GCE

Mathematics B MEI

H630/02: Pure Mathematics and Statistics

AS Level

Mark Scheme for June 2022

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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.

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:

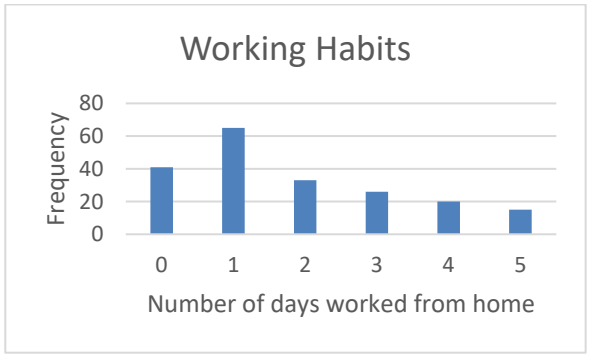
- If one attempt is clearly indicated as the one to mark, or only one is left uncrossed out, then mark that attempt and ignore the others.
- If more than one attempt is left not crossed out, then mark the last attempt unless it only repeats part of the first attempt or is substantially less complete.
- 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.

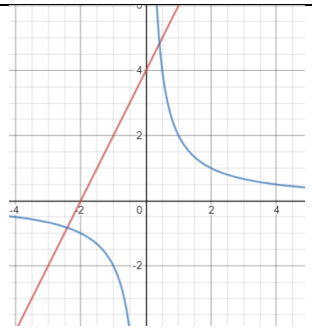
i If a calculator is used, some answers may be obtained with little or no working visible. Allow full marks for correct answers provided that there is nothing in the wording of the question specifying that analytical methods are required such as the bold "In this question you must show detailed reasoning", 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.

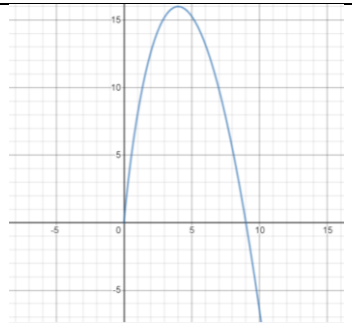
Question			Answer	Marks	AO	Guidance
1			a = 0.24	B1 [1]	1.1	**CHECK additional pages,** mark as seen or attach NB 0.2 + 0.15 + a + 0.27 + 0.14 = 1
2	(a)		eg $3x^2 - 21x + 2x - 14$ $(3x + 2)(x - 7)$	M1 A1 [2]	1.1 1.1	any valid attempt at factorisation three out of four terms correct or signs opposite isw after factorisation solutions to eq=0 if no factorisation M0A0 accept 3(x+2/3)(x-7)
2	(b)		$-\frac{2}{3}$ and 7 identified $-\frac{2}{3} < x < 7$	M1 FT A1FT [2]	1.1a 1.1	FT from part(a) accept x<7∩x>-2/3 or ' x<7 and x>-2/3' Not ≤ or ≥
3			$\ln\frac{y}{A} = \ln e^{0.02t}$ **or** $\ln y = \ln A + \ln e^{0.02t}$ $t = 50\ln\frac{y}{A}$ **oe** t = 21 **or** 20.6 – 20.625	M1 A1 B1 [3]	2.1 1.1 1.1	First stage of taking logs correct, t=(lny-lnA)/0.02 t=(Log y-logA)/0.02log e awrt 20.6
4	(a)		$\binom{24}{7}$ 25	B1 B1 [2]	1.1 1.1	Not necessary for B1B1

Question			Answer	Marks	AO	Guidance	
4	(b)		$\tan\theta = \frac{7}{24}$ or $\sin\theta = \frac{7}{25}$ or $\cos\theta = \frac{24}{25}$ 16.3°	**M1FT** **A1** **[2]**	**1.1** **1.1**	FT their **PQ** if possible Cosine rule/sine rule acceptable , formula must be used correctly awrt 16.3	
5	(a)			**M1** **A1** **[2]**	**1.1a** **1.1**	bar line graph (accept one bar/line missing or 1 height incorrect) Shape of heights correct and axes labelled reasonably and complete	Bars with no spaces, label in middle of bar, Crosses with vertical lines Pie chart Coordinates plotted but not joined **not acceptable**
5	(b)		$\bar{x} = 1.82$ sd = 1.526 to 1.53	**B1** **B1** **[2]**	**1.1** **1.1**	BC BC Accept 1.5224/1.52	
5	(c)		No evidence to suggest one or both samples flawed, as different random samples may lead to different results	**B1** **[1]**	**2.4**	**oe ….** Different samples of workers lead to different results so no	
5	(d)		Ali's conclusion is incorrect. 120 workers aged 60 or less worked from home, and this is about 75% of 159, not 90%.	**B1** **[1]**	**1.2**	**Oe** compare 144 with 120 and reason Incorrect as 90% is less than 63 years 40/160 =25% greater than 60	

