AQA

LEVEL 2 CERTIFICATE
Further Mathematics

8360/2 – Paper 2 Calculator

Mark scheme

June 2018

Version/Stage: 1.0 Final

Mark schemes are prepared by the Lead Assessment Writer and considered, together with the relevant questions, by a panel of subject teachers. This mark scheme includes any amendments made at the standardisation events which all associates participate in and is the scheme which was used by them in this examination. The standardisation process ensures that the mark scheme covers the students' responses to questions and that every associate understands and applies it in the same correct way. As preparation for standardisation each associate analyses a number of students' scripts. Alternative answers not already covered by the mark scheme are discussed and legislated for. If, after the standardisation process, associates encounter unusual answers which have not been raised they are required to refer these to the Lead Assessment Writer.

It must be stressed that a mark scheme is a working document, in many cases further developed and expanded on the basis of students' reactions to a particular paper. Assumptions about future mark schemes on the basis of one year's document should be avoided; whilst the guiding principles of assessment remain constant, details will change, depending on the content of a particular examination paper.

Further copies of this mark scheme are available from aqa.org.uk

Glossary for Mark Schemes

GCSE examinations are marked in such a way as to award positive achievement wherever possible. Thus, for GCSE Mathematics papers, marks are awarded under various categories.

If a student uses a method which is not explicitly covered by the mark scheme the same principles of marking should be applied. Credit should be given to any valid methods. Examiners should seek advice from their senior examiner if in any doubt.

M	Method marks are awarded for a correct method which could lead to a correct answer.
M dep	A method mark dependent on a previous method mark being awarded.
A	Accuracy marks are awarded when following on from a correct method. It is not necessary to always see the method. This can be implied.
B	Marks awarded independent of method.
B dep	A mark that can only be awarded if a previous independent mark has been awarded.
ft	Follow through marks. Marks awarded following a mistake in an earlier step.
SC	Special case. Marks awarded within the scheme for a common misinterpretation which has some mathematical worth.
oe	Or equivalent. Accept answers that are equivalent. eg, accept 0.5 as well as $\frac{1}{2}$
[a, b]	Accept values between a and b inclusive.
3.14…	Accept answers which begin 3.14 eg 3.14, 3.142, 3.1416

Examiners should consistently apply the following principles.

Diagrams

Diagrams that have working on them should be treated like normal responses. If a diagram has been written on but the correct response is within the answer space, the work within the answer space should be marked. Working on diagrams that contradicts work within the answer space is not to be considered as choice but as working, and is not, therefore, penalised.

Responses which appear to come from incorrect methods

Whenever there is doubt as to whether a candidate has used an incorrect method to obtain an answer, as a general principle, the benefit of doubt must be given to the candidate. In cases where there is no doubt that the answer has come from incorrect working then the candidate should be penalised.

Questions which ask candidates to show working

Instructions on marking will be given but usually marks are not awarded to candidates who show no working.

Questions which do not ask candidates to show working

As a general principle, a correct response is awarded full marks.

Misread or miscopy

Candidates often copy values from a question incorrectly. If the examiner thinks that the candidate has made a genuine misread, then only the accuracy marks (A or B marks), up to a maximum of 2 marks are penalised. The method marks can still be awarded.

Further work

Once the correct answer has been seen, further working may be ignored unless it goes on to contradict the correct answer.

Choice

When a choice of answers and/or methods is given, mark each attempt. If both methods are valid then M marks can be awarded but any incorrect answer or method would result in marks being lost.

Work not replaced

Erased or crossed out work that is still legible should be marked.

Work replaced

Erased or crossed out work that has been replaced is not awarded marks.

Premature approximation

Rounding off too early can lead to inaccuracy in the final answer. This should be penalised by 1 mark unless instructed otherwise.

Continental notation

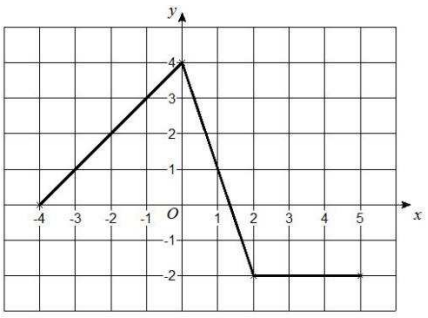
Accept a comma used instead of a decimal point (for example, in measurements or currency), provided that it is clear to the examiner that the candidate intended it to be a decimal point.

Q	Answer	Mark	Comments
1 (a)	$1420 - 5n = 0$ or $5n = 1420$ or $\frac{1420}{5}$	M1	oe eg $5(284 - n) = 0$
	284	A1	
	Additional Guidance		
	$\frac{1420 - 5n}{1420 + 5n} = 0$		Zero
	$1420 - 5n = 0(1420 + 5n)$		Zero
	$n = 284$		M1A1
	$1420 - 5n = 0$ and $1420 + 5n = 0$ with correct equation not selected		Zero
	±284 is A0		
	Embedded answer		M1A0
1 (b)	–1	B1	
	Additional Guidance		
	$-\frac{5}{5}$		B0
	$-1 \quad n \to \infty$		B1
	$-1 \to \infty$		B0
	$x \to -1$ (any letter other than n)		B1

Q	Answer	Mark	Comments
2	Any pair of integer values for a and b for which $b = 12a + 26$	B2	B1 Correct equation in any form eg $\frac{b - -10}{a - -3} = 12$ or $b + 10 = 12(a + 3)$ or $\frac{y - -10}{x - -3} = 12$ or $y + 10 = 12(x + 3)$ or $b = 12a + c$ and $c = 26$ or $y = 12x + c$ and $c = 26$ or $–3 + k$ and $–10 + 12k$ where k is a non-zero integer
	Additional Guidance		
	Examples of B2 responses $a = –4$ and $b = –22$ or $a = –2$ and $b = 2$ or $a = –1$ and $b = 14$ or $a = 0$ and $b = 26$ or $a = 1$ and $b = 38$ or $a = 2$ and $b = 50$ or $a = 3$ and $b = 62$ or $a = 4$ and $b = 74$		B2
	$a = –3$ and $b = –10$ is point *P* so will not score B2 (B1 possible)		
	$–3 + 1$ and $–10 + 12$		B1
	$–3 + 2$ and $–10 + 24$		B1

Q	Answer	Mark	Comments
3(a)	-0.112 or $-\frac{14}{125}$	B1	oe fraction
	Additional Guidance		
	Ignore incorrect conversion between fraction and decimal if correct value seen		
	Ignore rounding or truncation after correct value seen		
	Answer $-\frac{3.5}{31.25}$		B0
3(b)	$2(m^2+1) = m + 2$ or $2m^2 + 2 = m + 2$ or $2m^2 = m$ or $2m^2 - m = 0$	M1	oe equation without fractions
	$m(2m - 1)$ (= 0) or $m(1 - 2m)$ (= 0) or $\frac{--1 \pm \sqrt{(-1)^2 - 4\times2\times0}}{2\times2}$	M1dep	oe eg $\frac{1}{4} \pm \sqrt{\frac{1}{16}}$ may be implied by both correct solutions
	0.5 0 or $\frac{1}{2}$ 0	A1	oe
	Additional Guidance		
	0.5 0 in working but only one of these on answer line		M2A0
	Equation left in terms of p and m		Zero
	Answers only of 0.5 0		M2A1
	Answer only of 0.5		Zero
	Answer only of 0		Zero
	If using formula with an error seen the maximum mark is M1M0A0 eg $2m^2 - m = 0$ $\frac{--1 \pm \sqrt{(-1)^2 - 4\times1\times0}}{2\times2}$ Answers 0.5 0		M1M0A0

