OCR
Oxford Cambridge and RSA

GCE

Mathematics B MEI

H630/01: Pure Mathematics and Mechanics

AS Level

Mark Scheme for June 2022

OCR (Oxford Cambridge and RSA) is a leading UK awarding body, providing a wide range of qualifications to meet the needs of candidates of all ages and abilities. OCR qualifications include AS/A Levels, Diplomas, GCSEs, Cambridge Nationals, Cambridge Technicals, Functional Skills, Key Skills, Entry Level qualifications, NVQs and vocational qualifications in areas such as IT, business, languages, teaching/training, administration and secretarial skills.

It is also responsible for developing new specifications to meet national requirements and the needs of students and teachers. OCR is a not-for-profit organisation; any surplus made is invested back into the establishment to help towards the development of qualifications and support, which keep pace with the changing needs of today's society.

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.

© OCR 2022

Text Instructions

1. Annotations and abbreviations

Annotation in RM Assessor	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
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 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 indicates that the instruction **In this question you must show detailed reasoning** appears in the question.

2. Subject-specific Marking Instructions for AS Level Mathematics B (MEI)

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.

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" and "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			$\frac{(2+\sqrt{n})(3-\sqrt{n})}{(3+\sqrt{n})(3-\sqrt{n})}$	M1	1.1a	Attempt to multiply numerator and denominator by $(3-\sqrt{n})$ May be implied by fully correct answer
			$\frac{6+\sqrt{n}-n}{9-n}$	A1 A1 [3]	1.1b 1.1b	Correct expansion for either numerator or denominator Final answer fully correct

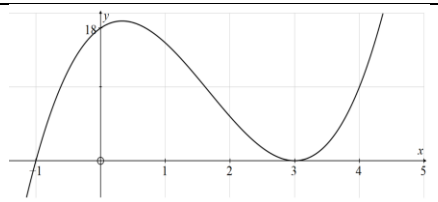
2	(a)		$\frac{100!}{98!}=\frac{100\times99\times98!}{98!}$ =9900	M1 A1 [2]	1.1a 1.1b	oe cao
2	(b)		$\left[{}_{100}C_{98}\right]=4950$	B1 [1]	1.2	Allow for $4950x^{98}$ seen

3	(a)		$v=-t^2+6t-6=2$ $t=2,4$ s	M1 A1 [2]	1.1a 1.1b	Use $v=2$ to form and attempt to solve a quadratic equation Both values required	May be implied by both correct roots
3	(b)		6 m s^{-1}	B1 [1]	1.1b	cao	

Question			Answer	Marks	AO	Guidance
4	(a)		$f(x) = x^2 - 3x + 2 = \left(x - \frac{3}{2}\right)^2 + b$	M1	1.1b	Begins process of completing the square as far as $\left(x - \frac{3}{2}\right)^2$ Also allow for $\left(x + \frac{3}{2}\right)^2$
			$= \left(x - \frac{3}{2}\right)^2 - \frac{1}{4}$	A1 [2]	1.1b	All correct
4	(b)		Minimum point $\left(\frac{3}{2}, -\frac{1}{4}\right)$	B1 B1 [2]	1.1b 1.1b	x-coordinate FT their (a) y-coordinate FT their (a)
4	(c)		translation $\begin{pmatrix} -\frac{5}{2} \\ 0 \end{pmatrix}$	B1 B1 [2]	1.1a 1.1b	Correct term must be seen Also allow for 2.5 to the left

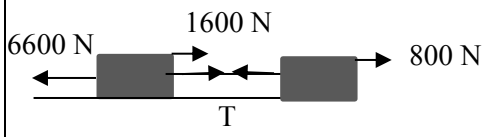
Question			Answer	Marks	AO	Guidance
5	(a)		$y = \tan(ax°)$ $y = \tan\left(\frac{3}{2}x°\right)$	B1 B1 [2]	1.2 1.1b	For any $a \neq 1$ with no other transformation o.e. SC 1 for just $f\left(\frac{3}{2}x\right)$ o.e. seen
5	(b)		120°	B1 [1]	1.1b	cao
5	(c)		**DR** $\arctan 1 = 45°$ $x = \frac{2}{3} \times 45° = 30°$ function is periodic with period 120° so roots are 30°, 150°, 270°	M1 M1 B1 [3]	1.1a 2.1 1.1b	Complete method for solving their $y = 1$ leading to at least one root. Do not allow where their $y = \tan x$ Appropriate use of the periodicity of their y or $\tan x$ leading to at least one more root Cao Allow for all the roots seen and no extras in the interval $[0°, 360°]$ Ignore values outside this range

