CAMBRIDGE INTERNATIONAL EXAMINATIONS

International General Certificate of Secondary Education

MARK SCHEME for the May/June 2014 series

0459 ADDITIONAL MATHEMATICS (US)

0459/02 Paper 2, 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.

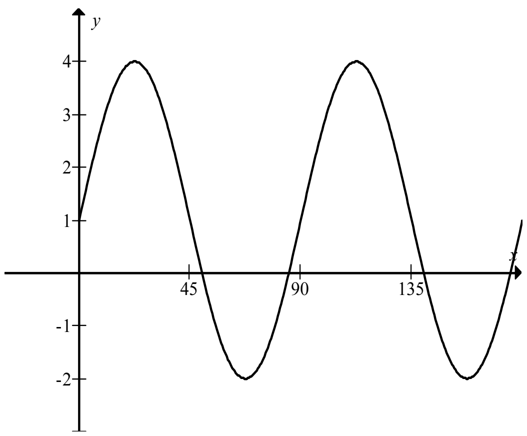
Cambridge will not enter into discussions about these mark schemes.

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 **(i)**	f(3) = 4	**B1**	
(ii)	$c = 4$ $x^3 - 2x^2 - x - 2 = (x-3)(x^2 + ax + b) + 4$ consts: $-2 = -3b + 4$ $b = 2$ coeffs of x: $-1 = -3a + b$ $a = 1$ coeffs of x^2: $-2 = -3 + a,$ $a = 1$ attempt to equate coeffs for one case either $b = 2$ or $a = 1$ $(x-3)(x^2 + x + 2) + 4$	**B1** **M1** **A1** **A1**	OR $x - 3\overline{)x^3 - 2x^2 - x - 2}$ giving $x^2 + x + 2$ $\underline{x^3 - 3x^2}$ $x^2 - x$ $\underline{x^2 - 3x}$ $2x - 2$ $\underline{2x - 6}$ 4 **M1** for $x^3 - 3x^2$ in working **A1** for $x^2 + x\ldots$ **B1** for remainder of 4 or $c = 4$ stated **A1** for $(x-3)(x^2 + x + 2) + 4$
2 **(i)** **(a)**	$2a$ Real	**B1**	
(b)	$(a + 2\text{i})(a - 2\text{i})$		
	$a^2 + 2a\text{i} - 2a\text{i} - (2\text{i})^2$ oe	**M1**	correctly multiplying out brackets
	$a^2 + 4$ Real	**A1**	
(c)	4i Imaginary	**B1**	
(ii)	$\dfrac{a+2\text{i}}{a-2\text{i}} \times \dfrac{a+2\text{i}}{a+2\text{i}}$	**M1**	condone omission of brackets if recovered
	$= \dfrac{a^2 + 4a\text{i} - 4}{a^2 + 4}$	**A1**	
	$a^2 = 4$	**M1**	**ft** *their* fraction, making numerator imaginary
	$a = \pm 2$	**A1**	

3 (i)	gradients = -2, -2, $\frac{1}{2}$, $\frac{1}{2}$	**B1**	
	Two parallel pairs which are perp.	**B1**	allow second **B1** for rearranging equations correctly and commenting even if gradients not explicitly stated
(ii)	Attempting to solve $2y = x + 3$ and $y = 14 - 2x$ or $4y = 2x - 9$ and $y = 4 - 2x$	**M1**	or Attempting to solve $2y = x + 3$ and $y = 4 - 2x$ or $y = 14 - 2x$ and $4y = 2x - 9$
	$A(1, 2)$	**A1**	$B(5, 4)$
	$C(6.5, 1)$	**A1**	$D(2.5, -1)$
	$(6.5-1)^2 + (1-2)^2$ or better	**M1**	$(5-2.5)^2 + (4--1)^2$ or better
	$\frac{\sqrt{125}}{2}$ oe or 5.59 (3 sf) cao	**A1**	
(iii)	$\left(\frac{1+6.5}{2}, \frac{2+1}{2}\right)$ oe	**M1**	$\left(\frac{5+2.5}{2}, \frac{4-1}{2}\right)$ oe
	(3.75, 1.5) oe	**A1**	**FT**
4 (i)	$\mathbf{A}^{-1} = \mathbf{B}^2$ $\Rightarrow \mathbf{AA}^{-1} = \mathbf{AB}^2$ or $\mathbf{A}^{-1}\mathbf{B}^{-1} = \mathbf{B}^2\mathbf{B}^{-1}$ $\Rightarrow \mathbf{I} = \mathbf{AB}^2$ or $\mathbf{A}^{-1}\mathbf{B}^{-1} = \mathbf{B}$	**M1**	attempt left multiplication by **A**
	$\Rightarrow \mathbf{B}^{-1} = \mathbf{AB}^2\mathbf{B}^{-1}$ or $\mathbf{AA}^{-1}\mathbf{B}^{-1} = \mathbf{AB}$	**M1**	attempt right multiplication by $\mathbf{B}^{-1}$
	$\Rightarrow \mathbf{B}^{-1} = \mathbf{AB}$	**A1**	
(ii)	$\Rightarrow \mathbf{BB}^{-1} = \mathbf{BAB}$ $\Rightarrow \mathbf{I} = \mathbf{BAB}$ $\Rightarrow \mathbf{B}^{-1} = \mathbf{BABB}^{-1}$ $\Rightarrow \mathbf{B}^{-1} = \mathbf{BA}$	**M1**	attempt left multiplication by **B** or attempt right multiplication by $\mathbf{B}^{-1}$
	$\Rightarrow \mathbf{AB} = \mathbf{BA}$	**A1**	for correct completion
5 (i)	$\frac{5}{6}$ or 0.667 or 0.833 seen	**B1**	
	$\left(\frac{5}{6}\right)^{25}$	**M1**	
	= 0.0105 (3 sf)	**A1**	allow 1.05%
(ii)	Small probability oe Probably effective oe	**B2,1,0**	or very unlikely oe allow "Drug is effective"

