Mark Scheme (Results)

Summer 2019

Pearson Edexcel GCE
In Mathematics (6664) Paper 1
Core Mathematics 2

Summer 2019
Publications Code 6664_01

General Marking Guidance

- All candidates must receive the same treatment. Examiners must mark the first candidate in exactly the same way as they mark the last.
- Mark schemes should be applied positively. Candidates must be rewarded for what they have shown they can do rather than penalised for omissions.
- Examiners should mark according to the mark scheme not according to their perception of where the grade boundaries may lie.
- There is no ceiling on achievement. All marks on the mark scheme should be used appropriately.
- All the marks on the mark scheme are designed to be awarded. Examiners should always award full marks if deserved, i.e. if the answer matches the mark scheme. Examiners should also be prepared to award zero marks if the candidate's response is not worthy of credit according to the mark scheme.
- Where some judgement is required, mark schemes will provide the principles by which marks will be awarded and exemplification may be limited.
- When examiners are in doubt regarding the application of the mark scheme to a candidate's response, the team leader must be consulted.
- Crossed out work should be marked UNLESS the candidate has replaced it with an alternative response.

SOME GENERAL PRINCIPLES FOR MATHEMATICS MARKING

1. The total number of marks for the paper is 75.

2. The Edexcel Mathematics mark schemes use the following types of marks:

- **M** marks: Method marks are awarded for 'knowing a method and attempting to apply it', unless otherwise indicated.
- **A** marks: Accuracy marks can only be awarded if the relevant method (M) marks have been earned.
- **B** marks are unconditional accuracy marks (independent of M marks)
- Marks should not be subdivided.

3. Abbreviations

These are some of the traditional marking abbreviations that will appear in the mark schemes and can be used if you are using the annotation facility on ePEN.

- bod – benefit of doubt
- ft – follow through
- the symbol √ or the letters ft will be used for correct follow through
- cao – correct answer only
- cso - correct solution only. There must be no errors in this part of the question to obtain this mark
- isw – ignore subsequent working
- awrt – answers which round to
- SC: special case
- oe – or equivalent (and appropriate)
- d… or dep – dependent
- indep – independent
- dp decimal places
- sf significant figures
- ∗ The answer is printed on the paper or ag- answer given
- ⊏ or d… The second mark is dependent on gaining the first mark
- quotation marks are used to indicate "their value"

4. All A marks are 'correct answer only' (cao.), unless shown, for example, as A1 ft to indicate that previous wrong working is to be followed through. After a misread however, the subsequent A marks affected are treated as A ft, but manifestly absurd answers should never be awarded A marks.

5. For misreading which does not alter the character of a question or materially simplify it, deduct two from any A or B marks gained, in that part of the question affected. If you are using the annotation facility on ePEN, indicate this action by 'MR' in the body of the script.

6. If a candidate makes more than one attempt at any question:
    - If all but one attempt is crossed out, mark the attempt which is NOT crossed out.
    - If either all attempts are crossed out or none are crossed out, mark all the attempts and score the highest single attempt.

7. Ignore wrong working or incorrect statements following a correct answer.

8. Marks for each question are scored by clicking in the marking grids that appear below each student response on ePEN. The maximum mark allocation for each question/part question(item) is set out in the marking grid and you should allocate a score of ‘0’ or ‘1’ for each mark, or “trait”, as shown:

	0	1
aM		●
aA	●	
bM1		●
bA1	●	
bB	●	
bM2		●
bA2		●

9. Be careful when scoring a response that is either all correct or all incorrect. It is very easy to click down the ‘0’ column when it was meant to be ‘1’ and all correct.

General Principles for Core Mathematics Marking

(But note that specific mark schemes may sometimes override these general principles).

Method mark for solving 3 term quadratic:

1. Factorisation

$(x^2 + bx + c) = (x + p)(x + q)$, where $|pq| = |c|$, leading to $x = \ldots$

$(ax^2 + bx + c) = (mx + p)(nx + q)$, where $|pq| = |c|$ and $|mn| = |a|$, leading to $x = \ldots$

2. Formula

Attempt to use correct formula (with values for a, b and c).

