

Cambridge Technicals

Engineering

Unit 23: Applied mathematics for engineering

Level 3 Cambridge Technical Certificate/Diploma in Engineering
05823 - 05825 & 05873

Mark Scheme for June 2025

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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.

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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 available in RM Assessor
3. Log-in to RM Assessor and mark the **required number** of practice responses (“scripts”) and the **required number** of 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% 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, email or via the RM Assessor messaging system.
5. **Crossed-Out Responses**
Where a candidate has crossed out a response and provided a clear alternative then the crossed-out response is not marked. Where no alternative response has been provided, examiners may give candidates the benefit of the doubt and mark the crossed-out response where legible.

Multiple-Choice Question Responses

When a multiple-choice question has only a single, correct response and a candidate provides two responses (even if one of these responses is correct), then no mark should be awarded (as it is not possible to determine which was the first response selected by the candidate).

When a question requires candidates to select more than one option/multiple options, then local marking arrangements need to ensure consistency of approach.

Contradictory Responses

When a candidate provides contradictory responses, then no mark should be awarded, even if one of the answers is correct.

Short Answer Questions (requiring only a list by way of a response, usually worth only one mark per response)

Where candidates are required to provide a set number of short answer responses then only the set number of responses should be marked. The response space should be marked from left to right on each line and then line by line until the required number of responses have been considered. The remaining responses should not then be marked. Examiners will have to apply judgement as to whether a 'second response' on a line is a development of the 'first response', rather than a separate, discrete response. *(The underlying assumption is that the candidate is attempting to hedge their bets and therefore getting undue benefit rather than engaging with the question and giving the most relevant/correct responses.)*

Short Answer Questions (requiring a more developed response, worth two or more marks)

If the candidates are required to provide a description of, say, three items or factors and four items or factors are provided, then mark on a similar basis – that is downwards (as it is unlikely in this situation that a candidate will provide more than one response in each section of the response space).

Longer Answer Questions (requiring a developed response)

Where candidates have provided two (or more) responses to a medium or high tariff question which only required a single (developed) response and not crossed out the first response, then only the first response should be marked. Examiners will need to apply professional judgement as to whether the second (or a subsequent) response is a 'new start' or simply a poorly expressed continuation of the first response.

6. Always check the pages (and additional objects if present) at the end of the response in case any answers have been continued there. If the candidate has continued an answer there, then add the annotation 'SEEN' to confirm that the work has been seen and mark any responses using the annotations in section 10.

7. There is a NR (**No Response**) option. Award NR (No Response):

- if there is nothing written at all in the answer space
- OR if there is a comment which does not in any way relate to the question (e.g., 'can't do', 'don't know')
- OR if there is a mark (e.g., a dash, a question mark) which is not an attempt at the question.

Note: Award 0 marks – for an attempt that earns no credit (including copying out the question).

8. The RM Assessor **comments box** is used by your Team Leader to explain the marking of the practice responses. Please refer to these comments when checking your practice responses. **Do not use the comments box for any other reason.**

9. *Assistant Examiners will send a brief report on the performance of candidates to their Team Leader (Supervisor) via email by the end of the marking period. The report should contain notes on particular strengths displayed as well as common errors or weaknesses. Constructive criticism of the question paper/mark scheme is also appreciated.*

10. For answers marked by levels of response: Not applicable in F501

To determine the level – start at the highest level and work down until you reach the level that matches the answer

To determine the mark within the level, consider the following

Descriptor	Award mark
On the borderline of this level and the one below	At bottom of level
Just enough achievement on balance for this level	Above bottom and either below middle or at middle of level (depending on number of marks available)
Meets the criteria but with some slight inconsistency	Above middle and either below top of level or at middle of level (depending on number of marks available)
Consistently meets the criteria for this level	At top of level

11. Annotations

Annotation	Meaning
	Correct response
	Incorrect response
	Missing something
	Follow through
	Benefit of doubt
	Ignore subsequent working
	Method mark awarded 0
	Method mark awarded 1
	Accuracy mark awarded 0
	Accuracy mark awarded 1
	Independent mark awarded 0
	Independent mark awarded 1
	Special Case
	Transcription error

Mark scheme abbreviations

Other abbreviations in mark scheme	Meaning
oe	Or equivalent
Soi	Seen or implied
www	Without wrong working
ecf	Error carried forward
DM	Method mark dependent on previous M mark

12. Subject-specific marking instructions

Annotations should be used whenever appropriate during your marking.

