



Oxford Cambridge and RSA

AS Level Mathematics B (MEI)

H630/02 Pure Mathematics and Statistics
Question Paper

Wednesday 23 May 2018 – Morning

Time allowed: 1 hour 30 minutes



You must have:

- Printed Answer Booklet

You may use:

- a scientific or graphical calculator

INSTRUCTIONS

- Use black ink. HB pencil may be used for graphs and diagrams only.
- Complete the boxes provided on the Printed Answer Booklet with your name, centre number and candidate number.
- Answer **all** the questions.
- **Write your answer to each question in the space provided in the Printed Answer Booklet.** Additional paper may be used if necessary but you must clearly show your candidate number, centre number and question number(s).
- Do **not** write in the barcodes.
- You are permitted to use a scientific or graphical calculator in this paper.
- Final answers should be given to a degree of accuracy appropriate to the context.

INFORMATION

- The total number of marks for this paper is **70**.
- The marks for each question are shown in brackets [].
- You are advised that an answer may receive **no marks** unless you show sufficient detail of the working to indicate that a correct method is used. You should communicate your method with correct reasoning.
- The Printed Answer Booklet consists of **12** pages. The Question Paper consists of **8** pages.

Formulae AS Level Mathematics B (MEI) (H630)**Binomial series**

$$(a+b)^n = a^n + {}^n C_1 a^{n-1} b + {}^n C_2 a^{n-2} b^2 + \dots + {}^n C_r a^{n-r} b^r + \dots + b^n \quad (n \in \mathbb{N}),$$

$$\text{where } {}^n C_r = {}_n C_r = \binom{n}{r} = \frac{n!}{r!(n-r)!}$$

$$(1+x)^n = 1 + nx + \frac{n(n-1)}{2!}x^2 + \dots + \frac{n(n-1)\dots(n-r+1)}{r!}x^r + \dots \quad (|x| < 1, n \in \mathbb{R})$$

Differentiation from first principles

$$f'(x) = \lim_{h \rightarrow 0} \frac{f(x+h) - f(x)}{h}$$

Sample variance

$$s^2 = \frac{1}{n-1} S_{xx} \text{ where } S_{xx} = \sum (x_i - \bar{x})^2 = \sum x_i^2 - \frac{(\sum x_i)^2}{n} = \sum x_i^2 - n\bar{x}^2$$

Standard deviation, $s = \sqrt{\text{variance}}$

The binomial distribution

If $X \sim B(n, p)$ then $P(X = r) = {}^n C_r p^r q^{n-r}$ where $q = 1 - p$

Mean of X is np

Kinematics

Motion in a straight line

$$v = u + at$$

$$s = ut + \frac{1}{2}at^2$$

$$s = \frac{1}{2}(u+v)t$$

$$v^2 = u^2 + 2as$$

$$s = vt - \frac{1}{2}at^2$$

Answer **all** the questions

1 Write down the value of

(A) $\log_a(a^4)$, [1]

(B) $\log_a\left(\frac{1}{a}\right)$. [1]

2 Doug has a list of times taken by competitors in a ‘fun run’. He has grouped the data and calculated the frequency densities in order to draw a histogram to represent the information. Some of the data are presented in Fig. 2.

Time in minutes	15 –	20 –	25 –	35 –	45 – 60
Number of runners	12	23	59	71	
Frequency density	2.4		5.9	7.1	1.4

Fig. 2

(i) Write down the missing values in the copy of Fig. 2 in the Printed Answer Booklet. [2]

(ii) Doug labels the horizontal axis on the histogram ‘time in minutes’ and the vertical axis ‘number of minutes per runner’. State which one of these labels is incorrect and write down a correct version. [1]

3 P and Q are consecutive **odd** positive integers such that $P > Q$.

Prove that $P^2 - Q^2$ is a multiple of 8. [3]

4 The probability distribution of the discrete random variable X is given in Fig. 4.

r	0	1	2	3	4
$P(X=r)$	0.2	0.15	0.3	k	0.25

Fig. 4

(i) Find the value of k . [2]

X_1 and X_2 are two independent values of X .

(ii) Find $P(X_1 + X_2 = 6)$. [3]

- 5 Find the set of values of a for which the equation

$$ax^2 + 8x + 2 = 0$$

has no real roots.

[3]

- 6 Show that $\int_0^9 (3 + 4\sqrt{x}) dx = 99$.

[4]

- 7 Rose and Emma each wear a device that records the number of steps they take in a day. All the results for a 7-day period are given in Fig. 7.

Day	1	2	3	4	5	6	7
Rose	10 014	11 262	10 149	9361	9708	9921	10 369
Emma	9204	9913	8741	10 015	10 261	7391	10 856

Fig. 7

The 7-day mean is the mean number of steps taken in the last 7 days. The 7-day mean for Rose is 10 112.

- (i) Calculate the 7-day mean for Emma.

[1]

At the end of day 8 a new 7-day mean is calculated by including the number of steps taken on day 8 and omitting the number of steps taken on day 1. On day 8 Rose takes 10 259 steps.

- (ii) Determine the number of steps Emma must take on day 8 so that her 7-day mean at the end of day 8 is the same as for Rose.

