Mark Scheme (Results)

Summer 2025

Pearson Edexcel GCE
In A Level Further Mathematics (9FM0)
Paper 01 Core Mathematics

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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.

EDEXCEL GCE MATHEMATICS
General Instructions for Marking

1. The total number of marks for the paper is 100.

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.

- 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)
- dep – dependent
- indep – independent
- dp decimal places
- sf significant figures
- ∗ The answer is printed on the paper
- ⎾ The second mark is dependent on gaining the first mark

4. 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.

5. Where a candidate has made multiple responses <u>and indicates which response they wish to submit</u>, examiners should mark this response.

If there are several attempts at a question which have not been crossed out, examiners should mark the final answer which is the answer that is the most complete.

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

7. Mark schemes will firstly show the solution judged to be the most common response expected from candidates. Where appropriate, alternatives answers are provided in the notes. If examiners are not sure if an answer is acceptable, they will check the mark scheme to see if an alternative answer is given for the method used.

Question	Scheme	Marks	AOs
1(a)	$\det(\mathbf{M}) = 3(3a-a)-6(a^2-2)=0$	M1	1.2
	$6a^2-6a-12=0 \Rightarrow a=\ldots$	dM1	1.1b
	$a=-1, 2$	A1	1.1b
		(3)	
(b)	Sets determinant = –108, solves a 3TQ to find a negative value of *a* $-6a^2+6a+12=-108 \Rightarrow a=\ldots$ or $6a^2-6a-12=108 \Rightarrow a=\ldots$	M1	3.1a
	$a=-4$	A1	2.2a
	$\begin{pmatrix} \frac{2}{27} & -\frac{2}{9} & -\frac{1}{18} \\ \frac{7}{54} & \frac{1}{9} & \frac{1}{36} \\ -\frac{5}{54} & -\frac{2}{9} & -\frac{11}{36} \end{pmatrix}$	A1	1.1b
		(3)	
			(6 marks)

Notes:

(a)

M1: Finds the determinant of the matrix **M** and sets = 0

Allow for sight of $\pm 3(3a-a)\pm 6(a^2-2)\pm 0(a^2-6)=0$ and do not allow sign slips in their minors.

Need not be simplified

dM1: Solves their 3TQ. Usual rules apply for solving a quadratic by any means including using a calculator.

A1: Both correct values for *a*.

Note: Correct answers without a method can be awarded M1dM1A1

Alternatively, the determinant can be found using the vector product, for example:

$\Delta = 0$

$\Delta = a \cdot b \times c$

$$0 = \begin{pmatrix} 3 \\ a \\ 2 \end{pmatrix} \cdot \begin{pmatrix} 6 \\ 3 \\ a \end{pmatrix} \times \begin{pmatrix} 0 \\ 1 \\ a \end{pmatrix}$$

$$0 = \begin{pmatrix} 3 \\ a \\ 2 \end{pmatrix} \cdot \begin{pmatrix} 3a-a \\ -6a \\ 6 \end{pmatrix}$$

$$0 = \begin{pmatrix} 3 \\ a \\ 2 \end{pmatrix} \cdot \begin{pmatrix} 2a \\ -6a \\ 6 \end{pmatrix}$$

$$0 = 6a - 6a^2 + 12$$

If you are uncertain, please send to review

(b)

M1: A complete method to find a value for *a*. Sets **their** determinant equal to –108, solves a 3TQ and proceeds to find at least one negative value of *a*.

They must use their determinant equal to –108 and not for example a changed quadratic from (a) equal to –108. Usual rules apply for solving a quadratic by any means including using a calculator.

A1: Deduces $a=-4$ **only**, which could be implied by a correct matrix.

A1: Correct matrix. Accept exact equivalents but not answers rounded to decimal places. Isw once a correct matrix is seen.

e.g. Accept $\frac{1}{108}\begin{pmatrix} 8 & -24 & -6 \\ 14 & 12 & 3 \\ -10 & -24 & -33 \end{pmatrix}$ or $-\frac{1}{108}\begin{pmatrix} -8 & 24 & 6 \\ -14 & -12 & -3 \\ 10 & 24 & 33 \end{pmatrix}$

Question	Scheme	Marks	AOs
2	Uses the identity $\sinh 2x = 2\sinh x\cosh x$ to find a value for sinh$x$ or cosh$x$ $2\sinh x\cosh x = 3\sinh x \Rightarrow 2\sinh x\cosh x - 3\sinh x = 0$ $\sinh x(2\cosh x - 3) = 0 \Rightarrow \sinh x = ...$ or $\cosh x = ...$	M1	3.1a
	$\sinh x = 0 \Rightarrow x = 0$	B1	1.1b
	$\cosh x = "\frac{3}{2}" \Rightarrow x = \ln\left["\frac{3}{2}" + \sqrt{\left("\frac{3}{2}"\right)^2 - 1}\right]$ **Alternatively** $\cosh x = \frac{3}{2} \Rightarrow \frac{1}{2}(e^x + e^{-x}) \Rightarrow e^{2x} - 3e^x + 1 = 0$ $\Rightarrow e^x = \frac{3+\sqrt{5}}{2}$ or $\frac{3-\sqrt{5}}{2} \Rightarrow x = \ln ...$	dM1	1.1b
	$x = \ln\left[\frac{3}{2} + \sqrt{\left(\frac{3}{2}\right)^2 - 1}\right]$	A1	1.1b
	$x = \pm\ln\left(\frac{3+\sqrt{5}}{2}\right)$ or $x = \ln\left(\frac{3\pm\sqrt{5}}{2}\right)$	A1	2.2a
		(5)	
	<u>Alternative method use of exponentials</u> Uses the identities $\sinh x = \frac{e^x - e^{-x}}{2}$ and $\sinh 2x = \frac{e^{2x} - e^{-2x}}{2}$ $\frac{e^{2x} - e^{-2x}}{2} = 3\left(\frac{e^x - e^{-x}}{2}\right)$ leading to a quartic equation for e^x (Note correct equation is $e^{4x} - 3e^{3x} + 3e^x - 1 = 0$)	M1	3.1a
	$e^x = 1 \Rightarrow x = 0$	B1	1.1b
	Solves quartic to find a value for e^x leading to $x = \ln ...$	dM1	1.1b
	$x = \ln\left[\frac{3}{2} + \sqrt{\left(\frac{3}{2}\right)^2 - 1}\right]$	A1	1.1b
	$x = \pm\ln\left(\frac{3+\sqrt{5}}{2}\right)$ or $x = \ln\left(\frac{3\pm\sqrt{5}}{2}\right)$	A1	2.2a
		(5)	
			(5 marks)

