GCE

Mathematics B MEI

H630/01: Pure Mathematics and Mechanics

AS Level

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% (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, 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.

   Rubric Error Responses – Optional Questions
   Where candidates have a choice of question across a whole paper or a whole section and have provided more answers than required, then all responses are marked and the highest mark allowable within the rubric is given. Enter a mark for each question answered into RM Assessor, which will select the highest mark from those awarded. *(The underlying assumption is that the candidate has penalised themselves by attempting more questions than necessary in the time allowed.)*

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 11.

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
✓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
SC	Special case
^	Omission sign
MR	Misread
BP	Blank Page
Seen	
Highlighting	

Other abbreviations in mark scheme	Meaning
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.

12. **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 NR (No Response)
- if there is nothing written at all in the answer space and no attempt elsewhere in the script
- 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, a picture) which isn't an attempt at the question.

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

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.

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. 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		$(2a)^4 + 4(2a)^3(-b) + 6(2a)^2(-b)^2 +$	M1	1.1a	Uses the binomial expansion to give at least three terms with descending powers of $2a$ (or a) (condone missing brackets) and ascending powers of $-b$ (or b) soi
		$4(2a)(-b)^3 + (-b)^4$	A1	1.1	At least 3 correct terms in the un-simplified or simplified expression seen
		$= 16a^4 - 32a^3b + 24a^2b^2 - 8ab^3 + b^4$	A1	1.1	All correct and fully simplified
		Alternative method: $(4a^2 - 4ab + b^2)(2a - b)^2$	M1		Expands brackets as far as a quadratic factor seen
		$= 16a^4 - 32a^3b + 24a^2b^2 - 8ab^3 + b^4$	A1 A1		At least 3 correct terms in the fully expanded expression Fully correct
			[3]		

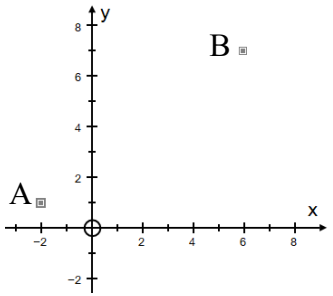
Question		Answer	Marks	AO	Guidance
2		$\frac{\sin \text{CAB}}{3p} = \frac{\sin 25}{2p}$	M1	1.1a	Attempt to use the sin rule soi. Do not allow for $\frac{\sin \text{CAB}}{2p} = \frac{\sin 25}{3p}$
		$\text{CAB} = 180 - \sin^{-1}(1.5 \sin 25)$ $= 140.65$	A1	1.1	Cao, must be obtuse. Awrt 141°
			[2]		

Question	Answer	Marks	AO	Guidance
3	**DR** Gradient of PQ is $\frac{3-0}{-1-5} = -0.5$	**M1**	**1.1**	May be implied by $\pm\frac{1}{2}$ seen used as gradient. Do not allow if reciprocal of gradient formula used.
	Equation of PQ is $y - 3 = -0.5(x + 1)$	**A1**	**1.1**	$y = -0.5x + 2.5$ or $2y + x = 5$
	Substitution method $3x - 4 = -0.5x + 2.5$	**M1**	**1.1**	Eliminates one variable leading to a value for the other variable
	$x = \frac{13}{7},\ y = \frac{11}{7}$	**A1**	**1.1**	Both correct. Condone 1.86 and 1.57 or better
	Alternative elimination method for final M1A1: $3x - y = 4$ $\underline{x + 2y = 5}$ $6x - 2y = 8$ or $3x - y = 4$ $\underline{x + 2y = 5}$ $\underline{3x + 6y = 15}$	**M1**		Attempt to match coefficients must be seen eg $6x - 2y = 8$ or $3x + 6y = 15$ leading to a value for either x or y
	$x = \frac{13}{7}, y = \frac{11}{7}$	**A1**		Both correct. Condone 1.86 and 1.57 or better
		[4]		

Question		Answer	Marks	AO	Guidance
4	(a)	Discriminant $k^2 - 4(-k^2) = 5k^2$	M1	2.1	Attempt to evaluate the discriminant in terms of k. Also allow for an attempt to use the roots of the equation
		This is never negative so has real roots for all (real) values of k	A1 [2]	2.2a	Clear argument from correct discriminant Condone "This is always positive" or > 0 used in the argument for real roots Also allow for solving the equation and arguing that the roots are real for all k.
4	(b)	Roots $x = \frac{-k \pm \sqrt{5k^2}}{2}$ oe	M1	2.1	using the quadratic formula FT with their discriminant Also allow for completing the square. Also allow for substituting both roots into the equation and clearly demonstrating the zero
		$= \left(\frac{-1 \pm \sqrt{5}}{2}\right) k$	A1 [2]	2.1	**AG** Must be clearly shown

