GCE

Mathematics B (MEI)

H630/01: Pure Mathematics and Mechanics

Advanced Subsidiary GCE

Mark Scheme for Autumn 2021

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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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Annotations and abbreviations

Annotation in scoris	**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
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 *
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/A Level Mathematics B (MEI)

a 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. For subsequent marking you must make it clear how you have arrived at the mark you have awarded.

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 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
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.**
  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 is lost for each distinct accuracy error.

g Rules for replaced work: if a candidate attempts a question more than once, and indicates which attempt he/she wishes to be marked, then examiners should do as the candidate requests; if there are two or more attempts at a question which have not been crossed out, examiners should mark what appears to be the last (complete) attempt and ignore the others. NB Follow these maths-specific instructions rather than those in the assessor handbook.

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 mark in the question. Marks designated as cao may be awarded as long as there are no other errors. E marks are lost unless, by chance, the given results are established by equivalent working. 'Fresh starts' will not affect an earlier decision about a misread. 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, of course, that there is nothing in the wording of the question specifying that analytical methods are required). 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.

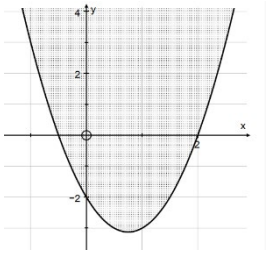
j If in any case the scheme operates with considerable unfairness consult your Team Leader.

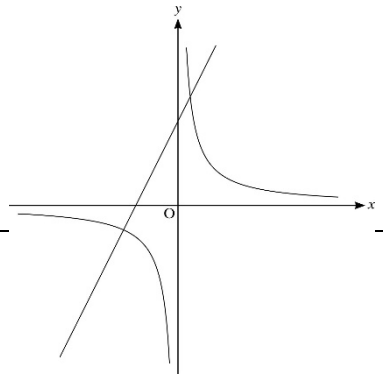
Question			Answer	Marks	AOs	Guidance	
1			Solving $y = 3x - 2$ and $x + 2y = 10$ simultaneously e.g. $x + 2(3x - 2) = 10$ or $\begin{matrix} 6x - 2y = 4 \\ x + 2y = 10 \end{matrix}$ $7x = 14 \Rightarrow x = 2$ When $x = 2$, $y = 4$ [So the point of intersection is (2, 4)]	**M1** **A1** **[2]**	**1.1** **1.1**	Attempt at elimination or substitution or solution of simultaneous equations BC cao	May be implied by the correct answers; award full marks for correct BC solution
2			Using *suvat* equation(s) with $s = 1.5, u = 0, t = 0.9$ $s = ut + \frac{1}{2}at^2$ $1.5 = \frac{1}{2}a \times 0.9^2$ Giving $a = 3.70 \text{ m s}^{-2}$	 **M1** **A1** **[2]**	 **3.1b** **1.1**	Allow for chain of equations leading to a value for a Allow for 3.7	
3			$\mathbf{F}_1 + \mathbf{F}_2 + \mathbf{F}_3 = \mathbf{0}$ $\mathbf{F}_3 = -(2\mathbf{i} + 9\mathbf{j} - \mathbf{i} + \mathbf{j}) = -\mathbf{i} - 10\mathbf{j}$	**M1** **A1** **[2]**	**1.1a** **1.1**	soi cao may be written as a column vector	
4	(a)		$4! = 24$ and $4^4 = 256$ or $4! = 4 \times 3 \times 2 \times 1$ and $4^4 = 4 \times 4 \times 4 \times 4$ So $4! < 4^4$	**M1** **E1** **[2]**	**2.1** **2.2a**	Evaluating both expressions or clearly comparing the factors of each Clear conclusion seen	
4	(b)		Using counterexample $n = 1$ $1! = 1^1 = 1$ So the statement is false / Nina is incorrect	**M1** **E1** **[2]**	**2.1** **2.2a**	Attempt to find a counterexample Clear argument about the statement from $n = 1$	