The A, M and B annotations must be used on your standardisation scripts for responses that are not awarded either 0 or full marks.

It is vital that you annotate standardisation scripts fully to show how the marks have been awarded. These annotations must be in the body of the work and **not** anywhere near the right hand margin of each page.

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 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, award marks according to the spirit of the basic scheme; if you are in any doubt whatsoever (especially if several marks or candidates are involved) you should contact your Team Leader.

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.

DM

A method mark which is dependent on a previous method mark.

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.

Unless otherwise indicated, marks once gained cannot subsequently be lost, eg 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.

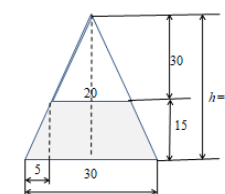
When a part of a question has two or more 'method' steps, the M marks are in principle independent unless the scheme specifically says otherwise; and similarly where there are several B marks allocated. Of course, in practice it may happen that when a candidate has once gone wrong in a part of a question, 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.

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, exactly what is acceptable will be detailed in the mark scheme rationale. If this is not the case please consult your Team Leader.

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.

Wrong or missing units in an answer should not lead to the loss of a mark unless the scheme specifically indicates otherwise. Candidates are expected to give numerical answers to an appropriate degree of accuracy, with 3 significant figures often being the norm. Small variations in the degree of accuracy to which an answer is given (e.g. 2 or 4 significant figures where 3 is expected) should not normally be penalised, while answers which are grossly over- or under-specified should normally result in the loss of a mark. The situation regarding any particular cases where the accuracy of the answer may be a marking issue should be detailed in the mark scheme rationale. If in doubt, contact your Team Leader.

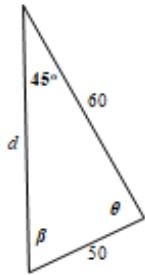
Question			Answer	Mark	Guidance
1	(a)		Using similar triangles $\frac{15}{5} = \frac{h}{15}$ $h = 45$ Volume of tub = $\frac{1}{3}\pi(15^2)(45) - \frac{1}{3}\pi(10^2)(30)$ 7461.28 (cm³) or 7460 (cm³)	M1 A1 M1 A1	Relevant proportional reasoning that would lead to height of larger cone or height of smaller cone Obtains 45 for height of larger cone or 30 for height of smaller cone. Both marks can be implied from a labelled diagram. Forms expression for volume using their heights and $\frac{1}{3}\pi r^2 h$ Accept answers in range 7460 to 7462, accept 2375π
			<u>Volume of frustrum alternative:</u> $\frac{1}{3}15(\pi \cdot 15^2 + \pi \cdot 10^2 + \sqrt{\pi \cdot 15^2 \times \pi \cdot 10^2})$ Or $\frac{1}{3}\pi 15(15^2 + 10^2 + 15 \times 10)$ 7461.28 (cm³) or 7460 (cm³)	M1 M1 A1 A1	$\frac{1}{3}h(A_1 + A_2 + \sqrt{A_1 \times A_2})$ or $\frac{1}{3}\pi h(R^2 + r^2 + Rr)$ where A_1 and A_2 are the areas of the top and bottom Sight of formula with $h = 15$ used Use radii for bottom and top of frustrum Fully correct Accept answers in range 7460 to 7462, accept 2375π
				[4]	