3. Completing the square

Solving $x^2 + bx + c = 0$: $(x \pm \frac{b}{2})^2 \pm q \pm c$, $q \neq 0$, leading to $x = \ldots$

Method marks for differentiation and integration:

1. Differentiation

Power of at least one term decreased by 1. ($x^n \to x^{n-1}$)

2. Integration

Power of at least one term increased by 1. ($x^n \to x^{n+1}$)

Use of a formula

Where a method involves using a formula that has been learnt, the advice given in recent examiners' reports is that the formula should be quoted first.

Normal marking procedure is as follows:

Method mark for quoting a correct formula and attempting to use it, even if there are mistakes in the substitution of values.

Where the formula is not quoted, the method mark can be gained by implication from correct working with values, but may be lost if there is any mistake in the working.

Exact answers

Examiners' reports have emphasised that where, for example, an exact answer is asked for, or working with surds is clearly required, marks will normally be lost if the candidate resorts to using rounded decimals.

Answers without working

The rubric says that these may not gain full credit. Individual mark schemes will give details of what happens in particular cases. General policy is that if it could be done "in your head", detailed working would not be required. Most candidates do show working, but there are occasional awkward cases and if the mark scheme does not cover this, please contact your team leader for advice.

June 2018
6664 Core Mathematics C2
Mark Scheme

Question Number	Scheme	Marks
1.(a)	<table><tr><td>x</td><td>2</td><td>2.5</td><td>3</td><td>3.5</td><td>4</td></tr><tr><td>y</td><td>0.631</td><td>0.834</td><td>1</td><td>**1.140**</td><td>1.262</td></tr></table>	B1
		(1)
(b)	$\frac{1}{2}\times 0.5$ or 0.25 ; or $h = 0.5$	B1 oe
	$\underline{\left\{0.631+1.262+2\left(0.834+1+1.140\right)\right\}}$ For structure of $\underline{\{...............\}}$;	M1A1ft
	$\frac{1}{2}\times 0.5\,\underline{\left\{0.631+1.262+2\left(0.834+1+1.140\right)\right\}}\,\{=0.25(7.841)=1.96..\}=$ awrt 1.96	A1
		(4)
		(5 marks)

Notes

(a) B1: 1.140 (accept 1.14)

(b) B1: for using $\frac{1}{2}\times 0.5$ or 0.25 outside bracket; or stating $h = 0.5$ or equivalent.

M1: requires the correct $\{......\}$ bracket structure. It needs the first bracket to contain first y value **plus** last y value and the second bracket to be multiplied by 2 and to be the summation of the remaining y values in the table with no additional values. If the only mistake is a copying error or is to omit one value from 2nd bracket this may be regarded as a slip and the M mark can be allowed (An extra repeated term (or several) forfeits the M mark however). M0 if values used in brackets are x values instead of y values

A1ft: for the correct bracket $\{......\}$ following through candidate's y value found in part (a).

A1: for answer which rounds to 1.96 (accept 1.960)

NB: Separate trapezia may be used : B1 for 0.5, M1 for 1/2 $h(a + b)$ used 4 times (and A1ft if it is all correct) Then A1 as before.

Special case: Bracketing mistake $0.25\times(0.631+1.262)+2\left(0.834+1+1.140\right)$ scores B1 M1 A0 A0 unless the final answer implies that the calculation has been done correctly (then full marks can be given). An answer of 6.42 usually indicates this error but check brackets as if they are stated correctly the M mark is awarded.

Question Number	Scheme	Marks
2. (a)	Way 1: Attempt f(3) or f (-3) and put equal to 0 (So $81-225+3a-15=0$ and) obtains a = 53 Way 2: Divides by $(x-3)$ to obtain quadratic and puts their remainder " $a-48-5$" = 0 obtains a = 53	M1 A1 **(2)** M1 A1 **(2)**
(b)	$(\mathrm{f}(x)=)\quad (x-3)(3x^2 \text{...............})$ ....$(3x^2-16x+5)$ $(\mathrm{f}(x)=)\quad (x-3)(3x-1)(x-5)$	M1 A1 dM1A1 cso **(4)** **(6 marks)**

Notes

Mark parts (a) and (b) together

(a) Way 1:

M1: for attempting either $\mathrm{f}(3)$ or $\mathrm{f}(-3)$ – with **numbers substituted into expression and put = 0**

A1: Obtaining correct value for a (not 159/3)

Way 2: M1: Attempts division in part (a) and obtains a remainder as a linear function of a and puts this equal to 0

A1: As before

(b)

M1: Attempt to obtain quadratic which combines with (x-3) to give original cubic – obtaining $3x^2 \pm ...$ (may be done by division or comparing coefficients or may be just seen) However $x(3x^2-25x+53)=15$ is M0A0

A1: for obtaining the correct quadratic expression $(3x^2-16x+5)$

dM1: for attempting to factorise their quadratic (see notes) or attempt to solve quadratic and use roots to form factors. This depends on previous M mark.