Notes:
M1: Uses the identity $\sinh 2x = 2\sinh x\cosh x$ and proceeds to find a value for sinh$x$ or cosh$x$ **B1:** $x = 0$ **dM1:** Uses the correct formula for arcosh$x$ with their value of cosh$x$ to find a value for x as a natural logarithm or alternatively gives awrt to 3sf. e.g. 0.962, – 0.962. You may need to check their workings. **Alternatively** uses the exponential definition for cosh$x$, forms and solves a quadratic for e^x leading to find a value for x as a natural logarithm. Usual rules apply for solving a quadratic by any means including using a calculator. You may need to check their workings. If correct answers are given without workings, you may award this mark. **A1**: Deduces one correct exact value for x. Accept exact unsimplified equivalents. **A1:** Deduces both correct exact values for x. Accept exact simplified equivalents. isw Accept, for example $x = \pm\ln\left(\frac{3}{2}+\frac{\sqrt{5}}{2}\right)$ and $x = \pm\ln\left(\frac{3}{2}+\sqrt{\frac{5}{4}}\right)$ Also accept equivalent answers which you may need to check; their may be several alternatives. e.g. Accept $x = \ln\left(\frac{2}{3+\sqrt{5}}\right)$ for $x = \ln\left(\frac{3-\sqrt{5}}{2}\right)$
Alternative method use of exponentials **M1:** Uses correct identities such as $\sinh x = \frac{e^x - e^{-x}}{2}$ and $\sinh 2x = \frac{e^{2x} - e^{-2x}}{2}$ to form a quartic equation for e^x **B1:** $x = 0$ **dM1:** Solve their quartic equation to find a value for x (other than $x = 0$) via a correct method. If correct answers are given from their quartic equation without workings, you may award this mark. You may need to check their workings. **A1**: Deduces one correct exact value for x, which may be unsimplified. **A1:** Deduces both correct exact values for x isw Note: Inexact answers for the quartic equation $e^x = 2.618, 0.3819$ leading to awrt 0.962, – 0.962 scores maximum M1 B1 dM1 A0 A0

Question	Scheme	Marks	AOs
3(a)	$\frac{z}{z^*}=\frac{a+b\text{i}}{a-b\text{i}}=\frac{(a+b\text{i})(a+b\text{i})}{(a-b\text{i})(a+b\text{i})}=\frac{(a^2-b^2)+2ab\text{i}}{a^2+b^2}$	M1	2.1
	$a^2-b^2=0 \Rightarrow a^2=b^2$ *	A1*	1.1b
		(2)	
	Alternative		
	$\frac{z}{z^*}=\frac{a+b\text{i}}{a-b\text{i}}=k\text{i} \Rightarrow a+b\text{i}=k\text{i}(a-b\text{i})$ $\Rightarrow a+b\text{i}=ka\text{i}+kb$	M1	2.1
	$\Rightarrow a=kb,\ b=ka$ e.g. $a=\frac{b}{a}\times b$ or $(k=)\frac{a}{b}=\frac{b}{a}$ $\Rightarrow a^2=b^2$	A1*	1.1b
		(2)	
(b)	$zz^*=(a+b\text{i})(a-b\text{i})=a^2+b^2=50$ Solves simultaneously with $a^2=b^2$ to find a value for *a* or *b* $2a^2=50 \Rightarrow a=...$ or $2b^2=50 \Rightarrow b=...$	M1	3.1a
	$(z)=\ 5-5\text{i},\ 5+5\text{i},\ -5-5\text{i},\ -5+5\text{i}$	A1 A1	1.1b 2.2a
		(3)	
		(5 marks)	

Notes:
(a) **M1:** Finds an expression for $\frac{z}{z^*}$ by rationalising the denominator and collects real parts, eliminating i^2 terms. e.g. Accept $\frac{a^2-b^2+2ab\text{i}}{a^2+b^2}$ or $\frac{a^2-b^2}{a^2+b^2}+\frac{2ab\text{i}}{a^2+b^2}$ but $\frac{a^2+2ab\text{i}-b^2}{a^2+b^2}$ is insufficient unless they then go on to identify the real parts Allow sign slips but must be a correct use of rationalising the denominator. **A1*:** Sets real part equal to zero and then achieves the correct equation, with no errors seen. $\frac{z}{z^*}=\frac{a^2-b^2+2ab\text{i}}{a^2+b^2} \Rightarrow a^2=b^2$ is insufficient, as they have not set or identified their real part as zero. **Alternative:** **M1:** Substitutes $z=a+b\text{i}$ and $z^*=a-b\text{i}$, sets equal to an imaginary number such as *k*i but not i. Then expands brackets, eliminating i^2 terms, achieving an equation equivalent to $a+b\text{i}=ka\text{i}+kb$ **A1*:** Equates real parts **and** imaginary parts and uses their pair of equations to eliminate *k* and then achieve the correct equation, with no errors seen. **If you see a method that involves using exponentials, or modulus argument form, or working backwards, or any other method which may be worthy of credit, please send to review.**
(b) **M1:** Uses the information $zz^*=50$ to form another equation for *a* and *b*, with no imaginary terms present. Then solves simultaneously to find a value for *a* or *b* If they obtain $a^2-b^2=50$ this will be M0 **A1:** At least two correct complex numbers. Accept e.g. $\pm(5+5\text{i})$ **A1:** Deduces all 4 correct complex numbers. Accept e.g. $\pm5\pm5\text{i}$ or $\pm(5\pm5\text{i})$ **Note:** Correct answers with no workings can achieve M1A1A1