Question			Answer	Marks	AO	Guidance	
6	(a)		$y = \int (6x^2 - 20x + 6)\ \mathrm{d}x = 2x^3 - 10x^2 + 6x + c$	M1	1.1a	Attempt to integrate	Do not allow if multiplied by x
			(2, 6) on curve so $6 = 2\times 2^3 - 10\times 2^2 + 6\times 2 + c \quad [c = 18]$	M1	1.1a		
			So $y = 2x^3 - 10x^2 + 6x + 18$	A1 [3]	1.1b	Complete equation must be seen	
6	(b)		$y = 2(x+1)(x^2 - 6x + 9)$ or $2(x^2 - 2x - 3)(x - 3)$	M1	2.1	o.e. Attempt to remove all brackets leading to a cubic expression. A quadratic factor must be seen.	
			So $y = 2x^3 - 10x^2 + 6x + 18$	E1	2.1	Correct expression found	
			Alternative method Division of $2x^3 - 10x^2 + 6x + 18$ by $(x+1)$ or $(x-3)$ and attempt to factorise quadratic factor $2(x+1)(x-3)^2$	M1 E1		Leading to a product of linear factors. A quadratic factor must be seen. Correct expression found	
			Alternative method [By Calculator] the roots of $y = 0$ are -1 and 3 [repeated] so $(x+1)$ and $(x-3)$ are factors $(x-3)$ is a repeated factor and the leading coefficient is 2 so $y = 2(x+1)(x-3)^2$	M1 E1		Method using the factor theorem used with roots found by calculator or substitution in their (a) Fully explained	
				[2]			

Question			Answer	Marks	AO	Guidance
6	(c)			B1 B1 B1 [3]	1.1b 1.1b 1.1b	Correct shape y-intercept at 18 labelled Curve crosses x-axis at (–1, 0) and touches at (3, 0)

Question			Answer	Marks	AO	Guidance
7	(a)		When the boat is modelled as a particle, the size and shape of the boat are not taken into account in the model Any rotation of the boat is neglected	B1 [1]	3.3	A sensible comment
7	(b)		Resistance is $-300\mathbf{i}$ N Newton's second law $\left(\left(450\mathbf{i}+20\mathbf{j}\right)+\left(420\mathbf{i}-20\mathbf{j}\right)\right)-300\mathbf{i}=9000\mathbf{a}$ $\left[570\mathbf{i}=9000\mathbf{a}\right]$	M1 A1 [2]	1.1a 1.1b	Sum of at least two forces seen in a N2L equation. Also allow for scalar equation in the **i** direction only. Allow missing or incorrect resistance Accept equivalent scalar equation and statement that there is no [resultant] force or no acceleration in the **j** direction)
7	(c)		$\mathbf{a}=\frac{570}{9000}\mathbf{i}=0.0633\mathbf{i}\ \text{m s}^{-2}$	B1 [1]	2.5	Must be vector. FT their equation(s) of motion

Question			Answer	Marks	AO	Guidance
8	(a)		When $x = 0$ number of cakes is 190	B1 [1]	3.4	Allow www
8	(b)		(1.20, 50) gives $50 = 1.2m + c$ (2.40, 140) gives $140 = 2.4m + c$	M1	3.3	Setting up simultaneous equations for m and c
			$m = 75,\ c = -40$	A1	3.3	Allow for values given or $y = 75x - 40$ seen
			Alternative method $m = \frac{140 - 50}{2.4 - 1.2}$	M1		using data to calculate m
			$m = 75,\ c = -40$	A1		Allow for values given or $y = 75x - 40$ seen
				[2]		
8	(c)		[When x is small,] y is negative and number of cakes donated cannot be negative	E1 [1]	3.5b	Negative y-values and y cannot be negative must both be stated or implied
8	(d)		Upper bound for demand to exceed supply Lower bound for y positive $190 - 70x = 75x - 40$ So $x < \frac{46}{29}$	M1 A1		Attempt to find one of the bounds for x using their $y = 75x - 40$ Accept $x < 1.586$ or $x < 1.59$ or $x < 1.58$ or $x \leq 1.56$ Allow use of $<$ or $\leq$ Allow for a separate inequality or as part of a combined inequality with lower bound Note the prices £1.58 and £1.57 do not lead to integer values for the number of cakes, so the fully correct answer is $x \leq 1.56$
			$y = 75x - 40 > 0$ $x > \frac{40}{75}$	A1		Accept $0.533 < x$ or $0.53 < x$ or $0.54 < x$ or $0.56 \leq x$ Allow use of $<$ or $\leq$ Allow for a separate inequality or as part of a combined inequality with upper bound Note the prices £0.54 and £0.55 do not lead to integer values for the number of cakes, so the fully correct answer is $0.56 \leq x$
				[3]		