A1cso:for obtaining a correct equivalent expression– need three brackets together and this is cso so no earlier errors

The correct factorisation with no working should be sent to review (question stated using algebra)

If, after a correct factorisation, they go on to solve an equation (e.g. x = 3, 1/3 or 5) then isw

Question Number	Scheme	Marks
	$(1+kx)^{10}$	
3. (a)	$1+{}^{10}C_1(kx)+{}^{10}C_2(kx)^2+{}^{10}C_3(kx)^3...$	
	$1+\left({}^{10}C_1\times...\times x\right)+\left({}^{10}C_2\times...\times x^2\right)+\left({}^{10}C_3\times...\times x^3\right)...$	M1
	$=1+10kx,+45k^2x^2+120k^3x^3..$	**B**1, A1
		(3)
(b)	$120k^3=10k$	M1
	$k^2=\frac{1}{12}$ *so* $k=...$	M1
	$k=\frac{\sqrt{3}}{6}$ o.e	A1
		(3)
(c)	$\frac{15}{4}$ o.e.	B1
		(1)
		(7 marks)

Notes

(a)

M1: All three binomial coefficients must be correct and must be with the correct power of x. (Ignore k) Accept ${}^{10}C_1$ or $\binom{10}{1}$ or 10 **as a coefficient, and** ${}^{10}C_2$ or $\binom{10}{2}$ or 45 **as another and** ${}^{10}C_3$ or $\binom{10}{3}$ or 120 **as another……..**

Pascal's triangle may be used to establish coefficients.

B1: The first two terms correct (i.e. $=1+10kx$)

A1: The third and fourth terms are correct – allow with brackets (kx) (i.e. $45k^2x^2+120k^3x^3$ or $45(kx)^2+120(kx)^3$)

(Accept answers without + signs, can be listed with commas or appear on separate lines)

If extra terms are given then isw

(b)

M1: Sets their **Coefficient** of x equal to their **Coefficient** of x^3 but must have differing powers of k

M1: Divides then takes a square root to give a value for k (May use difference of two squares to find k which is fine)

A1: $k=\frac{1}{\sqrt{12}}$ or $\frac{\sqrt{12}}{12}$ or $\frac{\sqrt{3}}{6}$ o.e. (needs to have just the one positive answer – if negative square root is also given, this is A0)

If there are x terms present e.g. $120k^3x^3=10kx$ then this is M0M0A0

If both powers of k are the same this is also M0M0A0

(c)

B1: $\frac{45}{12}$ or $\frac{15}{4}$ or 3.75 or equivalent Allow $\frac{15}{4}x^2$ (can follow negative value for k)

Question Number	Scheme	Marks
4(a)	Way 1: $250\ 000\times(1.1)^{n-1}>1000000$ or $250\ 000\times(1.1)^{n}>1000000$	M1
	$(1.1)^{n-1}>4$ or $(1.1)^{n}>4$	A1
	So $(n-1)\log1.1>\log4$ or $n-1>\log_{1.1}4$ or $n\log1.1>\log4$ or $n>\log_{1.1}4$	M1
	the year is 2034	A1 (4)
	Way 2: Alternative method using trial and improvement	
	$250\ 000\times(1.1)^{15}=1044312$	M1
	$250\ 000\times(1.1)^{14}=949374.58$	M1
	Gives correct two amounts, the year is 2034	A1, A1 (4)
(b)	$S=\dfrac{a(1-r^{"12"})}{1-r}$ or $S=\dfrac{a(r^{"12"}-1)}{r-1}$	M1
	$S=\dfrac{250000((1.1)^{12}-1)}{(1.1)-1}$	A1ft on their *r*
	= (£) 5346071 (allow in standard form)	A1 (3)
		[7]