1	(b)	Length of side of large cone $= \sqrt{45^2 + 15^2} = 47.434...$ Length of side of small cone $= \sqrt{30^2 + 10^2} = 31.622...$ Surface area of tub side $= \pi(15 \times 47.434... - 10 \times 31.622...) = 1241.82...$ Base of tub $= \pi \times 10^2... = 314.159...$ Total surface area = $1241.82 + 314.16 = 1555.98 \text{ (cm}^2\text{)}$ Or $1560 \text{ (cm}^2\text{)}$	M1 All method marks available <u>using Pythagoras</u> with their heights from 1a Note: $15\sqrt{10}$ M1 Note: $10\sqrt{10}$ M1 Uses πrl. Subtraction with <u>appropriate attempt at sloping lengths</u> Note: $125\sqrt{10}\pi$ B1 soi anywhere Note: 100π A1 Accept answers between 1550 and 1560 Note: $\approx 1634/1635$ including the bases with larger and smaller cones before subtracting: can score M1M1M1B1A0
		<u>Curved area of frustrum alternative:</u> Sloping side length $l = \sqrt{15^2 + 5^2}$ Surface area of tub side $\pi(15 + 10)\sqrt{250}$ or $\frac{1}{2}(2\pi \times 15 + 2\pi \times 10)\sqrt{250}$ $[=1241.82..]$ Base of tub $= \pi \times 10^2... = 314.159...$ Total surface area = $1241.82 + 314.16 = 1555.98 \text{ (cm}^2\text{)}$ Or $1560 \text{ (cm}^2\text{)}$	Formula: $\pi(R + r)l$ or $\frac{1}{2}(C_1 + C_2)l$ if using circumferences of top & bottom M1 note: $5\sqrt{10}$ or 15.8(11..) M1 Uses correct formula with their <u>appropriate attempt at l</u> M1 Uses radii for bottom and top of frustrum B1 Soi anywhere Note: 100π A1 Accept answers between 1550 and 1560
			[5]

Question			Answer	Mark	Guidance
2	(a)		$R = \frac{P}{\rho T}$ $\left(\frac{\text{N}}{\text{m}^2}\right)\left(\frac{\text{kg}}{\text{m}^3}\right)^{-1}(\text{K})^{-1} = \text{N m kg}^{-1}\text{K}^{-1}$	B1 B1	Correct rearrangement seen or implied or $\text{J kg}^{-1} \text{K}^{-1}$ or $\text{m}^2 \text{s}^{-2} \text{K}^{-1}$ Final answer (with Nm) must have the m terms collected
				[2]	
2	(b)		$\rho = \frac{P}{TR} = \frac{101300}{373 \times 287}$ $\rho = 0.946278 \dots \approx 0.946 \text{ (kg m}^{-3}\text{)}$	M1 A1	Correctly substitutes values into formula eg $101300 = \rho(373)(287)$ Correct to 3sf or better
				[2]	
2	(c)		Mass of air in envelope = $3000 \times 0.946 =$ $2838(.8\dots)$ (kg) Mass of air displaced = 3000×1.2 (kg) = 3600 (kg) Mass of the balloon's equipment together with its passengers can be up to $3600 - 2838.8 \approx$ 761 (kg)	M1 A1 B1 M1 A1	Using their value for density from 2b AWR 2840 here Correct mass of displaced air Accept answers between 760 and 762
				[5]	

