GCE

Further Mathematics B MEI

Y420/01: Core Pure

A Level

Mark Scheme for June 2024

This mark scheme is published as an aid to teachers and students, to indicate the requirements of the examination. It shows the basis on which marks were awarded by examiners. It does not indicate the details of the discussions which took place at an examiners' meeting before marking commenced.

All examiners are instructed that alternative correct answers and unexpected approaches in candidates' scripts must be given marks that fairly reflect the relevant knowledge and skills demonstrated.

Mark schemes should be read in conjunction with the published question papers and the report on the examination.

MARKING INSTRUCTIONS

PREPARATION FOR MARKING
RM ASSESSOR

1. Make sure that you have accessed and completed the relevant training packages for on-screen marking: *RM Assessor Online Training*; *OCR Essential Guide to Marking*.

2. Make sure that you have read and understood the mark scheme and the question paper for this unit. These are posted on the RM Cambridge Assessment Support Portal http://www.rm.com/support/ca

3. Log-in to RM Assessor and mark the **required number** of practice responses ("scripts") and the **number of required** standardisation responses.

MARKING

1. Mark strictly to the mark scheme.

2. Marks awarded must relate directly to the marking criteria.

3. The schedule of dates is very important. It is essential that you meet the RM Assessor 50% and 100% (traditional 40% Batch 1 and 100% Batch 2) deadlines. If you experience problems, you must contact your Team Leader (Supervisor) without delay.

4. If you are in any doubt about applying the mark scheme, consult your Team Leader by telephone or the RM Assessor messaging system, or by email.

5. **Annotations**

Annotation	Meaning
✓and ✗	
BOD	Benefit of doubt
FT	Follow through
ISW	Ignore subsequent working
M0, M1	Method mark awarded 0, 1
A0, A1	Accuracy mark awarded 0, 1
B0, B1	Independent mark awarded 0, 1
E	Explanation mark 1
SC	Special case
^	Omission sign
MR	Misread
BP	Blank Page
Seen	
Highlighting	

Other abbreviations in mark scheme	Meaning
E1	Mark for explaining a result or establishing a given result
dep*	Mark dependent on a previous mark, indicated by *. The * may be omitted if only one previous M mark
cao	Correct answer only
oe	Or equivalent
rot	Rounded or truncated
soi	Seen or implied
www	Without wrong working
AG	Answer given
awrt	Anything which rounds to
BC	By Calculator
DR	This question included the instruction: In this question you must show detailed reasoning.
BP	Blank Page
Seen	
Highlighting	

6. **Subject Specific Marking Instructions**

a. Annotations must be used during your marking. For a response awarded zero (or full) marks a single appropriate annotation (cross, tick, M0 or ^) is sufficient, but not required.

For responses that are not awarded either 0 or full marks, you must make it clear how you have arrived at the mark you have awarded and all responses must have enough annotation for a reviewer to decide if the mark awarded is correct without having to mark it independently.

It is vital that you annotate standardisation scripts fully to show how the marks have been awarded.

Award No Response (NR) if:

- there is nothing written in the answer space

Award Zero '0' if:

- anything is written in the answer space and is not worthy of credit (this includes text and symbols).

Team Leaders must confirm the correct use of the NR button with their markers before live marking commences and should check this when reviewing scripts.

If a candidate uses the answer space for one question to answer another, for example using the space for 8(b) to answer 8(a), then give benefit of doubt unless it is ambiguous for which part it is intended.

b. An element of professional judgement is required in the marking of any written paper. Remember that the mark scheme is designed to assist in marking incorrect solutions. Correct solutions leading to correct answers are awarded full marks but work must not always be judged on the answer alone, and answers that are given in the question, especially, must be validly obtained; key steps in the working must always be looked at and anything unfamiliar must be investigated thoroughly. Correct but unfamiliar or unexpected methods are often signalled by a correct result following an apparently incorrect method. Such work must be carefully assessed. When a candidate adopts a method which does not correspond to the mark scheme, escalate the question to your Team Leader who will decide on a course of action with the Principal Examiner.

If you are in any doubt whatsoever you should contact your Team Leader.

c. The following types of marks are available.

M
A suitable method has been selected and applied in a manner which shows that the method is essentially understood. Method marks are not usually lost for numerical errors, algebraic slips or errors in units. However, it is not usually sufficient for a candidate just to indicate an intention of using some method or just to quote a formula; the formula or idea must be applied to the specific problem in hand, e.g. by substituting the relevant quantities into the formula. In some cases the nature of the errors allowed for the award of an M mark may be specified.
A method mark may usually be implied by a correct answer unless the question includes the DR statement, the command words "Determine" or "Show that", or some other indication that the method must be given explicitly.

A
Accuracy mark, awarded for a correct answer or intermediate step correctly obtained. Accuracy marks cannot be given unless the associated Method mark is earned (or implied). Therefore M0 A1 cannot ever be awarded.

B
Mark for a correct result or statement independent of Method marks.

E
A given result is to be established or a result has to be explained. This usually requires more working or explanation than the establishment of an unknown result.

Unless otherwise indicated, marks once gained cannot subsequently be lost, e.g. wrong working following a correct form of answer is ignored. Sometimes this is reinforced in the mark scheme by the abbreviation isw. However, this would not apply to a case where a candidate passes through the correct answer as part of a wrong argument.

d. When a part of a question has two or more 'method' steps, the M marks are in principle independent unless the scheme specifically says otherwise; and similarly where there are several B marks allocated. (The notation 'dep*' is used to indicate that a particular mark is dependent on an earlier, asterisked, mark in the scheme.) Of course, in practice it may happen that when a candidate has once gone wrong in a part of a question, the work from there on is worthless so that no more marks can sensibly be given. On the other hand, when two or more steps are successfully run together by the candidate, the earlier marks are implied and full credit must be given.

e. The abbreviation FT implies that the A or B mark indicated is allowed for work correctly following on from previously incorrect results. Otherwise, A and B marks are given for correct work only – differences in notation are of course permitted. A (accuracy) marks are not given for answers obtained from incorrect working. When A or B marks are awarded for work at an intermediate stage of a solution, there may be various alternatives that are equally acceptable. In such cases, what is acceptable will be detailed in the mark scheme. If this is not the case please, escalate the question to your Team Leader who will decide on a course of action with the Principal Examiner.