Question	Scheme	Marks	AOs
4(a)	$m^2 - 4m + 4 = 0 \Rightarrow m = ...\{2\}$	M1	1.1b
	$(y) \quad = A\mathrm{e}^{2x} + Bx\mathrm{e}^{2x}$	A1	1.1b
	PI $y = \lambda\mathrm{e}^{3x}, \dfrac{\mathrm{d}y}{\mathrm{d}x} = 3\lambda\mathrm{e}^{3x}$ and $\dfrac{\mathrm{d}^2y}{\mathrm{d}x^2} = 9\lambda\mathrm{e}^{3x}$ $9\lambda\mathrm{e}^{3x} - 4(3\lambda\mathrm{e}^{3x}) + 4(\lambda\mathrm{e}^{3x}) = 2\mathrm{e}^{3x}$ leading to $\lambda = ...$	M1	3.1a
	$(y) \quad = CF + PI$	dM1	1.1b
	$y = A\mathrm{e}^{2x} + Bx\mathrm{e}^{2x} + 2\mathrm{e}^{3x}$	A1	1.1b
		(5)	
(b)	$x = 0,\ y = 5 \Rightarrow 5 = A + 2 \Rightarrow A = ...$	M1	1.1b
	$\dfrac{\mathrm{d}y}{\mathrm{d}x} = 2A\mathrm{e}^{2x} + B\mathrm{e}^{2x} + 2Bx\mathrm{e}^{2x} + 6\mathrm{e}^{3x}$ and uses their value of A and $x = 0, \dfrac{\mathrm{d}y}{\mathrm{d}x} = 12$ to find the value of B $12 = 6 + B + 6 \Rightarrow B = ...$	dM1	3.1a
	$y = 3\mathrm{e}^{2x} + 2\mathrm{e}^{3x}$	A1	1.1b
		(3)	
			(8 marks)

Notes:
(a) **M1:** Forms the correct auxiliary equation, leading to finding a value for *m*. Allow the use of any variable instead of *m* for this mark. **A1**: Correct complementary function, oe such as $y = (A + Bx)e^{2x}$ Do not need *y* = here but **must** be in terms of *x,* but may be recovered later. **M1:** A complete method to find the particular integral. Uses the correct form $y = \lambda e^{3x}$, differentiates twice and substitutes correctly into the differential equation to find a value for $\lambda(=2)$. May use a different variable for *x* here. **dM1:** Dependent on the previous method mark. Finds the general solution by adding the particular integral (of the correct form) to their complementary function (which may not be of the correct form). Do not need *y* = here. May use a different variable for *x* but their variable must be consistent. **A1:** Correct general solution. **Must** have *y* = here and **must** be in terms of *x*
(b) **M1:** For a general solution of the form $Ae^{\alpha x} + Bxe^{\alpha x} + \text{"their PI"}$, uses the initial conditions, $x = 0,\ y = 5$ to find a value for a constant. (The correct form will be $Ae^{mx} + Bxe^{mx} + \lambda e^{3x}$) **dM1:** Dependent on the previous method mark. Differentiates the general solution to achieve an expression of the form $mAe^{mx} + Be^{mx} + mBxe^{mx} + 3\lambda e^{3x}$ using their *m* from part (a) where $m \neq 1$ Then uses the initial conditions to find a value for the other constant. **A1:** Correct particular solution. Must have *y* = here and must be in terms of *x*

Question	Scheme	Marks	AOs
5	$\frac{4}{r^2-1} \equiv \frac{4}{(r-1)(r+1)} \equiv \frac{A}{r-1}+\frac{B}{r+1} \Rightarrow A=\ldots,\ B=\ldots$ $(\text{NB } A=2,\ B=-2)$	M1	3.1a
	$r=2 \quad \Rightarrow \frac{2}{1}-\frac{2}{3}$ $r=3 \quad \Rightarrow \frac{2}{2}-\frac{2}{4}$ $r=4 \quad \Rightarrow \frac{2}{3}-\frac{2}{5}$ $r=n-1 \quad \Rightarrow \frac{2}{n-2}-\frac{2}{n}$ $r=n \quad \Rightarrow \frac{2}{n-1}-\frac{2}{n+1}$	dM1	2.1
	$2+1-\frac{2}{n}-\frac{2}{n+1}$	A1	1.1b
	$\frac{3n(n+1)-2(n+1)-2n}{n(n+1)} = \frac{3n^2+3n-2n-2-2n}{n(n+1)} = \frac{3n^2-n-2}{n(n+1)}$	M1	1.1b
	$\frac{(3n+2)(n-1)}{n(n+1)}$ cso	A1	2.2a
		(5)	
			(5 marks)

Notes:
M1: A complete strategy to write as partial fractions **dM1:** Dependent on previous method mark. Completes the method of differences process, must have a minimum substitution of $r = 2$, $r = 3$, $r = n - 1$ and $r = n$. Condone the use of r for n for this mark. If pairs of terms are not seen in each substitution for r, this mark can be implied by sight of $2+1-\frac{2}{n}-\frac{2}{n+1}$ following correct partial fractions. **A1**: Correct 'fractions' from the beginning and end that do not cancel. Accept exact equivalents. Must be in terms of n **M1:** Combines all their 'fractions' (at least two algebraic fractions) over a correct common denominator, leading to a quadratic in the numerator, where brackets may not be expanded. Condone the use of r for n for this mark. **A1**: Since the form of the solution is given, only accept $\frac{(3n+2)(n-1)}{n(n+1)}$ and not equivalents, but isw Do not accept values for p and q written alone. **Note**: If they start with $r=0$, $r=1$ or $r=3$, the maximum they can score is M1M0A0M1A0 Similarly, if they use $r=n+1$ the maximum they can score is M1M0A0M1A0