Question			Answer	Mark	Guidance
3	(a)		$\mathbf{c} = \mathbf{a} + \mathbf{b} = (2\mathbf{i} + \mathbf{j} + 3\mathbf{k}) + (3\mathbf{i} + 2\mathbf{j} + \mathbf{k})$ Coordinates (5, 3, 4)	M1 A1	Adds the two vectors. May use column vectors. Must be given as coordinates or $x = 5, y = 3, z = 4$
				[2]	
3	(b)		$ \mathbf{a} = \sqrt{2^2 + 1 + 3^2} = \sqrt{14}$ $ \mathbf{b} = \sqrt{3^2 + 2^2 + 1} = \sqrt{14}$ $2 \times 3 + 1 \times 2 + 3 \times 1 = 11$ $\sqrt{14}\sqrt{14} = 11 \cos \theta$ $\cos \theta = 11/14$ $\theta = \cos^{-1}(11/14) = 38.213...(^{\circ})$ or $0.666..$ (radians)	M1* M1* A1 DM1 A1	<u>Do not</u> allow alternative methods here Magnitude of either vector seen or implied Forms dot product correctly as $a_1b_1 + a_2b_2 + a_3b_3$ Sight of “11” implies M1A1 Substitutes their values into correct scalar product equation. Dependent on both earlier M1 awarded Correct to 3sf or better
				[5]	
3	(c)		$\mathbf{a} \times \mathbf{b} = (1-6)\mathbf{i} - (2-9)\mathbf{j} + (4-3)\mathbf{k}$ $= -5\mathbf{i} + 7\mathbf{j} + \mathbf{k}$	M1 M1 A1	At least one component formed correctly All three components formed correctly Must be in i, j, k form
				[3]	
3	(d)		Area of triangle $= \frac{1}{2}\sqrt{14}\sqrt{14} \sin 38.2$ Area of parallelogram $= 2 \times \frac{1}{2}\sqrt{14}\sqrt{14} \sin 38.2 = 8.66$	M1 A1	With their magnitudes (from <u>appropriate Pythagoras</u> here or in 3b) and their angle from 3b OR area = mod ($\mathbf{a} \times \mathbf{b}$) $= \sqrt{5^2 + 7^2 + 1} (= \sqrt{75})$ Correct to 3sf or better Accept alternative methods: eg Area of parallelogram with $h = \sqrt{14} \sin \theta = 2.3145... \text{ Area} = \sqrt{14} \times h$
				[2]	

4	(b)		$\frac{50}{\sin 45} = \frac{60}{\sin \beta} \text{ oe}$ $\sin \beta = 6 \sin(45)/5 = 0.8485$ $\beta = 58(.052)$ $\theta = 180 - 45 - 58.052 = 76.948$ $\frac{d}{\sin \theta} = \frac{50}{\sin 45}$ $d = 50 \sin(76.948)/\sin(45)$ $= 68.88 \text{ (mm) or } 68.9$	M1 Appropriate use of sine rule A1 β correct M1 Appropriate use of sine rule or equivalent method to $d = ..$ A1 Accept answers between 68.8 and 68.9 <u>Accept alternative methods eg</u> cosine rule with appropriate quadratic in d. $50^2 = d^2 + 60^2 - 120 \times d \times \cos(45)$ $d^2 - 84.8528d + 1100 = 0$	
				[4]	

Question			Answer	Mark	Guidance
5	(a)		With $\alpha = 0$, $c = 70000$ With $\alpha = 5$, $120\,000 = 25a + 5b + 70\,000$ (or +c) With $\alpha = 10$, $250\,000 = 100a + 10b + 70\,000$ (or +c) $a = 1600$ $b = 2000$	B1 M1 A1 M1 A1	Forms at least one appropriate equation (using radians allow M1A0 here and can earn second M1) Two correct equations, in any equivalent form eg $50000 = 25a + 5b$ oe $180000 = 100a + 10b$ oe Solve by any appropriate method to $a = \dots$ or $b = \dots$ Both correct
				[5]	
5	(b)		$\frac{L}{D} = \frac{1\,000\,000 + 400\,000\theta}{1\,600\theta^2 + 2\,000\theta + 70\,000} \left[= \frac{1000 + 400\theta}{1.6\theta^2 + 2\theta + 70} \right]$ $\frac{d\left(\frac{L}{D}\right)}{d\theta} = \frac{(1.6\theta^2 + 2\theta + 70)400 - (1000 + 400\theta)(3.2\theta + 2)}{(1.6\theta^2 + 2\theta + 70)^2}$ $\frac{d\left(\frac{L}{D}\right)}{d\theta} = 0 \Rightarrow$ $(1.6\theta^2 + 2\theta + 70)400 - (1000 + 400\theta)(3.2\theta + 2) = 0$ $-640\theta^2 - 3200\theta + 26000 = 0$ $\theta = 4.3465\dots$ [$\theta = -9.34\dots$] $\theta = 4.3465\dots \approx 4.35$ as the only final answer	M1* M1* A1 M1* DM1 A1	Forms $\frac{L}{D}$ using their a, b, c Correct application of quotient rule All correct, any equivalent form Set numerator to 0 Simplify to 3 term quadratic, dependent on all earlier method marks Must discard $-9.3465\dots$ if seen Candidates are not required to prove this is a maximum
				[6]	