Question			Answer	Marks	AO	Guidance	
6	(a)		No evidence to support this statement as information in LDS is for 16 – 64 year olds	B1 [1]	2.4	**Oe** This age group not in data set Must refer to data set	LDS advantage
6	(b)		Model 1: 68.98% Model 2: 73% Model 1 gives the best approximation since 68.98 is closer to true value	*B1 *B1 DB1 [3]	3.4 1.1 3.5a	Reverse calculations Model 1 2019 (2018.9) Model 2 2018 (2018.3) Model 1 sufficient or unambiguous indication	
6	(c)		Not appropriate since employment trends vary across the boroughs	B1 [1]	2.4	Oe Westminster employment trends differs to other boroughs employment specific only to Westminster	LDS advantage
6	(d)		eg Employment rates will increase forever or eg Employment rates will exceed 100%	B1 [1]	3.5b	Oe not just increase not exponential Constant growth Rise over time Increase every year No limit/maximum.	

Question			Answer	Marks	AO	Guidance	
7	(a)			**B1** **B1** **[2]**	**1.1** **1.2**	correct line beyond the axes correct shaped curve- approaching axes, not touching, in quadrant 1 and 3, beyond points of intersections **Check second graph page**	
7	(b)		$2x + 4 = \frac{2}{x}$ $2x^2 + 4x - 2 = 0$ **oe** $(x+1)^2 - 1 - 1 = 0$ or $\frac{-2 \pm \sqrt{2^2 - 4 \times 1 \times (-1)}}{2 \times 1}$ **oe** $-1 \pm \sqrt{2}$ $[x =] -1 - \sqrt{2}$ or$[x =] -1 + \sqrt{2}$	**B1** **M1** **M1** **A1** **A1** **[5]**	**3.1a** **2.1** **1.1** **1.1** **3.2a**	 Some rearrangement to form quadratic, allow sign errors condone calculator for either root, exact answer only both roots correct isw when roots found	SC Exact answers only, no working B0M1M1A1A1 SC decimal values only – no working -2.414, 0.414 then B0M1M1A0A0
8	(a)		$H_0 : p = 0.81$ and $H_1 : p < 0.81$ p is the probability that a young adult (selected at random in England) has never donated blood	**B1** **B1** **[2]**	**3.3** **2.5**	H_0 : *probability* = 0.81 H_1 : *probability* < 0.81 Or proportion NOT number or how many young adults has never donated blood	
8	(b)		0.05	**B1** **[1]**	**1.2**	Accept 5%, 1/20 oe	

Question			Answer	Marks	AO	Guidance	
8	(c)		324	B1 [1]	1.1	400×0.81 =324	
8	(d)		0.026 – 0.026125 **BC**	B1 [1]	1.1	Percentages acceptable	
8	(e)		$P(X \leq 310) = 0.0448 – 0.045$ [< 0.05] $P(X \leq 311) = 0.0576 – 0.058$ [> 0.05] hence CR is [0 ≤] $x \leq 310$	*M1 *M1 DA1 [3]	2.1 1.1 2.2a	Additional calculations not penalised Accept x<311	**SC** If no marks scored and state $x \leq 310$ or x<311 B1,
8	(f)		314 is not in critical region accept H_0 there is insufficient evidence at the 5% level to **suggest** that the percentage of young adults (in England who have never given blood) is less than 81% **oe**	M1 A1 A1 [3]	1.1 2.2a 2.2b	FT Comparison of 314 with *their* CR FT consistent with M mark allow "not significant" / "reject H_1 Not a **definite** statement, not prove Oe.Not enough evidence to suggest that the campaign has made more young people donate blood.	**or** $P(X \leq 314) = 0.114 > 0.05$ SC If prob incorrect but correct comparison and consistent conclusion M1A0A0 If incorrect CR then could get M1A1A0
9	(a)		(0,0)	B1 [1]	1.1	Coordinates, must have brackets	
9	(b)		0	B1 [1]	1.1	B0 if more than 1 value given	