Sometimes the answer to one part of a question is used in a later part of the same question. In this case, A marks will often be 'follow through'. In such cases you must ensure that you refer back to the answer of the previous part question even if this is not shown within the image zone. You may find it easier to mark follow through questions candidate-by-candidate rather than question-by-question.

f. Unless units are specifically requested, there is no penalty for wrong or missing units as long as the answer is numerically correct and expressed either in SI or in the units of the question. (e.g. lengths will be assumed to be in metres unless in a particular question all the lengths are in km, when this would be assumed to be the unspecified unit.)
We are usually quite flexible about the accuracy to which the final answer is expressed; over-specification is usually only penalised where the scheme explicitly says so.
- When a value is given in the paper only accept an answer correct to at least as many significant figures as the given value.
- When a value is not given in the paper accept any answer that agrees with the correct value to 2 s.f. unless a different level of accuracy has been asked for in the question, or the mark scheme specifies an acceptable range.
  NB for Specification A the rubric specifies 3 s.f. as standard, so this statement reads "3 s.f".

Follow through should be used so that only one mark in any question is lost for each distinct accuracy error.
Candidates using a value of 9.80, 9.81 or 10 for g should usually be penalised for any final accuracy marks which do not agree to the value found with 9.8 which is given in the rubric.

g. Rules for replaced work and multiple attempts:
- If one attempt is clearly indicated as the one to mark, or only one is left uncrossed out, then mark that attempt and ignore the others.
- If more than one attempt is left not crossed out, then mark the last attempt unless it only repeats part of the first attempt or is substantially less complete.
- if a candidate crosses out all of their attempts, the assessor should attempt to mark the crossed out answer(s) as above and award marks appropriately.

h. For a genuine misreading (of numbers or symbols) which is such that the object and the difficulty of the question remain unaltered, mark according to the scheme but following through from the candidate's data. A penalty is then applied; 1 mark is generally appropriate, though this may differ for some units. This is achieved by withholding one A or B mark in the question. Marks designated as cao may be awarded as long as there are no other errors.

If a candidate corrects the misread in a later part, do not continue to follow through. E marks are lost unless, by chance, the given results are established by equivalent working. Note that a miscopy of the candidate's own working is not a misread but an accuracy error.

i. If a calculator is used, some answers may be obtained with little or no working visible. Allow full marks for correct answers, provided that there is nothing in the wording of the question specifying that analytical methods are required such as the bold "In this question you must show detailed reasoning", or the command words "Show" or "Determine". Where an answer is wrong but there is some evidence of method, allow appropriate method marks. Wrong answers with no supporting method score zero. If in doubt, consult your Team Leader.

j. If in any case the scheme operates with considerable unfairness consult your Team Leader.

Question			Answer	Marks	AO	Guidance
1			$\frac{1}{r+1}-\frac{1}{r+2}=\frac{1}{(r+1)(r+2)}$	B1	1.1	Denominator may be r^2+3r+2. Cannot be implied.
			so $\sum_{r=1}^{n}\frac{1}{(r+1)(r+2)}=\sum_{r=1}^{n}\left[\frac{1}{r+1}-\frac{1}{r+2}\right]$			
			$=\frac{1}{2}-\frac{1}{3}+\frac{1}{3}\ldots$	M1*	2.5	Enough correct terms to show cancellation in their series. First term must be correct. Fractions need not be simplified
			$\ldots-\frac{1}{n+2}$	M1dep	2.1	
			$=\frac{1}{2}-\frac{1}{n+2}$	A1	2.2a	isw (or $\frac{n}{2(n+2)}$)
			Alternative method			
			$\frac{1}{r+1}-\frac{1}{r+2}=\frac{1}{(r+1)(r+2)}$	B1		Denominator may be r^2+3r+2. Cannot be implied.
			$\sum_{r=1}^{n}\frac{1}{r+1}-\sum_{r=2}^{n+1}\frac{1}{r+1}$	M1*		Rewriting so both series have same fraction with correct limits
			$=\frac{1}{1+1}-\frac{1}{(n+1)+1}$	M1dep		Correct substitution of limits to leave two terms
			$=\frac{1}{2}-\frac{1}{n+2}$	A1		isw (or $\frac{n}{2(n+2)}$)
				[4]		

Question			Answer	Marks	AO	Guidance
2	**(a)**	**(i)**	1 + 2i	**B1**	**1.1**	cao
				[1]		
2	**(a)**	**(ii)**	**DR**			
			$\frac{u}{v}=\frac{(-1+\mathrm{i})(-2+\mathrm{i})}{(-2-\mathrm{i})(-2+\mathrm{i})}$	**M1***	**1.1a**	× numerator and denominator by $(-2+\mathrm{i})$ or $(2-\mathrm{i})$
			$=\frac{2-2\mathrm{i}-\mathrm{i}+\mathrm{i}^2}{5}$	**M1dep**	**2.1**	Numerator expanded to include at least three terms with correct denominator seen (must be expanded but need not be simplified). Allow one sign slip in numerator only.
			$=\frac{1}{5}-\frac{3}{5}\mathrm{i}$	**A1**	**1.1**	Or simplified equivalent, e.g. $\frac{1-3\mathrm{i}}{5}$
			Alternative method			
			$-1+\mathrm{i}=(-2-\mathrm{i})(a+b\mathrm{i})$			
			$=-2a-2b\mathrm{i}-a\mathrm{i}+b$	**M1***		Expanding $(-2-\mathrm{i})(a+b\mathrm{i})$. Allow one slip only.
			$-1=-2a+b$ and $1=-2b-a$	**M1dep**		Equating both real and imaginary coefficients
			$a=\frac{1}{5}, b=-\frac{3}{5}\Rightarrow\frac{u}{v}=\frac{1}{5}-\frac{3}{5}\mathrm{i}$	**A1**		Or simplified equivalent, e.g. $\frac{1-3\mathrm{i}}{5}$
				[3]		
2	**(b)**		$\sqrt{2}$	**B1**	**1.1**	Correct modulus seen
			$\frac{3}{4}\pi$	**B1**	**1.1**	Correct argument seen. Condone 135°
			$\sqrt{2}\left(\cos\frac{3\pi}{4}+\mathrm{i}\sin\frac{3\pi}{4}\right)$	**B1**	**1.1**	Must be exact; condone 135°
				[3]		

