end{pmatrix}$	M1	M1 for obtaining in matrix form
		$\begin{pmatrix} x \\ y \end{pmatrix} = \frac{1}{7}\begin{pmatrix} 5 & -1 \\ -3 & 2 \end{pmatrix}\begin{pmatrix} -1.5 \\ -11 \end{pmatrix} = \frac{1}{7}\begin{pmatrix} 3.5 \\ -17.5 \end{pmatrix}$	M1	M1 for pre-multiplying by $\mathbf{B}^{-1}$
		$x = 0.5,\ y = -2.5$	A1	A1 for both
7	(i)	$y = 2x^2 - \frac{1}{x+1}(+c)$	B1 B1	B1 for each correct term
		when $x = \frac{1}{2}, y = \frac{5}{6}$ so $\frac{5}{6} = \frac{1}{2} - \frac{2}{3} + c$	M1	M1 for attempt to find $+c$, must have at least 1 of the previous B marks
		leading to $c = 1$	A1	Allow A1 for $c = 1$
		$\left(y = 2x^2 - \frac{1}{x+1} + 1\right)$		
	(ii)	When $x = 1, y = \frac{5}{2}$	M1	M1 for using $x = 1$ in their (i) to find y
		$\frac{dy}{dx} = \frac{17}{4}$ so gradient of normal $= -\frac{4}{17}$	B1	B1 for gradient of normal
		Equation of normal $y - \frac{5}{2} = -\frac{4}{17}(x-1)$	DM1	DM1 for attempt at **normal** equation
		$(8x + 34y - 93 = 0)$	A1	A1 – allow unsimplified (fractions must not contain decimals)

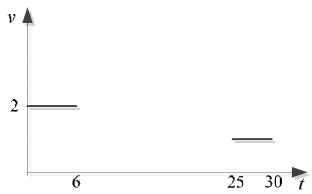
<table>
<tr><td>8 (i)</td><td>$\log p = n\log V + \log k$
<table><tr><td>$\ln V$</td><td>2.30</td><td>3.91</td><td>4.61</td><td>5.30</td></tr><tr><td>$\ln p$</td><td>4.55</td><td>2.14</td><td>1.10</td><td>0.10</td></tr></table><table><tr><td>$\lg V$</td><td>1</td><td>1.70</td><td>2</td><td>2.30</td></tr><tr><td>$\lg p$</td><td>1.98</td><td>0.93</td><td>0.48</td><td>0.04</td></tr></table>



</td><td>B1

M1
A2,1,0</td><td>B1 for statement, but may be implied by later work.

M1 for plotting a suitable graph
–1 for each error in points plotted</td></tr>
<tr><td>(ii)</td><td>Use of gradient = n
$n = -1.5$ (allow –1.4 to –1.6)</td><td>DM1
A1</td><td>DM1 for equating numerical gradient to n</td></tr>
<tr><td>(iii)</td><td>Allow 13 to 16</td><td>DM1
A1</td><td>DM1 for use of their graph or substitution into their equation.</td></tr>
<tr><td>9 (a)</td><td>Distance travelled = area under graph
$= \frac{1}{2}(60+20)\times 12 = 480$</td><td>M1

A1</td><td>M1 for realising that area represents distance travelled and attempt to find area</td></tr>
<tr><td>(b)</td><td>


</td><td>B1
B1

B1</td><td>B1 for velocity of 2 ms^{-1} for $0 \leqslant t \leqslant 6$
B1 for velocity of zero for their ‘6’ to their ‘25’
B1 for velocity of 1 ms^{-1} for $25 \leqslant t \leqslant 30$</td></tr>
<tr><td>(c) (i)</td><td>$v = 4 - \frac{16}{t+1}$

When $v = 0,\ t = 3$</td><td>M1

DM1
A1</td><td>M1 for attempt at differentiation

DM1 for equating velocity to zero and attempt to solve</td></tr>
<tr><td>(ii)</td><td>$a = \frac{16}{(t+1)^2}$

$0.25(t+1)^2 = 16$

$t = 7$</td><td>M1

A1</td><td>M1 for attempt at differentiation and equating to 0.25 with attempt to solve</td></tr>
</table>

10 (a)	1 digit even numbers 2	B1	
	2 digit even numbers $4 \times 2 = 8$	B1	
	3 digit even numbers $3 \times 3 \times 2 = 18$	B1	
	Total = 28	B1	
(b) (i)	3M 5W = 35 4M 4W = 175 5M 3W = 210	B1 B1 B1	
	Total = 420	B1	**B1** for addition to obtain final answer, must be evaluated.
	or ${}^{12}C_8 - 6\text{M } 2\text{W} - 7\text{M } 1\text{W}$ $495 - 70 - 5 = 420$		**or**: as above, final **B1** for subtraction to get final answer
(ii)	Oldest man in, oldest woman out and vice–versa		
	${}^{10}C_7 \times 2 = 240$	B1, B1	**B1** for ${}^{10}C_7$, B1 for realising there are 2 identical cases
	Alternative: 1 man out 1 woman in 6 men 4 women		
	6M 1W : ${}^6C_6 \times {}^4C_1 = 4$ 5M 2W : ${}^6C_5 \times {}^4C_2 = 36$ 4M 3W : ${}^6C_4 \times {}^4C_3 = 60$ 3M 4W : ${}^6C_3 \times {}^4C_4 = 20$ Total = 120	B1	All separate cases correct for **B1**
	There are 2 identical cases to consider, so 240 ways in all.	B1	**B1** for realising there are 2 identical cases, which have integer values

11 (a)	$5\sin 2x + 3\cos 2x = 0$ $\tan 2x = -0.6$ $2x = 149°, 329°$ $x = 74.5°, 164.5°$	 M1 DM1 A1,A1	**In each case the last A mark is for a second correct solution and no extra solutions within the range** **M1** for use of tan **DM1** for dealing with $2x$ correctly **A1** for each
	Alternatives: $\sin(2x + 31°) = 0$ or $\cos(2x - 59°) = 0$	M1	**M1** for either, then mark as above
(b)	$2\cot^2 y + 3\operatorname{cosec} y = 0$ $2(\operatorname{cosec}^2 y - 1) + 3\operatorname{cosec} y = 0$ $2\operatorname{cosec}^2 y + 3\operatorname{cosec} y - 2 = 0$	 M1	 **M1** for use of correct identity
	$(2\operatorname{cosec} y - 1)(\operatorname{cosec} y + 2) = 0$	M1	**M1** for attempt to factorise a 3 term quadratic equation
	One valid solution $\operatorname{cosec} y = -2,\ \sin y = -\frac{1}{2}$ $y = 210°, 330°$	 A1,A1	 **A1** for each
	Alternative: $2\frac{\cos^2 y}{\sin^2 y} + \frac{3}{\sin y} = 0$	M1	**M1** for use of $\cot y = \frac{\cos y}{\sin y}$ and $\operatorname{cosec} y = \frac{1}{\sin y}$
	leads to $2\sin^2 y - 3\sin y - 2 = 0$ and $\sin y = -\frac{1}{2}$ only	 M1	 **M1** for attempt to factorise a 3 term quadratic equation
	$y = 210°, 330°$	A1A1	
(c)	$3\cos(z + 1.2) = 2$ $\cos(z + 1.2) = \frac{2}{3}$		
	$(z + 1.2) = 0.8411, 5.442, 7.124$	M1	**M1** for correct order of operations to end up with 0.8411 radians or better
	$z = 4.24, 5.92$	A1 A1A1	**A1** for one of 5.441 or 7.124 (or better) **A1** for each valid solution