Qualification Accredited

Oxford Cambridge and RSA

A LEVEL

Examiners' report

MATHEMATICS B (MEI)

H640

For first teaching in 2017

H640/02 Autumn 2021 series

Version 1

ocr.org.uk/maths

Introduction

Our examiners' reports are produced to offer constructive feedback on candidates' performance in the examinations. They provide useful guidance for future candidates.

i	Reports for the November 2021 series will provide a broad commentary about candidate performance, with the aim for them to be useful future teaching tools. As an exception for this series they will not contain any questions from the question paper nor examples of candidate responses.

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.

A full copy of the question paper and the mark scheme can be downloaded from OCR.

Paper 2 series overview

H640/02 is the second of three compulsory components in A Level Mathematics. It contributes 36.4% of the total A Level and assesses content from pure mathematics and statistics.

Candidates are expected to have studied statistics using the large data set and to have routinely used spreadsheets, graphing software and calculators when studying this course.

To do well in this component, candidates need to be able to apply their knowledge of the specification content in a variety of modelling and statistical contexts. They should be able to use the statistical functions on their calculators efficiently in a variety of contexts and be familiar with the command words detailed in the specification.

They also need to be able to explain their reasoning when providing a critique of diagrams or propositions, and to relate their answers to the context, citing calculations and information from the text where appropriate.

Candidates who did well on this paper generally did the following:	*Candidates who did less well on this paper generally did the following:*
• Presented clear and concise responses which were easy to follow. • Demonstrated a thorough working knowledge of the specification content. • Made efficient use of their calculators, for example to calculate probabilities using standard distributions or to calculate sample statistics from a given frequency distribution. • Made reference to calculations and given information when interpreting spreadsheet and software output. • Understood what could be inferred from statistical diagrams and calculations, and were able to explain this in the given context. • Recognised whether their answers were sensible in the context of the question. • Were able to relate their knowledge of the pre-release material to the context of the question.	• Presented incomplete or no working, or presented responses which were difficult to follow. • Demonstrated only a partial understanding of some areas of the specification. • Calculated probabilities and sample statistics using time-consuming written methods. • Made general comments, which may have been correct, but did not quite answer the question when interpreting spreadsheet and software output. • Did not fully understand how to interpret probabilities and statistical measures in context. • Did not realise that their calculator answer (for example a probability greater than 1) could not be correct. • Were not able to apply their knowledge of the pre-release material.

Section overview

Section A proved accessible to most candidates, with many earning three quarters of the marks or more. However, a significant minority of candidates appeared to be unfamiliar with the topics covered in Q6 and Q7.

Candidates who did well in Q1 knew they needed to work with f(½ *x*) and generally earned both marks. A few slipped up with the algebra or did not heed the request for the answer in the given form. Candidates who did less well worked with f(2*x*). Candidates who did not do well worked with ½ f(*x*) or f(*x* – 2).

Q2, 3 and 4 were very well done indeed, with only a few slips seen.

Candidates who did well in Q5 made efficient use of their calculator to present the correct answers, often without any working. In part (b), candidates who did less well calculated $P(X \geq 7)$ or presented their answer to a different precision. Candidates who did not do well in part (b) worked with $P(X = 7)$ or $P(X = 8)$. Some candidates misunderstood the question and worked with $\frac{12}{32}$ in part (a) and $\frac{8}{32}$ in part (b).

Candidates who did well in Q6 were able to multiply vectors by scalars and add vectors. They understood how to find the length of a vector, but may have made a slip in the arithmetic. In part (b) they understood the relationship between their vector and the direction of **i**. Candidates who did less well made slips in part (a) and worked with an incorrect triangle in part (b), sometimes finding the angle between their vector and **j** and sometimes subtracting 1 from their *x* component before using trigonometry to find an incorrect angle. Candidates who did not do well were not able to combine the two vectors in part (a) correctly or were not able to find the magnitude of the vector. Part (b) was sometimes not attempted.