Question			Answer	Marks	AO	Guidance
3			$\alpha+\beta+\gamma=1$	B1	3.1a	May be embedded
			$\alpha\beta+\beta\gamma+\gamma\alpha=4$	B1	1.1	May be embedded
			$[\alpha^2+\beta^2+\gamma^2=](\alpha+\beta+\gamma)^2-2(\alpha\beta+\beta\gamma+\gamma\alpha)$	M1	3.1a	oe Accept numerical values in terms of their 1 and 4, i.e. $1^2-2\times 4$. No slips allowed.
			$=-7$	A1	1.1	
			Alternative method			
			Let $z=x^2$			
			$2(\sqrt{z})^3-2(\sqrt{z})^2+8\sqrt{z}-15=0$	M1		Correct substitution chosen and attempted
			$(\sqrt{z})^2(2z+8)^2=(15+2z)^2$	M1		Rearranging and squaring both sides to remove square root
			$4z^3+28z^2+4z-225=0$	A1		Correct equation
			$\alpha^2+\beta^2+\gamma^2=-7$	A1		
				[4]		

Question			Answer	Marks	AO	Guidance
4			$[V =]\ \pi \int_0^k \frac{1}{k^2 + x^2} [\mathrm{d}x]$	B1	1.1	Ignore limits and condone missing $\mathrm{d}x$. Multiplication by π may appear later.
			$\pi \left[\frac{1}{k} \arctan\left(\frac{x}{k}\right)\right]_0^k$	B1	1.1	$\left[\frac{1}{k} \arctan\left(\frac{x}{k}\right)\right]$, ignore limits. Condone missing π.
			$[1 =] \frac{\pi^2}{4k}$	B1	1.1	oe single term provided arctan terms evaluated
			$k = \frac{\pi^2}{4}$	B1	3.1a	
				[4]		

Question			Answer	Marks	AO	Guidance
5	(a)		$\mathbf{u}\times\mathbf{v}=\begin{pmatrix}1\\2+2a\\-a\end{pmatrix}$	B1	1.1	oe soi by correct equations
			$2 + 2a = b$, $-a = 3$	M1	1.1	Both equations ft their $\mathbf{u}\times\mathbf{v}$
			$a = -3$, $b = -4$	A1	1.1	www
				[3]		
5	(b)		$\sin\theta=\frac{\lvert\mathbf{u}\times\mathbf{v}\rvert}{\lvert\mathbf{u}\rvert\lvert\mathbf{v}\rvert}$	M1	3.1a	$\lvert\mathbf{u}\times\mathbf{v}\rvert=\lvert\mathbf{u}\rvert\lvert\mathbf{v}\rvert\sin\theta$ must be used with their **u** and **v** soi by correct expression for their $\sin\theta$. Formula alone is M0.
			$=\frac{\sqrt{26}}{\sqrt{9}\sqrt{10}}$	A1FT	1.1	ft their a and b, need not be simplified
			$\theta = 32.51\ldots°$	A1	1.1	33° or 0.57 rad or better
				[3]		

Question			Answer	Marks	AO	Guidance
6	**(a)**		circle	**M1**	**1.2**	
			centre 1 + 2i, radius 4	**A1**	**1.1**	soi. Can be seen beside sketch as long as sketch not contradicted. Circle must enter all four quadrants.
			inside shaded	**A1**	**1.1**	Line for circle must be solid. Candidates may shade the region that is not required but should clearly indicate that what they have shaded is not required.
				[3]		
6	**(b)**		Half line	**M1**	**1.2**	Intention for a half line must be clear
			starting at –i	**A1**	**1.1**	Can be seen beside sketch as long as sketch not contradicted.
			at $\frac{\pi}{3}$ rad to real axis	**A1**	**1.1**	Labelled acute angle made with any horizontal line. Accept 60°. Accept x-intercept at $\frac{\sqrt{3}}{3}$ without angle drawn if half line starts at −i. Condone incorrect x-intercept if correct angle shown. Do not accept $-\frac{\pi}{3}$ rad.
				[3]		

Question			Answer	Marks	AO	Guidance
7	(a)		Because $\frac{1}{\sqrt[3]{x-2}}$ is not defined when $x = 2$	B1 [1]	2.4	isw. Must explicitly refer to $x = 2$. See appendix.
7	(b)		**DR** $\int \frac{1}{(x-2)^{\frac{1}{3}}}\,dx = \frac{3}{2}(x-2)^{\frac{2}{3}}$	B1*	2.1	
			$\lim_{a\to 2}\int_1^a \frac{1}{\sqrt[3]{x-2}}\,dx$ or $\lim_{a\to 2}\left[\frac{3}{2}(a-2)^{\frac{2}{3}}\right]_1^a$	B1	2.1	Introducing an algebraic limit for '2' in original integral or in integral of form $k(a-2)^{2/3}$. Soi by next B1. Do not allow x as a limit.
			$\lim_{a\to 2}\left[\frac{3}{2}(a-2)^{\frac{2}{3}}\right] = 0$ $\left[\int_1^2 \frac{1}{\sqrt[3]{x-2}}\,dx =\right] 0 - \frac{3}{2}(1-2)^{\frac{2}{3}}$	B1	2.4	Clear limit argument used for $k(a-2)^{2/3}$ as $a \to 2$. Do not allow x used for a. $=$ or $\to$ must be used correctly.
			$= -\frac{3}{2}$	B1dep	2.2a	Integral must have been explicitly evaluated for both limits. Do not accept "$\to -\frac{3}{2}$". Withhold if two limit arguments considered.
			Alternative method Let $u = x - 2$ $\int \frac{1}{\sqrt[3]{u}}\,du = \frac{3}{2}u^{\frac{2}{3}}$	B1*		Correct substitution and integration
			$\lim_{a\to 0}\int_{-1}^a \frac{1}{\sqrt[3]{u}}\,du$ or $\lim_{a\to 0}\left[\frac{3}{2}u^{\frac{2}{3}}\right]_{-1}^a$	B1		Introducing an algebraic limit for '0' in original integral in terms of u or in integral of form $ku^{2/3}$. Soi by next B1. Do not allow u as a limit.
			$\lim_{a\to 0}\left[\frac{3}{2}a^{\frac{2}{3}}\right] = 0$ $\left[\int_{-1}^0 \frac{1}{\sqrt[3]{u}}\,du =\right] 0 - \frac{3}{2}(-1)^{\frac{2}{3}}$	B1		Clear limit argument used for $k(a)^{2/3}$ as $a \to 0$. Do not allow x used for a. $=$ or $\to$ must be used correctly.