[4]

In fact, over a long period of time, the mean of the number of steps per day that Emma takes is 10 341 and the standard deviation is 948.

- (iii) Determine whether the number of steps Emma needs to take on day 8 so that her 7-day mean is the same as that for Rose in part (ii) is unusually high.

[3]

- 8 In this question you must show detailed reasoning.

The centre of a circle C is at the point $(-1, 3)$ and C passes through the point $(1, -1)$. The straight line L passes through the points $(1, 9)$ and $(4, 3)$. Show that L is a tangent to C .

[7]

9 In this question you must show detailed reasoning.

Research showed that in May 2017 62% of adults over 65 years of age in the UK used a certain online social media platform. Later in 2017 it was believed that this proportion had increased. In December 2017 a random sample of 59 adults over 65 years of age in the UK was collected. It was found that 46 of the 59 adults used this online social media platform.

Use a suitable hypothesis test to determine whether there is evidence at the 1% level to suggest that the proportion of adults over 65 in the UK who used this online social media platform had increased from May 2017 to December 2017. [7]

10 (i) A curve has equation $y = 16x + \frac{1}{x^2}$. Find

(A) $\frac{dy}{dx}$, [2]

(B) $\frac{d^2y}{dx^2}$. [2]

(ii) Hence

- find the coordinates of the stationary point,
- determine the nature of the stationary point. [5]

- 11 The pre-release material contains data concerning the death rate per thousand people and the birth rate per thousand people in all the countries of the world. The diagram in Fig. 11.1 was generated using a spreadsheet and summarises the birth rates for all the countries in Africa.

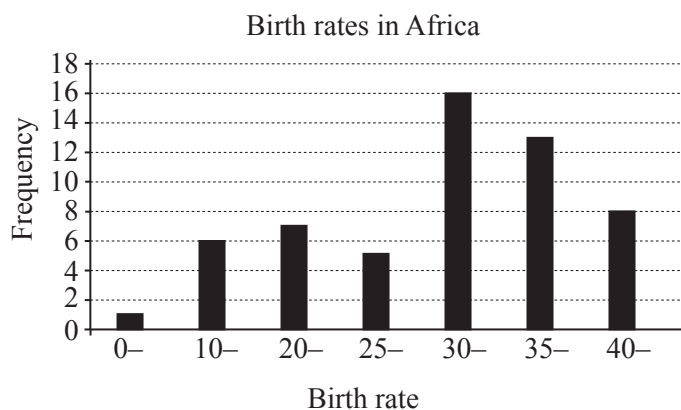


Fig. 11.1

- (i) Identify **two** respects in which the presentation of the data is incorrect. [2]

Fig. 11.2 shows a scatter diagram of death rate, y , against birth rate, x , for a sample of 55 countries, all of which are in Africa. A line of best fit has also been drawn.

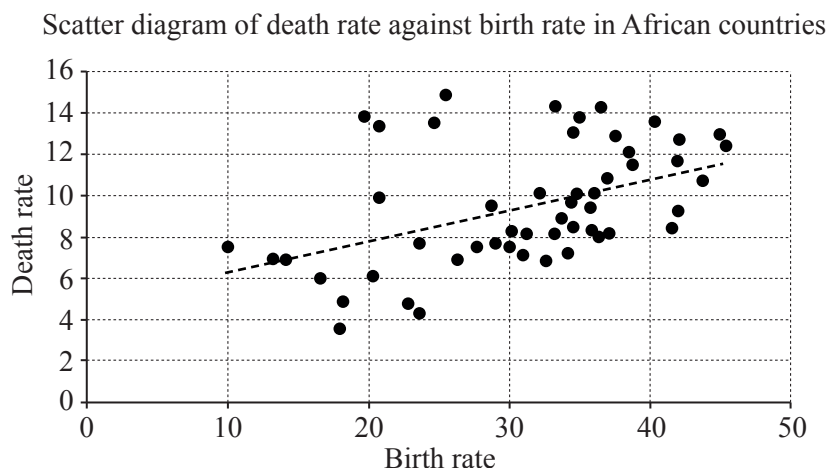


Fig. 11.2

The equation of the line of best fit is $y = 0.15x + 4.72$.

- (ii) (A) What does the diagram suggest about the relationship between death rate and birth rate? [1]
- (B) The birth rate in Togo is recorded as 34.13 per thousand, but the data on death rate has been lost. Use the equation of the line of best fit to estimate the death rate in Togo. [1]
- (C) Explain why it would not be sensible to use the equation of the line of best fit to estimate the death rate in a country where the birth rate is 5.5 per thousand. [1]
- (D) Explain why it would not be sensible to use the equation of the line of best fit to estimate the death rate in a Caribbean country where the birth rate is known. [1]
- (E) Explain why it is unlikely that the sample is random. [1]

Including Togo there were 56 items available for selection.

- (iii) Describe how a sample of size 14 from this data could be generated for further analysis using systematic sampling. [2]

- 12 In an experiment 500 fruit flies were released into a controlled environment. After 10 days there were 650 fruit flies present.

Munirah believes that N , the number of fruit flies present at time t days after the fruit flies are released, will increase at the rate of 4.4% per day. She proposes that the situation is modelled by the formula $N = Ak^t$.