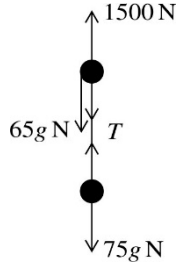
Question			Answer	Marks	AOs	Guidance	
5			Let AB = c and BC = a Using perimeter $a+c+13=32$ giving $a+c=19$	M1	3.1a	Forming an equation – need not be simplified	
			Using area $\frac{1}{2}ac\sin B=\frac{1}{2}ac\times\frac{4}{5}=24$ giving $ac=60$	M1	3.1a	Forming another equation – need not be simplified	
			Solving simultaneously $a(19-a)=60\Rightarrow a^2-19a+60=0$	M1	1.1	Attempt to solve their non-linear simultaneous equations	
			Giving $a=4$ or 15	A1	1.1	Correct roots of quadratic	
			AB is the shortest side, so AB = 4 cm and BC = 15 cm	A1 [5]	3.2a	Must be the right way round	

6	(a)		(2, 11) on the graph tells Kai that the displacement from the origin at that time is 11 m and not the distance travelled. [The particle starts 7 m from the origin, so actual distance travelled is 11 – 7 = 4 m]	E1 [1]	2.3	Draws a clear distinction between displacement from the origin at t = 2 and the distance travelled	Allow for a statement that the displacement during the first 2 s is 4 m
6	(b)		When t = 10, s = –53	M1	1.1	Evaluating displacement or distance from the origin at t = 10 soi	May be implied by substitution seen or by –53 seen or by [distance of] 53 m
			Distance travelled is 53 + 11 + 4	M1	1.1	Adds at least one distance to their 53m	
			= 68 m	A1 [3]	1.1		
6	(c)		$v=\frac{ds}{dt}=4-2t$	M1 A1 [2]	1.1a 1.1	Attempt to differentiate	
6	(d)		When t = 10 v = $4-2\times10$ [–16] therefore the speed is 16 m s^{-1}	M1 A1 [2]	3.4 3.2a	Substitution of t = 10 soi Allow for speed = 16 m s^{-1} seen www	Allow **M1A0** for speed -16 m s^{-1} seen or for $4-2\times10=16$

Question			Answer	Marks	AOs	Guidance	
7			$y = \int \left(6x + \frac{8}{x^3}\right) \mathrm{d}x = \int (6x + 8x^{-3}) \, \mathrm{d}x$	**M1**	**2.1**	Attempt to integrate with a negative power. Condone missing $+c$	
			$= 6 \times \frac{x^2}{2} + 8 \times \frac{x^{-2}}{-2} + c$	**A1**	**1.1**	First two terms correct. Condone missing $+c$	
			When $x = 1, y = 0$ $0 = 3 \times 1^2 - 4 \times 1^{-2} + c$ giving $c = 1$	**M1**	**2.1**	Attempt to evaluate c	
			So $y = 3x^2 - 4x^{-2} + 1$	**A1**	**1.1**	Correct equation for the curve soi	
			When $x = 2$, $y = 3 \times 2^2 - 4 \times 2^{-2} + 1 = 12 - 1 + 1 = 12$	**M1**	**2.1**	Using $x = 2$ in their non-linear equation	
			So the point (2, 12) lies on the curve.	**E1** **[6]**	**2.2a**	Conclusion from their y-value FT	