Question		Answer	Marks	AO	Guidance
5	(a)	$-7-1.75=(5+2)a$	M1	1.1a	Uses the combined mass in N2L equation. Allow sign errors. No extra forces. Do not allow for mga.
			A1	1.1	Correct equation Also allow $8.75=7a$ soi.
		$a=-\frac{8.75}{7}=-1.25$ ms^{-2}	A1	1.1	Cao. Negativity must follow from their working, or clearly states deceleration of 1.25 ms^{-2}
		Alternative method For 5kg block $T-7=5a$ For 2kg block $-T-1.75=2a$	M1		Sets up an equation for each block including Tension. Allow sign errors. No extra forces. Do not allow for mga.
		$-7-1.75=(5+2)a$	A1		Correct equation with T eliminated. Any form. Also allow $8.75=7a$ soi.
		$a=-\frac{8.75}{7}=-1.25$ ms^{-2}	A1		Cao. Negativity must follow from their working, or clearly states deceleration of 1.25 ms^{-2}
			[3]		
	(b)	Model the resistance with a variable force	B1	3.5c	Allow a particular example of a variable force or variation in some other factor
			[1]		

Question		Answer	Marks	AO	Guidance
6		**DR** $6(1-\sin^2 x) = 5 - \sin x$	**M1**	**1.1a**	Uses correct identity to form equation in $\sin x$
		$6\sin^2 x - \sin x - 1 = 0$ $(2\sin x - 1)(3\sin x + 1) = 0$	**M1**	**1.1**	Rearranges and attempts to solve their 3 term quadratic leading to 2 values for $\sin x$
		$\sin x = \frac{1}{2}$ giving $x = 30, 150$	**A1 FT**	**1.1**	At least one correct value for x in the range $0° < x < 360°$ FT their value for $\sin x$ for first A mark only
		$\sin x = -\frac{1}{3}$ giving $x = 199.5, 340.5$	**A1** **[4]**	**1.1**	All 4 correct values and no extras in the range $0° < x < 360°$

Question		Answer	Marks	AO	Guidance
7	(a)	B is (6, 7)  	B1 B1 [2]	1.1 1.1	May be explicit or implied by position vector $\begin{pmatrix}6\\7\end{pmatrix}$ and seen on their diagram. Diagram showing A (-2, 1) relative to the origin. Do not allow for a sketch with no scale nor labelling.
7	(b)	Distance AB is $\sqrt{8^2+6^2}=10$	B1FT [1]	1.1	Allow 10 www. FT their A and B
7	(c)	Midpoint is (2, 4) This lies on the line $y=2x$ as the y-coordinate is double the x-coordinate	M1 A1 [2]	1.1 2.2a	Attempt to find the coordinates or position vector of the midpoint of their AB Clear explanation. Allow $4=2\times 2$

Question		Answer	Marks	AO	Guidance
8	(a)	$s = 2, u = 0, a = 3.71$ $s = ut + \frac{1}{2}at^2$ gives $2 = \frac{1}{2} \times 3.71t^2$ So $t = 1.04$ s	M1 A1 [2]	3.4 1.1	Uses *suvat* equation(s) leading to a value of t with $a = \pm 3.71$ Soi Www. Accept 1.0 but not 1
8	(b)	Normal reaction = weight = $2.5 \times 3.71 = 9.275$ N (9.28 to 3 s.f.)	B1 [1]	1.1	Allow for 9.3 or better seen

Question		Answer	Marks	AO	Guidance
9	(a)	$3x^{-2} + x^{\frac{1}{2}}$	B1 [1]	1.1	cao
	(b)	$y = \int \left(3x^{-2} + x^{\frac{1}{2}}\right) \mathrm{d}x$	M1*	3.1a	Attempts to integrate at least one term.
		$y = \frac{3x^{-1}}{-1} + \frac{x^{\frac{3}{2}}}{\left(\frac{3}{2}\right)} (+c)$	A1FT	1.1	Oe At least one correct term on RHS. FT their negative or fractional (a). Need not be simplified. Condone missing $+c$
		When $x = 1, y = -2$ $-2 = -3 + \frac{2}{3} + c$	depM1	1.1	Uses given information to attempt to find c
		$c = \frac{1}{3}$ so equation is $y = -\frac{3}{x} + \frac{2}{3}x^{\frac{3}{2}} + \frac{1}{3}$	A1 [4]	1.1	Any form. Must have $y =$