- (i) Write down the values of A and k . [2]
- (ii) Determine whether the model is consistent with the value of N at $t = 10$. [2]
- (iii) What does the model suggest about the number of fruit flies in the long run? [1]

Subsequently it is found that for large values of t the number of fruit flies in the controlled environment oscillates about 750. It is also found that as t increases the oscillations decrease in magnitude.

Munirah proposes a second model in the light of this new information.

$$N = 750 - 250 \times e^{-0.092t}$$

- (iv) Identify three ways in which this second model is consistent with the known data. [3]
- (v) (A) Identify one feature which is not accounted for by the second model. [1]
- (B) Give an example of a mathematical function which needs to be incorporated in the model to account for this feature. [1]

END OF QUESTION PAPER

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AS Level Mathematics B (MEI)

H630/02 Pure Mathematics and Statistics

Printed Answer Booklet

Wednesday 23 May 2018 – Morning

Time allowed: 1 hour 30 minutes



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- Question Paper H630/02 (inserted)

You may use:

- a scientific or graphical calculator



First name										
Last name										
Centre number						Candidate number				

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1(A)																							
1(B)																							
2(i)																							
<table border="1"><tr><td>Time in minutes</td><td>15 –</td><td>20 –</td><td>25 –</td><td>35 –</td><td>45 – 60</td></tr><tr><td>Number of runners</td><td>12</td><td>23</td><td>59</td><td>71</td><td></td></tr><tr><td>Frequency density</td><td>2.4</td><td></td><td>5.9</td><td>7.1</td><td>1.4</td></tr></table>						Time in minutes	15 –	20 –	25 –	35 –	45 – 60	Number of runners	12	23	59	71		Frequency density	2.4		5.9	7.1	1.4
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<p style="text-align: center;">Fig. 2</p>																							
2(ii)																							
3																							

4(i)	

4(ii)	

5	
6	

7(iii)	
8	
	(answer space continued on next page)

10(i)(A)	
10(i)(B)	
10(ii)	

11(i)	
11(ii)(A)	
11(ii)(B)	
11(ii)(C)	
11(ii)(D)	
11(ii)(E)	

11(ii)	
12(i)	
12(ii)	

12(iii)	
12(iv)	
12(v)(A)	
12(v)(B)	



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GCE

Mathematics B (MEI)

Unit **H630/02**: Pure Mathematics and Statistics

Advanced Subsidiary GCE

Mark Scheme for June 2018

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.

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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.

Subject-specific Marking Instructions for 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. This rule should be applied to each case. When a value is not given in the paper accept any answer that agrees with the correct value to 2 s.f. Follow through should be used so that only one mark is lost for each distinct accuracy error, except for errors due to premature approximation which should be penalised only once in the examination. There is no penalty for using a wrong value for g. E marks will be lost except when results agree to the accuracy required in the question.
- 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 graphical 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	(A)	4	B1 [1]	1.2		
	(B)	-1	B1 [1]	1.1		
2	(i)	Frequency density 4.6 Number of runners 21	B1 B1 [2]	2.2a 1.1		
2	(ii)	Vertical axis should be labelled “number of runners per minute”	E1 [1]	2.3	Or frequency density	
3		$(2n+1)^2 - (2n-1)^2$ oe $4n^2 + 4n + 1 - (4n^2 - 4n + 1)$ $= 8n$ (so multiple of 8)	B1 M1 A1 [3]	2.1 1.1 2.4	Allow one slip eg sign error Note: Numerical verification 0	OR $P = Q + 2$ $P^2 - Q^2 = (Q + 2)^2 - Q^2$ B1 $= 4(Q + 1)$ (factorized) M1 $(Q + 1)$ divisible by 2 so $4(Q + 1)$ is multiple of 8 A1 OR $Q = P - 2$
4	(i)	$0.2 + 0.15 + 0.3 + k + 0.25 = 1$ oe $k = 0.1$	M1 A1 [2]	1.1 1.1		
4	(ii)	k^2 seen $0.3 \times 0.25 \times 2 + k^2$ 0.16	M1 M1 A1 [3]	3.1a 1.1 1.1	Or $0.3 \times 0.25 \times 2$ seen Allow slip eg omission of 2; or insertion of 2	Ft k from (i) for M1M1
5		Use of discriminant $8^2 - 4 \times a \times 2 < 0$ $a > 8$	M1 A1 A1 [3]	3.1a 1.1 1.1	Accept = or any inequality Accept $8 < a$	Values must be substituted