Question			Answer	Marks	AO	Guidance
			$= -\frac{3}{2}$	**B1dep**		Integral must have been explicitly evaluated for both limits. Do not accept "$\to -\frac{3}{2}$". Withhold if two limit arguments considered.
				[4]		

Question			Answer	Marks	AO	Guidance
8	(a)		Shear with x-axis fixed, mapping (0, 1) to (λ, 1)	M1 A1 [2]	1.2 1.1	Do not accept "sheaf" Accept x-axis is a line of invariant points (not an invariant line only). "Shear parallel to x-axis" is insufficient. Accept alternative mappings, e.g. $(1,1)$ to $(1+\lambda, 1)$. Do not accept shear factor.
8	(b)	(i)	1	B1 [1]	1.1	
8	(b)	(ii)	Preserves area Preserves orientation	B1 B1 [2]	1.2 1.2	FT their determinant. Condone area scale factor = 1. FT their determinant. Do not accept "orientation not reversed".
8	(c)		When n = 1 $[\mathbf{M}^1 =] \begin{pmatrix} 1 & 1\times\lambda \\ 0 & 1 \end{pmatrix} = \begin{pmatrix} 1 & \lambda \\ 0 & 1 \end{pmatrix}$ so true when $n = 1$ [Assume result holds for n = k] $[\mathbf{M}^{k+1} =] \begin{pmatrix} 1 & k\lambda \\ 0 & 1 \end{pmatrix} \begin{pmatrix} 1 & \lambda \\ 0 & 1 \end{pmatrix}$ $[\mathbf{M}^{k+1} =] \begin{pmatrix} 1 & \lambda + k\lambda \\ 0 & 1 \end{pmatrix} = \begin{pmatrix} 1 & \lambda(1+k) \\ 0 & 1 \end{pmatrix}$ So true for n = 1 and if true for n = k then true for n = k + 1, so true for all n	B1 M1 A1* A1dep [4]	2.1 2.1 2.2a 2.4	$1 \times \lambda$ must be seen. "True when $n = 1$" could appear later. $\mathbf{M}^{k+1} = \mathbf{M}^k\mathbf{M}$ or $\mathbf{M}^{k+1} = \mathbf{M}\mathbf{M}^k$ could be used. Required matrix with intermediate step seen $n = 1$ must have been considered
8	(d)		A shear with x-axis fixed, mapping (0,1) to ($n\lambda$, 1)	B1 [1]	1.1	Accept x-axis is a line of invariant points (not an invariant line only). Accept alternative mappings, e.g. $(1,1)$ to $(1+n\lambda, 1)$. Do not accept shear factor

Question			Answer	Marks	AO	Guidance
9	(a)			B1*	1.1	One loop in correct position (requires initial line drawn)
				B1*	1.1	Exactly three loops in correct position
				B1dep	1.1	Lower loop only shown with a broken line. Any coordinates on the curve must be correct (either polar or cartesian)
				[3]		
9	(b)		**DR**			
			$A=\int_0^{\frac{1}{3}\pi}\frac{1}{2}a^2\sin^2 3\theta\,\mathrm{d}\theta$	M1	1.1	$A=\int\frac{1}{2}a^2\sin^2 3\theta\,\mathrm{d}\theta$. Condone missing $\mathrm{d}\theta$.
				A1	1.1	Limits correct. Accept alternative limits between 0 and π provided correct multiplication or division of integral is seen or implied at some stage.
			$A=\int_0^{\frac{1}{3}\pi}\frac{1}{4}a^2(1-\cos 6\theta)\,\mathrm{d}\theta$	M1	3.1a	Double angle formula used correctly in their integral. Condone missing $\mathrm{d}\theta$.
			$=\frac{1}{4}a^2\left[\theta-\frac{1}{6}\sin 6\theta\right]_0^{\frac{1}{3}\pi}$	A1	1.1	$k[\theta-\frac{1}{6}\sin 6\theta]$. Condone incorrect or missing limits
			$=\frac{1}{12}\pi a^2$	A1	1.1	SC B4 for an otherwise fully correct answer using limits outside the range 0 to π.
				[5]		

Question			Answer	Marks	AO	Guidance
10	(a)		$x^3 - \frac{x^6}{2} + \frac{x^9}{3}$	B1 [1]	1.1	Must be simplified
10	(b)		let $x = \frac{1}{2}$	M1	3.1a	Or $x^3 = 0.125$. Must be seen, can be implied by explicit substitution.
			[ln 1.125 ≈] $\left(\frac{1}{2}\right)^3 - \frac{1}{2}\left(\frac{1}{2}\right)^6 + \frac{1}{3}\left(\frac{1}{2}\right)^9$	A1	1.1	oe correct substitution. If $x^3 = 0.125$ used then $0.125 - \frac{0.125^2}{2} + \frac{0.125^3}{3}$. FT their three terms. Cannot be implied.
			$= \frac{181}{1536}$ [so n = 181]	A1 [3]	1.1	cao
10	(c)		Charlie takes x = 2 The series only converges for $-1 < x \leq 1$	M1 A1	2.3 2.4	May be embedded See appendix. Do not award if spoilt by an incorrect statement.
			Alternative method Charlie takes $x^3 = 8$ The series only converges for $-1 < x^3 \leq 1$	M1 A1		May be embedded See appendix. Do not award if spoilt by an incorrect statement.
				[2]		

Question			Answer	Marks	AO	Guidance
11	(a)		$d = \frac{\lvert 2\times 8+(-1)\times 4+2\times 5-4\rvert}{\sqrt{2^2+(-1)^2+2^2}}$	M1	1.1	Use of distance from point to plane formula, must be correct. Condone missing modulus.
			$= 6$	A1	1.1	
			Alternative method Perpendicular from P to plane intersects plane at $(4, 6, 1)$ $d = \sqrt{(8-4)^2+(4-6)^2+(5-1)^2}$	M1		No slips allowed
			$= 6$	A1		
				[2]		
11	(b)		$\frac{8-2}{3} = \frac{4}{2} = \frac{5+3}{4} \quad [=2]$	M1	2.1	Substituting coordinates into line equation
			so P(8, 4, 5) lies on the line	A1	2.2a	Conclusion
			Alternative method $x = 2 + 3\lambda$, $y = 2\lambda$, $z = -3 + 4\lambda$ $2 + 3\lambda = 8$ $\Rightarrow \lambda = 2$	M1		A method to find λ from one coordinate
			$y = 2\times 2 = 4$, $z = -3 + 4\times 2 = 5$ so P(8, 4, 5) lies on the line	A1		Must show substitution for all three coordinates and conclude
				[2]		
11	(c)		$2(2+3\lambda)-2\lambda+2(-3+4\lambda)=4$	M1	1.1	or $(2\mathbf{i} - \mathbf{j} + 2\mathbf{k}).\big((2+3\lambda)\mathbf{i} + 2\lambda\mathbf{j} + (-3+4\lambda)\mathbf{k}\big) = 4$ Allow a slip
			$\Rightarrow \lambda = \frac{1}{2}$	A1	1.1	
			Point of intersection is $(\frac{7}{2}, 1, -1)$	A1	1.1	Accept $x = \frac{7}{2}, y = 1, z = -1$ Do not accept a position vector