Q	Answer	Mark	Comments
4	3rd box ticked	B1	
	Additional Guidance		

5	Line from (–4, 0) to (0, 4)	M1	mark intention lines do not have to be straight but must pass through all integer points only condone the first instance of a line that extends beyond the given domain
	Line from (0, 4) to (2, –2)	M1	
	Line from (2, –2) to (5, –2)	M1	
	Straight line from (–4, 0) to (0, 4) and straight line from (0, 4) to (2, –2) and straight line from (2, –2) to (5, –2)	A1	all straight lines must be the correct length with no other lines graph must be accurate SC3 (–4, 0) and (–3, 1) and (–2, 2) and (–1, 3) and (0, 4) and (1, 1) and (2, –2) and (3, –2) and (4, –2) and (5, –2) plotted (any other points plotted must be correct ones for the graph) SC2 (–4, 0) and (0, 4) and (2, –2) and (5, –2) plotted (any other points plotted must be correct ones for the graph)
	Additional Guidance		
	 (crosses do not have to be shown)		M3A1
	Dashed or dotted lines can score up to M3A0		
	Points may be implied by a correct line		
	M mark examples eg1 2 correct lines and 1 extended line (but otherwise correct) eg2 1 correct line and 2 extended lines (but otherwise correct) eg3 3 extended lines (but otherwise correct)		M3A0 M2A0 M1A0

Q	Answer	Mark	Comments
6(a)	$f(x) \geqslant -7$ or $-7 \leqslant f(x)$	B1	
	Additional Guidance		
	$f(x)$ may be replaced by y or f or fx or $g(x)$ or g or gx or $x^2 - 7$		
	$x \geqslant -7$		B0
	$\geqslant -7$		B0
	Condone $-7 \leqslant f(x) < \infty$ or $-7 \leqslant f(x) \leqslant \infty$ or $-7 \leqslant f(x) <$ or $-7 \leqslant f(x) \leqslant$		B1
	$[-7, \infty)$ or $[-7, \infty]$		B0
6(b)	$-11 \leqslant g(x) \leqslant 13$ or $13 \geqslant g(x) \geqslant -11$	B2	B1 $g(x) \geqslant -11$ or $g(x) \leqslant 13$ on their own or embedded within an inequality or $-11 < g(x) < 13$ or $[-11, 13]$ or $-11 \leqslant x \leqslant 13$
	Additional Guidance		
	$g(x)$ may be replaced by y or g or gx or $f(x)$ or f or fx or $1 - 3x$ in B2 or B1 responses		
	$g(x) \geqslant -11$ $g(x) \leqslant 13$		B1
	–11 to 13 inclusive ('inclusive' must be seen) Do not allow if 24 also seen		B1
	B1 may be seen with an incorrect inequality eg1 $-11 < g(x) \leqslant 13$ eg2 $-11 \leqslant g(x) < 13$ eg3 $0 < g(x) \leqslant 13$ eg4 $13 \leqslant g(x) \geqslant -11$		B1 B1 B1 B1
	$[-11, 13)$ or $(-11, 13]$ or $(-11, 13)$		B0
	$-11 < x \leqslant 13$ or $-11 \leqslant x < 13$ or $-11 < x < 13$		B0
	{–11, –10, –9, ... 0, 1, 2, 3, ..., 12, 13}		B0

Q	Answer	Mark	Comments
6(c)	$2x^2 - 14$	M1	
	$2x^2 + 3x - 15$ (= 0) or $-2x^2 - 3x + 15$ (= 0) or $2x^2 + 3x = 15$ or $-2x^2 - 3x = -15$	A1	
	$\frac{-3 \pm \sqrt{3^2 - 4 \times 2 \times -15}}{2 \times 2}$ or $\frac{-3 \pm \sqrt{9 + 120}}{4}$ or $\frac{-3 \pm \sqrt{129}}{4}$	M1	oe eg $-\frac{3}{4} \pm \sqrt{\frac{15}{2} + \left(\frac{3}{4}\right)^2}$ correct method to solve their 3-term quadratic implied by correct solutions to their 3-term quadratic to at least 2 dp
	2.089 –3.589	A1ft	correct or ft M1A0M1 or M0A0M1 must both be rounded to 3 decimal places
	Additional Guidance		
	2nd M1 Allow correct factorisation of their 3-term quadratic if it does factorise		
	2nd M1 Allow correct use of formula even if discriminant is negative		
	Two 'correct' solutions to at least 2 decimal places implies M1A1M1 eg 2.09 and –3.59		M1A1M1A0
	2.089 and –3.589 in working but only one on answer line		M1A1M1A0
	Answers only 2.089 –3.589		M1A1M1A1
	Answer only 2.089		Zero
	Answer only –3.589		Zero
	$2x^2 - 7$ from incorrect expansion leading to 1.386 –2.886		M0A0M1A1ft
	$x^2 - 14$ from incorrect expansion leading to 2.653 –5.653		M0A0M1A1ft
	$2x^2 - 14$ and $2x^2 + 3x - 13$ (= 0) Answers 1.908 –3.408		M1A0 M1A1ft

Q	Answer	Mark	Comments
7	$\frac{1}{2} \times (8 + 4) \times a$ (= 63) or $\frac{1}{2} \times 12 \times a$ (= 63) or $6a$ (= 63) or $63 \div 6$	M1	any letter oe eg $12a = 126$ or $\frac{1}{2} \times 3 \times a + 4 \times a + \frac{1}{2} \times 1 \times a$ (= 63)
	10.5 or $10\frac{1}{2}$ or $\frac{21}{2}$	A1	
	Additional Guidance		
	M1 is for a full area calculation (= 63)		

Q	Answer	Mark	Comments
8	**Alternative method 1**		
	(x-coordinate of P =) 5.5 and (y-coordinate of P =) 2.25	B2	oe may be seen on diagram B1 (x-coordinate of P =) 5.5 or (y-coordinate of P =) 2.25 or x-coordinate of P = 2.25 and y-coordinate of P = 5.5
	$(9 - \text{their } 5.5)^2 + (12 - \text{their } 2.25)^2$ or $3.5^2 + 9.75^2$ or 12.25 + 95.06(25) or 12.25 + 95.063 or 107.3(125) or 107.313	M1	oe eg $\sqrt{3.5^2 + 9.75^2}$ or $\frac{1717}{16}$ 1 < their 5.5 < 7 1 < their 2.25 < 6
	10.36	A1ft	correct or ft their 5.5 and/or their 2.25 must be rounded to 4 sig figs
	Alternative method 2 Uses $AC = 10$, $BC = \sqrt{125}$ or $5\sqrt{5}$ or 11.18… and $AB = \sqrt{61}$ or 7.81…		
	$\cos^{-1}\frac{10^2 + 7.81...^2 - 11.18...^2}{2 \times 10 \times 7.81...}$ or [76.67, 76.71]	M1	oe eg $\cos^{-1}$ 0.23(0…) or $\cos^{-1}$ 0.231 may be on diagram angle BAC
	$(0.75 \times 7.81\ldots)^2 + 10^2$ $- 2 \times (0.75 \times 7.81\ldots) \times 10 \times \cos$ their [76.67, 76.71]	M1dep	
	[107.3, 107.4]	A1	
	10.36	A1	