Question	Answer	Marks	AOs		Guidance	
6	$F[x] = 3x + \frac{4x^2}{\frac{3}{2}}$ oe $F[9] - F[0]$ $27 + \frac{4 \times 2 \times 27}{3} = 99$	M1 A1 B1 B1 [4]	2.1 1.1 1.1 2.4	Attempt at integration; sight of (first term) kx or (second term) kx^2 Dep M1; fit their $F(x)$; Accept $27 + 72 = 99$ AG	Allow +c Must see convincing arithmetic for award of final mark	
7	(i)	9483	B1 [1]	1.1	BC	
7	(ii)	$7 \times 10\,112 + 10\,259 - 10\,014$ soi $= 71\,029$ $66\,381 - 9\,204 + x = \text{“}71\,029\text{”}$ Emma needs to make 13852 steps	M1 A1 M1 A1 [4]	3.1a 1.1 1.1 3.2a	NB Rose's new mean is 10147 Using 8 days can gain M1 only	$\frac{7 \times 10\,112 + 10\,259 - 10\,014}{7}$ $= 10\,147$ $= \frac{66\,381 - 9\,204 + x}{7}$
7	(iii)	$10\,341 + 2 \times 948$ soi $= 12\,237$ Comparison of their 13852 with their 12237 13852 is an outlier, so Emma would need to make an unusually high number of steps on day 8	M1 M1 A1 [3]	3.1b 1.1 3.2b	Soi Conclusion; 'outlier' not essential. Dep M2 www	
8		$(x - -1)^2 + (y - 3)^2 = r^2$ $r^2 = (1 - -1)^2 + (-1 - 3)^2$ L: $m = -2$ $y = -2x + 11$ oe substitution of their $y = -2x + 11$ in their $(x + 1)^2 + (y - 3)^2 = 20$ $x^2 - 6x + 9 = 0$ oe $(x - 3)^2 = 0$ so repeated root Hence line touches the curve and is a tangent	M1 M1 B1 B1 M1 A1 E1 [7]	2.1 1.1 1.1 1.1 1.1 1.1 2.4	Left side correct and $= r^2$ Or find L first (B1B1), then find equation of line perp to L through $(-1, 3)$ (M1M1) then substitute (M1), solve (A1) then check (E1). soi or $(-6)^2 - 4 \times 1 \times 9 = 0$	or line through centre which is perpendicular to L has equation $y - 3 = \frac{1}{2}(x - -1)$ meets L at $(3, 5)$ $(3 + 1)^2 + (5 - 3)^2 = r^2 = 20$ so lines meet at circumference of circle at right angles so L is a tangent

Question		Answer	Marks	AOs	Guidance	
9		$H_0: p = 0.62$ $H_1: p > 0.62$ p is the proportion of adults over 65 in the (UK population) who use the onine social media platform $1 - P(X \leq 45) = 0.0068(1)$ $0.0068 < 0.01$ Result is significant or “reject H_0 ” The evidence suggests that the proportion of adults over 65 (in the UK population) using platform has increased from 62%	B1 B1 B1\$ B1& M1& A1 E1 [7]	1.1 1.1 2.5 1.1 1.1 2.2b 2.4	Allow null Allow alternative May be seen in hypotheses Allow probability NB from use of B(59, 0.62) Comparison of their 0.0068 with 0.01 or 0.68% with 1%; not allowed from point probability Depends on B1&M1& Conclusion in context Depends on all other marks except B1\$	Allow for sight of 0.9932, (from 0.99318902) Allow ‘accept H_1 ’ OR Critical region ≥ 46 B1 46 in critical region, M1, hence conclusion
10	(i)	(A)	$16 - \frac{2}{x^3}$ oe [2]	M1 A1 [2]	1.1 1.1 One term correct	
		(B)	kx^{-3-1} $6x^{-4}$ or $\frac{6}{x^4}$	M1 A1 [2]	1.1 1.1 FT their $\frac{dy}{dx}$ for M1	
10	(ii)		their $\frac{dy}{dx} = 0$ $x = \frac{1}{2}$ $y = 12$ substitution of their $x = \frac{1}{2}$ in their second derivative [96] which is positive so $(\frac{1}{2}, 12)$ is a minimum [5]	M1 A1 A1 M1 A1 [5]	2.1 1.1 1.1 1.1 2.4 FT their x ; dependent on (i)(B) involving x www	

Question		Answer	Marks	AOs		Guidance	
11	(i)	Any two distinct reasons eg classes of different widths represented by bars of same width eg vertical axis should be frequency density eg final upper class boundary not given eg should have continuous horizontal scale / no gaps between bars	E1	2.4			
			E1	1.1			
			[2]				
11	(ii)	A	Positive correlation	B1 [1]	2.2b	oe	
11	(ii)	B	9.8395 or 9.8 or 9.84 or 9.840	B1 [1]	1.1		
11	(ii)	C	extrapolation	B1 [1]	3.2b	oe	
11	(ii)	D	Birth rates and death rates in the Caribbean, may be very different from those in Africa.	E1 [1]	2.2a	oe	Advantage
11	(ii)	E	eg other continents to select countries from	E1 [1]	2.2a	eg a random sample would almost certainly not just include countries from Africa	Advantage
11	(iii)	Eg Generate a random number, n , between 1 and 4 and select the n th item in the data set.	B1	1.2		Candidates may choose other valid starting points	
		Eg Select every 4 th item on the list thereafter (stopping when 14 have been selected)	B1 [2]	1.1		Candidates may choose other valid intervals	
12	(i)	$A = 500$ $k = 1.044$	B1	3.3			
			B1 [2]	1.1			
12	(ii)	500×1.044^{10} $= 769.1$ which is not close to 650 so not consistent	M1 A1 [2]	3.4 1.1	Ft www	May use 650 and show k or A different	
12	(iii)	exponential growth oe	B1 [1]	3.5a	OR increase for ever, oe		

Question		Answer	Marks	AOs		Guidance	
12	(iv)	$t = 0, N = 500$ $t = 10, N = 650.37 \approx 650$ model predicts number of fruit flies tends to 750 in the long run	B1 B1 B1 [3]	1.1 1.1 3.5a	Oe 'N will not go beyond 750'	Allow shown using large value of t	
12	(v)	(A)	Oscillations	B1 [1]	3.5b	oe	
		(B)	cosine or sine oe	B1 [1]	3.5c	Eg Introducing a multiplier of $(-1)^t$ if t is a large integer.	