6 (i)	Class *A* more evenly spread or more widely spread oe	**B1**	or Class *B* more bunched oe
	Class *B* has one outlier, *A* has none oe	**B1**	
(ii) (a)	Unchanged oe	**B1**	
(b)	Decrease oe	**B1**	
(iii) (a)	$\frac{\sum fx}{\sum f}$ attempted $\left(=\frac{218}{39}\right)$	**M1**	$\frac{4\times5 + 5\times16 + 6\times11 + 7\times4 + 8\times3}{5+16+11+4+3}$
	= 5.59 (3 sf)	**A1**	
(b)	(With Freda) *A* better than *B* but without Freda *B* better than *A* oe	**B1**	
7 (i)	*BC* = *CD* (triangle *BCD* isosceles) *CE* = *CA* (angle *CAE* = angle *CEA*, base angles of isosceles triangle *ACE*) *BE* = *DA* (given)		
	Triangle *BCE* is congruent to triangle *DCA* (SSS)	**B2,1,0**	allow **B1** for two correct statements with supporting reasons
	Angle *BCE* = Angle *DCA* Therefore *BCA* + *ACE* = *DCE* + *ACE* *BCA* = *DCE*.	**B1**	
(ii) and (iii)	Triangle *BCA* is congruent to triangle *DCE* (SAS) Hence *AB* = *ED*	**B2,1,0**	no need to repeat reasons if given in **(i)**
	Angle *CBA* = Angle *CDE* Therefore *CBD* + *ABD* = *CDB* + *BDE* , hence *ABD* = *BDE*	**B2,1,0**	No need to restate that triangle *BCA* is congruent to triangle *DCE* if stated in **(ii)**

8 (i)	$k = 5$	B1	
(ii)	$2\pi R = 5r$ oe	M1	or $\frac{1}{2}r^2(5) = \pi Rr$
	$r^2 = R^2 + 10^2$ and a valid attempt to eliminate R	M1	
	Attempt to solve as far as $r =$	M1	condone one slip in rearrangement
	$r = 16.5$ cao	A1	
(iii)	$\frac{1}{2}(\text{their } r)^2 \times 5$ soi	M1	
	awrt 681 or 682	A1	
9 (i)	$\frac{\sin x}{5} = \frac{\sin 30}{12}$	M1	If **M0** then **SC1** for a correctly orientated and sufficiently labelled sketch
	$x = \sin^{-1}\left(\frac{5}{12}\sin 30\right)$ or better	M1	
	132(.02…)	A1	
(ii)	$\frac{\text{speed}}{\sin(\textit{their}\ 137.975...)} = \frac{12}{\sin 30}$	M1	or $\frac{\text{distance}}{\sin 30} = \frac{6}{\sin(\textit{their}\ 137.975...)}$
	correct	A1	
	time = $\frac{6}{16.06(682...)}$	M1	or $\frac{4.48(128...)}{12}$
	0.37 (hours) or 22.4 mins	A1	
10 (i)	amplitude 3	B1	
	period 90	B1	
(ii)	f(x) = 1	B1	or $y = 1$
(iii)		B3, 2, 1, 0	Correct shape between 0 and 180 –2 and 4 marked on vertical axis Passing through at least 2 of (45, 1) (90, 1) and (135, 1) Both maxima and minima correctly located
(iv)	0, 45, 90, 135, 180	B2	**B1** for any 3 correct

11 (i)	Accuracy of plots	**B2,1,0**	–1 each error, allow tolerance ± 1 mm
(ii)	Reasonable line of best fit through (3.2, 56) $s = mt + b$ with m between 7 and 11 and b between 22 and 32	**B1** **B1**	
(iii)	Every extra 1 hour spent revising gives an increase of *their m*% in marks	**B1FT**	**ft** *their m* provided line reasonable
(iv)	Approx 43%	**B1FT**	
(v)	The fact that as the number of hours revising increases, the percentage increases **does not mean that the number of hours revising causes the good score.** It might be that for example, better students spend more time at their studies than weaker students. oe	**B1**	or 10 hours is outside the range of this data and it is dangerous to extrapolate beyond the data given oe
12 (a)	Two equations from $17 = 3a + b \quad 73 = 17a + b \quad 297 = 73a + b$ $a = 4$ $b = 5$	**B1** **B1** **B1**	correct answers for both a and b imply first **B1** if no working seen
(b)	$f(0) = 1650$ $f(n+1) = 1.035 \times f(n) \quad n \geq 0$	**B2,1,0**	or $f(1) = 1650$ $f(n+1) = 1.035 \times f(n) \quad n \geqslant 1$