Mark scheme and additional guidance continues on the next page

Q	Answer	Mark	Comments
8	**Alternative method 3** Uses $AC = 10$, $BC = \sqrt{125}$ or $5\sqrt{5}$ or 11.18… and $AB = \sqrt{61}$ or 7.81…		
	$\cos^{-1}\dfrac{7.81...^2 + 11.18...^2 - 10^2}{2 \times 7.81... \times 11.18...}$ or [60.49, 60.66]	M1	oe eg $\cos^{-1}$ [0.49, 0.4925] may be on diagram angle *ABC*
	$(0.25 \times 7.81\ldots)^2 + 11.18\ldots^2$ $- 2 \times (0.25 \times 7.81\ldots) \times 11.18\ldots$ $\times$ cos their [60.49, 60.66]	M1dep	
	[107.3, 107.4]	A1	
	10.36	A1	
	Additional Guidance		
	If 5.5 is from gradient *BC*		B0
	Alt 1 *P* (4.5, 3.75) $(9 - 4.5)^2 + (12 - 3.75)^2$ 9.397		B0 M1 A1ft

Q	Answer	Mark	Comments
9	$\frac{2x^6}{3}$ or $\frac{2}{3}x^6$ or $\frac{15x}{3}$ or $5x$	M1	implied by $\frac{2x^6+a}{3}$ or $\frac{b+15x}{3}$ a can be numerical or algebraic b can be numerical or algebraic allow 0.66… or 0.67 for $\frac{2}{3}$
	$6 \times \frac{2x^5}{3}$ or $\frac{12x^5}{3}$ or $4x^5$ or $\frac{15}{3}$ or 5	M1dep	correct differentiation of one correct term implied by $\frac{6\times 2x^5+a}{3}$ or $\frac{b+15}{3}$
	$4x^5 + 5 = 133$ or $4x^5 = 128$ or $x^5 = 32$ or $\sqrt[5]{32}$	A1	oe both correct terms differentiated and simplified correctly and equated to 133
	2	A1	
	Additional Guidance		
	$\frac{14x^6+30x}{3}$		Zero

Q	Answer	Mark	Comments
10	$\begin{pmatrix} a & b \\ 2a & 3b \end{pmatrix}\begin{pmatrix} 1 \\ -3 \end{pmatrix} = \begin{pmatrix} 1 \\ 4 \end{pmatrix}$	M1	oe implied by a correct equation
	$a - 3b = 1$	A1	oe may be implied by correct answers
	$2a - 9b = 4$	A1	
	Correct elimination of a variable from their 2 linear equations with both equations having the same two variables	M1	eg $3a - 2a = 3 - 4$ or $-6b - -9b = 2 - 4$
	$a = -1 \quad b = -\frac{2}{3}$	A1	must be exact values

Additional guidance continues on the next page

Q	Answer	Mark	Comments

	Additional Guidance	
10	$\begin{pmatrix} a-3b \\ 2a-9b \end{pmatrix} = \begin{pmatrix} 1 \\ 4 \end{pmatrix}$ implies M1 but does not imply any correct equations	
	If the same method is used for both a and b (eg equates coefficients and eliminates a variable), mark the attempt that favours the student	
	Ignore commas and lines within matrices	
	Allow missing brackets if arrays are correct dimensions	
	Answers only $a = -1$ and $b = -\frac{2}{3}$	5 marks
	Allow use of $\begin{pmatrix} 1 \\ 3 \end{pmatrix}$ as a misread If solution $a = -1$ and $b = \frac{2}{3}$	M1A0A0 M1A1ft (A1ft after misread)
	Transposing $\begin{pmatrix} 1 \\ -3 \end{pmatrix}$ and $\begin{pmatrix} 1 \\ 4 \end{pmatrix}$ is not a misread (could still score 2nd M1)	
	$\begin{pmatrix} 1 \\ -3 \end{pmatrix}\begin{pmatrix} a & b \\ 2a & 3b \end{pmatrix} = \begin{pmatrix} 1 \\ 4 \end{pmatrix}$ followed by $a - 3b = 1$ and $2a - 9b = 4$ (could still score 2nd M1)	M1A1A1
	$\begin{pmatrix} 1 \\ -3 \end{pmatrix}\begin{pmatrix} a & b \\ 2a & 3b \end{pmatrix} = \begin{pmatrix} 1 \\ 4 \end{pmatrix}$ with only one of $a - 3b = 1$ and $2a - 9b = 4$ (could still score 2nd M1)	M1A1A0
	$\begin{pmatrix} 1 \\ -3 \end{pmatrix}\begin{pmatrix} a & b \\ 2a & 3b \end{pmatrix} = \begin{pmatrix} 1 \\ 4 \end{pmatrix}$ with neither equation correct # (could still score 2nd M1)	M0A0A0

Q	Answer	Mark	Comments
11	**Alternative method 1** expands $(x + 2)(x + 3)$ first		
	$x^2 + 3x + 2x + 6$ or $x^2 + 5x + 6$	M1	oe must have a term in x^2 allow one error but no omissions or extras implied by $x^2 + 5x + k$ or $ax^2 + 5x + 6$
	$x^3 + 5x^2 + 6x + 4x^2 + 20x + 24$	M1dep	oe eg $x^3 + 3x^2 + 2x^2 + 6x + 4x^2 + 12x + 8x + 24$ allow one further error but no omissions or extras
	$x^3 + 9x^2 + 26x + 24$	A1	
	Alternative method 2 expands $(x + 3)(x + 4)$ first		
	$x^2 + 3x + 4x + 12$ or $x^2 + 7x + 12$	M1	oe must have a term in x^2 allow one error but no omissions or extras implied by $x^2 + 7x + k$ or $ax^2 + 7x + 12$
	$x^3 + 7x^2 + 12x + 2x^2 + 14x + 24$	M1dep	oe eg $x^3 + 3x^2 + 4x^2 + 12x + 2x^2 + 6x + 8x + 24$ allow one further error but no omissions or extras
	$x^3 + 9x^2 + 26x + 24$	A1	

Mark scheme and additional guidance continues on the next page

Q	Answer	Mark	Comments
11	**Alternative method 3** expands $(x + 2)(x + 4)$ first		
	$x^2 + 4x + 2x + 8$ or $x^2 + 6x + 8$	M1	oe must have a term in x^2 allow one error but no omissions or extras implied by $x^2 + 6x + k$ or $ax^2 + 6x + 8$
	$x^3 + 6x^2 + 8x + 3x^2 + 18x + 24$	M1dep	oe eg $x^3 + 4x^2 + 2x^2 + 8x + 3x^2 + 12x + 6x + 24$ allow one further error but no omissions or extras
	$x^3 + 9x^2 + 26x + 24$	A1	
	Additional Guidance		
	For M marks terms may be seen in a grid (+ signs not needed)		
	Correct answer followed by further work		M2A0
	Ignore further simplification after 4 terms seen eg Alt 1 $x^2 + 3x + 2x + 6 = x^2 + 6x + 6$ $(x^2 + 6x + 6)(x + 4) \rightarrow x^3 + 4x^2 + 6x^2 + 24x + 6x + 18$ (error)		M1 M1depA0
	Second M1 Must be the product of a two term bracket and a three or four term bracket		
	Missing brackets may be recovered		