Question			Answer	Mark	Guidance
6	(a)		$A = \int_0^{\pi/4} \cos x - \sin x \, dx = [\sin x + \cos x]_0^{\pi/4}$	B1	Integration correct. May be done separately
			$A = \frac{\sqrt{2}}{2} + \frac{\sqrt{2}}{2} - 1 = \sqrt{2} - 1 \text{ AG}$	B1	Correct use of limits to obtain given answer eg $\left(\frac{\sqrt{2}}{2}\right) - \left(-\frac{\sqrt{2}}{2} - -1\right)$
				[2]	
6	(b)		$\bar{x} = \frac{1}{\sqrt{2} - 1} \int_0^{\pi/4} x(\cos x - \sin x) \, dx$	B1	Correct integral stated, with A substituted and correct limits seen or implied at any point
			$\begin{array}{lll} u = x & v' = \cos x - \sin x & \text{oe} \\ u' = 1 & v = \sin x + \cos x & \text{oe} \end{array}$	M1*	Attempt integration by parts, soi by u, v' , and attempt at u', v
			$\int x(\cos x - \sin x) \, dx = x(\sin x + \cos x) - \int (\sin x + \cos x) \, dx$	DM1	Complete attempt at integration by parts, dependent on M1
			$[x(\sin x + \cos x)]_0^{\pi/4} - [-\cos x + \sin x]_0^{\pi/4}$	A1	Fully correct integration of $x(\cos x - \sin x)$ soi
			$\left[\frac{\pi}{4}\left(\frac{\sqrt{2}}{2} + \frac{\sqrt{2}}{2}\right) - (0)\right] - \left[\left(-\frac{\sqrt{2}}{2} + \frac{\sqrt{2}}{2}\right) - (-1)\right]$	DM1	Apply limits correctly, following earlier M1M1
			$\bar{x} = \left(\frac{1}{\sqrt{2}-1}\right)\left(\frac{\pi}{4}\sqrt{2} - 1\right) \text{ AEF}$	A1	Any equivalent surd form or decimal $2.4142... \times 0.11072 = 0.2673... \approx 0.267 \text{ (mm)}$
				[6]	

6	(c)	$\bar{y} = \frac{1}{2(\sqrt{2}-1)} \int_0^{\pi/4} (\cos^2 x - \sin^2 x) dx$ $\int \frac{1 + \cos 2x}{2} - \frac{1 - \cos 2x}{2} dx$ $\int \cos 2x dx$ $\left[\frac{\sin 2x}{2} \right]_0^{\pi/4}$ $\frac{\sin 2\left(\frac{\pi}{4}\right)}{2} - \frac{\sin 2(0)}{2} = \frac{1}{2}$ $\bar{y} = \frac{1}{2(\sqrt{2}-1)} \times \frac{1}{2} = \frac{1}{4(\sqrt{2}-1)}$ $(=0.60355.. \approx 0.604)$	B1 All correct at any point M1* Substitutes the given identities oe eg straight to $\cos 2x$ M1* Integrate to obtain $\frac{\sin 2x}{k}$, $k = 2, \frac{1}{2}$ Allow with $\frac{1}{2}x$.. $-\frac{1}{2}x$ still present DM1 Correct application of limits A1 Any equivalent surd form $\frac{1+\sqrt{2}}{4}$ eg or decimal Accept alternatives, eg $\frac{1}{4} \int_0^{\pi/4} ((1 - \sin^2 x) - \sin^2 x) dx$ $\frac{1}{4} \int_0^{\pi/4} ((1 - 2 \sin^2 x)) dx$ $\frac{1}{4} \int_0^{\pi/4} ((1 - 2(1 - \cos(2x))/2) dx$ $\frac{1}{4} \int_0^{\pi/4} (\cos 2x) dx$
			[5]