Question	Scheme	Marks	AOs
6	**<u>Method 1:</u>** using roots		
	$z_2 = 2-4\mathrm{i}$	B1	1.1b
	$12 = \frac{1}{2}(4--4)\times h \Rightarrow h = ... \Rightarrow z_3 = 2+h$ or $2-h$	M1	3.1a
	$\left(z-(2-4\mathrm{i})\right)\left(z-(2+4\mathrm{i})\right)(z-5)$ or $\left(z-(2-4\mathrm{i})\right)\left(z-(2+4\mathrm{i})\right)\left(z-(-1)\right)$	dM1	2.1
	$\left(\mathrm{f}(z)\right) \quad = z^3 - 9z^2 + 40z - 100$ $\left(\mathrm{f}(z)\right) \quad = z^3 - 3z^2 + 16z + 20$	ddM1 A1	1.1b 2.2a
		(5)	
	<u>Method 2:</u> using sum, pair sum and product of roots		
	$z_2 = 2-4\mathrm{i}$	B1	1.1b
	$12 = \frac{1}{2}(4--4)\times h \Rightarrow h = ... \Rightarrow z_3 = 2+h$ or $2-h$	M1	3.1a
	Sum = $2+4\mathrm{i}+2-4\mathrm{i}+"5" = 9 = -a$ Pair sum = $(2+4\mathrm{i})(2-4\mathrm{i})+"5"(2+4\mathrm{i})+"5"(2-4\mathrm{i}) = 40 = b$ Product = $"5"(2+4\mathrm{i})(2-4\mathrm{i}) = 100 = -c$ OR Sum = $2+4\mathrm{i}+2-4\mathrm{i}+"(-1)" = 3 = -a$ Pair sum = $(2+4\mathrm{i})(2-4\mathrm{i})+"(-1)"(2+4\mathrm{i})+"(-1)"(2-4\mathrm{i}) = 16 = b$ Product = $"(-1)"(2+4\mathrm{i})(2-4\mathrm{i}) = -20 = -c$	dM1	2.1
	$\left(\mathrm{f}(z)\right) \quad = z^3 - 9z^2 + 40z - 100$ $\left(\mathrm{f}(z)\right) \quad = z^3 - 3z^2 + 16z + 20$	ddM1 A1	1.1b 2.2a
		(5)	
			(5 marks)

Notes:

Method 1:

B1: States the other complex root. May be implied by later working.

M1: Uses the area of the triangle to determine at least one value for the real root. You can award for sight of one correct value of z_3

(Note: $h=3 \Rightarrow z_3 = 5$ or -1)

dM1: Dependent on the previous method mark. Deduces a correct expression for one of their real roots. Award for $(z-(2-4\text{i}))(z-(2+4\text{i}))(z-z_3)$ or equivalent e.g. $(z^2-4z+20)(z-z_3)$

z_3 must be real.

ddM1: Dependent on previous method marks. Multiplies out to find values for the constants *a*, *b* and *c***.** Award for the sight of at least 2 correct values of the constants *a*, *b* and *c* in any one of their attempts at the function.

A1: Deduces the correct two functions.

Method 2:

B1: States the other complex root. May be implied by later working.

M1: Uses the area of the triangle to determine at least one value for the real root, You can award for sight of one correct value of z_3 **(Note:** $h=3 \Rightarrow z_3 = 5$ or -1)

dM1: Dependent on the previous method mark. Attempts sum, pair sum and product for at least one of their real roots.

ddM1: Dependent on previous method marks. Multiplies out to find values for the constants *a*, *b* and *c*

Award for the sight of at least 2 correct values of the constants *a*, *b* and *c* in any one of their attempts at the function.

A1: Deduces the correct two functions.

Note: There are several methods that can be used to obtain the first method mark:

- Uses vertices (2, 4), (2, –4) and $(x_3, 0)$ to determine at least one value for the real root. Alternatively uses (x_3, y_3). This may come from a diagram. Do not be concerned about the variables they use.

  e.g. $12 = \frac{1}{2}\times 8 \times |x_3 - 2| \Rightarrow z_3 =$ or $x_3 =$

- Uses the formula for the area of a triangle with vertices $(x_1, y_1), (x_2, y_2), (x_3, y_3)$ to determine at least one value for the real root. Do not be concerned about the variables they use.

  $$\left[\frac{1}{2}\left|x_1(y_2-y_3)+x_2(y_3-y_1)+x_3(y_1-y_2)\right|\right]$$

  $$12 = \frac{1}{2}\left|2(-4-y_3)+2(y_3-4)+x_3(4--4)\right|$$

  $$24 = \left|-16+8x_3\right|$$

  $$\Rightarrow z_3 = \text{ or } x_3 =$$

- Uses the shoelace method with no sign errors.

  e.g. Area = $\frac{1}{2}\begin{vmatrix} 2 & 2 & x_3 & 2 \\ 4 & -4 & 0 & 4 \end{vmatrix}$

$$12 = \frac{1}{2}\left|(2 \times -4 + 4x_3) - (2 \times 4 - 4x_3)\right|$$

$$24 = \left|-16 + 8x_3\right|$$

$$\Rightarrow z_3 = \text{ or } x_3 =$$

If you are uncertain in how to apply a method, then please send to review.

Question	Scheme	Marks	AOs
7(a)	$\dfrac{2x^3+10x^2+9x+22}{(x+2)(x^2+3)} = A + \dfrac{B}{x+2} + \dfrac{Cx+D}{x^2+3}$	M1	1.1a
	$2x^3+10x^2+9x+22 = A(x+2)(x^2+3)+B(x^2+3)+(Cx+D)(x+2)$ Correct method to find at least 3 of the values A, B, C and D for example $x=-2 \Rightarrow B = ...\{28=7B\}$ coeff $x^3 \Rightarrow A = ...\{2=A\}$ coeff $x^2 \Rightarrow C = ...\{10=2A+B+C\}$ coeff $x \Rightarrow D = ...\{9=3A+2C+D\}$ $x=0 \Rightarrow D = ...\{22=6A+3B+2D\}$	dM1	3.1a
	$A=2$	B1	1.1b
	$2+\dfrac{4}{x+2}+\dfrac{2x-1}{x^2+3}$	A1	1.1b
		(4)	
	Alternative: long division $x^3+2x^2+3x+6 \overline{\smash{)}\ 2x^3+10x^2+9x+22}$ quotient 2 $\underline{2x^3+4x^2+6x+12}$ or states $6x^2+3x+10$ $2+\dfrac{...}{2x^3+10x^2+9x+22}$ $\dfrac{6x^2+3x+10}{(x+2)(x^2+3)} = \dfrac{P}{x+2}+\dfrac{Qx+R}{x^2+3}$	M1	1.1a
	$6x^2+3x+10 = P(x^2+3)+(Qx+R)(x+2)$ Correct method to find at least two of the values P, Q and R for example $x=-2 \Rightarrow P = ...\{28=7P\}$ coeff $x^2 \Rightarrow Q = ...\{6=P+Q\}$ $x=0 \Rightarrow R = ...\{10=3P+2R\}$ coeff $x \Rightarrow R = ...\{3=2Q+R\}$	dM1	3.1a
	$x^3+2x^2+3x+6 \overline{\smash{)}\ 2x^3+10x^2+9x+22}$ quotient 2 $\underline{2x^3+4x^2+6x+12}$ $6x^2+3x+10$ or states $2+\dfrac{...}{2x^3+10x^2+9x+22}$	B1	1.1b