Q	Answer	Mark	Comments
12(a)	Valid common denominator with at least one numerator correct	M1	eg $\frac{7x}{9x^2}$ and $\frac{a}{9x^2}$ or $\frac{7x+a}{9x^2}$ or $\frac{b}{9x\times 3x^2}$ and $\frac{2\times 9x}{9x\times 3x^2}$ numerators and denominators may be seen as products a can be numerical or algebraic b can be numerical or algebraic
	Valid common denominator with both numerators correct	M1dep	$\frac{7x}{9x^2}$ and $\frac{6}{9x^2}$ or $\frac{7\times 3x^2}{9x\times 3x^2}$ and $\frac{2\times 9x}{9x\times 3x^2}$ numerators and denominators may be seen as products
	$\frac{7x+6}{9x^2}$ or $\frac{7x+6}{(3x)^2}$ with no further work	A1	
	Additional Guidance		
	$\frac{21x^2+18x}{27x^3}$ or $\frac{21x+18}{27x^2}$ or $\frac{7x^2+6x}{9x^3}$		M2A0
	$\frac{7x^{-1}+6x^{-2}}{9}$		M2A0
	$7x + 6 / 9x^2$		M2A0

Q	Answer	Mark	Comments
12(b)	Changes division to multiplication and inverts to $\frac{3x+12}{x^2}$	M1	may be implied
	$(3x + 12 =)\ 3(x + 4)$	M1	may be implied
	Correct expression written as a single fraction or a product must have factor $(x + 4)$ in a numerator and denominator $x + 4$ or correct expression written as a single fraction or a product must have denominator x^3 or x^2 or x or 1	A1	may be implied by final A1 eg $\frac{3x(x+2)(x+4)}{x+4}$ or $\frac{(3x^2+6x)(x+4)}{x+4}$ or $\frac{x}{x+4} \times \frac{x+2}{1} \times 3(x+4)$ or $\frac{x}{x+4} \times 3(x+2)(x+4)$ or $\frac{3x^4(x+2)}{x^3}$ or $x^4 \times \frac{x+2}{x} \times \frac{3}{x^2}$ or $\frac{(x+2)}{x^3} \times 3x^4$ or $\frac{3x^3(x+2)}{x^2}$ or $\frac{3x^2(x+2)}{x}$ or $\frac{3x(x+2)}{1}$ or $x \times (x + 2) \times 3$ or $3x(x + 2)$
	$3x^2 + 6x$	A1	SC2 $\frac{x(x+2)(3x+12)}{x+4}$
	Additional Guidance		
	The list of examples in the first A1 is not exhaustive		
	$3x^2 + 6x$ with no incorrect working		4 marks

Q	Answer	Mark	Comments
13(a)	1	B1	allow in words
	Additional Guidance		
13(b)	0	B1	allow in words eg none or zero
	Additional Guidance		
13(c)	(0, 1) (90, 0) (270, 0) with no other points	B2	B1 two answers, both correct or three answers, two correct or four answers, three correct
	Additional Guidance		
	Condone 0, 1 for (0, 1) etc		
	0, 90, 270		B0
	(1, 0) (0, 90) (0, 270)		B0

Q	Answer	Mark	Comments
14(a)	$6pq^2r\,(2q - 3r + 4)$	B2	B1 correct factorised expression with a common factor involving at least two variables eg $pq(12q^2r - 18qr^2 + 24qr)$ or $2q^2r\,(6pq - 9pr + 12p)$ or common factor $6pq^2r$ with two out of the three terms in the bracket correct eg $6pq^2r\,(2q - 3r + 4p)$
	Additional Guidance		
	B2 answer followed by further work		B1
	$6pq^2r\,(2q - 3r + 4)$ in working with $6qp^2r\,(2q - 3r + 4)$ on answer line		B1
	B1 answer followed by further work		B1
	$2q^2r\,(6pq - 9pr + 12p)$ in working with $2p^2r\,(6pq - 9pr + 12p)$ on answer line		B1
	Use of multiplication signs scores a maximum of B1		
	$qpq(12qr - 18r^2 + 24r)$		B1
	$6pqrq\,(2q - 3r + 4)$		B1

Q	Answer	Mark	Comments
14(b)	Correct factorised expression with a common factor	M1	eg $(y + 3)[6(y + 3)^4 + 4(y + 3)^3]$ or $2[3(y + 3)^5 + 2(y + 3)^4]$ or $2(y + 3)^2[3(y + 3)^3 + 2(y + 3)^2]$
	$2(y + 3)^4[3(y + 3) + 2]$ or $2(y + 3)^4(3y + 9 + 2)$ or $(y + 3)^4[6(y + 3) + 4]$ or $(y + 3)^4(6y + 18 + 4)$ or $(y + 3)^4(6y + 22)$	A1	
	$2(y + 3)^4(3y + 11)$	A1	
	Additional Guidance		
	Use of multiplication signs scores a maximum of M1A1A0		
	Any combination of bracket shape may be used		
	Correct answer followed by further work		M1A1A0
	Incorrect notation eg $(y + 3)^4 2(3y + 11)$		M1A1A0
	$(2)(y + 3)^4(3y + 11)$ or $(2(y + 3)^4)(3y + 11)$		M1A1A1
	Allow substitution eg $n = (y + 3)$ for M1A1 but must revert to $(y + 3)$ for final mark		
	Missing brackets must be recovered eg $(y + 3)^4 6y + 22$ with M1 not seen		Zero

Q	Answer	Mark	Comments
14(c)	$3(4 + 5x)(4 – 5x)$ or $3(–4 – 5x)(5x – 4)$ or $–3(4 + 5x)(5x – 4)$ or $–3(–4 – 5x)(4 – 5x)$	B2	B1 Partial factorisation eg $3(16 – 25x^2)$ or $–3(25x^2 – 16)$ or $(12 + 15x)(4 – 5x)$ or $(12 – 15x)(4 + 5x)$
	Additional Guidance		
	Brackets in either order for B2 or B1		
	$–(75x^2 – 48)$		B0
	$(–5x + 4)$ is equivalent to $(4 – 5x)$ etc		
	Incorrect notation eg $(4 + 5x)3(4 – 5x)$		B1
	Use of surds eg $(\sqrt{48} + \sqrt{75}\,x)(\sqrt{48} – \sqrt{75}\,x)$ or $(4\sqrt{3} + 5\sqrt{3}\,x)(4\sqrt{3} – 5\sqrt{3}\,x)$		B1
	Use of multiplication signs scores a maximum of B1 eg $3 \times (4 + 5x)(4 – 5x)$		B1
	B2 answer followed by further work		B1
	B1 answer followed by further work		B1
	Missing brackets must be recovered eg $3 \times 16 – 25x^2$		B0

Q	Answer	Mark	Comments
15	$x^4 - 9x^2$	M1	
	$4x^3$ or $(-)2 \times 9x$ or $(-)18x$	M1	differentiates at least one of their terms their term must be a function of x after an attempt to expand brackets $4x^3 - 18x$ implies M2
	$4 \times (-2)^3 - 18 \times -2$ or $4 \times -8 - 18 \times -2$ or $-32 + 36$	M1dep	oe dep on 2nd M1 substitutes –2 into their $4x^3 - 18x$ their $4x^3 - 18x$ must be two terms, each a function of x
	4	A1	
	Additional Guidance		
	Allow recovery of brackets		
	4×-2^3 is allowed for $4 \times (-2)^3$		
	3rd M can still be awarded even if further substitution seen eg1 $4x^3 - 18x$ $4 \times (-2)^3 - 18 \times -2$ and $4^4 - 9 \times 4^2 = 112$ Answer 112 eg2 $4x^3 - 18x$ $4 \times (-2)^3 - 18 \times -2 = 4$ and $4 \times 4^3 - 18 \times 4 = 184$ Answer 184		M3 A0 M3 A0
	Only substituting $x = -2$ into second derivative can score a maximum of M1M1M0A0		
	4 followed by answer $y = 4$		M3A1
	4 followed by answer $y = 4x$		M3A0
	Do not regard substitution of $x = 2$ as a misread		
	Beware that finding the gradient of the line through (–2, –20) and (3, 0) gives answer 4		Zero
	Beware that $(-)18x$ may come from wrong method eg1 $2x(2x - 9) = 4x^2 - 18x$ eg2 $2x(x^2 - 9) = 2x^3 - 18x$		Zero Zero