Question			Answer	Marks	AO	Guidance	
9	(c)		$\frac{dy}{dx} = 12 - 6\sqrt{x}$ **oe**	**B1**	**3.1a**	allow one coefficient error	Correct answer with no working for M and A marks gives (4,16) gives M1M1A1A1 x=4 only gives M1M1A1A0
			their $\frac{dy}{dx} = 0$	**M1**	**2.1**	Must be two terms	
			$\sqrt{x} = 2$	**M1**	**1.1**	rearrange equation to make $\sqrt{x}$ or x the subject	
			$x = 4$	**A1**	**1.1**	www. A0 if more than one value of x	
			(4, 16)	**A1**	**3.2a**	www. Must have brackets	
				[5]			
9	(d)			**B1**	**1.1**	correct shape of curve	
				B1	**1.1**	curve passes through (4,16) and (9,0) and touches (condone passes through) (0,0); may be identified on or adjacent to graph	**FT** their stationary point
				B1	**1.1**	curve in 1st and 4th quadrants only with correct shape, No points in 2nd or 3rd quadrant	
				[3]			

10			Valid attempt to solve $12x^3 - 24x^2 - 60x + 72 = 0$	**M1**	**3.1a**	eg divide by 12 and find f(k) where k = ±1, ± 2, ±3, ±6	Must see x= -2, 1 and 3 as a minimum for the first 4 marks
			$(x-1), (x-3) or\ (x+2)$ identified	**A1**	**1.1**		
			$(x-1)(x^2 - x - 6)$ **oe**	**M1**	**1.1**	or attempt at long division, allow sign errors	Must see integration
			x-values are $-2, 1$ and 3	**A1**	**1.1**	could be implied from the limits	
			$F[x] = 3x^4 - 8x^3 - 30x^2 + 72x$	**M1**	**2.1**	integration with at least 2 terms correct; may be unsimplified (+c not necessary)	If divided by 12 at the beginning and attempt to integrate twelfth of function then M1A0
				A1	**1.1**	all terms correct and may be unsimplified can have +c	
			F[b] – F[a] or F[c] – F[b]	**M1**	**1.1**	One subtraction attempted where a,b and c are their solutions to original equation	
			189 or –64 seen	**A1**	**1.1**		If divided by 12 earlier and then multiply by 12 at end can achieve all marks
			253	**A1**	**3.2a**		
				[9]			

Question			Answer	Marks	AO	Guidance	
11	(a)		Not a simple random sample, since not all sets of 12 possible samples have an equal chance of being chosen in this way.	B1 [1]	1.2	Or equivalent Not random as first 12 areas chosen Convenience	
11	(b)		#N/A means there was no data available and we cannot use median income on its own	B1 B1 [2]	1.1 1.1	No data so no relationship can be established B1B1	LDS advantage
11	(c)		the 3 largest *x*-values ringed	B1 [1]	1.1	No extra points ringed	
11	(d)		60.9(074) obtained which is close to 60.4 so a good fit	B1 [1]	3.4	Must be some evidence of comparison	
11	(e)		92.669 – 92.7	B1 [1]	3.4	awrt 92.7	
11	(f)		extrapolation It would be an outlier. This model was calculated without outliers.	B1 B1 [2]	3.5a 2.3	Or equivalent Causation with explanation Might live in different boroughs than they go to school in. City of London's median would be an outlier compared to other areas P=92.67 with median £61100 with relevant comment Not many schools in City of London Or other acceptable response	

Question			Answer	Marks	AO	Guidance	
11	(g)		from diagram, percentage is above 50% in all areas and data is for 5 or more passes **including** English and Maths, so there **is** evidence to support this statement	**B1** **[1]**	**2.3**	Not **proves** All of the points on scatter graph are above 50% so suggests that statement is correct percentage is above 50% in all areas and data is for 5 or more passe **including English and Maths**, so there i**s** evidence to support this statement	LDS advantage

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