	or states $A=2$		
	$2+\dfrac{4}{x+2}+\dfrac{2x-1}{x^2+3}$	A1	1.1b
		(4)	
(b)	$\cdots+\int\dfrac{4}{x+2}+\dfrac{2x-1}{x^2+3}\,\mathrm{d}x=\cdots+\int\dfrac{4}{x+2}+\dfrac{2x}{x^2+3}-\dfrac{1}{x^2+3}\,\mathrm{d}x$ $=\alpha\ln(x+2)+\beta\ln(x^2+3)+\lambda\arctan\left(\dfrac{x}{\sqrt{3}}\right)$	M1	3.1a
	$=2x+4\ln(x+2)+\ln(x^2+3)-\dfrac{1}{\sqrt{3}}\arctan\left(\dfrac{x}{\sqrt{3}}\right)$	A1	2.1
	$=\left[2(1)+4\ln(1+2)+\ln(1^2+3)-\dfrac{1}{\sqrt{3}}\arctan\left(\dfrac{1}{\sqrt{3}}\right)\right]-\left[2(0)+4\ln(0+2)+\ln(0^2+3)-\dfrac{1}{\sqrt{3}}\arctan\left(\dfrac{0}{\sqrt{3}}\right)\right]$ $=\left[2+4\ln(3)+\ln(4)-\dfrac{1}{\sqrt{3}}\arctan\left(\dfrac{1}{\sqrt{3}}\right)\right]-\left[4\ln2+\ln3\right]=\ldots$	dM1	1.1b
	$2+\ln\left(\dfrac{27}{4}\right)-\dfrac{\pi}{6\sqrt{3}}$ * cso	A1*	2.1
		(4)	
			(8 marks)

Notes:

(a)

M1: Selects the correct form for partial fractions.

Must be of the form $A+\frac{B}{x+2}+\frac{Cx+D}{x^2+3}$ so do not award if their A is not present.

Allow if they set up an expression of the form $A+\frac{\mu x+B}{x+2}+\frac{Cx+D}{x^2+3}$ or $A+\mu x+\frac{B}{x+2}+\frac{Cx+D}{x^2+3}$ provided they then go on to show their $\mu=0$

dM1: Dependent on having the correct form for the partial fractions.

Complete method for finding the value of at least 3 constants in $A+\frac{B}{x+2}+\frac{Cx+D}{x^2+3}$

Allow slips, provided their intention is clear.

B1: Correct value for A. This is independent of any method and should be awarded regardless of an incorrect use of partial fractions.

A1: Correct solution written as partial fractions, but not for listing values for constants.

Alternative: long division

M1: Selects the correct form for partial fractions, (following an attempt at algebraic long division which led to an integer quotient, which may or may not be 2, and their remainder must be a 3TQ)

Their partial fractions must be of the form $\frac{P}{x+2}+\frac{Qx+R}{x^2+3}$

dM1: Complete method for finding the value of at least 2 constants. Dependent on having the correct form for the partial fractions. Allow slips, provided their intention is clear.

B1: Correct constant 2, may be seen in their long division and is likely to appear at the beginning of their workings. This is independent of any method and should be awarded regardless of any incorrect use of partial fractions.

A1: Correct solution written as partial fractions, but not for listing values for constants.

(b)

M1: Rewrites the integral (without the constant term) into an integrable form and integrates to the correct form $\alpha\ln(x+2)+\beta\ln(x^2+3)+\lambda\arctan\left(\frac{x}{\sqrt{3}}\right)$,where α,β and λ are non-zero constants.

A1: Fully correct integration for the **whole** expression.

dM1: Uses the limits of 0 and 1, subtracts the correct way round and combines their ln terms correctly.

A1*: Correct answer **cso** (but can be written in any order)

Question	Scheme	Marks	AOs
8(a)	$(\sin 1)(273.2) - 213\cos 1 = A(\sin 2)(\sin 1) \Rightarrow A = 150$	B1	3.3
		(1)	
(b)	$\sin t\frac{dx}{dt} - x\cos t = 150\sin 2t\sin t \Rightarrow \frac{dx}{dt} - x\frac{\cos t}{\sin t} = 150\sin 2t$ $IF = e^{-\int\frac{\cos t}{\sin t}dx} = e^{-\ln\sin t} = \text{cosec}\, t$ $\Rightarrow \text{cosec}\, t\frac{dx}{dt} - x\,\text{cosec}\, t\cot t = 150\frac{\sin 2t}{\sin t}$ oe or $x\,\text{cosec}\, t = \int 150\frac{\sin 2t}{\sin t}\,dt$ oe	M1	3.1b
	Uses $\sin 2t = 2\sin t\cos t$ to arrange into an integrable form and then integrates $x\text{cosec}\, t = 300\int\cos t\,dt \Rightarrow x\text{cosec}\, t = \ldots$	dM1	3.1a
	$x\text{cosec}\, t = 300\sin t\{+c\}$	A1	1.1b
	Uses $t = 1,\ x = 213$ to find the value of c $\frac{213}{\sin 1} = \text{"300"}\sin 1 + c$ $\Rightarrow c = \ldots$	M1	3.4
	$x = \text{"300"}\sin^2 t + \text{"0.687"}\sin t$ or $f(t) = \text{"300"}\sin^2 t + \text{"0.687"}\sin t$	A1	1.1b
		(5)	
(c)	$300\sin^2 t + 0.687\sin t = 0$ $\sin t(300\sin t + 0.687) = 0$ $\Rightarrow \sin t = \ldots$	M1	3.4
	$t = \pi$ or $t = \pi - \sin^{-1}\left(-\frac{0.687}{300}\right)$ or $\pi + \sin^{-1}\left(\frac{0.687}{300}\right)$ or awrt $t = 3.14$	M1	1.1b
	13:08 or 13:09 or 1.08 (pm) or 1.09 (pm)	A1	3.2a
		(3)	
(d)	$300\sin^2 t + 0.687\sin t = 300.68$ $300\sin^2 t + 0.687\sin t - 300.68 = 0$ $\Rightarrow \sin t = \ldots$	M1	3.4
	$t =$ awrt 1.57	A1	1.1b