Question			Answer	Marks	AOs	Guidance	
8	(a)		**DR** $\frac{dy}{dx} = 4x - 3 = 0$ at a stationary point $x = 0.75$ When $x = 0.75$, $y = 2\times0.75^2 - 3\times0.75 - 2 = -3.125$ So stationary point at (0.75, –3.125)	**M1** **A1** **A1** **[3]**	**1.1** **1.1** **1.1**	Attempt to differentiate and equate to zero cao any form cao	Differentiation must be used $\left(\frac{3}{4}, -\frac{25}{8}\right)$
8	(b)		**DR** $\frac{d^2y}{dx^2} = 4 > 0$ so minimum point	**M1** **E1** **[2]**	**1.1** **2.2a**	Finding the second derivative FT their derivative Clear conclusion from consideration of the sign of the second derivative	Do not allow from an argument based on the coefficient of x^2
8	(c)		**DR**  Min point at (0.75, –3.125) (0, –2) is on the curve $y \geq 2x^2 - 3x - 2$ is the shaded region above the curve including the boundary	**M1** **A1** **A1** **[3]**	**1.1a** **1.1a** **1.1b**	Attempt to sketch a parabola using their labelled minimum point Parabola with their minimum point and one other correct point clearly shown Area above their curve indicated and the boundary clearly included	Also allow M1 for attempt to sketch parabola using the intersection with at least one axis A1 parabola through 3 correct points eg (–0.5, 0), (2. 0) and (0, –2). Other points include (–2, 12), (–1, 3) (1, –3) (3, 7)
8	(d)		**DR** $(2x+1)(x-2) > 0$ boundary values $x = -\frac{1}{2}$ and 2 $\left\{x : x < -\frac{1}{2}\right\} \cup \{x : x > 2\}$	**M1** **A1** **A1** **A1** **[4]**	**1.1a** **1.1a** **1.1a** **2.5**	Factorising the quadratic expression or attempting to solve $2x^2 - 3x - 2 = 0$ Correct roots of the quadratic equation soi Indicates that the required sets are less than their lower root and more than their upper root Correct set notation must be used. FT their roots	Allow M1A1 for roots of quadratic equation BC Allow **M1A1A1A0** if solved BC without set notation seen

Question			Answer	Marks	AOs	Guidance	
9	(a)	(i)	 One point labelled. eg (1, 12), (2, 6), (3, 4) etc	**B1** **B1dep** **[2]**	**1.1a** **1.1**	General shape for curve with axes as asymptotes One correct point clearly seen	
9	(a)	(ii)	$y = 2x + 8$ drawn (–4, 0) and (0, 8) clearly labelled	**B1** **B1** **[2]**	**1.1a** **1.1**	Line with positive gradient and positive intercept Both intercepts correctly labelled	Allow marks for the line even if the curve is wrong or missing
9	(b)		**DR** $2x + 8 = \frac{12}{x}$ $2x^2 + 8x - 12 = 0$ $x = -2 \pm \sqrt{10}$ When $x = -2 + \sqrt{10}$, $y = 2\left(-2 + \sqrt{10}\right) + 8 = 4 + 2\sqrt{10}$ $x = -2 - \sqrt{10}$, $y = 2\left(-2 - \sqrt{10}\right) + 8 = 4 - 2\sqrt{10}$ So coordinates are $\left(-2 + \sqrt{10}, 4 + 2\sqrt{10}\right)$ and $\left(-2 - \sqrt{10}, 4 - 2\sqrt{10}\right)$	**M1** **M1** **A1** **M1** **A1** **[5]**	**1.1a** **1.1a** **1.1** **1.1** **1.1**	Attempt to eliminate one variable Attempt to rewrite into the form $ax^2 + bx + c = 0$ and attempt to solve Both roots seen (allow BC if both **M** marks awarded) Substituting their roots into either equation Both coordinates correct and exact	Allow **SC1** for (–5.16, –2.32) and (1.16, 10.3) BC www If substitution into the curve used, allow $\frac{12}{-2 \pm \sqrt{10}}$ for **M1A0** if denominator not rationalised