Question		Answer	Marks	AO	Guidance
10	(a)	A particle is an object [with mass] with negligible size	B1 [1]	1.2	Also allow object whose size and shape does not matter. Accept point mass. Do not award if other wrong statements also made.
10	(b)	Weight is $-3g\mathbf{j}$ For equilibrium $-3g\mathbf{j} + h\mathbf{i} + k\mathbf{i} + (k-5)\mathbf{j} = \mathbf{0}$ In the **j** direction $-3g + k - 5 = 0$ [so $k = 34.4$] **i** direction $h + k = 0$ so $h = -34.4$	B1 M1 A1 [3]	1.1 3.1b 1.1	Accept $-29.4\mathbf{j}$. May be implied by the use of weight (with correct sign) in their vertical equation and not their horizontal equation. May be implied by $k = 34.4$ seen with no equation Vector equation need not be seen explicitly Uses the **j**-direction to find a value for k. Allow only sign errors. Need not be simplified. May be implied by $k = 34.4$ seen Cao
10	(c)	$h\mathbf{i} - 3g\mathbf{j} = 3\mathbf{a}$	B1FT [1]	2.5	Must be vector equation FT their h from (b) and accept numerical equivalents (e.g. note $-34.4\mathbf{i} - 29.4\mathbf{j} = 3\mathbf{a}$ is fully correct) ISW if **a** is evaluated

Question		Answer	Marks	AO	Guidance
11	(a)	**DR** $f(x) = (x+2)(x-1)(x-6)$	**M1**	**1.1a**	Attempt to factorise the quadratic factor or solve the equation $x^2 - 7x + 6 = 0$ algebraically
		$x = 1,6$	**A1**	**1.1**	Must follow algebraic method
		$x = -2$	**B1**	**1.1**	Allow if seen
			[3]		
11	(b)	**DR** $y = x^3 - 5x^2 - 8x + 12$			
		$\frac{dy}{dx} = 3x^2 - 10x - 8$	**M1**	**2.1**	Differentiating their expanded $f(x)$
		When $x = 4$, $\frac{dy}{dx} = 48 - 40 - 8 = 0$ so stationary point	**M1**	**2.2a**	Substitution seen to give zero Also allow evidence of solving their $\frac{dy}{dx} = 0$ (eg factors, formula or both roots seen) Also allow for max or min stated
		$\frac{d^2y}{dx^2} = 6x - 10$	**M1**	**2.1**	Attempt to differentiate their first derivative
		When $x = 4$, $\frac{d^2y}{dx^2}[= 14] > 0$ so minimum point	**A1**	**2.2a**	Draw a correct conclusion from correct value
		Alternative method			
		When $x = 3$, $\frac{dy}{dx} = -11$ When $x = 5$, $\frac{dy}{dx} = 17$	**M1**		Evaluates gradient for points $-\frac{2}{3} < x < 4$ and for $x > 4$
		Gradient changes from negative to positive so minimum point	**A1**		Draw a correct conclusion from correct values
			[4]		

Question		Answer	Marks	AO	Guidance
11	(c)	**DR** Solving $\frac{dy}{dx} = 3x^2 - 10x - 8 = 0$ gives $x = -\frac{2}{3}$ $y = \frac{400}{27}$	**B1** **B1** **[2]**	**1.1** **1.1**	Correct exact x-coordinate found. Exact y-coordinate found. Allow for only for fraction or recurring decimal $14.\dot{8}1\dot{4}$

Question		Answer	Marks	AO	Guidance
12	(a)	$\log M = \log(ak^t)$ $\log M = \log k^t + \log a$ $\log M = t\log k + \log a$	 B1 [1]	 2.1	 This line of working must be seen as well as the given result AG
12	(b)(i)	Intercept $\log a = -0.2403$ $a = 10^{-0.2403} = 0.575$ Gradient $\log k = -0.0214$ $k = 10^{-0.0214} = 0.9519$	M1 A1 A1 [3]	3.1a 3.3 3.3	Equates $\log a$ to the intercept of the given line or equates $\log k$ to the gradient of the given line Accept awrt 0.57 or 0.58 Accept one answer in index form Accept awrt 0.95. Second value must be evaluated
	(b)(ii)	This means that every minute, the mass of salt is reduced to 95% of its mass at the start of the minute	B1 [1]	3.3	Also accept that the mass is reduced by 4.8% or 5% per minute FT their value Accept without a value for "the proportion of the mass of salt preserved each minute" oe
12	(c)	When $t = 0,\ M[= a] = 0.575$ Which is quite close to the given value 0.5 kg	M1 A1 [2]	3.4 3.5a	Uses $t = 0$ and their positive value of a. Also allow for $\log 0.5 = -0.3010$ Compares their M with 0.5 kg or their $\log 0.5$ with -0.2403 (must be seen) Small percentage error so reasonable model. Allow for not very good fit

