Mark Scheme (Results)

Summer 2026

Pearson Edexcel International Advanced Level
In Pure Mathematics P2
WMA12/01A

Edexcel and BTEC Qualifications

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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.

General Instructions for 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 $\sqrt{}$ will be used for correct ft
   - 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
   - $\llcorner$ or d… – The second mark is dependent on gaining the first mark

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:
   a) If all but one attempt is crossed out, mark the attempt which is NOT crossed out.
   b) 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.

General Principles for Pure Mathematics Marking

(NB 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 = …

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

2. Formula

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

3. Completing the square

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

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 small 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

Question	Scheme	Marks
1(a)	$f(\pm 2) = a \times (\pm 2)^3 + 7(\pm 2)^2 \pm 46 \times 2 + 24$	M1
	[Remainder is] $8a - 40$	A1
		(2)
(b)	$8a - 40 = 0 \Rightarrow a = 5$ *	B1*
		(1)
(c)	$5x^3 + 7x^2 - 46x + 24 = (x-2)(5x^2 + 17x - 12)$	M1 A1
	$5x^2 + 17x - 12 = (5x-3)(x+4)$	dM1
	$[f(x)] = (x-2)(5x-3)(x+4)$	A1
		(4)
		(7 marks)

Notes:

(a)

M1: Attempts $f(\pm 2)$

OR Polynomial Division

$$\begin{array}{r l}
 & ax^2 + (7+2a)x + 4a - 32 \\
x-2 \big) & ax^3 + 7x^2 - 46x + 24 \\
 & \underline{ax^3 - 2ax^2} \\
 & (7+2a)x^2 - 46x + 24 \\
 & \underline{(7+2a)x^2 - 2(7+2a)x} \\
 & (4a-32)x + 24 \\
 & \underline{(4a-32)x - 2(4a-32)} \\
 & 8a - 40
\end{array}$$

M1 for a complete method to obtain a quotient of $ax^2 + f(a)x + g(a)$ where f(a) and g(a) are linear in a and then obtains a linear expression in a for the remainder.

OR Tabular method

	ax^2	$(7+2a)x$	$4a - 32$
x	ax^3	$(7+2a)x^2$	$(4a-32)x$
-2	$-2ax^2$	$-2(7+2a)x$	$64 - 8a$

So remainder is $24 - (64 - 8a)$

M1: A complete method as above and reaches a linear expression in a in the bottom right hand box and subtracts it from 24

A1: Correct expression in a [Accept $f(2) = 8a - 40$]

Following polynomial division the remainder must be extracted or identified as the remainder.
If their remainder has **not** been clearly identified or extracted, but then used in part (b) then award A1 here.

(b)
B1*: Sets $8a-40=0$ and correctly shows a = 5. Allow a restart, but the work must be correct for this mark, there is no ft.
(c)
M1: Attempts to factor out, or divide through, by the $(x-2)$.

Look for $(x-2)(5x^2+\alpha x+\beta)$ OR $(5x^2+\alpha x+\beta)$ as the quotient from long division where $\alpha,\beta\neq 0$

A1: Correct quadratic factor found.
dM1: Factorises their quadratic factor (usual rules).

A1: Fully factorised cubic all together on one line. Accept $[\mathrm{f}(x)]=5(x-2)\left(x-\frac{3}{5}\right)(x+4)$ but not forms with common factors in the linear terms.

Note: Question specifies all stages of working must be shown, so answers without first finding the quadratic factor score no marks. Accept alternative forms of long division.

Question	Scheme	Marks
2(a)	$\int kx^{-3}+4x^{\frac{3}{2}}\,\mathrm{d}x = k\dfrac{x^{-2}}{-2}+4\dfrac{x^{\frac{5}{2}}}{5/2}\ \ (+c)$	M1 A1
	$\int_1^4 kx^{-3}+4x^{\frac{3}{2}}\,\mathrm{d}x = \left[-\dfrac{k}{2x^2}+\dfrac{8x^{\frac{5}{2}}}{5}\right]_1^4 = \left(-\dfrac{k}{2\times16}+\dfrac{8(4)^{\frac{5}{2}}}{5}\right)-\left(-\dfrac{k}{2}+\dfrac{8}{5}\right)$	M1
	$=\dfrac{15k}{32}+\dfrac{248}{5}$	A1
		(4)
(b)	$\dfrac{15k}{32}+\dfrac{248}{5}=50 \Rightarrow k=\ldots$	M1
	$k=\dfrac{64}{75}$ o.e.	A1
		(2)
		(6 marks)

Notes:

(a)

M1: Raises the power by 1 in **both** terms. Need not be simplified

Accept for example, $\alpha x^{-3+1}+\beta x^{\frac{3}{2}+1}$ for this mark.