Candidates who did well in Q7 understood how to convert from parametric to cartesian form and recognised how to apply Pythagoras' identity. Some made slips with arithmetic, such as forgetting to square 5. They were nearly always able to use their cartesian equation to write down the correct answer to part (b). A very small number of candidates found the centre of the circle from the parametric form, and then wrote down the cartesian equation. Candidates who did less well gave an equation in terms of inverse trig functions and only rarely gave a correct answer to part (b). Candidates who did not do well either didn't understand the need to eliminate the parameter, or attempted to do so but were unable to manipulate algebraically.

Section B proved accessible, at least in parts, to most candidates. There was no common theme to this, it seemed to depend on which areas of the specification the candidates had been exposed to. For example, Q9 was misunderstood by many candidates, but a good number of candidates whose overall performance was modest were able to score quite well.

Themes in candidate responses

Pure

There were many good answers to Q14, although not many achieved full marks. Q15 proved challenging, even though it was heavily structured. Perhaps the modelling context and the combination of pure topics and probability proved off putting. Only the higher ability candidates made significant progress. A good number of candidates recognised that a substitution was needed in Q16 and most were able to make some progress. Some candidates went on to achieve full marks with some very clear and concise solutions seen. Future candidates would be well advised to practise longer, unstructured questions which draw on more than one area of the specification, and to practise modelling questions in the many and varied contexts in which they appear.

Statistics

Many candidates seemed able to make some correct calculations of probabilities and statistical measures, but often ran into difficulty when interpretation and explanation were required. Once again it seemed that some candidates had little, if any, experience of working with the pre-release material.

All the questions elicited very good responses from some candidates, but very few candidates were able to present good responses to every statistics question.

i	**OCR support**	Guidance for working with questions based on the Large Data Set, like Question 12, is provided in our Notes on the large data set resources.

Comments on responses by question type

Pure

Candidates who did well in Q14 (a) used the product and chain rules to find the first derivative and were then able to factorise their answer. Candidates who did less well did not perform a compete factorisation or made slips with the algebra. Some did not simplify to 5x – 4 in the final bracket or did not spot that *x* is also a factor. Candidates who did less well expanded the brackets before differentiating, sometimes making a slip. Only rarely did these candidates recover to present an answer in factorised form, as requested.

Candidates who did well in Q14 (b) set their factorised derivative equal to zero and found all three *x*-values, going on to give the correct coordinates. Some candidates were able to achieve full marks in this part even if they had not done so in part (a) – occasionally after finding $\frac{dy}{dx}$ again. Candidates who did less well missed one of the *x*-values – quite often it was $x = 0$.

Candidates who did well in Q14 (c) used the given result to evaluate the second derivative at the three turning points. They were able to identify the local maximum and local minimum correctly. The best candidates knew that a second derivative of zero meant that the test was indecisive, and went on to examine the gradient either side of the turning point. Candidates who did less well made slips with their arithmetic or misinterpreted one or more of their results.

Candidates who did well in Q14 (d) presented a correct sketch, on which they identified the intercepts correctly. Some candidates earned both marks following incorrect or incomplete work in earlier parts, and some candidates were unable to earn any marks following completely correct work in earlier parts, often not showing the inflection with zero gradient correctly.

Candidates who did well in Q16 used a suitable substitution and were able to complete the change of variable to produce the integrand in a suitable form. They may have lost one or both of the final A marks through slips in the algebraic manipulation before integrating. Candidates who did less well obtained a correct or nearly correct integrand, but were unable to make further progress. Candidates who did not do well tried to use integration by parts.

Pure and Statistics

Candidates who did well in Q15 (a) recognised a and r and substituted in the correct formula to obtain the given result. Candidates who did less well did not identify a correctly (1 instead of 0.01 was frequently seen; the given result was then contrived incorrectly).

Candidates who did well in Q15 (b) recognised the context and understood that they needed to work with 312 (or 313) weeks. They worked with the formula for the sum of the first n terms and related their answer to Kofi's statement. Candidates who did less well worked with 312, but with $P(X = n)$ rather than $P(X \le n)$.

Candidates who did well in Q15 (c) and (d) framed their responses in terms of the greater probability of Layla winning as r increases, due to her improvement from practising.