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AS LEVEL

Examiners' report

MATHEMATICS B (MEI)

H630

For first teaching in 2017

H630/02 Summer 2018 series

Version 1

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Introduction

Our examiners' reports are produced to offer constructive feedback on candidates' performance in the examinations. They provide useful guidance for future candidates. The reports will include a general commentary on candidates' performance, identify technical aspects examined in the questions and highlight good performance and where performance could be improved. The reports will also explain aspects which caused difficulty and why the difficulties arose, whether through a lack of knowledge, poor examination technique, or any other identifiable and explainable reason.

Where overall performance on a question/question part was considered good, with no particular areas to highlight, these questions have not been included in the report. A full copy of the question paper can be downloaded from OCR.

Paper H630/02 series overview

This was the first session in which the new AS Level specification Mathematics B (MEI) was available. Candidates coped perfectly well with the mixture of questions from the Pure and Statistics parts of the specification.

All part questions were answered correctly by a good number of candidates, and all part questions provided some discrimination since all were sometimes answered incorrectly. Only a few candidates gained full or almost full marks, and very few candidates were unable to make some progress on some of the questions. In particular, the first seven questions proved accessible to the full range of candidature. The last parts of Question 12 were often omitted; this could have been caused by candidates running out of time, or it may just be that candidates realised they did not know the answer to these parts.

There were two part questions designed to give an advantage to candidates who had been taught using data from the Large Data Set linked to this examination. Most candidates were sufficiently familiar with the Large Data Set to be able to answer Question 11(ii)(D), which relied on candidates knowing that Africa and the Caribbean are quite different parts of the world. However, few candidates were able to answer part (E) correctly by explaining why it is unlikely that, when a sample of 55 countries taken from all 237 countries in the world results in only African countries being in the sample, the sample is random.

Question 1 (a)

- 1 Write down the value of

$$(A) \log_a(a^4), \quad [1]$$

Many candidates gave the correct answer to this part. However, some candidates omitted this, and some others gave answers in terms of a .

Question 1 (b)

$$(B) \log_a\left(\frac{1}{a}\right). \quad [1]$$

This part was sometimes omitted, and some candidates gave answers involving a .

Question 2 (i)

- 2 Doug has a list of times taken by competitors in a 'fun run'. He has grouped the data and calculated the frequency densities in order to draw a histogram to represent the information. Some of the data are presented in Fig. 2.

Time in minutes	15 –	20 –	25 –	35 –	45 – 60
Number of runners	12	23	59	71	
Frequency density	2.4		5.9	7.1	1.4

Fig. 2

- (i) Write down the missing values in the copy of Fig. 2 in the Printed Answer Booklet. [2]

This part was usually done correctly, though some candidates omitted one or both answers. Multiples of the correct answer were sometimes seen instead of 4.6.

Question 2 (ii)

- (ii) Doug labels the horizontal axis on the histogram 'time in minutes' and the vertical axis 'number of minutes per runner'. State which one of these labels is incorrect and write down a correct version. [1]

The most common wrong answer was to say that the vertical axis should be labelled 'frequency'.

Question 3

- 3 P and Q are consecutive **odd** positive integers such that $P > Q$.

Prove that $P^2 - Q^2$ is a multiple of 8.

[3]

There were quite a number of completely correct proofs, usually starting with $P = 2n + 1$ or $2n + 3$. A small number of candidates put $P = 2n + 1$ and $Q = 2n + 3$; these candidates could gain some credit for subsequent work. A considerable number of candidates did not use the fact that P and Q were odd at the start of the proof, and worked with P and $(P - 2)$ or Q and $(Q + 2)$, or with n and $(n + 2)$ or $(n - 1)$ and $(n + 1)$. These candidates generally showed that $P^2 - Q^2$ is a multiple of 4; full credit could have been awarded by using the fact that P and Q are odd at this point to prove the required result, but this was not seen.

Attempts to show this by giving numerical responses were also seen, but these scored 0. Occasionally a candidate gave several numerical responses, and claimed that this was 'proof by exhaustion'.

Question 4 (i)

- 4 The probability distribution of the discrete random variable X is given in Fig. 4.

r	0	1	2	3	4
$P(X=r)$	0.2	0.15	0.3	k	0.25

Fig. 4

- (i) Find the value of k .

[2]

Candidates generally did this correctly, with many showing exactly the working given in the mark scheme.

Question 4 (ii)

X_1 and X_2 are two independent values of X .

- (ii) Find $P(X_1 + X_2 = 6)$.

[3]

This part caused considerable difficulty, with some candidates omitting it, others drawing a possibility space with equally likely outcomes, and others copying information from the table given in the question.