A1: Correct integral with or without $+c$. Need not be simplified although indices must be simplified for this mark. Look for $k\dfrac{x^{-2}}{-2}+4\dfrac{x^{\frac{5}{2}}}{5/2}$ as a minimum.

M1: Substitutes and subtracts either way around into an expression with changed indices.

A1: Correct simplified answer. Accept e.g., $\dfrac{75k+7936}{160}$

condone e.g., $0.46875k+49.6$ with no rounded decimals.

(b)

M1: Sets the result of their changed expression from (a) [provided it is a linear expression of least **2 terms** in terms of k] equal to 50, and solves to find k

A1: Correct answer from a correct equation. Accept equivalent fractions and also accept $0.85\dot{3}$

Question	Scheme	Marks
3(a)	$u_2=\frac{3}{2}(5)-\frac{1}{2}(5)^2+4=...(=-1)$	M1
	$u_3=\frac{3}{2}("-1")-\frac{1}{2}("-1")^2+4=(2),\ u_4=\frac{3}{2}("2")-\frac{1}{2}("2")^2+4=(5)\ [=u_1]$	M1
	e.g., $(u_4=u_1)$ (so sequence is periodic) with period 3.	A1
		(3)
(b)	$u_{200}=-1$	B1
		(1)
(c)	$\sum_{r=1}^{200}u_r=(u_1+u_2+u_3)+...+(u_{196}+u_{197}+u_{198})+[+u_{199}+u_{200}]$	M1
	$=66\times(5-1+2)+5-1$ OR $=67\times(5-1+2)-2$	M1
	$=400$	A1
		(3)
		(7 marks)

Notes:

(a)

M1: Substitutes 5 into the equation to find u_2

M1: Continue by using their u_2 to find the next term(s) until a repeat is found.

A1: All terms correct, (concludes periodic) **and** states period is 3

Accept either $u_1=u_4$ or $(u_1=5$ and$)$ $u_4=5$ seen in the working with a conclusion

(b)

B1: Correct value coming from a correct sequence.

(c)

M1: Attempts to group the sum into multiples of the **three** term sum. Look for any attempt at using a multiple of the sum of their terms from part (a) e.g $\alpha(5-1+2)$ where α is an integer.

M1: Splitting the sum correctly to get 66 sets of 3 and the extra terms, or 67 sets of 3 minus one term

A1: For 400

Question	Scheme	Marks
4(a)	$\frac{\mathrm{d}y}{\mathrm{d}x} = ax^2 + b + \frac{c}{x^2}$	M1
	$\frac{\mathrm{d}y}{\mathrm{d}x} = 6x^2 + 7 - \frac{3}{x^2}$	A1
	$6x^2 + 7 - \frac{3}{x^2} = 0 \Rightarrow 6x^4 + 7x^2 - 3 = 0 \Rightarrow (3x^2 - 1)(2x^2 + 3) = 0 \Rightarrow x^2 = \ldots$	M1
	$\left[x^2 = -\frac{3}{2} \text{ impossible}\right] x^2 = \frac{1}{3} \Rightarrow (x =) \pm \frac{1}{\sqrt{3}}$	A1
		(4)
(b)	$6x^2 + 7 - \frac{3}{x^2} \geqslant 0 \Rightarrow 6x^4 + 7x^2 - 3 \geqslant 0 \; (\text{as } x^2 \geqslant 0)$	
	So need $"3x^2 - 1" \geqslant 0 \Rightarrow x \leqslant "-\frac{1}{\sqrt{3}}", x \geqslant "\frac{1}{\sqrt{3}}"$	M1
	$x \leqslant -\frac{1}{\sqrt{3}}, x \geqslant \frac{1}{\sqrt{3}}$ or $x < -\frac{1}{\sqrt{3}}, x > \frac{1}{\sqrt{3}}$	A1
		(2)
		(6 marks)

Notes:

(a)

M1: Differentiates with power decreased by 1 in at least two of the three terms

A1: Correct derivative. Coefficients need not be simplified, but indices must be simplified.