Notes

(a) M1: Accept = or < or > for this mark and allow *n* or *n* – 1. Allow 1.01 for this mark.
A1: Correct power equation but allow = or < and allow *n* or *n* - 1
M1: Correct use of logs on their power equation or inequation
NB if they use sum of series formula, in error, on part (a) they may get this mark if they use correct algebra to solve a power equation (usually M0A0M1A0)
A1cao: Need 2034 (16th year is insufficient)

(b) M1: Correct use of sum formula with power 11 or 12
A1ft: Correct unsimplified using 12 with their *r* (e.g. 1.01)
A1: Allow awrt (£)5346071

Special case: Candidates using 1.01 instead of 1.1 may get a maximum of M1A0M1A0M1A1ftA0

Question number	Scheme	Marks
5	$x^2 + y^2 - 3x + 6y = 1$	
(a)	Obtain LHS as $\underline{(x \pm \frac{3}{2})^2} + \underline{\underline{(y \pm 3)^2}} = ...$	M1
	Centre is $(\frac{3}{2}, -3)$.	A1 **(2)**
(b)	Uses $\underline{(x \pm \frac{3}{2})^2} - \frac{9}{4} + \underline{\underline{(y \pm 3)^2}} - 9 = 1$ to give $r = \sqrt{1 + "\frac{9}{4}" + "9"}$ or just $r^2 = 1 + "\frac{9}{4}" + "9"$	M1
	$r = \frac{7}{2}$	A1 **(2)**
Special case	Uses (5, -3) from (c) to find radius $\underline{(5 - \frac{3}{2})^2} + \underline{\underline{(-3+3)^2}} = ...$	M1
	$r = \frac{7}{2}$	A1 **(2)**
(c)	Way 1: Deduces gradient is infinite (from diagram or from perpendicular to zero gradient	M1
	So equation is $x = 5$	A1 **(2)**
	Way 2: Implicit differentiation $\frac{dy}{dx} = \frac{3-2x}{2y+6} = \frac{3-10}{0}$ **so infinite gradient o.e.**	M1
	So equation is $x = 5$	A1 **(2)** **(6 marks)**
<u>Alternatives</u> (a)	*Method 2:* Comparing with $x^2 + y^2 + 2gx + 2fy + c = 0$ to write down centre $(-g, -f)$ directly. Condone sign errors for this **M** mark**.**	M1
	Centre is $(\frac{3}{2}, -3)$.	A1 **(2)**
(b)	*Method 2*: Using $\sqrt{g^2 + f^2 - c}$, $r = \frac{7}{2}$	M1, A1 **(2)**

Notes

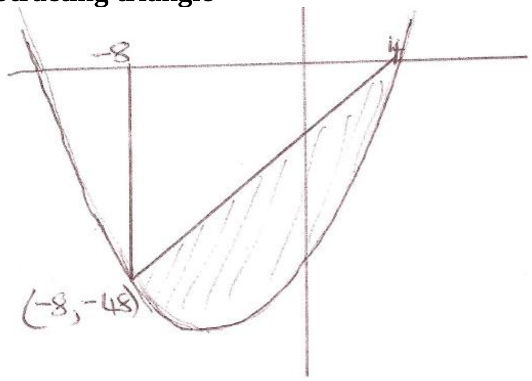
(a) **M1** as in scheme and can be <u>implied</u> by $(\pm\frac{3}{2}, \mp 3)$. **A1:** $(\frac{3}{2}, -3)$.

(b) **M1** for a full method leading to $r = \ldots$, or $r^2 =$ with their 9/4 and their 9. Completion of square method errors result in **M0** here So need $r = \sqrt{1 + "\frac{9}{4}" + "9"}$ or just $r^2 = 1 + "\frac{9}{4}" + "9"$ (Can mark (a) and (b) together)

N.B. $1 + "\frac{9}{4}" + "9" = \frac{49}{4}$ without identification as r^2 , followed by $r = \frac{49}{4}$ is M0A0

A1 $r = \frac{7}{2}$ or 3.5 Can be achieved after wrong signs for centre. Answer only is M1A1

(c) M1A1 as in the scheme (Correct answer implies both marks) Answer of $y = -3$ is awarded M0A0