12	**(d)**	$\log 0.01 = -0.0214t - 0.2403$ $t = 82.2$	**M1** **A1**	**3.4** **3.4**	Uses $\log 0.01$ in the given equation soi Allow value between $82 \le t \le 83$
		Alternative method When $0.01 = ak^t$ $t = 82.2$	**M1** **A1**		Uses their values of a and k to form an equation for t and attempt to solve. May be implied by a value for t seen To allow for values of a and k rounded to 2 sf, allow value $78 \le t \le 83$
			[2]		
12	**(e)**	$M = a\mathrm{e}^{-ht} = ak^t$ So $\mathrm{e}^{-h} = k$ $h = -\ln k = 0.0493$ $M = 0.575\mathrm{e}^{-0.0493t}$	**M1** **A1FT**	**3.1a** **1.1**	Equates expressions for M soi FT their k and a FT their a only. Allow $0.049 < h < 0.052$ Allow $M = 0.575\, e^{-\ln 0.952t}$
		Alternative methods Uses given value for initial mass $M = 0.01 = 0.5\mathrm{e}^{-ht} = 0.5e^{-82h}$ $h = 0.0477$ so $M = 0.5\mathrm{e}^{-0.0477t}$ Uses their a as initial mass $M = 0.575\mathrm{e}^{-ht}$ $0.01 = 0.575e^{-82h}$ $h = 0.0494$ so $M = 0.575\mathrm{e}^{-0.0494t}$	**M1** **A1** **M1** **A1**		Allow the use of one of the data points from the table for M1 only Allow $0.0471 < h < 0.0502$ Allow the use of one of the data points from the table for M1 only Allow their value of a Allow $0.0488 < h < 0.0519$
			[2]		
12	**(f)**	Rate of decrease is $ha\mathrm{e}^{-ht}$ At $t = 10$ rate of decrease is $0.0493 \times 0.575\mathrm{e}^{-0.0493\times 10} =$ 0.0173 ... [kg per minute]	**M1** **A1** **[2]**	**1.2** **3.1a**	Soi Allow sign error. FT their h (Q. asks for rate of *decrease*) Accept values between 0.017 and 0.018

Question		Answer	Marks	AO	Guidance
13	(a)	Acceleration of A is 0.75 Velocity of A is $[v_A =] -3 + 0.75t$	 B1	 3.1b	 Correct expression for velocity from graph
		Same velocity when $t = T$ $-3 + 0.75T = 1.5 + 0.03T^2$	M1	3.1a	Equated velocities and attempts to solve.
		$T = 10$ or ~~$T = 15$~~ So $T = 10$	A1	2.1	**AG** Must see exclusion of $T = 15$ If M0A0 awarded, **SC1** can be awarded if $T = 10$ substituted into both velocity equations and are shown to be equal. Can be awarded if $v_A = 4.5$ calculated at $t = 10$ and used to calculate the time for $v_B = 4.5$ or vice versa. (Beware circular argument) "First time" equal is not established by these methods
			[3]		

13	**(b)**	At $T = 10$ A has travelled a distance $\left\|\frac{1}{2}(-3 \times 4)\right\| + \frac{1}{2}(10 - 4) \times 4.5$	**M1**	**3.4**	Attempting to find at least one area under the velocity-time graph
			A1	**1.1**	At least one part correct allowing sign errors
		$= 6 + 13.5 = 19.5$ m	**A1**	**1.1**	soi
		At $T = 10$ B has travelled	**M1**	**3.1a**	Attempts definite integral to calculate distance
		$\int_0^{10} (1.5 + 0.03t^2)\,\mathrm{d}t = 25$	**A1**	**1.1**	Cao
		So B has travelled 5.5 m further than A	**A1FT**	**1.1**	FT their distances (dep on both method marks)
		Alternative method for finding the distance for A $u = -3, a = 0.75, t = 4$ so $s = -6$ $u = 0, a = 0.75, t = 10 - 4$ so $s = 13.5$	**M1**		Uses *suvat* equations for $0 < t < 4$ or $4 < t < 10$ or $0 < t < 10$ using $u = -3$, and their $a = 0.75$,
			A1		Correct displacement or distance for either part
		So total distance is 19.5 m	**A1**		soi
		Alternative method for finding the distance for A $\int_0^4 (-3 + 0.75t)\,\mathrm{d}t = -6$	**M1**		Attempt to find definite integral $0 < t < 4$ or $4 < t < 10$ or $0 < t < 10$. FT their v_A
		$\int_4^{10} (-3 + 0.75t)\,\mathrm{d}t = 13.5$	**A1**		Correct displacement or distance for either part soi
		So total distance is 19.5 m	**A1**		BC may give total area so allow $\int_0^{10} (-3 + 0.75t)\,\mathrm{d}t = 19.5$
			[6]		

APPENDIX

Exemplar responses for Q2(b)

Response	Mark

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