M1: Sets equal to 0, multiplies through and attempts to solve the **quadratic** in x^2 vis a non-calculator method reaching at least **one value for** x^2. **They must show us their method for solving the 3TQ in x^2 explicitly.** (Allow any letter to substitute for x^2)

A1: Correct values only with no other values given.

(b)

M1: Selects the outside region for **their** values.

A1: Correct range, accept with loose or strict inequalities.

Accept any valid notation.

For example:

$\left\{x : x \leqslant -\frac{1}{\sqrt{3}}\right\} \cup \left\{x : x \geqslant \frac{1}{\sqrt{3}}\right\}$ or $\left\{x : x < -\frac{1}{\sqrt{3}}\right\} \cup \left\{x : x > \frac{1}{\sqrt{3}}\right\}$

$x \leqslant -\frac{1}{\sqrt{3}}$ OR $x \geqslant \frac{1}{\sqrt{3}}$ Do not accept $x \leqslant -\frac{1}{\sqrt{3}}$ AND $x \geqslant \frac{1}{\sqrt{3}}$ for the **A** mark

Question	Scheme	Marks
5(a)	$\frac{1}{2}\times\underline{0.25}\underline{\underline{\left(5.389+6.469+2\left(6.231+6.815+7.028+6.901+6.732\right)\right)}}$	<u>B1</u> <u>M1</u>
	$\left(=\frac{1}{8}\times\left(11.858+2\left(33.707\right)\right)=\frac{1}{8}\times 79.272\right)$	
	$=$ awrt 9.91	A1
		(3)
(b)	$\int\sqrt{x}\left(3+\frac{1}{x^2}\right)\mathrm{d}x=\int\left(3x^{\frac{1}{2}}+x^{-\frac{3}{2}}\right)\mathrm{d}x=\ldots x^{\frac{3}{2}}\pm\ldots x^{-\frac{1}{2}}$	M1
	$=2x^{\frac{3}{2}}-2x^{-\frac{1}{2}}\ (+c)$	A1A1
		(3)
(c)	$\int_3^{4.5}\sqrt{x}\left(3+\frac{1}{x^2}\right)\mathrm{d}x=\left(2(4.5)^{\frac{3}{2}}-2(4.5)^{-\frac{1}{2}}\right)-\left(2(3)^{\frac{3}{2}}-2(3)^{-\frac{1}{2}}\right)=\ldots(8.911\ldots)$ $\Rightarrow$ Area $R=$ "9.909" $-$ "8.911" $=\ldots$	M1
	$=$ awrt 1.0	A1
		(2)
		(8 marks)

Notes:

(a)

B1: For using $h = 0.25$ or equivalent for the width in an attempt at the trapezium rule. Must be used as part of the attempt, not just stated separately.

M1: Correct bracket structure for the trapezium rule.

$$\ldots\ldots\ldots\ldots\underline{\underline{\left(5.389+6.469+2\left(6.231+6.815+7.028+6.901+6.732\right)\right)}}$$

Look for first + last y values + 2(attempt at sum of remaining values). If one value is missing, allow the M as a slip, but M0 if 1st or last value repeated. Must be y values used.

A1: awrt 9.91

(b)

M1: Expands the brackets and attempts to integrate, look for power increasing by 1 at least once in either a term with power $\frac{1}{2}$ or $-\frac{3}{2}$

A1: One of the two terms correct. Need not be simplified for this mark.

A1: Both terms correct (no need for c). Must be simplified coefficients. Accept equivalents, e.g. $2\left(\sqrt{x^3}-\frac{1}{\sqrt{x}}\right)$ or $2\left(\frac{x^2-1}{\sqrt{x}}\right)$

(c)

M1: Applies limits 3 and 4.5 to their answer to (b) and attempts to subtract the result from the answer to (a).

.**A1:**, awrt 1.0 isw Note: Allow an answer of $9.91 - 8.91 = 1$ following correct work.