		(2)	
(e)	The model suggests that the time to go up the hill and the time to go down will be the similar. In reality the times will be different.	B1ft	3.5b
		(1)	
			(12 marks)

Notes:
(a) **B1**: $A=$ awrt 150 **Note** $A=150.0436....$
You may mark (b) (c) and (d) together so do not be concerned about the labelling. **(b)** **M1**: Finds an integrating factor of the form $\mathrm{e}^{\pm\int\frac{\cos t}{\sin t}\mathrm{d}x}=\mathrm{e}^{\pm\ln\sin t}$ or $\operatorname{cosec} t$ (or $\sin t$) and proceeds to multiply through by their IF oe Look for $I.F.=\mathrm{e}^{\pm\int\frac{\cos t}{\sin t}\mathrm{d}t}\Rightarrow x\times\text{'their }I.F.\text{'}=\int A\sin 2t\times\text{'their }I.F.\text{'}\,\mathrm{d}t$ Where they must be using a numerical A **dM1:** Dependent on the previous method mark**.** Uses the identity $\sin 2t=2\sin t\cos t$ to arrange RHS into an integrable form with a correct integrating factor of $\operatorname{cosec} t$ and then attempts to integrate using their numerical *A*. Condone a sign slip on their RHS. $x\operatorname{cosec} t=2A\int\cos t\,\mathrm{d}t\Rightarrow x\operatorname{cosec} t=\pm\alpha\sin t\quad(+c)$ **A1**: Correct general solution, condone missing + c **M1:** Using the model, $t=1$, $x=213$ to find the value of their constant c. Substitution if not seen is implied by sight of 213 for x and at least one correct value for $\sin t$. They must use radians and not degrees; you may need to check. **A1:** Correct particular solution of $x=300\sin^2 t+0.687\sin t$ $c=$ awrt 0.69 (when using $A=150$) **Alternatively:** When using answers for A which have not been rounded to 3sf, the equation will instead be $x=300.0872..\sin^2 t+0.613\sin t$ in which case allow $c=$ awrt 0.61
(c) **M1**: Sets $x=0$ and solves a quadratic equation of the form $\lambda\sin^2 t+\mu\sin t=0$,where $\lambda,\mu\neq 0$ finding at least one value for sin*t* **M1:** Solves a quadratic equation of the form $2A\sin^2 t+c\sin t=0$ where A, c >0 to find a correct value of *t*. May be implied by a value of *t* awrt 3.14 Award for $t=\pi$ but accept the use of $\arcsin\left(\frac{-\mu}{\lambda}\right)+\pi$ oe, where they must add π to a **positive** value of *t*. They must also be working in radians. **A1:** Correct time awrt 13:08 or 13:09 or 1.08 (pm), 1.09 (pm), which comes from a **correct** equation
(d) **M1:** Solves their 3TQ equation of the form $2A\sin^2 t+c\sin t=300.68$ where A,c >0 to find an answer for $\sin t$. You may need to check the value for $\sin t$ or *t* obtained from their quadratic. A correct equation followed by $t=$ awrt 1.57 is sufficient. **A1:** $t=$ awrt 1.57 isw. Answer must come from a **correct** equation. Do not allow an answer of $\frac{\pi}{2}$ which may have been obtained from $\sin t=1$ even if it proceeds to 1.57

Here it asks for the value of *t*, so do not accept a time, for example 11.42am

Alternatively uses
$300.0872\sin^2 t + 0.613\sin t - 300.68 = 0 \Rightarrow \sin t = ...\ t =$ awrt 1.56

(e)
B1ft: They must have stated times or values for *t* in (c) and (d) for this mark.
We need a comparison consistent with their **times** from (c) and (d) **and** reality.
Their values may not be correct, but their statement should be consistent with their times.
You may ignore incorrect statements once a correct statement is given, provided their incorrect statement does not contradict their correct statement.

e.g.

Accept
- The time to go up and down is the same, which is not realistic
- The times are similar which is unlikely
- It should take longer to go up the hill
- In reality it will take longer to go up the hill than down the hill (because of the slope)

Condone
- It takes longer to go up the hill than down the hill
- It takes the same amount of time to go up and down
- In the model it takes them longer to go down the hill
- The rambler may not walk **up and down** at the same speed, or rate

Reject
- the rambler may need to take a rest
- the model is inaccurate or invalid for certain values of *t*
- the rambler may walk down a different path or route
- the rambler is modelled as a particle
- the rambler walks at a constant velocity
- the rambler may not walk at the same speed/pace for the entire journey

