Question	1	2	3	4	5	6	7	8	9	10	Total
Marks											
Max	3	4	5	4	9	8	8	6	8	9	64

1.

Marking Instructions	AO	Marks	Typical Solution
Multiplies numerator and denominator by the conjugate surd of the denominator	AO1.1a	M1	$\frac{5\sqrt{3}+3}{3\sqrt{3}+4}\times\frac{3\sqrt{3}-4}{3\sqrt{3}-4}$
Obtains **either** numerator **or** denominator correctly, in expanded or simplified form	AO1.1b	A1	$\frac{45-20\sqrt{3}+9\sqrt{3}-12}{11}$
Constructs rigorous mathematical argument to show the required result Only award if they have a completely correct solution, which is clear, easy to follow and contains no slips NMS = 0	AO2.1	R1	$\frac{33-11\sqrt{3}}{11}$ $3-\sqrt{3}$ a=3, b= -1
			Total 3 marks

2.

	Marking Instructions	AO	Marks	Typical Solution
(a)(i)	States correct value of p	AO1.2	B1	$p=\frac{1}{2}$
(ii)	States correct value of q	AO1.2	B1	$q=-3$
(b)	Uses valid method to find x , PI	AO1.1a	M1	$\frac{1}{2}+2x+1=-3$
	Obtains correct x , ACF	AO1.1b	A1	$x=\frac{-9}{4}$
				Total 4 marks

3.

(a) p (4) = $(4)^3 - 13(4) - 12$
must attempt p (4) NOT long division

M1

= 64-52-12
= 0

$\Rightarrow$ x -4 is factor
shown = 0 ***plus statement***

A1

(b) x -4 $x^2 + bx + c$
Full long division, comparing coefficients
or by inspection either b = 4 or c = 3

M1

$x^2 + 4x + 3$ obtained
or M1 A1 for either x +3 or x + 1
clearly found using factor theorem

A1

$x + 3$ $x - 4$ $x + 1$
CSO; must be seen as a product of 3 factors
NMS full marks for correct product
SC B1 for $x + 3$ $x - 4$
or $(x + 3)(x + 1)(\ )$
or $(x + 3)(x + 4)(x - 1)$ NMS

A1

4.

$(3x-2)^4 = 81x^4 - 216x^3 + 216x^2 - 96x + 16$	M1		Attempt binomial expansion, including attempt at coeffs.
	A1		Obtain one correct, simplified, term
	A1		Obtain a further two, simplified, terms
	A1	4	Obtain a completely correct expansion
		4	

5.

	Marking Instructions	AO	Marks	Typical Solution
(a) (i)	States correct radius CAO	AO1.2	B1	Radius = $\sqrt{10}$
(ii)	States correct centre CAO	AO1.2	B1	C is (4, −1)
(b)	Finds gradient of the line through the points *P* and 'their' *C* (as found in part **(a)**) Condone one sign error	AO3.1a	M1	Gradient $CP = \frac{2-4}{3+1} = \frac{-2}{4}$
	Correct tangent gradient obtained from 'their' *CP* gradient	AO3.1a	M1	So tangent gradient = 2
	Uses a correct form for the equation of a straight line with correct coordinates of *P* and 'their' tangent gradient	AO1.1a	M1	$y - 2 = 2(x - 3)$
	States correct final answer in required form (ax+by =c) FT from 'their' *C* found in part **(a)**	AO1.1b	A1F	$2x - y = 4$
(c)	Uses Pythagoras' theorem for length CQ		M1	
	Obtains CQ	AO1.1a	M1	CQ=3
	Compares with radius of circle and reasons that point must be inside since CQ<r *FT* 'their' *QC* and 'their' radius found in part **(a)**	AO1.1b	A1F	$3>\sqrt{10}$ *Point is inside the circle*
				Total 10 marks

6.

(a) $(k-2)^2 - 4 \times (2k-7)(k-3)$

discriminant − condone one slip − condone omission of brackets

M1

$k^2 - 4k + 4 - 4(2k^2 - 6k - 7k + 21)$

A1

" their " $-7k^2 + 48k - 80 < 0$

No real roots condition; f(k)< 0 must appear before final line

B1

$7k^2 - 48k + 80 > 0$

***AG** (all working correct with no missing brackets etc)*

A1cso

(b) $7k^2 - 48k + 80 = (7k-20)(k-4)$

correct factors

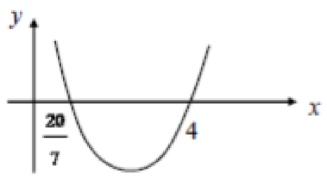
(or roots unsimplified) $\frac{48 \pm \sqrt{64}}{14}$

M1

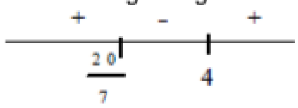
critical values are 4 and $\frac{20}{7}$

accept $\frac{56}{14}$, $\frac{40}{14}$ *etc here*

A1



sketch or sign diagram including values



M1

$k < \frac{20}{7}$ or $k > 4$

Take their final line as their answer

fractions must be simplified here, do not allow 'and' between the inequalities

A1cao

7.