Q	Answer	Mark	Comments
16	**Alternative method 1**		
	$2(2 - 5x) + 3(3x - 1)$ or $4 - 10x$ or $9x - 3$	M1	
	$4 - 10x + 9x - 3 = 1 - x$	M1dep	
	$(1 - x)^2 = 1 - 2x + x^2$	A1	must see working for M2
	$2 - 5x + 3x - 1 + x^2 = 1 - 2x + x^2$	B1	
	Alternative method 2		
	$4(2 - 5x)^2 + 6(2 - 5x)(3x - 1)$ $+ 6(2 - 5x)(3x - 1) + 9(3x - 1)^2$	M1	oe allow $+ 12(2 - 5x)(3x - 1)$ for $+ 6(2 - 5x)(3x - 1) + 6(2 - 5x)(3x - 1)$
	$4(4 - 10x - 10x + 25x^2)$ $+ 6(6x - 2 - 15x^2 + 5x)$ $+ 6(6x - 2 - 15x^2 + 5x)$ $+ 9(9x^2 - 3x - 3x + 1)$ $= 16 - 40x - 40x + 100x^2 + 36x - 12$ $- 90x^2 + 30x + 36x - 12 - 90x^2$ $+ 30x + 81x^2 - 27x - 27x + 9$	M1dep	oe must see expansions must see working for 1st M1 allow $+ 12(6x - 2 - 15x^2 + 5x)$ for $+ 6(6x - 2 - 15x^2 + 5x)$ $+ 6(6x - 2 - 15x^2 + 5x)$
	$1 - 2x + x^2$	A1	must see working for M2
	$2 - 5x + 3x - 1 + x^2 = 1 - 2x + x^2$	B1	

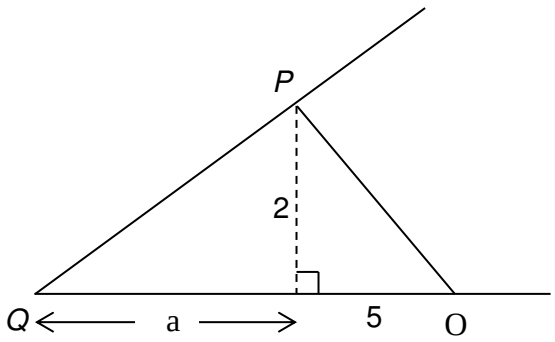
Mark scheme and additional guidance continues on the next page

Q	Answer	Mark	Comments
16	**Alternative method 3**		
	$2(2-5x)+3(3x-1)$ or $4-10x$ or $9x-3$	M1	oe
	$(4-10x+9x-3)^2$ $=16-40x+36x-12-40x+100x^2$ $-90x^2+30x+36x-90x^2+81x^2$ $-27x-12+30x-27x+9$	M1dep	oe must see expansions
	$1-2x+x^2$	A1	must see working for M2
	$2-5x+3x-1+x^2=1-2x+x^2$	B1	
	Additional Guidance		
	Allow working down both sides of an equation/identity		
	M2A1 is for working on $(2A+3B)^2$		
	B1 is for working on $A+B+C$		
	$1-2x+x^2$ with working for M2 seen and $2-5x+3x-1+x^2=x^2-2x+1$		4 marks
	$1-x^2=1-2x+x^2$ (do not allow missing brackets even if recovered)		

Q	Answer	Mark	Comments
17(a)	$(-5)^2 + 2^2 = 29$	B1	oe involving use of –5 and 2 eg $(-5 - 0)^2 + (2 - 0)^2 = 29$ or $(0 - -5)^2 + (0 - 2)^2 = 29$ or $\sqrt{(-5)^2 + 2^2} = \sqrt{29}$ or $29 - (-5)^2 = 2^2$ or $29 - 2^2 = (-5)^2$ or $\sqrt{29 - (-5)^2} = 2$ or $\sqrt{29 - 2^2} = -5$
	Additional Guidance		
	$25 + 4 = 29$		B0
	$-5^2 + 2^2 = 29$		B0
	Allow 29 to be written as $\sqrt{29}^2$		

Q	Answer	Mark	Comments
17(b)	**Alternative method 1** Using gradients		
	(gradient OP =) $\frac{2-0}{-5-0}$ or $-\frac{2}{5}$ or –0.4	M1	oe may be implied eg $y = -\frac{2}{5}x$ or gradient of tangent = $\frac{5}{2}$ (with gradient OP not seen)
	(gradient tangent =) $\frac{-1}{\text{their } -\frac{2}{5}}$ or $\frac{5}{2}$ or 2.5	M1	oe correct or ft their $-\frac{2}{5}$
	$y - 2 = \text{their } \frac{5}{2}(x - -5)$ or $0 - 2 = \text{their } \frac{5}{2}(x - -5)$ or $2 = \text{their } \frac{5}{2} \times -5 + c$	M1dep	oe dep on 2nd M1 equation of their tangent with or without substitution of $y = 0$ implied by $y = \frac{5}{2}x + \frac{29}{2}$ oe or $0 = \frac{5}{2}x + \frac{29}{2}$ oe
	$-\frac{29}{5}$ or –5.8	A1	oe allow $\left(-\frac{29}{5}, 0\right)$ SC2 answer –10 (grad tangent = $\frac{2}{5}$) SC2 answer $-\frac{21}{5}$ or –4.2 oe (grad tangent = $-\frac{5}{2}$)

Mark scheme and additional guidance continues on the next page

Q	Answer	Mark	Comments
17(b)	**Alternative method 2** Using similar triangles (see diagram in Additional Guidance)		
	$\frac{a}{2} = \frac{2}{5}$	M1	oe equation any letter
	$a = \frac{2}{5} \times 2$ or $a = \frac{4}{5}$	M1dep	
	-5 – their $\frac{4}{5}$	M1dep	dep on M2
	$-\frac{29}{5}$ or -5.8	A1	oe allow $\left(-\frac{29}{5}, 0\right)$ SC2 answer -10 (grad tangent = $\frac{2}{5}$) SC2 answer $-\frac{21}{5}$ or -4.2 oe (grad tangent = $-\frac{5}{2}$)
	Additional Guidance		
	Alt 1 2nd M mark is not dependent but there must be a numerical value for grad OP to ft		
	grad $OP = -0.4$ and grad tangent = -0.4		M1M0M0A0
	$\left(0, -\frac{29}{5}\right)$		M3A0
	Ignore any incorrect conversion between fraction and decimal after correct answer seen		
	Alt 2 diagram  		