Candidates who realised that a total of 6 could be made either from 3 and 3 or else from 2 and 4 sometimes did not realise that 4 and 2 is also possible; others thought the probability of 3 and 3 had to be counted twice.

Question 5

- 5 Find the set of values of a for which the equation

$$ax^2 + 8x + 2 = 0$$

has no real roots.

[3]

Almost all candidates realised that they needed to use the discriminant. Many stated that the discriminant needed to be less than 0 and worked competently to get the correct inequality. Others made slips in the algebra, especially by reversing signs without changing the inequality. Quite a number of candidates found the value of a for which the discriminant is 0, and worked out that the answer is $a > 8$ by checking values, or by reasoning.

Question 6

- 6 Show that $\int_0^9 (3 + 4\sqrt{x}) dx = 99$.

[4]

Most candidates were able to integrate the expression, though the square root did cause some problems. Quite a number of candidates seemed uncertain as to the point at which the integral sign with limits before the expression should be replaced with square brackets to show that the expression should now be evaluated. In order to gain full marks candidates were required to show that they had worked out $F(9)$ and $F(0)$ and had calculated $F(9) - F(0)$. They were also required to show that the value of 99 for $F(9)$ came from $27 + 72$. The question asked for the given result to be shown; writing $\left[3x + \frac{8}{3}x^{\frac{3}{2}}\right]_0^9 = 99 - 0 = 99$ does not show this sufficiently well to be given full marks.

Question 7 (i)

- 7 Rose and Emma each wear a device that records the number of steps they take in a day. All the results for a 7-day period are given in Fig. 7.

Day	1	2	3	4	5	6	7
Rose	10014	11262	10149	9361	9708	9921	10369
Emma	9204	9913	8741	10015	10261	7391	10856

Fig. 7

The 7-day mean is the mean number of steps taken in the last 7 days. The 7-day mean for Rose is 10112.

- (i) Calculate the 7-day mean for Emma.

[1]

This part was almost always done correctly.

Question 7 (ii)

At the end of day 8 a new 7-day mean is calculated by including the number of steps taken on day 8 and omitting the number of steps taken on day 1. On day 8 Rose takes 10 259 steps.

- (ii) Determine the number of steps Emma must take on day 8 so that her 7-day mean at the end of day 8 is the same as for Rose. [4]

Most candidates found this part quite straightforward. One common error in this part was to use 10 112, the original 7-day mean for Rose, rather than work out the new 7-day mean for days 2 to 8 inclusive. Another common error was to find how many steps Emma should take on day 8 so that she has taken as many steps as Rose over the period of 8 days; this was often done by considering 8-day means.

Question 7 (iii)

In fact, over a long period of time, the mean of the number of steps per day that Emma takes is 10 341 and the standard deviation is 948.

- (iii) Determine whether the number of steps Emma needs to take on day 8 so that her 7-day mean is the same as that for Rose in part (ii) is unusually high. [3]

Candidates were expected to compare their answer to part (ii) with the long-term mean number of steps for Emma given in the question, 10 341. In order to gain full credit candidates were expected to understand that the question was asking if the answer to part (ii) was an outlier, and were expected to use the definition of outlier given in section D13 of the specification; candidates using other definitions of outlier were not given full credit. Candidates using the data in the table in the question to work out quartiles or mean and standard deviation were not given credit.

Question 8

- 8 In this question you must show detailed reasoning.**

The centre of a circle C is at the point $(-1, 3)$ and C passes through the point $(1, -1)$. The straight line L passes through the points $(1, 9)$ and $(4, 3)$. Show that L is a tangent to C . [7]

There were a good many completely correct answers to this question. Many candidates worked out the equation of C and the equation of L and found that C and L only intersected at the point where $x = 3$ (and $y = 5$). Most of these candidates then went on to say that, since this was a repeated root, L was a tangent to C . Some of these candidates omitted to state this final essential fact, while others spent a considerable amount of time establishing it by other means.

Another successful approach to this question was to find the equation of L and the equation of the line perpendicular to L that passes through the centre of C , and show that they intersect at $(3, 5)$. It is then necessary to show that this point lies on C , either by finding the equation of C or by showing that the distance from $(3, 5)$ to the centre of C , $(-1, 3)$, is equal to the radius of C .

A small number of candidates noted that the gradient of L is the same as the gradient of the radius joining the centre of C to the point $(1, -1)$; a few candidates tried to argue that this made L a tangent to C .

Question 9

9 In this question you must show detailed reasoning.

Research showed that in May 2017 62% of adults over 65 years of age in the UK used a certain online social media platform. Later in 2017 it was believed that this proportion had increased. In December 2017 a random sample of 59 adults over 65 years of age in the UK was collected. It was found that 46 of the 59 adults used this online social media platform.

Use a suitable hypothesis test to determine whether there is evidence at the 1% level to suggest that the proportion of adults over 65 in the UK who used this online social media platform had increased from May 2017 to December 2017. [7]

The majority of candidates made valid attempts at this question. Common errors at the start of the question included defining H_1 as $p < 0.62$ and failing to define p . Some candidates wrongly used the probability that $X \leq 46$ in the test, others wrongly used a point probability. Most candidates who arrived at the correct p value correctly compared it with 0.01 and went on to reject H_0 . A small number of otherwise successful candidates did not give a conclusion in the context of the question.