(i)	$\sin^2 x = 1 - \cos^2 x \Rightarrow 2\cos^2 x + \cos x - 1 = 0$	M1		For transforming to a quadratic in cos *x*
	Hence $(2\cos x - 1)(\cos x + 1) = 0$	M1		For solution of a quadratic in cos *x*
	$\cos x = \frac{1}{2} \Rightarrow x = 60°$	A1		For correct answer 60°
	$\cos x = -1 \Rightarrow x = 180°$	A1	4	For correct answer 180° [Max 3 out of 4 if any extra answers present in range, or in radians] **SR** answer only is B1, B1 justification – ie graph or substitution is B2, B2
(ii)	$\tan 2x = -1 \Rightarrow 2x = 135$ or 315	M1 M1		For transforming to an equation of form tan2*x* = *k* For correct solution method, i.e. inverse tan followed by division by 2
	Hence $x = 67.5°$ or $157.5°$	A1 A1	4	For correct value 67.5 For correct value 157.5
	OR $\sin^2 2x = \cos^2 2x$ $2\sin^2 2x = 1$ $\quad 2\cos^2 2x = 1$ $\sin 2x = \pm\frac{1}{2}\sqrt{2}$ $\quad \cos 2x = \pm\frac{1}{2}\sqrt{2}$ Hence $x = 67.5°$ or $157.5°$	M1 M1 A1 A1		Obtain linear equation in cos 2*x* or sin 2*x* Use correct solution method For correct value 67.5 For correct value 157.5 [Max 3 out of 4 if any extra answers present in range, or in radians] **SR** answer only is B1, B1 justification – ie graph or substitution is B2,

[8]

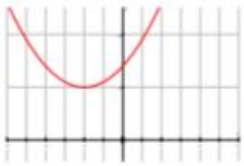
8.

Method 1 (Substituting a = 3b into second equation at some stage)		
Using a law of logs correctly (anywhere)	e.g. $\log_3 ab = 2$	M1
Substitution of 3*b* for *a* (or a/3 for b)	e.g. $\log_3 3b^2 = 2$	M1
Using base correctly on **correctly derived** $\log_3 p = q$	e.g. $3b^2 = 3^2$	M1
First correct value	$b = \sqrt{3}$ (allow $3^{½}$)	A1
Correct method to find other value (dep. on at least first M mark)		M1
Second answer	$a = 3b = 3\sqrt{3}$ or $\sqrt{27}$	A1
Method 2 (Working with two equations in $\log_3 a$ and $\log_3 b$)		
" Taking logs" of first equation and " separating"	$\log_3 a = \log_3 3 + \log_3 b$ $(= 1 + \log_3 b)$	M1
Solving simultaneous equations to find $\log_3 a$ or $\log_3 b$		M1
[$\log_3 a = 1½$, $\log_3 b = ½$] Using base correctly to find a or b		M1
Correct value for *a* or *b*	$a = 3\sqrt{3}$ or $b = \sqrt{3}$	A1
Correct method for second answer, dep. on first M; correct second answer [Ignore negative values]		M1;A1
		[6]

9.

(a)	AB: $m = \frac{2-7}{8-6}$, $\left(= -\frac{5}{2}\right)$	B1
	Using $m_1 m_2 = -1$: $m_2 = \frac{2}{5}$	M1
	$y - 7 = \frac{2}{5}(x-6)$, $2x - 5y + 23 = 0$ (o.e. with integer coefficients)	M1 A1
		(4)
(b)	Using $x = 0$ in the answer to (a), $y = \frac{23}{5}$ or 4.6	M1 A1ft
		(2)
(c)	Area of triangle = $\frac{1}{2} \times 8 \times \frac{23}{5} = \frac{92}{5}$ (o.e) e.g. $\left(18\frac{2}{5},\ 18.4,\ \frac{184}{10}\right)$	M1 A1
		(2)
		[8]

10.

(a)	$(x+2k)^2$ or $\left(x+\frac{4k}{2}\right)^2$	M1	
	$(x \pm F)^2 \pm G \pm 3 \pm 11k$ (where F and G are any functions of k, not involving x	M1	
	$(x+2k)^2 - 4k^2 + (3+11k)$ Accept unsimplified equivalents such as $\left(x+\frac{4k}{2}\right)^2 - \left(\frac{4k}{2}\right)^2 + 3 + 11k$, and i.s.w. if necessary.	A1	
			(3)
b)	Accept part (b) solutions seen in part (a)		
	"$4k^2 - 11k - 3$"$=0$ $(4k+1)(k-3)=0$ $k = \ldots$,	M1	
	[Or, 'starting again', $b^2 - 4ac = (4k)^2 - 4(3+11k)$ and proceed to $k = \ldots$]		
	$-\frac{1}{4}$ and 3 (Ignore any inequalities for the first 2 marks in (b)).	A1	
	Using $b^2 - 4ac < 0$ for no real roots, i.e. "$4k^2 - 11k - 3$"<0, to establish inequalities involving their two critical values m and n (even if the inequalities are wrong, e.g. $k < m$, $k < n$).	M1	
	$-\frac{1}{4} < k < 3$ (See conditions below) Follow through their critical values.	A1ft	
	The final A1ft is still scored if the answer $m < k < n$ follows $k < m$, $k < n$. Using x instead of k in the final answer loses only the 2nd A mark, (condone use of x in earlier working).		(4)
(c)	 Shape (seen in (c))	B1	
	Minimum in correct quadrant, not touching the x-axis, not on the y-axis, and there must be no other minimum or maximum	B1	
	0, 14) or 14 on y-axis. Allow (14, 0) marked on y-axis.	B1	
	.b. Minimum is at $(-2,10)$, (but there is no mark for this).		(3)
			[10]