If you are uncertain please send to review

Question	Scheme	Marks	AOs
9(i)(a)	$\sinh x = \left(\dfrac{e^x - e^{-x}}{2}\right)$ and $\tanh x = \dfrac{e^{2x}-1}{e^{2x}+1}$ or $\dfrac{e^x - e^{-x}}{e^x + e^{-x}}$	B1	1.2
	$\dfrac{3}{4}\sinh x = \tanh x + \dfrac{1}{5} \Rightarrow \dfrac{3}{4}\left(\dfrac{e^x - e^{-x}}{2}\right) = \dfrac{e^{2x}-1}{e^{2x}+1} + \dfrac{1}{5}$ or $\dfrac{3}{4}\left(\dfrac{e^x - e^{-x}}{2}\right) = \dfrac{e^x - e^{-x}}{e^x + e^{-x}} + \dfrac{1}{5}$ Leading to a quartic equation for e^x	M1	3.1a
	$15e^{4x} - 48e^{3x} + 32e^x - 15 = 0$ *	A1*	1.1b
		(3)	
(i)(b)	$15(3)^4 - 48(3)^3 + 32(3) - 15 = 0$ therefore $e^x = 3$ is a solution	B1	1.1b
		(1)	
(i)(c)	$(\ln 3, 1)$	B1	1.1b
		(1)	
(ii)	$\displaystyle\int \frac{e^{\frac{1}{x}}}{x^2}\,dx = \lambda e^{\frac{1}{x}}$ $\left\{u = x^{-1} \Rightarrow \dfrac{du}{dx} = -x^{-2} \Rightarrow \displaystyle\int x^{-2}e^u.\frac{du}{-x^{-2}} = \int -e^u\ du\right\}$	M1	3.1a
	$\displaystyle\int \frac{e^{\frac{1}{x}}}{x^2}\,dx = -e^{\frac{1}{x}}$	A1	1.1b
	$\displaystyle\int_{-4}^{0} \frac{e^{\frac{1}{x}}}{x^2}\,dx = \lim_{t\to 0}\left[-e^{\frac{1}{x}}\right]_{-4}^{t} = \lim_{t\to 0}\left[\left(-e^{\frac{1}{t}}\right) - \left(-e^{-\frac{1}{4}}\right)\right]$	M1	2.5
	$t \to 0^- \Rightarrow \dfrac{1}{t} \to -\infty \Rightarrow e^{\frac{1}{t}} \to 0$ therefore $\displaystyle\int_{-4}^{0} \frac{e^{\frac{1}{x}}}{x^2}\,dx = e^{-\frac{1}{4}}$ *	A1*	2.4
		(4)	
			(9 marks)

Notes:

(i)(a)

B1: Recalls the exponential definitions for sinh*x* and at least one of cosh*x* or tanh*x*, which may be embedded in their workings.

M1: Substitutes the correct exponential definitions to form an equation leading to a quartic equation for e^x. Any identities used such as $\sinh 2x = 2\sinh x\cosh x$ must be correct

A1*: Correct equation following at least one intermediate stage, with no errors seen. They cannot go directly from their substitution to the given answer. cso

(i) (b)

B1: Substitutes $e^x = 3$ into each term of the equation, shows = 0 and states therefore a solution or writes $\left(e^x - 3\right)$ is a factor. Allow a tick, box, QED or appropriate conclusion.

OR

Substitutes x = ln3 into each term of the equation, shows = 0 and states therefore a solution or writes $\left(e^x - 3\right)$ is a factor. Allow a tick, box, QED or appropriate conclusion.

OR

Factorises their equation:

$15e^{4x} - 48e^{3x} + 32e^x - 15 = 0$

$\Rightarrow (e^x - 3)(15e^{3x} - 3e^{2x} - 9e^x + 5) = 0$

and states hence $e^x = 3$ is a solution

Do not award this mark for simply solving a quartic such as $15y^4 - 48y^3 + 32y - 15 = 0$ on the calculator and stating $y = 3$, hence $e^x = 3$ is a solution.

(i)(c)

B1: States the correct exact coordinates. Allow $x =..$, $y =\ldots$ Do not accept decimals.

(ii)

M1: Use the substitution $u = \pm\frac{1}{x}$ to obtain an integral of the form $\int \lambda e^u \, du$ oe and integrates to λe^u

Award for a sight of $\pm\lambda e^{\frac{1}{x}}$ as the answer to their integral.

Alternatively applies the reverse of the chain rule $\frac{d}{dx}\left(e^{\frac{1}{x}}\right) = \pm\frac{1}{x^2}e^{\frac{1}{x}}$ and integrates to reach $\pm\lambda e^{\frac{1}{x}}$

Answers using integration by parts are unlikely to lead to a correct solution.

A1: Correct integration. Award for correct answer with minimal workings as this can be done by inspection using the reverse of the chain rule. However, withhold this mark for incorrect workings.

M1: Uses correct notation to write the integral as the limit as $t \to 0$, with the limits of *t* (or any such variable) and – 4. Applies correctly the limits of – 4 and *t* with correct limit notation, with limits seen substituted the right way round.
Withhold this mark if there is no evidence of using the limiting process. We must see as a minimum $\lim\limits_{t\to 0}$ oe at some stage in their work.

A1*: Produces an argument that includes an upper limit that approaches 0 from below.
e.g. States that $t \to 0^- \Rightarrow \frac{1}{t} \to -\infty \Rightarrow e^{\frac{1}{t}} \to 0$ and reaches a value of $e^{-\frac{1}{4}}$

Alternative method: changing limits using $u = \frac{1}{x}$

$\int_{-4}^{0} \frac{e^{\frac{1}{x}}}{x^2} dx = \int -e^u du = \lambda e^u$ M1

$= \left(\lim\limits_{t\to 0}\right) \left[-e^u\right]_{-\frac{1}{4}}^{\frac{1}{t}}$ correct limits required A1

$= \lim\limits_{t\to 0}\left[\left(-e^{\frac{1}{t}}\right) - \left(-e^{-\frac{1}{4}}\right)\right]$ M1

$t \to 0^- \Rightarrow \frac{1}{t} \to -\infty \Rightarrow e^{\frac{1}{t}} \to 0$ therefore $\int_{-4}^{0} \frac{e^{\frac{1}{x}}}{x^2} dx = e^{-\frac{1}{4}}$ A1*