Question			Answer	Marks	AO	Guidance
9	(a)		Horizontal forces (could be mirror image)  	**B1** **B1** **[2]**	**3.3** **3.3**	Ignore vertical forces. 6600 N and resistances correctly placed and labelled. No extra horizontal forces Common tension in the towbar shown.
9	(b)		Tractor and trailer together $6600-1600-800=2800a$ $a=1.5\ \text{ms}^{-2}$ Newton's second law for the trailer $T-800=1000\times1.5$ $T=2300\ \text{N}$	**M1** **A1** **M1** **A1**	**3.1b** **1.1b** **3.1b** **1.1b**	2800 kg used. Allow a missing or an extra horizontal force for the method mark soi Newton's second law with correct mass. FT their acceleration Also allow for the tractor $6600-T-1600=1800\times1.5$ used cao
			Alternative method Newton's second law for the tractor $6600-T-1600=1800a$ Newton's second law for the trailer $T-800=1000a$ Simultaneous equations giving $T=2300$ N	 **M1** **A1** **M1** **A1**	 	 Newton's second law for both parts of the system with correct masses; allow a missing or an extra horizontal force for the method mark Both equations correct Attempt to solve simultaneous equations leading to a value of T BC means method need not be seen cao
				[4]		

Question			Answer	Marks	AO	Guidance	
10	(a)		gradient AC $= \frac{4-(-1)}{1-(-4)} = 1$	M1	2.1	Gradient calculation must be seen	
			A on the line so the equation of the line is $y-4=1(x-1)$			o.e. using C (–4, –1)	Also allow using $y=x+c$ and evaluating c
			so the equation is $y=x+3$	A1	2.1	AG Must be clearly shown	
			Alternative method				
			When $x=1$ $y=1+3=4$ so A lies on the line				
			When $x=-4$ $y=-4+3=-1$ so C lies on the line	M1		checking both points lie on the line	
			So the equation of the line AC is $y=x+3$	A1		clear conclusion must be seen	
				[2]			
10	(b)		M is (4, 2)	B1	1.1b		
			$y=x+3$ crosses the x-axis at D (–3, 0)	B1	1.1b		
			length DM is $\sqrt{49+4}=\sqrt{53}$	M1	3.1a	Attempt to find at least two of the sides of triangle DMA	Also allow for the AC^2 etc found if clear
			length MA is $\sqrt{9+4}=\sqrt{13}$				
			length DA is $\sqrt{16+16}=\sqrt{32}$	A1	1.1b	At least 2 correct lengths soi FT their coordinates	
			using the cosine rule				Allow M1A0A0 for cosine rule used leading to one of the other two angles of the triangle. (101.3° or 29.1°) and not used to find 49.6°
			$\cos \hat{DMA} = \frac{13+53-32}{2\times\sqrt{13}\times\sqrt{53}}$	M1	1.1a	Allow sign errors Any form	
				A1	1.1b	FT their lengths. Must be correct expression for $\cos \hat{DMA}$	
			$\hat{DMA} = 49.6°$	A1	1.1b	Accept 49.7°	
				[7]			