Q	Answer	Mark	Comments
18(a)	$-5-3<4x\leqslant 13-3$ or $-8<4x\leqslant 10$ or $-1.25<x+0.75\leqslant 3.25$ or $x\leqslant 2.5$ or $x>-2$ or $x\leqslant 2$ or $x\geqslant -1$	M1	could be embedded eg $-2\leqslant x\leqslant 2.5$
	$\frac{\text{their}-8}{4}<x\leqslant\frac{\text{their }10}{4}$ or their $-1.25-0.75<x\leqslant$ their $3.25-0.75$ or $-2<x\leqslant 2.5$ or $-2<x\leqslant 2$ or $-1\leqslant x\leqslant 2.5$ or $-1\leqslant x\leqslant 2$ or $x\leqslant 2.5$ and $x>-2$ or $x\leqslant 2$ and $x>-2$ or $x\leqslant 2.5$ and $x\geqslant -1$ or $x\leqslant 2$ and $x\geqslant -1$	M1dep	oe eg (– 2, 2.5] or [–1, 2.5]
	–1 0 1 2 with no incorrect working	A1	
	Additional Guidance		
	Answer only –1 0 1 2		M2A1
	Answer only –1 1 2		Zero
	$x = 2.5$ and $x = -2$ (from solving equations) followed by –1 0 1 2		M2A1
	$x = 2.5$ and $x = -2$ (from solving equations)		Zero
	–1 0 1 2 with no incorrect working and a correct inequality on answer line		M2A1
	–1 0 1 2 in working but –1 1 2 on answer line		M2A0
	Ignore repeated integers eg Answer only –1 0 1 1 2 2		M2A1

Q	Answer	Mark	Comments
18(b)	$(x-4)(x-7)$ or $\frac{--11\pm\sqrt{(-11)^2-4\times1\times28}}{2\times1}$ or $\frac{11}{2}\pm\sqrt{\frac{9}{4}}$	M1	oe
	Identifies 4 and 7	A1	may be on a graph or implied by an inequality using 4 and 7
	$x<4 \quad x>7$	A1	do not allow incorrect notation eg $4>x>7$
	Additional Guidance		
	$x<4$ with M1 not scored		Zero
	$x>7$ with M1 not scored		Zero
	Both $x<4$ and $x>7$ in working but only one on answer line		M1A1A0
	$x<4$ and $x>7$		M1A2
	$x<4$ or $x>7$		M1A2

Q	Answer	Mark	Comments
19	**Alternative method 1** C(BA)		
	$\begin{pmatrix}0 & -1\\1 & 0\end{pmatrix}\begin{pmatrix}0 & -1\\-1 & 0\end{pmatrix} = \begin{pmatrix}1 & 0\\0 & -1\end{pmatrix}$ and $\begin{pmatrix}1 & 0\\0 & -1\end{pmatrix}\begin{pmatrix}1 & 0\\0 & -1\end{pmatrix} = \begin{pmatrix}1 & 0\\0 & 1\end{pmatrix}$ and indication that $\begin{pmatrix}1 & 0\\0 & 1\end{pmatrix}$ is the identity matrix	B5	for B5, products must be seen in correct order and results of products must be correct B4 a B5 response with no indication that $\begin{pmatrix}1 & 0\\0 & 1\end{pmatrix}$ is the identity matrix B3 (reflection in $y = -x$) $\begin{pmatrix}0 & -1\\-1 & 0\end{pmatrix}$ and (rotation) $\begin{pmatrix}0 & -1\\1 & 0\end{pmatrix}$ and (reflection in x-axis) $\begin{pmatrix}1 & 0\\0 & -1\end{pmatrix}$ B2 Any two of the above B1 Any one of the above
	Alternative method 2 (CB)A		
	$\begin{pmatrix}1 & 0\\0 & -1\end{pmatrix}\begin{pmatrix}0 & -1\\1 & 0\end{pmatrix} = \begin{pmatrix}0 & -1\\-1 & 0\end{pmatrix}$ and $\begin{pmatrix}0 & -1\\-1 & 0\end{pmatrix}\begin{pmatrix}0 & -1\\-1 & 0\end{pmatrix} = \begin{pmatrix}1 & 0\\0 & 1\end{pmatrix}$ and indication that $\begin{pmatrix}1 & 0\\0 & 1\end{pmatrix}$ is the identity matrix	B5	for B5, products must be seen in correct order and results of products must be correct B4 a B5 response with no indication that $\begin{pmatrix}1 & 0\\0 & 1\end{pmatrix}$ is the identity matrix B3 (reflection in $y = -x$) $\begin{pmatrix}0 & -1\\-1 & 0\end{pmatrix}$ and (rotation) $\begin{pmatrix}0 & -1\\1 & 0\end{pmatrix}$ and (reflection in x-axis) $\begin{pmatrix}1 & 0\\0 & -1\end{pmatrix}$ B2 Any two of the above B1 Any one of the above

Mark scheme continues on the next page

Q	Answer	Mark	Comments
19	**Alternative method 3** transforms a general point		
	$\begin{pmatrix}0 & -1\\ -1 & 0\end{pmatrix}\begin{pmatrix}x\\ y\end{pmatrix} = \begin{pmatrix}-y\\ -x\end{pmatrix}$ and $\begin{pmatrix}0 & -1\\ 1 & 0\end{pmatrix}\begin{pmatrix}-y\\ -x\end{pmatrix} = \begin{pmatrix}x\\ -y\end{pmatrix}$ and $\begin{pmatrix}1 & 0\\ 0 & -1\end{pmatrix}\begin{pmatrix}x\\ -y\end{pmatrix} = \begin{pmatrix}x\\ y\end{pmatrix}$ and indication that $\begin{pmatrix}x\\ y\end{pmatrix}$ has mapped to itself	B5	for B5, products must be seen in correct order and results of products must be correct B4 a B5 response with no indication that $\begin{pmatrix}x\\ y\end{pmatrix}$ has mapped to itself B3 (reflection in $y = -x$) $\begin{pmatrix}0 & -1\\ -1 & 0\end{pmatrix}$ and (rotation) $\begin{pmatrix}0 & -1\\ 1 & 0\end{pmatrix}$ and (reflection in x-axis) $\begin{pmatrix}1 & 0\\ 0 & -1\end{pmatrix}$ B2 Any two of the above B1 Any one of the above
	Alternative method 4 transforms the unit square		
	$\begin{pmatrix}0 & -1\\ -1 & 0\end{pmatrix}\begin{pmatrix}0 & 1 & 1 & 0\\ 0 & 0 & 1 & 1\end{pmatrix}$ $= \begin{pmatrix}0 & 0 & -1 & -1\\ 0 & -1 & -1 & 0\end{pmatrix}$ and $\begin{pmatrix}0 & -1\\ 1 & 0\end{pmatrix}\begin{pmatrix}0 & 0 & -1 & -1\\ 0 & -1 & -1 & 0\end{pmatrix}$ $= \begin{pmatrix}0 & 1 & 1 & 0\\ 0 & 0 & -1 & -1\end{pmatrix}$ and $\begin{pmatrix}1 & 0\\ 0 & -1\end{pmatrix}\begin{pmatrix}0 & 1 & 1 & 0\\ 0 & 0 & -1 & -1\end{pmatrix}$ $= \begin{pmatrix}0 & 1 & 1 & 0\\ 0 & 0 & 1 & 1\end{pmatrix}$ and indication that unit square has mapped to itself	B5	columns in 2 by 4 matrices can be in any order for B5, products must be seen in correct order and results of products must be correct B4 a B5 response with no indication that unit square has mapped to itself B3 (reflection in $y = -x$) $\begin{pmatrix}0 & -1\\ -1 & 0\end{pmatrix}$ and (rotation) $\begin{pmatrix}0 & -1\\ 1 & 0\end{pmatrix}$ and (reflection in x-axis) $\begin{pmatrix}1 & 0\\ 0 & -1\end{pmatrix}$ B2 Any two of the above B1 Any one of the above