Question			Answer	Mark	Guidance
7	(a)		$A \frac{dh}{dt} = Q_i - ch$ $\int \frac{dh}{Q_i - ch} = \int \frac{dt}{A}$ $\frac{\ln(Q_i - ch)}{-c} = \frac{t}{A} + (k)$ $\ln(Q_i - ch) = -\frac{ct}{A} + K \quad Q_i - ch = Ke^{-\frac{ct}{A}}$ $ch = Q_i - Ke^{-\frac{ct}{A}} \rightarrow h = \frac{Q_i - Ke^{-\frac{ct}{A}}}{c}$ $t = 0, h = 0 \Rightarrow k = Q_i$ $h = \frac{Q_i(1 - e^{-\frac{ct}{A}})}{c}$ AG		B1 oe Separate variables correctly. Allow with integral signs missing M1 Integrate to obtain an appropriate log term with divisor A1 Integration fully correct (allow without constant) M1 Antilogs M1 Make h the subject M1 Attempt constant of integration using $t = 0, h = 0$ Note: these method marks can be earned in any order A1 Must be convincing SC: Integrating factor method: M1: equation written as $\frac{dh}{dt} + \frac{c}{A}h = \frac{Q_i}{A}$ B1: integrating factor $e^{\frac{ct}{A}}$ M1: $e^{\frac{ct}{A}} \cdot h = \int Q_i \cdot e^{\frac{ct}{A}}$ A1: $e^{\frac{ct}{A}} \cdot h = \frac{Q_i}{c} \cdot e^{\frac{ct}{A}} + D$ M1: attempt D $\rightarrow D = -\frac{Q_i}{c}$ M1: make h the subject $\rightarrow h = \frac{Q_i}{c} - \frac{Q_i}{c} \cdot e^{-\frac{ct}{A}}$ A1: $h = \frac{Q_i(1 - e^{-\frac{ct}{A}})}{c}$
				[7]	

7	(b)		$Q_o = ch \rightarrow 0.15 = c \cdot 0.5$ $c = 0.3 \quad (\text{L m}^{-1}\text{s}^{-1})$	B1	
				[1]	
7	(c)		Using $h = \frac{Q_i(1-e^{-\frac{0.3t}{A}})}{0.3}$ As $t \rightarrow \infty h \rightarrow \frac{Q_i}{c} = 0.25/0.3 [=0.833\dots (\text{m})]$ $0.8333 < 1$ Therefore the water does not overflow.	M1 A1	Appropriate justification of a limiting value, with their c. Without any justification eg $h = \frac{0.25}{0.3}$ scores M0
				[2]	
7	(d)		$0.4 = \frac{0.25(1-e^{-\frac{0.3t}{1000}})}{0.3}$ $0.48 = 1 - e^{-0.3t/1000}$ $e^{-0.3t/1000} = 0.52$ $\frac{-0.3t}{1000} = \ln 0.52 = -0.6539$ $t = 2179.7 (\text{s}) \quad (36.32 \text{ min} \approx 36.3)$	M1 M1 A1	Apply formula with $h = 0.4$, $A = 1000$, and their c Rearrange and take logs Allow answers that round to 2180
				[3]	

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