Question	Scheme	Marks
6(i)	E.g $7^{x+3}=5\Rightarrow(x+3)\log 7=\log 5\Rightarrow x=\dfrac{\log 5}{\log 7}-3$ or $x+3=\log_7 5\Rightarrow x=...$ Alt: $7^{x+3}=5\Rightarrow 7^x=\dfrac{5}{7^3}\Rightarrow x=\log_7\dfrac{5}{343}$	M1
	$=-2.17$	A1
		(2)
(ii)(a)	$\log_8 64y^3=\log_8 64+\log_8 y^3$ or $\log_8 y^3=3\log_8 y$ or $\log_8 64=2$ Or $\log_8\left(64y^3\right)\Rightarrow\log_8\left(4y\right)^3\Rightarrow 3\log_8\left(4y\right)$ or $\log_8 4=\dfrac{2}{3}$	M1
	$18\left(\log_8 y\right)^2+5\log_8\left(64y^3\right)=73\Rightarrow 18\left(\log_8 y\right)^2+5\log_8 64+5\log_8 y^3=73$ $\Rightarrow 18\left(\log_8 y\right)^2+5\times 2+15\log_8 y=73$	dM1
	$\Rightarrow 18\left(\log_8 y\right)^2+15\log_8 y-63=0\Rightarrow 6\left(\log_8 y\right)^2+5\log_8 y-21=0$ *	A1*
		(3)
(b)	$\left(2\log_8 y-3\right)\left(3\log_8 y+7\right)=0\Rightarrow\log_8 y=\dfrac{3}{2},-\dfrac{7}{3}\Rightarrow y=8^k$	M1
	e.g $y=8^{\frac{3}{2}}$ or $8^{-\frac{7}{3}}$ oe	A1
	e.g $16\sqrt{2}$ or $\sqrt{512}$ and $\dfrac{1}{128}$ oe	A1
		(3)
		(8 marks)

Notes:

(i)
M1: Correct method for solving to find x, e.g. takes logs and rearranges, as shown in scheme. May divide through by 7^3 first or take log to base 7. There must be evidence of correct use of logs.
A1: Correct answer, accept awrt -2.17

(ii)(a)
M1: Attempt the sum or power law of logs on the $\log_8 64y^3$ or applies $\log_8 64=2$ in the proof or

Note this cannot be scored for an attempt at $\left(\log_8 y\right)^2=2\log_8 y$

dM1: Correct use of both the sum and the power law of logs seen or implied on the $\log_8 64y^3$ term and simplifies the $\log_8 64$ to achieve a quadratic in any form.

A1*: Correctly rearranges to the printed equation **with no errors seen** and use of the log laws clear.

(b)
M1: Solves the **given** quadratic and uses a correct method to obtain at least one solution for y from an equation of form $\log_8 y=k$. i.e., $\log_8 y=k\Rightarrow y=8^k$. Accept a calculator method to solve the 3TQ.
A1: At least one correct **exact** answer in either exponential or numerical form.
A1: Both correct, accepting any equivalent **exact** forms. ie., exponential or numerical

Question	Scheme	Marks
7(a)	(3,6)	B1
		(1)
(b)	Gradient $=\frac{6-0}{3-0}(=2)$	M1
	Hence equation of l is $y=2x$	A1
		(2)
(c)	Distance from O to centre is $\sqrt{3^2+6^2}=...\left(=3\sqrt{5}\right)$	M1
	$\Rightarrow r=3\sqrt{5}\pm\sqrt{5}$	M1
	For radius either $2\sqrt{5}$ or $4\sqrt{5}$ or one correct value for k	A1
	For both 20 and 80	A1
		(4)
		(7 marks)

Notes:

(a)
B1: Correct centre. Allow $x = 3$, $y = 6$
(b)
M1: Attempts the gradient from O to the centre. May be implied by $\pm\frac{6}{3}$ ft their centre.

OR from the equation $y=2x$ seen.
A1: Correct equation from correct centre.

(c)
M1: Attempts the distance from the origin to the centre of the circle.
M1: Finds the radius as the sum or difference of their distance and $\sqrt{5}$
A1: For one of the two possible radii correct or one of the two possible values for k correct.
A1: Both values correct.