There were a small number of scripts from candidates who either omitted the question completely, or wrote vague comments such as 46 out of 59 is about 78%, which is a lot more than 62%.

Question 10 (i) (a)

10 (i) A curve has equation $y = 16x + \frac{1}{x^2}$. Find

(A) $\frac{dy}{dx}$,

[2]

A small number of candidates had difficulty differentiating $\frac{1}{x^2}$.

Question 10 (i) (b)

(B) $\frac{d^2y}{dx^2}$.

[2]

This part was generally correct, with a small number of candidates gaining some credit on follow through from an incorrect answer to (A).

Question 10 (ii)

(ii) Hence

- find the coordinates of the stationary point,
- determine the nature of the stationary point.

[5]

Almost all candidates correctly equated their answer to part (i)(A) to 0, though some with a correct equation ended up with $x = \pm \frac{1}{2}$ and others with $x = 2$. Some candidates with the correct x -coordinate did not give the y -coordinate. Most candidates knew that they had to check the value of the second differential when $x = \frac{1}{2}$, but not all then correctly concluded that the stationary point was a minimum. Some candidates correctly identified the stationary point as a minimum by considering the sign of the first differential either side of $x = \frac{1}{2}$.

There were a significant minority that either omitted this part completely, started by equating the original equation to zero, or equated their answer to part (i)(B) to zero.

Question 11 (i)

- 11 The pre-release material contains data concerning the death rate per thousand people and the birth rate per thousand people in all the countries of the world. The diagram in Fig. 11.1 was generated using a spreadsheet and summarises the birth rates for all the countries in Africa.

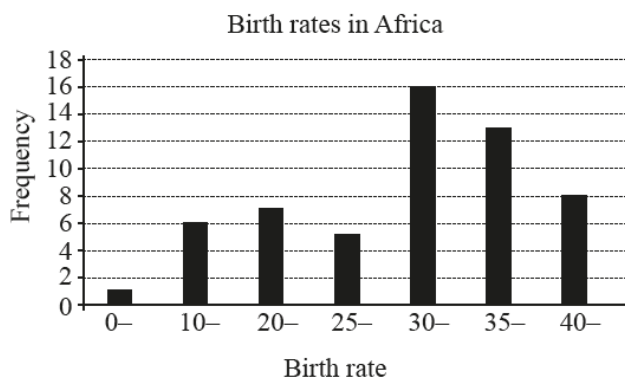


Fig. 11.1

- (i) Identify **two** respects in which the presentation of the data is incorrect.

[2]

Many candidates gave valid answers. However, the question asked for two respects in which the presentation of the data is incorrect, and an answer like 'it should be a histogram' does not answer the question.

Question 11 (ii) (a)

Fig. 11.2 shows a scatter diagram of death rate, y , against birth rate, x , for a sample of 55 countries, all of which are in Africa. A line of best fit has also been drawn.

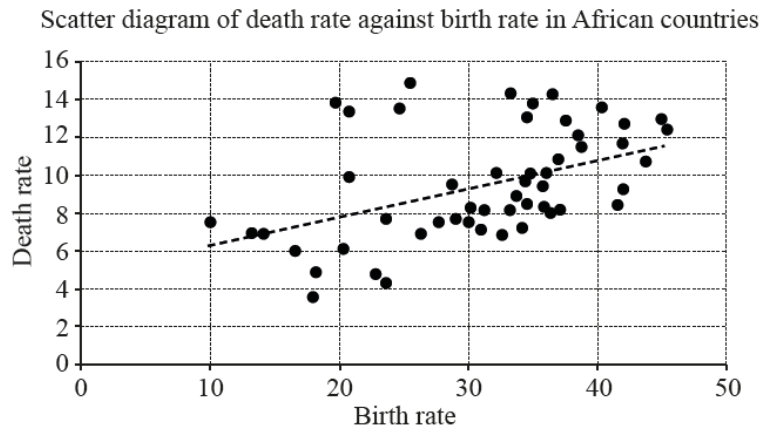


Fig. 11.2

The equation of the line of best fit is $y = 0.15x + 4.72$.

- (ii) (A) What does the diagram suggest about the relationship between death rate and birth rate? [1]

Most candidates gave a correct answer to this part. However, stating that there is a correlation between birth and death rates was not given any credit, nor were statements like 'higher birth rates cause higher death rates'.

Question 11 (ii) (b)

- (B) The birth rate in Togo is recorded as 34.13 per thousand, but the data on death rate has been lost. Use the equation of the line of best fit to estimate the death rate in Togo. [1]

This question was usually answered correctly. However, a small number of candidates appeared to have read an approximate answer from the graph (usually 10) despite the clear instruction to use the equation of the line of best fit to calculate this.

Question 11 (ii) (c)

- (C) Explain why it would not be sensible to use the equation of the line of best fit to estimate the death rate in a country where the birth rate is 5.5 per thousand. [1]

Many candidates correctly answered that this would require extrapolation; many others gave an acceptable equivalent answer by pointing out that there was no data in that part of the scatter diagram so using the line of best fit would be unreliable.

Question 11 (ii) (d)

- (D) Explain why it would not be sensible to use the equation of the line of best fit to estimate the death rate in a Caribbean country where the birth rate is known. [1]

Most candidates were sufficiently familiar with the Large Data Set to answer this part.