Question Number	Scheme	Marks
6	Way 1: Area of trapezium = $\frac{1}{2}(a+b)\times h = \frac{1}{2}(18+66)\times"(4--8)"=$ or may use combination of rectangle and triangle to find trapezium area or may use integration $\int_{-8}^{4}(4x+50)\mathrm{d}x = \left[2x^2+50x\right]_{-8}^{4} = (232)-(128-400)=$	M1
	504 (may be implied by correct final answer)	A1
	$\int x^2+8x+18\mathrm{d}x = \frac{1}{3}x^3+4x^2+18x$	M1 A1
	Use limits 4 **and** -8 $[(\frac{1}{3}(4)^3+4(4)^2+18\times 4)-(\frac{1}{3}(-8)^3+4.(-8)^2+18\times(-8))] = A_1$ $(=216)$ **And** uses correct combination of correct areas. Area of region = Area of trapezium $-$ A_1	dM1
	$=504-\left(\frac{472}{3}--\frac{176}{3}\right)$ = 288	A1 [6]
	Way 2: Alternative method using "line – curve" **Sets up** $y=4x+50-(x^2+8x+18)$	M1 A1
	$\int -x^2-4x+32\mathrm{d}x = -\frac{x^3}{3}-2x^2+32x$	M1A1
	Use limits 4 and -8 on this *subtracted* integration Obtains 288	dM1 A1 [6]
	Way 3: Method involving translating curve and line down 66 units and integrating then subtracting triangle  	
	Area of triangle = $\frac{1}{2}b\times h = \frac{1}{2}48\times"(4--8)"=288$	**M1A1**
	$\int x^2+8x-48\mathrm{d}x = \frac{1}{3}x^3+4x^2-48x$	M1A1
	Use limits 4 **and** -8 **and** uses correct combination of correct areas. Area of region = Area above curve - Area of triangle (576 – 288) Obtains 288	dM1 A1 [6]
	Mixture of methods may earn M1A1M1A1M0A0	
		(6 marks)

	Notes
	Way 1 M1: Correct method for area under line – either trapezium or integration or equivalent correct method A1: Obtains 504 (this may be implied by final correct answer) M1: Attempt at integration of the quadratic expression by raising powers A1: Correct work dM1: Uses correct limits and then correct combination of areas to give required area. Depends on previous method mark. A1: 288 **Way 2** M1: **Sets up** $y = \pm\left(4x + 50 - (x^2 + 8x + 18)\right)$ A1: Removes brackets correctly and has $-x^2 - 4x + 32$ or $x^2 + 4x - 32$ (may be awarded later) M1: Attempt at integration of their quadratic expression (may be unsimplified) by raising powers A1: Correct integration to give answer equivalent to those on scheme. Allow correct answer even if terms not collected nor simplified. Sign errors subtracting before integration gain M1A0 dM1: uses limits 4 and -8 and subtracts A1: 288 NB IF subtraction is wrong way round and leads to -288 then area is given as 288 with no further explanation – still award the A1 **Way 3** **Unusual method but it has been used. See scheme above.**

Question Number	Scheme	Marks
7. (a)	$6(1-\sin^2 x)-\sin x-4=0$	M1
	$6\sin^2 x+\sin x-2=0$ *	A1 *
		(2)
(b)	$6\sin^2 2y+\sin 2y-2=0$	
	$(2\sin 2y-1)(3\sin 2y+2)=0$ *so* $\sin\theta=$	M1
	$(\sin 2y=)\frac{1}{2}$, $(\sin 2y=)-\frac{2}{3}$	A1
	$2y$ = 30° or 150° or −41.8° or −138.2° so y =	M1
	y = 15° or 75° or −20.9° or −69.1° (accept awrt)	A1 A1
		(5)
		[7]

Notes

(a)

M1: Uses $(1-\sin^2 x)$ (do not need "=0")

A1*: Need everything correct including "=0" and $6\sin^2 x+\sin x-2=0$ Missing x e.g. $(1-\sin^2)$ gets M1A0

(b)

M1:Solves quadratic by any valid method to give values for sin θ where the variable may be x or y or $2y$ or any letter.