Question			Answer	Marks	AO	Guidance
			Alternative method $x = \frac{3y+4}{2}$ and $z = 2y - 3 \Rightarrow 2\left(\frac{3y+4}{2}\right) - y + 2(2y-3) = 4$	**M1**		For an equation of the plane in only one of x, y or z. Allow a slip.
			$y = 1$	**A1**		Solving for the correct coordinate
			Point of intersection is $(\frac{7}{2}, 1, -1)$	**A1**		Accept $x = \frac{7}{2}$, $y = 1$, $z = -1$ Do not accept a position vector
				[3]		

Question			Answer	Marks	AO	Guidance
11	(d)		Let angle between line and normal = θ			
			$\cos\theta = \dfrac{(2\mathbf{i}-\mathbf{j}+2\mathbf{k}).(3\mathbf{i}+2\mathbf{j}+4\mathbf{k})}{\sqrt{2^2+(-1)^2+2^2}\times\sqrt{3^2+2^2+4^2}}$	**M1**	**1.1**	Must see a dot product or sum of three terms
			$= \dfrac{12}{\sqrt{9}\sqrt{29}}$		**1.1**	
			$\theta = 42.03°$	**A1**		or 0.73[358…] rad
			angle between line and plane = $90 - 42.03$	**M1**	**1.1**	Allow their angle $\theta - 90$ if their θ obtuse. Can be implied by correct final answer if correct θ found.
			= 48.0°	**A1**	**1.1**	or 0.837… rad. www.
			Alternative method 1			
			Let angle between line and plane $= \phi$			
			$\sin\phi = \dfrac{(2\mathbf{i}-\mathbf{j}+2\mathbf{k}).(3\mathbf{i}+2\mathbf{j}+4\mathbf{k})}{\sqrt{2^2+(-1)^2+2^2}\times\sqrt{3^2+2^2+4^2}}$	**M2**		Must see a dot product or sum of three terms
			$= \dfrac{12}{\sqrt{9}\sqrt{29}}$			
			$\phi = 48.0°$	**A2**		or 0.837… rad
			Alternative method 2			
			Let angle between line and normal $= \theta$			
			$\sin\theta = \dfrac{\lvert(2\mathbf{i}-\mathbf{j}+2\mathbf{k})\times(3\mathbf{i}+2\mathbf{j}+4\mathbf{k})\rvert}{\sqrt{2^2+(-1)^2+2^2}\times\sqrt{3^2+2^2+4^2}}$	**M1**		Complete method using vector product. Do not condone missing modulus unless a correct value for $\sin\theta$ is given
			$= \dfrac{\sqrt{117}}{\sqrt{9}\sqrt{29}}$			
			$\theta = 42.03°$	**A1**		or 0.73[358…] rad
			angle between line and plane = $90 - 42.03$	**M1**	**1.1**	Allow their angle $\theta - 90$ if their θ obtuse. Can be implied by correct final answer if correct θ found.
			= 48.0°	**A1**	**1.1**	or 0.837… rad. www.
				[4]		

Question			Answer	Marks	AO	Guidance
11	(e)		P to intersection $= \sqrt{(8-\frac{7}{2})^2 + (4-1)^2 + (5+1)^2}$	M1	3.1a	FT their coordinates from (c)
			$= \frac{3\sqrt{29}}{2}$	A1	1.1	or 8.0777... Do not FT.
			$\frac{3\sqrt{29}}{2} \times \frac{12}{3\sqrt{29}} = 6$	A1	3.2a	Condone using approximate values, e.g sin 48° or cos 42° for $\frac{12}{3\sqrt{29}}$, in which case condone ≈ for = FT their angle labels from previous parts
				[3]		

Question			Answer	Marks	AO	Guidance
12	(a)	(i)	At A, $\cosh t - 2\sinh t = 0 \Rightarrow \tanh t = \frac{1}{2}$	M1* A1	3.1a 1.1	Use of $\tanh t = \sinh t / \cosh t$ in $y = 0$ equation Correct value of $\tanh t$
			$\Rightarrow t = \frac{1}{2}\ln\frac{1+\frac{1}{2}}{1-\frac{1}{2}}$	M1dep	1.1	Use of artanh formula with their $\frac{1}{2}$
			$= \frac{1}{2}\ln 3$	A1	1.1	Must be exact, www
			Alternative method 1			
			$\cosh t - 2\sinh t = 0 \Rightarrow \frac{e^t+e^{-t}}{2} - 2\left(\frac{e^t-e^{-t}}{2}\right) = 0$	M1*		Exponential definitions used
			$3e^{-t} - e^t = 0$	A1		Collecting e^t terms and e^{-t} terms correctly
			$3 - e^{2t} = 0$			
			$2t = \ln 3$	M1dep		Logs taken to isolate a term in t correctly
			$t = \frac{1}{2}\ln 3$	A1		Must be exact www
			Alternative method 2			
			$\cosh^2 t = 4\sinh^2 t$			
			$1 + \sinh^2 t = 4\sinh^2 t$ or $\cosh^2 t = 4(\cosh^2 t - 1)$	M1*		Squaring both sides and using $\cosh^2 t - \sinh^2 t = 1$
			$\sinh t = \frac{1}{\sqrt{3}}$ or $\cosh t = \frac{2}{\sqrt{3}}$	A1		Correct value of $\sinh t$ or $\cosh t$. Condone $\sinh t = \pm\frac{1}{\sqrt{3}}$ but not $\cosh t = \pm\frac{2}{\sqrt{3}}$
			$t = \ln\left(\frac{1}{\sqrt{3}} + \sqrt{\frac{1}{3}+1}\right)$ or $t = \ln\left(\frac{2}{\sqrt{3}} + \sqrt{\frac{4}{3}-1}\right)$	M1dep		Use of arsinh or arcosh formula with their $\frac{1}{\sqrt{3}}$ or $\frac{2}{\sqrt{3}}$
			$= \frac{1}{2}\ln 3$	A1		Must be exact, www. Any $\sinh t < 0$ must be explicitly rejected.
				[4]		
12	(a)	(ii)	$x = 2\cosh\left(\frac{1}{2}\ln 3\right) + \sinh\left(\frac{1}{2}\ln 3\right)$	M1	1.1	Substituting *their* $\frac{1}{2}\ln 3$ $(= 0.5493)$ into correct expression for x. FT a decimal for their exact value.
			$= 2.89$ (3 s.f.)	A1 **[2]**	1.1	Must be 3sf