Question	Scheme	Marks	AOs
10(a)	$\left(z-\frac{1}{z}\right)^4=(2\mathrm{i}\sin\theta)^4=16\sin^4\theta$	B1	1.1b
	$\left(z-\frac{1}{z}\right)^4=z^4+4(z^3)\left(-\frac{1}{z}\right)+6(z^2)\left(-\frac{1}{z}\right)^2+4(z)\left(-\frac{1}{z}\right)^3+\left(-\frac{1}{z}\right)^4$	M1	2.1
	$=\left[z^4+\frac{1}{z^4}\right]-4\left[z^2+\frac{1}{z^2}\right]+6$	A1	1.1b
	Uses $z^n+\frac{1}{z^n}=2\cos n\theta$ $\{16\sin^4\theta\}\equiv 2\cos4\theta-8\cos2\theta+6$	M1	2.1
	$8\sin^4\theta\equiv\cos4\theta-4\cos2\theta+3$ * cso	A1 *	1.1b
		(5)	
(b)	$\text{vol}=\pi\int\left(\sin^2\left(\frac{1}{2}y\right)\right)^2\,\mathrm{d}y$	B1	3.4
	$\text{vol}=\{\pi\}\int\sin^4\left(\frac{1}{2}y\right)\quad(\mathrm{d}y)$ $=\{\pi\}\int\frac{1}{8}(\cos(2y)-4\cos(y)+3)\quad(\mathrm{d}y)=\ldots$	M1	1.1b
	$=\{\pi\}\left[\frac{1}{8}\left(\frac{1}{2}\sin(2y)-4\sin(y)+3y\right)\right]$	A1	1.1b
	$=\pi\left[\frac{1}{8}\left(\frac{1}{2}\sin\left(2\times\frac{8\pi}{5}\right)-4\sin\left(\frac{8\pi}{5}\right)+\left(3\times\frac{8\pi}{5}\right)\right)-0\right]$ $=\ldots$	dM1	3.4
	awrt 7.3 (cm^3)	A1	1.1b
		(5)	
(c)	Mass = "7.3" x 0.85 $=\ldots$	M1	2.2b
	Mass = 6.2 (grams) therefore a good model	A1ft	3.5a
		(2)	
	Alternative 1		
	Volume = $6\div0.85=\ldots$	M1	2.2b
	Volume = 7.1 (cm^3) therefore a good model	A1ft	3.5a
		(2)	

	Alternative 2		
	Density = $6 \div "7.3"$	M1	2.2b
	Density = 0.82 (g/cm^3) therefore a good model	A1ft	3.5a
		(2)	
(12 marks)			

Notes:
(a) **B1:** See scheme. This can appear anywhere in the proof. Accept $2^4\sin^4\theta$ for $16\sin^4\theta$, but not $(2\sin\theta)^4$ Alternatively, they may instead substitute $\sin\theta = \frac{1}{2\text{i}}\left(z-\frac{1}{z}\right)$ into the expression $8\sin^4\theta$. This can be implied but must come from correct work. This can appear anywhere in their proof. e.g. $8\sin^4\theta = 8\left[\frac{1}{2\text{i}}\left(z-\frac{1}{z}\right)\right]^4$ or $8\sin^4\theta = 8\left[\left(z-\frac{1}{z}\right)\right]^4\frac{1}{2^4}$ and allow $8\sin^4\theta = \frac{1}{2}\left[\left(z-\frac{1}{z}\right)\right]^4$ **M1:** Finds the expansion of $\left(z-\frac{1}{z}\right)^4$ which may be unsimplified. All five terms must be present. Condone sign slips only **A1:** Correct expansion, with terms grouped. **M1**: Uses $z^n+\frac{1}{z^n}=2\cos n\theta$ to write in terms of $\cos 4\theta$ and $\cos 2\theta$ **A1*:** Achieves the printed answer with no errors or omissions. Cso Follows A0.
(b) **B1:** Correct formula $\pi\int\left(\sin^2\left(\frac{1}{2}y\right)\right)^2\,\text{d}y$ (but not $\text{vol}=\pi\int x^2\,\text{d}y$) used to find a volume, stated or implied, ignore limits. If there is a missing π or dy in their integral, then withhold this mark only. However, this mark may be awarded if π and dy are seen together later in their integral. **Do not award the following marks if algebraic integration is not used. For example finding an answer of 7.3 without algebraic integration will obtain M0A0dM0A0** **M1:** Uses the result in part (a) to express the volume in an integrable form and attempts to integrate. Award for an integral of the form $\int\frac{1}{8}\left(A\cos(2y)+B\cos(y)+C\right)(\text{d}y)$ with at least one term integrated correctly. Do not be concerned if they use a different variable such as θ for y. **Special Case:** **If they have not used part (a) and instead use the double angle formulae:** $\sin^2\alpha=\frac{1}{2}-\frac{1}{2}\cos 2\alpha$ and $\sin^4\alpha=\left(\frac{1}{2}-\frac{1}{2}\cos 2\alpha\right)^2$ with $\alpha=\frac{1}{2}y$ In this case they must obtain an exact integral equivalent to $\int\frac{1}{8}\left(\cos(2y)-4\cos(y)+3\right)(\text{d}y)$ and proceed to integrate at least one term correctly. **A1:** Correct integration. May be in terms of another variable such as θ. Ignore π

dM1: Dependent on previous method mark. Finds the required volume using $\pi \int_0^{\frac{8\pi}{5}} x^2 \ \mathrm{d}y$ and applies their limits to their integral and subtracts the correct way round.

If there are no limits seen substituted, then a correct final answer implies the correct use of limits and the inclusion of π. This is provided they have already achieved an integrated expression of $\frac{1}{8}\left(\frac{1}{2}\sin(2y) - 4\sin(y) + 3y\right)$ oe with correct limits seen, possibly on their integral.

If their integration is incorrect, then there must be evidence of substituting both limits in each of their terms and subtracting. Allow the omission of subtracting zero provided their integration would produce zero for the lower limit.

A1: awrt 7.3

(c)

M1: Finds the mass of the ornament by multiplying their volume by 0.85

A1ft: Draws an appropriate conclusion about the suitability of the model, comparing their two masses.

If the masses differ by 10% then they must conclude it is a good model.

If the masses differ between 10% and 20% then they may conclude it is either a good model or poor model.

If the masses differ by greater than 20% then they must conclude it is a poor model.

Alternative 1

M1: Finds the volume of the ornament by dividing the mass of 6 grams by 0.85 g/cm^3

A1ft: Draws an appropriate conclusion about the suitability of the model, comparing their two volumes.

If the volumes differ by 10% then they must conclude it is a good model.

If the volumes differ between 10% and 20% then they may conclude it is either a good model or poor model.

If the volumes differ by greater than 20% then they must conclude it is a poor model.

Alternative 2

M1: Finds the density of the ornament by dividing the mass of 6 grams by 7.3 g/cm^3

A1ft: Draws an appropriate conclusion about the suitability of the model, comparing their two densities.

If the densities differ by 10% then they must conclude it is a good model.

If the densities differ between 10% and 20% then they may conclude it is either a good model or poor model.

If the densities differ by greater than 20% then they must conclude it is a poor model.

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