Question 11 (ii) (e)

(E) Explain why it is unlikely that the sample is random.

[1]

Very few candidates answered this part correctly. Many candidates gave answers that suggested that it would be difficult to take a random sample from all the population of Africa because of communication difficulties, size of the continent, unreliability of records, etc., whilst true, do not address the context of the question. The majority of candidates did not appreciate that the sample taken was of 55 countries, and that this sample was taken from all the countries of the world, as listed in the Large Data Set.

Question 11 (iii)

Including Togo there were 56 items available for selection.

(iii) Describe how a sample of size 14 from this data could be generated for further analysis using systematic sampling. [2]

There were very few completely correct answers to this part. A great many candidates described how to find a random sample by assigning random numbers to the countries. A great many others described stratified sampling. Those candidates who did describe taking, typically, every fourth country often omitted to point out the need to use a random starting point.

Question 12 (i)

12 In an experiment 500 fruit flies were released into a controlled environment. After 10 days there were 650 fruit flies present.

Munirah believes that N , the number of fruit flies present at time t days after the fruit flies are released, will increase at the rate of 4.4% per day. She proposes that the situation is modelled by the formula $N = Ak^t$.

(i) Write down the values of A and k .

[2]

While many candidates wrote down the correct answers from the information given, quite a large minority wrongly calculated the value of k that would make the population 650 after 10 days.

Question 12 (ii)

(ii) Determine whether the model is consistent with the value of N at $t = 10$.

[2]

Candidates who had used the value of 650 to find their value of k could gain only partial credit for this part; the common wrong value of k suggests that the model is consistent. Many candidates correctly found that Munirah's first model would give about 769 flies after 10 days, which is not consistent with 650.

Question 12 (iii)

(iii) What does the model suggest about the number of fruit flies in the long run?

[1]

Almost all candidates realised that the number of flies would continue to rise in the long run.

Question 12 (iv)

Subsequently it is found that for large values of t the number of fruit flies in the controlled environment oscillates about 750. It is also found that as t increases the oscillations decrease in magnitude.

Munirah proposes a second model in the light of this new information.

$$N = 750 - 250 \times e^{-0.092t}.$$

- (iv) Identify three ways in which this second model is consistent with the known data. [3]

Although there were many completely correct answers, a lot of candidates identified only one or two of the ways. Some of these candidates used the increase of 4.4% per day from Munirah's original model to suggest an answer; this is not valid. Other candidates made far more general comments that did not answer the question.

Question 12 (v) (a)

- (v) (A) Identify one feature which is not accounted for by the second model. [1]

Very few candidates identified the required feature as (decreasing) oscillations. A considerable number of candidates did not attempt this question.

Question 12 (v) (b)

- (B) Give an example of a mathematical function which needs to be incorporated in the model to account for this feature. [1]

The most common response was to omit this part. The incorrect answer of a logarithmic function was considerably more common than a correct answer; correct answers invariably involved mention of a sine or cosine function.

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New AS Levels

AS GCE Mathematics B (MEI)

			Max Mark	a	b	c	d	e	u	
H630	01	Pure Mathematics and Mechanics	Raw	70	44	38	33	28	23	0
H630	02	Pure Mathematics and Statistics	Raw	70	50	45	39	33	28	0
			Overall	140	94	83	72	61	51	0

AS GCE Further Mathematics B (MEI) (H635)

			Max Mark	a	b	c	d	e	u		
Y410	01	Core Pure	Raw	60	46	41	36	32	28	0	
Y411	01	Mechanics a	Raw	60	37	32	27	22	18	0	
Y412	01	Statistics a	Raw	60	42	38	34	30	26	0	
Y413	01	Modelling with Algorithms	Raw	60	37	33	29	25	22	0	
Y414	01	Numerical Methods	Raw	60	35	29	24	19	14	0	
Y415	01	Mechanics b	Raw	No entry in June 2018							
Y416	01	Statistics b	Raw	60	43	38	33	28	24	0	
H635	Option Y410+Y411+Y412		Overall	180	125	111	98	85	72	0	
H635	Option Y410+Y411+Y413		Overall	180	120	107	94	81	68	0	
H635	Option Y410+Y411+Y414		Overall	180	118	103	88	74	60	0	
H635	Option Y410+Y412+Y413		Overall	180	125	112	100	88	76	0	
H635	Option Y410+Y412+Y414		Overall	180	123	109	95	81	68	0	
H635	Option Y410+Y412+Y416		Overall	180	131	117	104	91	78	0	
H635	Option Y410+Y413+Y414		Overall	180	118	104	90	77	64	0	

Qualification and notional component raw mark grade boundaries June 2018 series

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New A Levels

A Level Mathematics B (MEI)

			Max Mark	a*	a	b	c	d	e	u	
H640	01	Pure Mathematics and Mechanics	Raw	100	81	74	67	59	52	45	0
H640	02	Pure Mathematics and Statistics	Raw	100	75	68	61	54	47	40	0
H640	03	Pure Mathematics and Comprehension	Raw	75	62	55	48	42	36	30	0
			Overall	275	218	197	176	155	135	115	0