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AS LEVEL

Examiners' report

MATHEMATICS B (MEI)

H630
For first teaching in 2017

H630/02 Summer 2018 series

Version 1

Contents

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) $\log_a(a^4)$, **[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) $\log_a\left(\frac{1}{a}\right)$. **[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
$\mathrm{P}(X = r)$	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 $\mathrm{P}(X_1 + X_2 = 6)$. **[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 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	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]**

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.

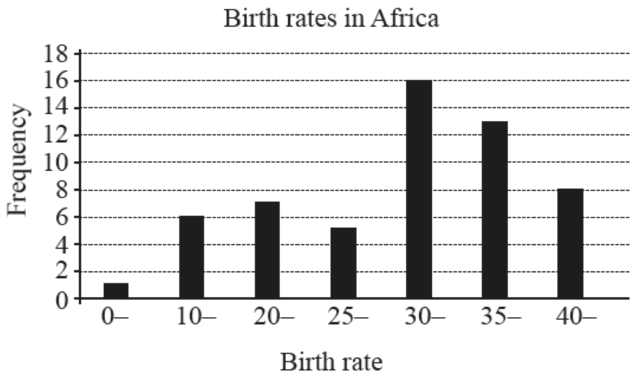

Fig. 11.1

(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.

Scatter diagram of death rate against birth rate in African countries

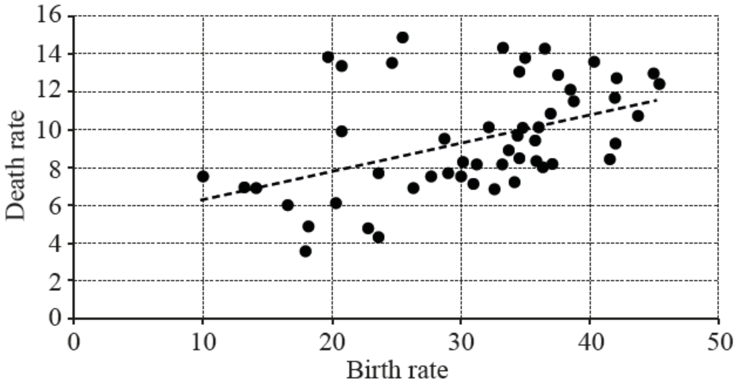

Fig. 11.2

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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