Additional guidance continues on the next page

Q	Answer	Mark	Comments

	Additional Guidance	
19	For B3, B2 and B1 the matrices must not be the answers to a product	
	Must use matrix multiplication	
	Ignore commas and lines within matrices	
	Allow missing brackets if arrays are correct	
	Examples of indication Alt 1 or 2 $\begin{pmatrix}1 & 0\\0 & 1\end{pmatrix} = \mathrm{I}$ or $\begin{pmatrix}1 & 0\\0 & 1\end{pmatrix}$ which is the identity matrix Alt 3 $\begin{pmatrix}x\\y\end{pmatrix}$ which is the same as the original Alt 4 $\begin{pmatrix}0 & 1 & 1 & 0\\0 & 0 & 1 & 1\end{pmatrix}$ which is the same as the original	
	Alts 1 and 2 Indications may be seen at the start of the solution	
	Alt 3 $\begin{pmatrix}x\\y\end{pmatrix}$ must be algebraic	

Q	Answer	Mark	Comments
20(a)	**Alternative method 1**		
	$12^2 + \left(\frac{10}{2}\right)^2$ or $12^2 + 5^2$ or 144 + 25 or 169	M1	oe RM^2
	$\sqrt{\text{their } 169}$ or 13	M1dep	oe *RM* may be seen on diagram 13 implies M2
	$\tan x = \frac{7}{\text{their } 13}$	M1dep	any letter oe eg $\tan^{-1}\frac{7}{\text{their } 13}$
	28(.3...)	A1	

Mark scheme and additional guidance continues on the next page

Q	Answer	Mark	Comments
20(a)	**Alternative method 2**		
	$12^2 + \left(\frac{10}{2}\right)^2 + 7^2$ or $12^2 + 5^2 + 7^2$ or $144 + 25 + 49$ or 218	M1	oe *UM* 2
	$\sqrt{\text{their } 218}$ or [14.76, 14.8]	M1dep	oe *UM* may be seen on diagram [14.76, 14.8] implies M2
	$\sin x = \frac{7}{\text{their [14.76, 14.8]}}$ or $\cos x = \frac{\sqrt{12^2 + 5^2}}{\text{their [14.76, 14.8]}}$	M1dep	any letter oe eg $\sin^{-1}\frac{7}{\text{their [14.76, 14.8]}}$ or $\sin x = \frac{\sin 90}{\text{their [14.76, 14.8]}} \times 7$ or $\cos x = \frac{12^2 + 5^2 + \text{their [14.76, 14.8]}^2 - 7^2}{2 \times \sqrt{12^2 + 5^2} \times \text{their [14.76,14.8]}}$
	28(.3...)	A1	
	Additional Guidance		
	Allow tan = $\frac{7}{\text{their } 13}$ etc		
	Do not allow tan $\frac{7}{\text{their } 13}$ etc unless recovered		
	If using sine or cosine rule, must rearrange to make sin x or cos x the subject		
	Allow up to M1M1dep from either alt 1 or alt 2 even if not subsequently used		

Q	Answer	Mark	Comments
20(b)	$\tan\alpha = \frac{10 \div 2}{12}$ or $\tan\alpha = \frac{5}{12}$ or $\sin\alpha = \frac{10 \div 2}{\text{their } 13}$ or $\sin\alpha = \frac{5}{\text{their } 13}$ or $\cos\alpha = \frac{12}{\text{their } 13}$	M1	any letter oe eg $\tan^{-1}\frac{5}{12}$ their 13 = *RM* from (a) may be seen on diagram oe eg $\sin\alpha = \frac{\sin 90}{\sqrt{12^2+5^2}} \times 5$ or $\sin\alpha = \frac{\sin 90}{\text{their } 13} \times 5$ or $\cos\alpha = \frac{12^2+5^2+12^2-5^2}{2\times 12\times\sqrt{12^2+5^2}}$ or $\cos\alpha = \frac{\text{their } 13^2+12^2-5^2}{2\times 12\times \text{their } 13}$
	22.6…	A1ft	allow 23 with working correct or ft ft answers correct to at least 1 dp
	Additional Guidance		
	Allow $\tan = \frac{5}{12}$ etc		
	Do not allow $\tan\frac{5}{12}$ etc unless recovered		
	If using sine or cosine rule, must rearrange to make $\sin\alpha$ or $\cos\alpha$ the subject		

Q	Answer	Mark	Comments
21	(–1, 3) or (2, 1)	M1	
	(–1, 3) max(imum)	A1	
	(2, 1) (point of) inflection	A1	SC1 (3, –1) max(imum) and (1, 2) (point of) inflection
	Additional Guidance		
	One correct point and nature		M1A1
	Ignore reference to ‘stationary points’ or ‘turning points’ or ‘local’		
	Condone p o i for point of inflection		

Q	Answer	Mark	Comments
22(a)	**Alternative method 1**		
	Divides trigonometric expression by $\cos x$ or rearranges equation	M1	eg $8\frac{\cos x}{\cos x}+5\frac{\sin x}{\cos x}$ or $8+5\frac{\sin x}{\cos x}$ or $8\cos x=-5\sin x$ or $\frac{\cos x}{\sin x}=-\frac{5}{8}$ or $8\frac{\cos x}{\cos x}=-5\frac{\sin x}{\cos x}$ or $5\tan x=-8$
	$\tan x=-\frac{8}{5}$ or $\tan x=-1.6$ or $\cos x=-\frac{5}{\sqrt{89}}$ or –57.9… or –58	A1	oe eg $\tan^{-1}-1.6$ may be implied by final answer
	122.(0…) with no other angle	A1	

Mark scheme and additional guidance continues on the next page

Q	Answer	Mark	Comments
22(a)	**Alternative method 2**		
	Divides trigonometric expression by $\cos x$ or rearranges equation	M1	eg $8\frac{\cos x}{\cos x}+5\frac{\sin x}{\cos x}$ or $8+5\frac{\sin x}{\cos x}$ or $8\cos x=-5\sin x$ or $\frac{\cos x}{\sin x}=-\frac{5}{8}$ or $8\frac{\cos x}{\cos x}=-5\frac{\sin x}{\cos x}$ or $5\tan x=-8$
	$\sin x=\frac{8}{\sqrt{89}}$ or 57.9… or 58	A1	oe eg $\sin^{-1}\frac{8}{\sqrt{89}}$ may be implied by final answer
	122.(0…) with no other angle	A1	
	Additional Guidance		
	Allow division of expression by $k\cos x$ eg (k = 8) $1+\frac{5\sin x}{8\cos x}$	M1	
	Answer only 122.(0…)	M1A2	
	Embedded answer 122.(0…)	M1A1A0	
	Answer only 121.9	Zero	
	If working seen, use the alt method for the working seen		
	Answer only –58 (BOD alt 1)	M1A1A0	
	Answer only 58 (BOD alt 2)	M1A1A0	
	Allow cos for $\cos x$ etc		
	Allow c for $\cos x$ etc		