Question			Answer	Marks	AO	Guidance
12	**(b)**		$\frac{\mathrm{d}y}{\mathrm{d}x} = \frac{\mathrm{d}y}{\mathrm{d}t} \Big/ \frac{\mathrm{d}x}{\mathrm{d}t}$	**M1**	**3.1a**	Parametric differentiation leading to an expression for $\frac{\mathrm{d}y}{\mathrm{d}x}$ with correct numerator or denominator. Implied by correct expression for $\frac{\mathrm{d}y}{\mathrm{d}x}$.
			$= \frac{\sinh t - 2\cosh t}{2\sinh t + \cosh t}$	**A1**	**2.1**	Could be in exponential form, e.g. $\frac{\mathrm{e}^{t}+3\mathrm{e}^{-t}}{\mathrm{e}^{-t}-3\mathrm{e}^{t}}$
			When $t = 0, \sinh t = 0, \cosh t = 1 \Rightarrow \frac{\mathrm{d}y}{\mathrm{d}x} = -2$	**A1**	**2.1**	
			B is (2, 1)	**B1**	**2.1**	soi by correct use in equation for tangent
			so equation of tangent is $y - 1 = -2(x - 2)$	**M1**	**2.1**	Use of $y = mx + c$ or $y - y_1 = m(x - x_1)$ with their B(2, 1) and their value for $\frac{\mathrm{d}y}{\mathrm{d}x}$
			$\Rightarrow y = -2x + 5$	**A1** **[6]**	**2.2a**	or $2x + y = 5$ or $2x + y - 5 = 0$. Must be simplified.

Question			Answer	Marks	AO	Guidance
13	(a)	(i)	$1:3$	B1 [1]	1.1	or $\frac{1}{3}:1$ only
13	(a)	(ii)	θ	B1 [1]	1.1	
13	(b)	(i)	$(3-e^{i\theta})(3-e^{-i\theta}) = 9-3e^{i\theta}-3e^{-i\theta}+1$	M1	2.1	Expanding correctly to give at least three terms. Condone $e^0 = 1$.
			$= 10-3(e^{i\theta}+e^{-i\theta})$ $= 10-6\cos\theta$	A1 [2]	2.1	www. Condone only incorrect values quoted for a and b. Intermediate step not required here.
13	(b)	(ii)	$[z+z^2+\ldots=]\frac{1}{3}e^{i\theta}+\frac{1}{9}e^{2i\theta}+\ldots$	M1	2.1	At least two terms of series in exponential form soi by correct GP formula or $\frac{z}{1-z}$ seen. Condone modulus-argument form.
			$=\dfrac{\frac{1}{3}e^{i\theta}}{1-\frac{1}{3}e^{i\theta}}$ $\left[=\dfrac{e^{i\theta}}{3-e^{i\theta}}\right]$	A1	2.1	Using sum to infinity formula correctly
			$=\dfrac{e^{i\theta}(3-e^{-i\theta})}{(3-e^{i\theta})(3-e^{-i\theta})}$	M1*	3.1a	Multiplying their numerator and denominator by a multiple of $3-e^{-i\theta}$. Must be a clear attempt at a sum to infinity.
			$=\dfrac{3e^{i\theta}-1}{10-6\cos\theta}$	A1	2.1	oe
			$=\dfrac{3(\cos\theta+i\sin\theta)-1}{10-6\cos\theta}$	M1dep	2.1	$e^{i\theta}=\cos\theta+i\sin\theta$ used when denominator has been simplified to a real expression. No errors allowed.
			$\left[\frac{1}{3}\sin\theta+\frac{1}{9}\sin 2\theta\ldots=\right]\dfrac{3\sin\theta}{10-6\cos\theta}$	A1 [6]	2.2a	**AG** www

Question			Answer	Marks	AO	Guidance
14	(a)		AE is $\lambda^2+\lambda-2=0$	M1	1.1	Forming AE
			$\Rightarrow \lambda=-2, 1$	A1	1.1	
			CF is $Ae^{-2x}+Be^{x}$	A1	1.1	
			PI is $y=Ce^{-x}$	B1	1.1	
			$y'=-Ce^{-x},\ y''=Ce^{-x} \Rightarrow (C-C-2C)e^{-x}=12e^{-x}$	M1	2.1	Attempt to differentiate their PI twice and substituting. Do not condone $y=Ce^{-2x}$ or $y=Ce^{x}$.
			$\Rightarrow C=-6$	A1	1.1	
			GS is $y=Ae^{-2x}+Be^{x}-6e^{-x}$	A1	1.1	Must see $y=$
				[7]		
14	(b)		$B=0$	B1FT	3.1a	Equating coefficient(s) of their e^{kx} term(s) to 0 where $k>0$
			$\frac{dy}{dx}=-2Ae^{-2x}+Be^{x}+6e^{-x}$	M1*	1.1	FT their GS. Accept $\frac{dy}{dx}=-2Ae^{-2x}+6e^{-x}$ if $B=0$ already found. Allow a slip. Not implied by $-2A+B+6=0$.
			$A=3$ (so $\Rightarrow y=3e^{-2x}-6e^{-x}$)	A1	1.1	Do not FT.
			$y=0 \Rightarrow 3e^{-x}(e^{-x}-2)=0$ or $3-6e^{x}=0$	M1dep	1.1	A complete method to solve their $y=0$ which leads to a solution
			$\Rightarrow x=-\ln 2$	A1	1.1	or exact equivalent
				[5]		

Question			Answer	Marks	AO	Guidance
15	(a)		$\begin{vmatrix} 1 & k & 3 \\ 3 & 4 & 2 \\ 1 & 3 & -1 \end{vmatrix}$	M1	2.1	Considering correct determinant
			$\det \mathbf{M} = 1\times(-10) - k\times(-5) + 3\times 5$	M1	2.1	A correct method to find the determinant, allow one slip. Must contain a sum of three terms.
			$= 5k+5$	A1	1.1	Could be implied by $k=-1$ if working with det $\mathbf{M}=0$
			So planes meet at a point except when $k=-1$	A1	2.2a	Must make it clear that the planes do meet at a point for all values of k other than -1. Do not accept "solution" for "point". SC B2 if $5k+5$ found without working and a correct conclusion given.
			Alternative method $x = \dfrac{-2k^2+15k+17}{5k+5}, y = \dfrac{-7-7k}{5k+5}, z = \dfrac{3k^2-k-4}{5k+5}$	B2*		Correctly finding x, y or z in terms of k using simultaneous equations
			Undefined when $k=-1$	B1dep		
			So planes meet at a point except when $k=-1$	B1		www. Must make it clear that the planes do meet at a point for all values of k other than -1. Do not accept "solution" for "point". All three previous marks must have been awarded.
				[4]		