1st A1: Need to see ½ and −2/3 (These two answers imply the previous M mark)

M1: Realises connection to (a) so uses inverse sin **then halves** (one angle is enough)

A1: Any two correct solutions

A1: All four solutions correct (Extra solutions in range lose this A mark, but outside range - ignore)

Question Number	Scheme	Marks
8. (i)	$\log_x 600 = 3$ means $x^3 = 600$	M1
	$x = \sqrt[3]{600} = 8.43$	A1
		(2)
(ii) Way 1	$\log_9 3x + \log_9 \frac{x^4}{81} = \log_9 \frac{3x^k}{81}$ where k = 4 or 5	M1
	Uses $\log_9 81 = 2$ or $9^2 = 81$	M1
	So $3x^5 = 81 \times 81$	A1
	So $x^5 = \frac{81\times 81}{3} = 3^7$ so $x =$ (must be power of 3)	dM1
	$x = 3^{1.4}$ (accept k = 1.4)	A1
		(5)
Way 2	$\log_9 3 + \log_9 x + 4\log_9 x - \log_9 81 = 2$	M1
	$5\log_9 x = \log_9 81 + \underline{\log_9 81} - \log_9 3$	M1
	$5\log_9 x = 3.5$	A1
	$\log_3 x = \frac{7}{5}$ so $x =$ (must be power of 3)	dM1
	$x = 3^{1.4}$ (accept k = 1.4)	A1
		(5)
Way 3	$\log_9 3^{k+1} + \log_9 \frac{3^{4k}}{81} = \log_9 \frac{3^{5k+1}}{81}$	M1
	Uses $\log_9 81 = 2$ or $9^2 = 81$ or $3^4 = 81$	M1
	So $3^{5k+1} = 81 \times 81$ or $3^{5k+1} = 3^4 \times 3^4$ o.e.	A1
	$5k+1=8$ so $k=$	dM1
	$x = 3^{1.4}$ (accept k = 1.4)	A1
		(5) **[7]**

Notes

(i) M1: Undoes logarithm correctly
A1: Accept answers which round to 8.43
If they use trial and improvement then mark awrt 8.43 as M1A1 – any other answer is M0A0
(ii) M1: Applying the subtraction or addition law of logarithms correctly to make **two** log **terms into one** log term in x (condone power of 4 instead of 5 here)
M1: Uses $\log_9 81 = 2$ or $9^2 = 81$ or $3^4 = 81$ or $9^4 = 81 \times 81$
A1: Correct equation $3x^5 = 81 \times 81$ or $3^{5k+1} = 81 \times 81$ or $5\log_9 x = 3.5$ or $5\log_3 x = 7$
dM1: (Ways 1 and 3) Correct method to move from $x^n = b$ to $x^n = 3^p$ so $x = \left(3^p\right)^{\frac{1}{n}}$ or move to linear equation in k This is dependent on having both earlier M marks
or (Way 2) Divides, then undoes log and produces x as a power of 3
A1: Any correct equivalent for k (allow even if calculator used in working)

Question Number	Scheme	Marks
9. (a) (i)	Uses $\cos ADC = \frac{7^2+9^2-3^2}{2\times7\times9}$	M1
	So ADC = 0.283	A1
(ii)	Uses $\cos ACD = \frac{3^2+9^2-7^2}{2\times3\times9}$ or uses $\frac{\sin ACD}{7} = \frac{\sin".207"}{3}$	M1
	so ACD = 0.709	A1 **(4)**
(b)	Finds angle ADB or angle ACB by doubling their ADC or ACD and uses $s = r\theta$	M1
	Finds both and adds (can follow failure to double angle so can earn M0M1) to give 8.2 (cm) (allow AWRT)	M1 A1 **3)**
(c)	Finds angle ADB or angle ACB and uses $\frac{1}{2}r^2(\theta-\sin\theta)$ for segment, or uses $\frac{1}{2}r^2\theta$ for sector **and** $\frac{1}{2}r^2\sin\theta$ for triangle and doubles at some point, with r = 3 or r = 7	M1
	Complete and correct method to establish required area (there are a few alternatives see notes below)	M1
	Obtains correct expressions $\frac{1}{2}7^2(0.565-\sin 0.565)$ and $\frac{1}{2}3^2(1.42-\sin 1.42)$ or awrt 0.7, **and** 1.933 and is using correct method to combine them	A1
	Awrt 2.6 or 2.7	A1 **(4)**
		(11 marks)

Notes

NB If there is a misread and they use AB = 9cm it leads to an impossibility. Please send to review.