Question	Scheme	Marks
Alt 1(c)	A lies on the line $y=2x\Rightarrow x^2+(2x)^2=\left(\sqrt{5}\right)^2\Rightarrow x=...$	M1
	$\Rightarrow k=("\pm1"-3)^2+("\pm2"-6)^2=...$	M1
	One of 20 or 80 ; both 20 and 80	A1;A1
		(4)

M1: Uses the equation to obtain a general point on the line and applies distance $OA=\sqrt{5}$ to find at least one x coordinate.
M1: Uses their coordinates of A to find at least one value for k using the circle equation.
A1: One of the two possible values for k correct.
A1: Both values correct.

Alt 2 (c)	Deduces that as A lies on $y = 2x$ then **EITHER** $\sqrt{5} = \sqrt{1^2 + 2^2}$ **OR** $\sqrt{5} = \sqrt{(-1)^2 + (-2)^2}$	**M1**
	$\Rightarrow k = (\text{"}\pm 1\text{"} - 3)^2 + (\text{"}\pm 2\text{"} - 6)^2 = \ldots$	**M1**
	One of 20 or 80 ; both 20 and 80	**A1;A1**
		(4)

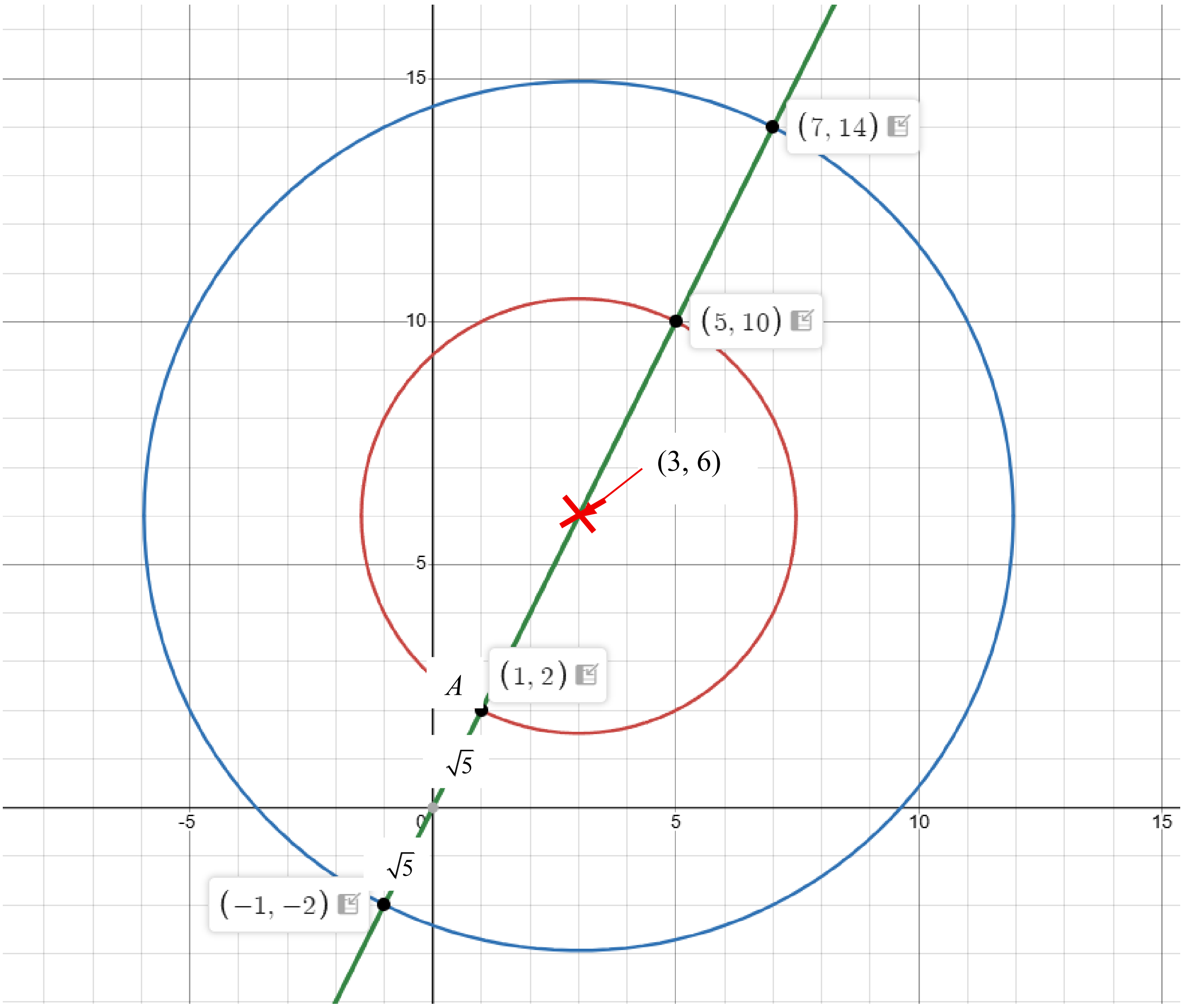
M1: Deduces that the coordinates of A must be either (1, 2) or $(-1, -2)$