Question			Answer	Marks	AO	Guidance
15	(b)			M1	3.1a	Finding at least two correct cofactors (could be in matrix of cofactors or adj **M** or not in a matrix)
			$\mathbf{M}^{-1} = \frac{1}{5k+5}\begin{pmatrix} -10 & k+9 & 2k-12 \\ \mathbf{5} & \mathbf{-4} & \mathbf{7} \\ 5 & k-3 & 4-3k \end{pmatrix}$	A1 M1	1.1 1.1	All cofactors in bold correct Cofactor matrix transposed and multiplying by their $\frac{1}{\det \mathbf{M}}$ (could be seen in later calculation)
				A1	1.1	Correct inverse matrix (ignore first and third rows)
			$\begin{pmatrix} x \\ y \\ z \end{pmatrix} = \frac{1}{5k+5}\begin{pmatrix} -10 & k+9 & 2k-12 \\ 5 & -4 & 7 \\ 5 & k-3 & 4-3k \end{pmatrix}\begin{pmatrix} 1 \\ 3 \\ -k \end{pmatrix}$	M1	1.1	soi (may only see middle row). Dependent on at least M1 scored. Do not accept -1 substituted for k, this is not MR.
			$y = \frac{-7-7k}{5k+5} = -\frac{7}{5}$ which is independent of k	A1	3.2a	www, any values given in $\mathbf{M}^{-1}$ and any x or z coordinates given must be correct. Statement of independence required.
			Alternative method 1			NB This work may be seen in 15(a)
			$5x + 10y = 3 - 2k$	M1*		Eliminating x or z using two equations. Allow one slip only. Do not accept -1 substituted for k, this is not MR.
				A1		Correct elimination
			$4x + (9+k)y = 1 - 3k$	M1*		Eliminating same variable using different pair of equations. Allow one slip only. Do not accept -1 substituted for k, this is not MR.
				A1		Correct elimination
			$(5+5k)y = -7k - 7$	M1dep		Eliminating correctly to leave in terms of y and k only
			$y = \frac{-7-7k}{5k+5} = -\frac{7}{5}$ which is independent of k	A1cao		www, any x or z coordinates given must be correct. Statement of independence required.
			Alternative method 2			NB This work may be seen in 15(a)
			$5x + 10y = 3 - 2k$	M1*		Eliminating x, y or z. Allow one slip only. Do not accept -1 substituted for k, this is not MR.

Question			Answer	Marks	AO	Guidance
			$x = \dfrac{3 - 2k - 10y}{5}$	**A1**		Finding (e.g.) x in terms of y and k.
			$(k-3)y + 4z = 1 + k$	**M1***		Eliminating another variable. Allow one slip only. Do not accept -1 substituted for k, this is not MR.
			$z = \dfrac{1 + k - ky + 3y}{4}$	**A1**		Correctly
			$\dfrac{3-2k-10y}{5} + ky + \dfrac{3(1+k-ky+3y)}{4} = 1$	**M1dep**		Finding an equation for y in terms of k correctly
			$y = \dfrac{-7-7k}{5+5k} = -\dfrac{7}{5}$ which is independent of k	**A1cao**		www, any x or z coordinates given must be correct. Statement of independence required.
				[6]		

Question			Answer	Marks	AO	Guidance
16			**DR**			
			$\int_0^1 \frac{1}{\sqrt{x^2+x+1}}\,dx = \int_0^1 \frac{1}{\sqrt{\left(x+\frac{1}{2}\right)^2+\frac{3}{4}}}\,dx$	**B1**	**3.1a**	Completing the square
			let $u = x+\frac{1}{2} \Rightarrow du = dx$, giving $\int_{\frac{1}{2}}^{\frac{3}{2}} \frac{1}{\sqrt{u^2+\frac{3}{4}}}\,du$	**M1***	**2.1**	Any correct substitution for their integral, e.g. $x+\frac{1}{2} = \frac{\sqrt{3}}{2}\sinh u$
			$= \left[\text{arsinh}\frac{u}{\frac{1}{2}\sqrt{3}}\right]_{\frac{1}{2}}^{\frac{3}{2}}$ or $\left[\ln\left(u+\sqrt{u^2+\frac{3}{4}}\right)\right]_{\frac{1}{2}}^{\frac{3}{2}}$	**A1**	**2.1**	e.g. $[u]_{\text{arsinh}\frac{1}{\sqrt{3}}}^{\text{arsinh}\sqrt{3}}$, ignore limits. Correct substitution must have been made for this mark.
			$\left[= \text{arsinh}\sqrt{3} - \text{arsinh}\frac{1}{\sqrt{3}}\right]$			
			$= \ln\left(\sqrt{3}+2\right) - \ln\frac{3}{\sqrt{3}}$ or $\ln\left(\frac{3}{2}+\sqrt{3}\right) - \ln\frac{3}{2}$	**A1**	**2.1**	A correct expression in logarithmic form (need not be simplified)
			$= \ln\left(\frac{3+2\sqrt{3}}{3}\right)$	**M1dep** **A1**	**2.1** **2.1**	Combining logs. www. Can be implied by correct final answer provided two log terms shown.
			Alternative method			
			$\int_0^1 \frac{1}{\sqrt{x^2+x+1}}\,dx = \int_0^1 \frac{1}{\sqrt{\left(x+\frac{1}{2}\right)^2+\frac{3}{4}}}\,dx$	**B1**		Completing the square
			$\left[\text{arsinh}\frac{x+\frac{1}{2}}{\frac{1}{2}\sqrt{3}}\right]_0^1$ or $\left[\ln\left(x+\frac{1}{2}+\sqrt{(x+\frac{1}{2})^2+\frac{3}{4}}\right)\right]_0^1$	**M1*** **A1**		By inspection for their integral, no slips Correct, ignore limits
			$= \ln\left(\sqrt{3}+2\right) - \ln\frac{3}{\sqrt{3}}$ or $\ln\left(\frac{3}{2}+\sqrt{3}\right) - \ln\frac{3}{2}$	**A1**		A correct expression in logarithmic form (need not be simplified)
			$= \ln\left(\frac{3+2\sqrt{3}}{3}\right)$	**M1dep** **A1**		Combining logs. www. Can be implied by correct final answer provided two log terms shown.