Question			Answer	Marks	AOs	Guidance	
10	(a)		The size/shape of the women are not taken into account	E1 [1]	3.3	Allow women are modelled as point masses	Allow model only involves their mass/weight
10	(b)		The mass (weight) of the rope is negligible [compared to that of the women]	E1 [1]	3.3	Allow either mass or weight used. Allow "no weight" oe	
10	(c)			B1 B1 [2]	3.3 3.3	Draw and label the correct weights Draw and label the given tension and the tension in the second rope. No extra forces	
10	(d)		Total mass 140 kg $1500-65g-75g=140a$	M1 A1 [2]	3.3 1.1	Attempt to form N2L equation with (65+75)*a*. Condone one missing force All correct	
10	(e)		$a=\frac{32}{35}=0.914\ \text{m s}^{-2}$	B1 [1]	1.1	cao Allow from the solution of two separate equations	(See below for correct separate equations)
10	(f)		N2L for rescued woman: $T-75g=75\times\frac{32}{35}$ $T=\frac{5625}{7}=804\ \text{N}$	M1 A1 A1	3.1b 1.1 1.1	Attempt to form an equation for the rescued woman (mass 75 kg) Correct equation FT their *a* Correct value for *T*. Allow for 800 N from a correct equation	Equation must include *T*
			Alternative solution N2L for rescue worker: $1500-65g-T=65\times\frac{32}{35}$ $T=\frac{5625}{7}=804\ \text{N}$	M1 A1 A1		Attempt to form an equation for the rescue worker (mass 65 kg) Correct equation FT their *a* Correct value for *T*. Allow for 800 N from a correct equation	Equation must include *T*
				[3]			

Question			Answer	Marks	AOs	Guidance	
11	(a)		Line joining (2, 3) to (10, 200) has gradient $\frac{200-3}{10-2}=24.625$	M1	3.3	Attempt to find the gradient of the line	
			Equation of the line is $N=24.625t-46.25$	A1	1.1	Each value correct. Accept rounded to 2 or more s.f.	Values may be implied by correct equation
			$m=\frac{197}{8}=24.625,\ c=-\frac{185}{4}=-46.25$	A1	1.1		
			Alternative solution 1 Regression line (BC) for data set (2, 3), (10, 200)	M1		Using the calculator to find the regression line (may be implied)	
			Regression line is $N=24.625t-46.25$ $m=24.625,\ c=-46.25$	A1 A1		Each value correct. Accept rounded to 2 or more s.f.	Values may be implied by correct equation
			Alternative solution 2 Simultaneous equations Using (2, 3) $2m+c=3$ and using (10, 200) $10m+c=200$	M1		Attempt to find and solve simultaneous equations (BC)	
			$m=\frac{197}{8}=24.625,\ c=-\frac{185}{4}=-46.25$	A1 A1		Each value correct. Accept rounded to 2 or more s.f.	
				[3]			
11	(b)		The number of calls increases by 24.625 per day	B1 [1]	3.4	FT their *m*. Condone missing units	
11	(c)		When $t=1,\ N=-21.625$ and N cannot be negative	B1 [1]	3.5b	Argument from a correct value for N FT their equation	
11	(d)		When $t=2,\ N=e^{0.53\times2}=2.886\approx3$ When $t=10,\ N=e^{0.53\times10}=200.33\approx200$	M1	1.1a	Substitution of both values into the model, soi	
			So this is a good model for these two points	E1 [2]	3.4	Conclusion from correct values	

Question			Answer	Marks	AOs	Guidance	
11	(e)		rate of increase $\frac{\mathrm{d}N}{\mathrm{d}t} = 0.53\mathrm{e}^{0.53t}$	**M1**	**1.1a**	Using gradient of $\mathrm{e}^{kx} = k\mathrm{e}^{kx}$	
			When $t = 10$, $\frac{\mathrm{d}N}{\mathrm{d}t} = 0.53\mathrm{e}^{0.53\times10}$	**M1**	**1.1a**	Substituting t = 10 into their expression	
			106 new calls per day	**B1** **[3]**	**3.4**	cao Allow for gradient found BC or numerical method	

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