M1: Uses their coordinates of A to find at least one value for k using the circle equation.

A1: One of the two possible values for k correct.

A1: Both values correct.

USEFUL SKETCH



Question	Scheme	Marks
8(a)	$(k+4x)^{12} = k^{12} + \dots$	B1
	$+\underline{\binom{12}{1}}k^{11}(4x)^1 + \underline{\binom{12}{2}}k^{10}(4x)^2 + \underline{\binom{12}{3}}k^9(4x)^3 + \dots$	M1
	$(k+4x)^{12} = k^{12} + 48k^{11}x + 1056k^{10}x^2 + 14080k^9x^3 + \dots$	A1A1
		(4)
(b)	$14080k^9 = \dfrac{55}{2} \Rightarrow k^9 = \dfrac{1}{512} \Rightarrow k = \dots$	M1
	$k = \dfrac{1}{2}$	A1
		(2)
(c)	$"48\left(\dfrac{1}{2}\right)^{11}"$ or $"1056\left(\dfrac{1}{2}\right)^{10} \times 2"$	M1
	$48\left(\dfrac{1}{2}\right)^{11} + 1056\left(\dfrac{1}{2}\right)^{10} \times 2 = \dots = \dfrac{267}{128}$	dM1A1
		(3)
		(9 marks)

Notes:

(a)

B1: For the correct constant term of k^{12} in their expression. They may have initially factored out the k, but must achieve the correct constant in the final expression for this mark.

M1: Correct binomial coefficients linked with **correct** powers of x in their expansion. Accept alternative notation, such as ${}^{12}C_1$ or just 12, 66, 220, for the coefficients. (The power 1 need not be seen.) The powers of 4 and k may be missing or incorrect.

ALT for the M mark

$$k^{12}\left(1+\frac{4x}{k}\right)^{12} = \left[k^{12}\right]\left(1+\underline{12}\times\left(\frac{4\underline{x}}{k}\right)+\left[\frac{12\times 11}{\underline{2!}}\right]\times\left(\frac{4\underline{x}}{k}\right)^{\underline{2}}+\left[\frac{12\times 11\times 10}{\underline{3!}}\right]\times\left(\frac{4\underline{x}}{k}\right)^{\underline{3}}+\right)$$

With **correct** coefficients (with the correct denominators [2 and 6 oe]) and with the **correct** power of x

A1: Any two of the final three terms correct and simplified

A1: All three of the final terms correct and simplified.

Note: Students may attempt to take out a common factor of k^{12} first. In such cases the **B** mark is for correct constant term in their final expansion, **M** follows as above, correct coefficients linked to correct powers of x. The first **A** can be awarded as above or SC $k^{12}\left(1+\dfrac{48}{k}x+\dfrac{1056}{k^2}x^2+\dfrac{14080}{k^3}x^3\right)$ (oe), final **A** as scheme

(b)

M1: Sets their x^3 coefficient equal to $\frac{55}{2}$ and proceeds to a value for *k*. They must have had a *k* in their coefficient.

A1: Correct answer.

(c)

M1: Correct attempt for at least one of the two terms in y^3 in the expansion

- Using their coefficients from (a) (which may not have involved *k*).
- Realises the *y*'s are squared.
- May be part of an attempt at a full expansion. Allow with *k* or their value of *k*.

dM1: Correct attempt at finding both terms and adding, must have both involved *k* (which may be left as *k*), but otherwise follow through their attempt at (a). May be part of an attempt at a full expansion.