Question			Answer	Marks	AO	Guidance
				[6]		

Question			Answer	Marks	AO	Guidance
17	(a)	(i)	After t minutes volume of liquid = 1000 – 5t [litres] so concentration = $\frac{x}{1000-5t}$	B1 [1]	3.1b	**AG** Volume of liquid (allow "volume", "amount of liquid", "capacity" or "liquid") in the container must be given in first step. Do not allow "volume leaving".
`17	(a)	(ii)	$\frac{dx}{dt} = 10$ ... ... $[-]5\left(\frac{x}{1000-5t}\right)$ $\Rightarrow \frac{dx}{dt} + \frac{x}{200-t} = 10$	B1* B1* B1dep [3]	3.3 3.3 3.3	 Not oe **AG** successful completion
17	(b)		IF is $e^{\int \frac{1}{200-t} dt}$ $= e^{-\ln(200-t)} = \frac{1}{200-t}$ $\Rightarrow \frac{1}{200-t}\frac{dx}{dt} + \frac{x}{(200-t)^2} = \frac{10}{200-t}$ $\Rightarrow \frac{d}{dt}\left(\frac{x}{200-t}\right) = \frac{10}{200-t}$ or $\frac{x}{200-t} = \int \frac{10}{200-t} dt$ $\frac{x}{200-t} = -10\ln(200-t)$ [$+c$] $t = 0, x = 0 \Rightarrow c = 10\ln 200$ $\frac{x}{200-t} = -10\ln(200-t) + 10\ln 200 = 10\ln\left(\frac{200}{200-t}\right)$ $x = 10(200-t)\ln\left(\frac{200}{200-t}\right)$	M1 A1 M1 M1* A1 B1FT M1dep A1 [8]	3.1a 2.1 2.1 2.1 2.1 3.1b 2.1 2.1	Finding integrating factor Allow $A\frac{1}{200-t}$ where A is clearly an unevaluated constant of integration and not from incorrect integration Multiplying equation by *their* IF, soi by next line Either, ft their IF (i.e. their IF × x) First A1 must have been scored. Condone missing $+c$ and bracketing errors. Correct c for their integral Combining their log terms correctly, do not condone bracketing errors without clear recovery **AG** www

Question			Answer	Marks	AO	Guidance
17	(c)	(i)	Half drawn off when $t = 100$ $\Rightarrow x = 10 \times 100 \times \ln 2 = 693$ [g]	M1 A1 [2]	3.4 3.4	May be embedded but must be seen Accept 690 or better, or $1000 \ln 2$
17	(c)	(ii)	[x is maximised when] $\frac{dx}{dt} = 0$ $10(200 - t)\ln\left(\frac{200}{200 - t}\right) = 10(200 - t)$ $\Rightarrow \ln\left(\frac{200}{200 - t}\right) = 1$ $\Rightarrow \frac{200}{200 - t} = e$ $\Rightarrow t = 126.42\ldots$	M1 M1* A1 M1dep A1 [5]	3.1a 1.1 1.1 1.1 3.4	soi. Implied by $x = 10(200 - t)$. Or finding $\frac{dx}{dt} = 10(1 - \ln\left(\frac{200}{200-t}\right))$ correctly Eliminating logarithms correctly 130 (2sf) or better. Do not accept exact value. Ignore units.
17	(d)		In reality the salt would not dissolve/mix/spread/diffuse/disperse/distribute instantly	B1 [1]	3.5b	Or "the salt does not dissolve/mix/spread/diffuse/disperse/distribute uniformly". Must be explicit that modelling assumption is unrealistic. Ignore subsequent comments Do not accept reference to volume or exogenous factors, e.g. evaporation/temperature

APPENDIX

Exemplar responses for Q7a

Response	**Mark**
$\dfrac{1}{\sqrt[3]{x-2}}$ is undefined when $x = 2$	**B1**
There is an asymptote at $x = 2$	**B1**
The function is not continuous at $x = 2$	**B1**
When $x = 2$ the denominator will be 0 and $\frac{1}{0}$ is undefined/impossible/invalid/improper/indeterminate/an error/cannot be computed	**B1**
When $x = 2$ we get 1 divided by 0 which is undefined/impossible/invalid/improper/indeterminate/an error/cannot be computed	**B1**
When $x = 2$ we get $\frac{1}{0}$ which makes the integral undefined/impossible/invalid/improper/indeterminate/an error/incomputable	**B1**
When $x = 2$ the denominator of the function is 0 and you cannot divide by 0	**B1**
When $x = 2$ it becomes $\frac{1}{0}$ = undefined	**B1**
When $x = 2$ we get $\frac{1}{0}$ which tends to infinity	**B0**
When $x = 2$ we get $\frac{1}{0}$ which is divergent	**B0**
When $x = 2$ we get $\frac{1}{0}$ which has no solutions	**B0**
When $x = 2$ we get 1 divided by 0 which is an error function	**B0**
When $x < 2$ the value is complex/not a real number	**B0**
It is undefined when $x \to 2$	**B0**
It is undefined when $x = 2$	**B1**

Exemplar responses for Q10c – A1 mark only; the M1 mark is not implied by any of the responses below and must be secured separately

Response	**Mark**
[The series] converges/works only when $-1 < x \leq 1$	**A1**
The series requires/works/converges when $-1 < x \leq 1$	**A1**
The series converges only when $-1 < x < 1$	**A0**
The series converges when $-1 \leq x \leq 1$	**A0**
The series does not converge when $x > 1$	**A1**
The series does not converge when x is greater than 1	**A1**
The series does not converge when $x \geq 1$	**A0**
The series converges only when $\lvert x \rvert < 1$	**A0**
The series does not converge when $\lvert x \rvert > 1$	**A1**
The series does not converge when $\lvert x \rvert \geq 1$	**A0**
The series does not converge when $\lvert x \rvert \geq 1$ unless $x = 1$	**A1**
$x = 2$ is greater than 1 so outside the range for convergence	**A1**
$2 \geq 1$	**A0**
For series to converge $x < 1$	**A0**
$2 > 1$ so the series does not converge	**A1**

The following statements do not score by themselves but will not spoil an otherwise correct answer:

The series converges when $-1 < x < 1$
The series converges when x is between -1 and 1
For the series to converge x must be between -1 and 1

The series converges when $\|x\| < 1$
$2 > 1$
The series does not converge when $x = 2$

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