Question			Answer	Marks	AO	Guidance	
11	(a)		Using $s=\frac{1}{2}(u+v)t$ with $u=0, v=9, t=5$ $s=\frac{1}{2}(0+9)5=22.5$ m	M1 A1* [2]	3.4 1.1b	Allow for any sequence of *suvat* equations leading to a value for s ($a=1.8$ may be seen)	
11	(b)		Substituting $t=5, v=9$ into $v=0.05t^3+kt$ $9=0.05\times5^3+5k$ $k=0.55$	M1 A1 [2]	3.3 1.1b	Uses $t=5, v=9$ to form an equation for k	
11	(c)		$a=\frac{\mathrm{d}v}{\mathrm{d}t}=0.15t^2+k$ When $t=5, a=0.15\times5^2+k=4.3$ m s^{-2}	M1 A1 [2]	3.4 1.1b	Differentiation of their model B FT their k	
11	(d)		$\int_0^5 v\,\mathrm{d}t=\int_0^5(0.05t^3+0.55t)\,\mathrm{d}t$ distance 14.6875 m (14.7 m) Model B distance 14.7 is closer to 16 m than model A (22.5 m) so B models this better	M1 A1* E1 (dep) [3]	3.4 1.1a 3.5a	Definite integral oe FT their k BC acceptable Comment which quotes at least two values. Dependent on both A marks indicated *	Do not allow for $s=0.05\frac{t^4}{4}+0.55\frac{t^2}{2}+c$ unless limits used, or there is an attempt to evaluate c

Question			Answer	Marks	AO	Guidance	
12	(a)		Letting $h=0$ does not make sense as this has the two points coincident Dividing by zero is not allowed $\frac{0}{0}$ is not well defined $\frac{0}{0}$ is not equal to 1	B1 [1]	2.3	Statement identifying a fault – should be equivalent to one of these statements Do not allow for $\frac{0}{0}=0$ or $\frac{0}{0}=6$ etc	
12	(b)		$\lim_{h\to 0}\left(\frac{f(3+h)-f(3)}{h}\right)$ gradient of chord is $6+h$ gradient of the curve is 6	M1 M1 A1 [3]	2.1 2.1 2.1	replaces $h=0$ with the idea of limit for an expression which is not just $\lim_{h\to 0}\left(\frac{f(x+h)-f(x)}{h}\right)$ Allow for the value 3 used or this function ie $\lim_{h\to 0}\left(\frac{(x+h)^2-x^2}{h}\right)$ Simplifies the fraction Must be seen	
12	(c)		Gradient of the normal is $-\frac{1}{6}$ Equation of the normal is $y-9=-\frac{1}{6}(x-3)$	M1 A1 [2]	1.1a 1.1b	Allow for $y=-\frac{1}{6}x+c$ seen even if their c is incorrect FT their (b) Any form FT their (b); ISW	Allow for a value found by an attempt to differentiate $y=x^2$ not from first principles $x+6y=57$

Need to get in touch?

If you ever have any questions about OCR qualifications or services (including administration, logistics and teaching) please feel free to get in touch with our customer support centre.

Call us on

01223 553998

Alternatively, you can email us on

support@ocr.org.uk

For more information visit

ocr.org.uk/qualifications/resource-finder

ocr.org.uk

Twitter/ocrexams

/ocrexams

/company/ocr

/ocrexams

CAMBRIDGE
UNIVERSITY PRESS & ASSESSMENT

OCR is part of Cambridge University Press & Assessment, a department of the University of Cambridge.

For staff training purposes and as part of our quality assurance programme your call may be recorded or monitored. © OCR 2022 Oxford Cambridge and RSA Examinations is a Company Limited by Guarantee. Registered in England. Registered office The Triangle Building, Shaftesbury Road, Cambridge, CB2 8EA.

Registered company number 3484466. OCR is an exempt charity.

OCR operates academic and vocational qualifications regulated by Ofqual, Qualifications Wales and CCEA as listed in their qualifications registers including A Levels, GCSEs, Cambridge Technicals and Cambridge Nationals.

OCR provides resources to help you deliver our qualifications. These resources do not represent any particular teaching method we expect you to use. We update our resources regularly and aim to make sure content is accurate but please check the OCR website so that you have the most up-to-date version. OCR cannot be held responsible for any errors or omissions in these resources.

Though we make every effort to check our resources, there may be contradictions between published support and the specification, so it is important that you always use information in the latest specification. We indicate any specification changes within the document itself, change the version number and provide a summary of the changes. If you do notice a discrepancy between the specification and a resource, please contact us.

Whether you already offer OCR qualifications, are new to OCR or are thinking about switching, you can request more information using our Expression of Interest form.

Please get in touch if you want to discuss the accessibility of resources we offer to support you in delivering our qualifications.