A1: Correct answer, accept $\frac{267}{128}y^3$, but must have been extracted from a full expansion and identified as the answer.

Question	Scheme	Marks
9(a)	At 12 noon $t=(12-8)=4$ so $\theta=17+5\sin\left(\frac{4\pi}{12}\right)$	M1
	$\theta=17+5\sin\left(\frac{4\pi}{12}\right)=(17+4.33...)\approx 21.3(°\text{C})$	A1
		(2)
	Alt: Working backwards from the given answer	
	$21.3=17+5\sin\left(\frac{\pi t}{12}\right)\Rightarrow \sin\left(\frac{\pi t}{12}\right)=\frac{43}{50}\Rightarrow t=\frac{12}{\pi}\arcsin\left(\frac{43}{50}\right)=...$	M1
	$t\approx 4$ with a conclusion; 8am + 4 = 12 noon	A1
		(2)
(b)	$17+5\sin\left(\frac{\pi T}{12}\right)=16+6\sin\left(\frac{\pi T}{12}\right)+3\cos^2\left(\frac{\pi T}{12}\right)$	M1
	Use of: $\cos^2\left(\frac{\pi T}{12}\right)=1-\sin^2\left(\frac{\pi T}{12}\right)$	B1
	$3\sin^2\left(\frac{\pi T}{12}\right)-\sin\left(\frac{\pi T}{12}\right)-2=0\ *$	A1*
		(3)
(c)	$\Rightarrow\left(3\sin\left(\frac{\pi T}{12}\right)+2\right)\left(\sin\left(\frac{\pi T}{12}\right)-1\right)=0\Rightarrow \sin\left(\frac{\pi T}{12}\right)=-\frac{2}{3},1$	B1
	$\Rightarrow T=\frac{12}{\pi}\left[(\pi-)\arcsin\left(-\frac{2}{3}\right)\right]$ or $\frac{12}{\pi}\left[\arcsin\left(-\frac{2}{3}\right)+2\pi\right]$ or $T=\frac{12}{\pi}\arcsin(1)$	M1
	$T=6,\text{awrt}\,14.8,\text{awrt}\ 21.2$	A1A1 A1
		(5)
		(10 marks)

Notes:

(a)
M1: Substitutes $t=4$ into the equation.
A1: Correct expression **seen** leading to awrt 21.3
Note: This is a show question and using $t=8$ leading to a value of $\theta=21.3$ is M0A0
Alt
M1: Substitutes 21.3 into the equation and works backwards to find a value for T
Allow working in degrees for the M mark
A1: Correct value for T with a conclusion that 8 am + 4 hrs = 12 noon.

(b)
M1: Sets the two equations equal.
B1 [M1 in Epen]: For use of **correct** Pythagorean identity to form an expression in just sine. This mark is specifically for the **correct** use of $\cos^2\left(\frac{\pi T}{12}\right)=1-\sin^2\left(\frac{\pi T}{12}\right)$

A1*: Correct simplified quadratic with no errors seen. Allow with t or T.
(c)
B1: Correct roots of quadratic seen – **both required**. Allow these value from a substitution for $\sin\left(\frac{\pi T}{12}\right)$, for example $x=-\frac{2}{3},\ 1$ seen, but do **not** isw if one of these values is 'rejected'.
M1: Uses arcsin with any of their solutions and rearranges to find a value for T (or t). Can be scored from any equation $\sin\left(\frac{\pi T}{12}\right)=k$ where $|k| \leqslant 1$, Allow for any appropriate solution (including negatives). E.g. if $\sin\left(\frac{\pi T}{12}\right)=-\frac{2}{3}$ or $\sin\left(\frac{\pi T}{12}\right)=1$ has been found then any of −2.787, 14.787, 21.213 or 6 can imply this mark (if method not explicitly shown).

Note: If they work in degrees they must convert $\frac{\pi}{12}=15^\circ$ otherwise it is M0

A1: At least one correct positive value for T or t (awrt 3 s.f. where appropriate). See scheme for answers
A1: Two correct values
A1: All three values correct to 3.s.f. as appropriate.
Ignore any extra values outside of the range – withhold this mark for extra values within range.