(a) (i) (Mark parts (i) and (ii) together. Some find the answer to part (ii) first, then may use sine rule in part (i))
M1: Uses cosine rule correctly to obtain required angle
A1: allow awrt 0.283 The answer in degrees is 16.2 and gets M1A0
(If they double this answer then do not isw here so 0.283 followed by 0.565 is M1A0)
(a) (ii)
M1: Uses cosine rule or sine rule correctly
A1: allow awrt 0.709 The answer in degrees is 40.6 (**only penalise the first time for answers in degrees**)

(b)
M1 Doubles one of the angles and uses formula for arc length (These are 3.962 and 4.254)
M1 for adding two appropriate arc lengths
A1 for awrt 8.2 (do not need to see units)

(c)
M1: Uses formula for segment with an appropriate angle, or uses at least one area of sector and corresponding area of triangle, or finds area of kite together with at least one area of sector
M1: Adds two segment areas, or two sectors and subtracts two triangles which form the kite.(They might even use four triangles to form the kite but this results in a long method)
A1: For **two** correct expressions added or for both awrt 0.73 and 1.9 added

OR $\frac{1}{2}7^2\times0.565+\frac{1}{2}3^2\times1.42-\frac{1}{2}7^2\times\sin 0.565-\frac{1}{2}3^2\times\sin 1.42$ (Needs both M marks)

A1: allow awrt 2.6 or 2.7 (do not need to see units)
(There are a number of ways of obtaining this area)

Question Number	Scheme	Marks
10(a)	$\{A=\}\ \frac{1}{2}x^2\sin 60^\circ + 3xy$ or $\frac{1}{2}x\sqrt{x^2-\frac{x^2}{4}} + 3xy$	M1 A1
	$3 = \frac{\sqrt{3}x^2}{4} + 3xy \Rightarrow y = \frac{1}{x} - \frac{\sqrt{3}x}{12}$ o.e.	A1
	$\{P=\}\ 3x + 6y$	B1
	$P = 3x + 6\left(\frac{1}{x} - \frac{\sqrt{3}x}{12}\right)$	M1
	So $P = 3x + \frac{6}{x} - \frac{\sqrt{3}}{2}x$	A1 *
(b)		**(6)**
	$\left(\frac{dP}{dx}=\right) 3 - \frac{6}{x^2} - \frac{\sqrt{3}}{2}$	M1 A1
	Puts their $P' = 0$ and attempts to solve for x^2 or x	M1
	$\Rightarrow x = \sqrt{\frac{12}{6-\sqrt{3}}} = \sqrt{\frac{24+4\sqrt{3}}{11}}$ or 1.68	A1
	$\Rightarrow P = 7.16...$ (m)	A1
		(5)
(c)	$\frac{d^2P}{dx^2} = \frac{12}{x^3} > 0 \Rightarrow$ Minimum	M1 A1 **(2)**
		(13 marks)

Notes

(a)

M1: Attempt to sum triangle and rectangle areas. These must be dimensionally correct – so involve product of two lengths

A1: Correct expression so $\frac{1}{2}x^2\sin 60^\circ + 3xy$ or $\frac{1}{2}x\sqrt{x^2-\frac{x^2}{4}} + 3xy$ (allow $\frac{1}{4}x^2\sqrt{3} + 3xy$ without explanation)

A1: Uses equation to find correct expression for *y* including root3

B1: Correct expression for the perimeter in terms of *x* and *y* (see scheme)

M1: Substitutes their *y* involving two terms in *x* into their complete expression for *P*

A1*: Correct proof

(b)

M1: $\frac{6}{x} \to \frac{\pm\lambda}{x^2}$ **A1**: Correct differentiation (need not be simplified) $3 - \frac{6}{x^2} - \frac{\sqrt{3}}{2}$ (ignore LHS)

M1: Puts their $P' = 0$ and attempts to solve for x^2 or x

A1: This is for x = awrt 1.68 if exact answer not seen (may be implied) NB $x = \frac{24+4\sqrt{3}}{11}$ gets A0

A1: Accept awrt 7.16

(c)

M1: Finds P'' (reduces powers in their P' by 1 each time) **and** considers sign.

A1: $\frac{12}{x^3}$ (need not be simplified) and > 0 and conclusion. Needs to have had correct value for *x*. Substitution need not be seen but if it is, it should be correct (i.e. approx. 2.5)

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