Q	Answer	Mark	Comments
22(b)	**Alternative method 1**		
	$6(1 - \cos^2 x) + 4\cos^2 x$ or $6 - 6\cos^2 x + 4\cos^2 x$ or $2(1 - \cos^2 x) + 4$ or $6 - 2\cos^2 x$	M1	oe expression in terms of $\cos^2 x$
	A = 6 and B = –2 with no incorrect working	A1	
	Alternative method 2		
	$A\sin^2 x + A\cos^2 x + B\cos^2 x$ and A = 6 and A + B = 4	M1	
	A = 6 and B = –2 with no incorrect working	A1	
	Additional Guidance		
	A = 6 and B = –2 with no working		M1A1

Q	Answer	Mark	Comments
23	$(a^2 + 3) \times k$ or $ka^2 + 3k$	M1	oe eg $b = ka^2 + 3k$ may be seen on diagram
	$(ak)^2 + 3$ or $a^2k^2 + 3$	M1	oe eg $b = a^2k^2 + 3$ may be seen on diagram
	$ka^2 + 3k = a^2k^2 + 3$	M1dep	oe equates and expands brackets correctly dep on M2 may include $-b$ on each side
	$a^2(k - k^2) = 3 - 3k$ or $ka^2(1 - k) = 3 - 3k$ or $ka^2 - a^2k^2 = 3(1 - k)$ or $a^2(k - k^2) = 3(1 - k)$ or $ka^2(1 - k) = 3(1 - k)$ or $a^2(k^2 - k) = 3k - 3$ or $ka^2(k - 1) = 3k - 3$ or $k^2a^2 - ka^2 = 3(k - 1)$ or $a^2(k^2 - k) = 3(k - 1)$ or $ka^2(k - 1) = 3(k - 1)$	M1dep	oe eg $(a^2 =) \frac{3 - 3k}{k - k^2}$ or $(a =) (\pm)\sqrt{\frac{3 - 3k}{k - k^2}}$ or $(a^2 =) \frac{3k - 3}{k^2 - k}$ or $(a =) (\pm)\sqrt{\frac{3k - 3}{k^2 - k}}$ collects terms in a^2 and factorises correctly on at least one side must use a^2 as a factor if awarding mark for factorising $ka^2 - a^2k^2$ dep on M3
	$(a^2 =) \frac{3(1-k)}{k(1-k)}$ or $(a^2 =) \frac{3}{k}$ or $(a =) (\pm)\sqrt{\frac{3(1-k)}{k(1-k)}}$	M1dep	oe eg $(a^2 =) \frac{3(k-1)}{k(k-1)}$ correct fraction with numerator and denominator factorised correctly dep on M4
	$(a =) \sqrt{\frac{3}{k}}$ or $(a =) \left(\frac{3}{k}\right)^{\frac{1}{2}}$	A1	oe eg $(a =) \frac{\sqrt{3}}{\sqrt{k}}$ or $(a =) \left(\frac{k}{3}\right)^{-\frac{1}{2}}$ $(a =) \pm\sqrt{\frac{3}{k}}$ M5A0 $(a =) -\sqrt{\frac{3}{k}}$ M5A0
	Additional Guidance		
	Only one machine fully correct		M1 only
	Missing brackets must be recovered		

Q	Answer	Mark	Comments
24	**Alternative method 1** Powers of 3		
	$(3^2)^{0.5p}$ or $(3^3)^{2p-1}$ or $3^{2\times0.5p+4}$	M1	oe powers of 3 eg 3^p or 3^{6p-3} or 3^{p+4} brackets not needed if intention clear eg $3^{2^{0.5p}}$
	$(3^2)^{0.5p}$ and 3^4 and $(3^3)^{2p-1}$ or $3^{2\times0.5p+4}$ and $(3^3)^{2p-1}$	M1dep	oe powers of 3 eg 3^p and 3^4 and 3^{6p-3} or 3^{p+4} and 3^{6p-3}
	$2 \times 0.5p + 4 = 3(2p - 1)$ or $p + 4 = 6p - 3$	M1dep	oe equation dep on M2
	1.4 or $\frac{7}{5}$	A1	oe
	Alternative method 2 Powers of 9		
	$9^{0.5p+2}$ or $(9^{1.5})^{2p-1}$	M1	oe power of 9 eg $9^{3p-1.5}$ brackets not needed if intention clear eg $9^{1.5^{2p-1}}$
	9^2 and $(9^{1.5})^{2p-1}$ or $9^{0.5p+2}$ and $(9^{1.5})^{2p-1}$	M1dep	oe powers of 9 eg 9^2 and $9^{3p-1.5}$ or $9^{0.5p+2}$ and $9^{3p-1.5}$
	$0.5p + 2 = 1.5(2p - 1)$ or $0.5p + 2 = 3p - 1.5$	M1dep	oe equation dep on M2
	1.4 or $\frac{7}{5}$	A1	oe

Mark scheme continues on the next page

Q	Answer	Mark	Comments
24	**Alternative method 3** Powers of 27		
	$\left(27^{\frac{2}{3}}\right)^{0.5p}$	M1	oe power of 27 eg $27^{\frac{2}{3}\times 0.5p}$ or $27^{\frac{1}{3}p}$ brackets not needed if intention clear eg $27^{\frac{2}{3}^{0.5p}}$
	$\left(27^{\frac{2}{3}}\right)^{0.5p}$ and $27^{\frac{4}{3}}$	M1dep	oe powers of 27 eg $27^{\frac{2}{3}\times 0.5p}$ and $27^{\frac{4}{3}}$ or $27^{\frac{1}{3}p}$ and $27^{\frac{4}{3}}$ M2 $27^{\frac{2}{3}\times 0.5p+\frac{4}{3}}$ or $27^{\frac{1}{3}p+\frac{4}{3}}$
	$\frac{2}{3}\times 0.5p + \frac{4}{3} = 2p - 1$ or $\frac{1}{3}p + \frac{4}{3} = 2p - 1$	M1dep	oe equation dep on M2
	1.4 or $\frac{7}{5}$	A1	oe

Mark scheme and additional guidance continues on the next page

Q	Answer	Mark	Comments
24	**Alternative method 4** Powers of 81		
	$(81^{0.5})^{0.5p}$ or $(81^{0.75})^{2p-1}$ or $81^{0.5\times0.5p+1}$	M1	oe powers of 81 eg $81^{0.25p}$ or $81^{1.5p-0.75}$ or $81^{0.25p+1}$ brackets not needed if intention clear eg $81^{0.5^{0.5p}}$
	$(81^{0.5})^{0.5p}$ and $(81^{0.75})^{2p-1}$ or $81^{0.5\times0.5p+1}$ and $(81^{0.75})^{2p-1}$	M1dep	oe powers of 81 eg $81^{0.25p}$ and $81^{1.5p-0.75}$ or $81^{0.25p+1}$ and $81^{1.5p-0.75}$
	$0.5 \times 0.5p + 1 = 0.75(2p - 1)$ or $0.25p + 1 = 1.5p - 0.75$	M1dep	oe equation dep on M2
	1.4 or $\frac{7}{5}$	A1	oe
	Additional Guidance		
	Mark positively if potentially more than one scheme used		
	Answer 1.4		M3A1
	Correct equation implies M3		
	Just seeing expressions not in an equation and not as powers scores zero eg Alt 1 $6p - 3$ and $p + 4$ not in an equation and not as powers of 3		M0M0M0
	Allow recovery of missing brackets		
	Use of logs with answer not 1.4 - escalate		