Question	Scheme	Marks
10(i)	Two of : $f(3)=504-(119+216)=\ldots, f(4)=672-(119+384)=\ldots,$ $f(5)=840-(119+600)=\ldots, f(6)=1008-(119+864)=\ldots$	M1
	All of the above, with at least two correct values.	M1
	So $f(1)=25=5^2=f(6), f(2)=121=11^2=f(5), f(3)=169=13^2=f(4)$ hence all are perfect squares.	A1
	(see table below)	
		(3)
(ii)	$${}^nC_r+{}^nC_{r+1}=\frac{n!}{r!(n-r)!}+\frac{n!}{(r+1)!(n-(r+1))!}$$ $$\left[(n-r)!=(n-r)(n-r-1)!\Rightarrow(n-(r+1))!=\frac{(n-r)!}{(n-r)}\right]$$	M1
	$$=\frac{n!(r+1)}{(r+1)!(n-r)!}+\frac{n!(n-r)}{(r+1)!(n-r)!}$$ **OR** $$\frac{n!(n-r-1)!(r+1)!+n!r!(n-r)!}{r!(n-r)!(r+1)!(n-r-1)!}$$	dM1
	$$=\frac{n!(r+1+n-r)}{(r+1)!(n-r)!}$$ **OR** $$\frac{n!\left[(n-r-1)!(r+1)!+r!(n-r)!\right]}{r!(n-r)!(r+1)!(n-r-1)!}$$	ddM1
	$$=\frac{n!(n+1)}{(r+1)!(n-r)!}=\frac{(n+1)!}{(r+1)!\left((n+1)-(r+1)\right)!}={}^{n+1}C_{r+1}\,*$$	A1*
		(4)
		(7 marks)

Value of n	Value of f(n)
1	$25=5^2$
2	$121=11^2$
3	$169=13^2$
4	$169=13^2$
5	$121=11^2$
6	$25=5^2$

Notes:

(i)

M1: Attempts f(n) for at least two values between 3 and 6 inclusive (need not be correct values), but if the values are incorrect, working must be seen with values obtained.

M1: Attempts all 4 remaining values, with at least two correct values. **A1:** All remaining values for f(n) for n = 3 to 6 attempted with correct values found, shown to be squares and minimal conclusion. Note: If all valid values are correct, but f (0) and/or f (7) are also included, do not award the A mark in (i) **(ii)** **M1:** Attempts the sum of the binomial coefficients using the formula. Allow a slip in $(n-r+1)!$ instead of $(n-r-1)!$ **dM1:** Puts the terms over a common denominator which need not be simplified in either one of the two forms shown. **ddM1:** Factorises the numerator which need not be simplified in either of one of the two forms shown. **A1*:** Achieves the correct form for the new coefficient from correct work and deduces equal to the required coefficient. Must achieve the correct expression with (n + 1) – (r + 1) shown.

Alt (ii)	$^{n+1}C_{r+1} - ^{n}C_{r+1} = \frac{(n+1)!}{(r+1)!(n+1-r-1)!} - \frac{n!}{(r+1)!(n-(r+1))!}$	**M1**
	$= \frac{(n+1)\times n!}{(r+1)!(n-r)\times(n-r-1)!} - \frac{n!}{(r+1)!(n-r-1)!} = \frac{n!}{(r+1)!(n-r-1)!}\times\left(\frac{n+1}{n-r}-1\right)$	**dM1**
	$= \frac{n!}{(r+1)!(n-r-1)!}\times\left(\frac{r+1}{n-r}\right)$	**ddM1**
	$= \frac{n!}{r!(n-r)!} = {}^{n}C_{r} \Rightarrow {}^{n}C_{r} + {}^{n}C_{r+1} = {}^{n+1}C_{r+1}$ *	**A1***
		(4)
Notes:		
Alt (ii) **M1:** Attempts the shown difference of binomial coefficients using the formula. Allow if slips are made in the signs, e.g. $(n-r+1)!$ instead of $(n-r-1)!$ **dM1:** Splits the factorials and takes out the common factor. Alt per main scheme is putting over a common denominator but with the difference instead of sum. The denominator need not be simplified. **ddM1:** Simplifies the factored term to a single fraction (oe if putting over common denominator). **A1*:** Deduces equal to the required coefficient and concludes the requisite result.		