Candidates who did well in Q15 (e) calculated k correctly and followed this with a correct probability and a comment relating to Layla's statement. Candidates who did less well attempted to find k, not always successfully, but made no further progress.

Statistics

Candidates who did well in Q8 understood that a did not affect the variance. They found b first and then went on to find a successfully. A small number of candidates calculated probabilities for each distribution and then used the standard Normal curve to obtain a pair of simultaneous equations which they then solved. This convoluted approach sometimes led to full marks, but often at least one of the accuracy marks was lost due to premature approximation. Candidates who did less well tried to solve two equations in a and b formed by substituting the mean and standard deviation (or variance) in $Y = a + bX$

Candidates who did well in Q9 understood that this was sampling without replacement. Most used a tree diagram to obtain the correct answers to parts (a) and (b), and some progress was usually made with part (c). The final mark in part (d) was sometimes earned. A successful approach based on combinations was sometimes seen. Candidates who did less well slipped up in the arithmetic or didn't multiply by 4 in part (a). Candidates who did not do well misunderstood the question and used the binomial theorem throughout.

Candidates who did well in Q10 (a) recognised that there might be seasonal variation in the birds seen and commented accordingly. Candidates who did less well presented a circular argument or gave general comments about the two different sampling methods. Q10 (b) was very well done with only a few writing 'negative skew' or making up their own description. Candidates who did well in Q10 (c) noted either directly or indirectly that the mode is in the lower tail of the distribution. Q10 (d) was generally very well done, although a few candidates slipped up in calculating (usually) the median or (less commonly) the interquartile range. Candidates who did well in Q10 (e) compared their answers to part (d) with the median and interquartile range deduced from the boxplot and related their findings to Ben's statements. Candidates who did less well made the correct comments, but didn't support them with a comparison of values. Candidates who did well in Q10 (f) commented that such a boxplot could arise from, for example, a Normal distribution, or observed that a boxplot does not give information about the frequency of different values within each quartile.

Candidates who did well in Q11 (a) wrote out correct hypotheses and defined μ correctly. They were able to explain why the test is one-tailed. Candidates who did less well defined μ as a mean, an average or a sample mean rather than the population mean, or they incorrectly identified the test as 2-tailed.

Candidates who did well in Q11 (b) used the correct distribution to find the critical region. Some lost the accuracy mark because they went on to define it in terms of μ or X. Candidates who did not do well used the distribution for X instead of $\bar{X}$ or they used $\frac{\sigma}{n}$ or occasionally $\frac{\sigma^4}{n}$ or $\frac{\sigma}{\sqrt{n}}$ instead of $\frac{\sigma^2}{n}$.

Candidates who did well in Q11 (c) identified whether 161.9 was in their critical region and went on to explain whether or not the first two statements were correct. They identified that it is only possible to make inferences, not to prove anything, when conducting a hypothesis test, when they commented on the third statement.

Candidates who did less well referred to whether or not the null hypothesis was accepted when commenting on the third statement.

Candidates who did not do well made insufficient reference to their answer to part (b) or misunderstood the idea of a critical region.

Q12 (a) and (b) were generally very well done. A minority of candidates did not appear to be familiar with the pre-release material or use of spreadsheets and accordingly made unsuccessful guesses in part (a).

Candidates who did well in Q12 (c) commented on whether or not the BMI values and pulse rate values were plausible and commented accordingly. Candidates who did not do well tried to construct an argument based on $\mu \pm 2\sigma$ or gave answers which indicated they were unfamiliar with the material.

Q12 (d) (e) and (f) were generally very well done. A few lost an easy mark in (d) by just writing "No" or by stating there is positive correlation. In part (e) not many candidates commented that the pmcc is close to 1, but many candidates commented that the correlation is strong, and were allowed the mark.

Candidates who did well in Q13 (a) used their calculator efficiently and wrote down the correct answers. Candidates who did less well wrote down the root mean squared deviation instead of the standard deviation, or calculated the values in the old-fashioned way and made a slip.

Some candidates wrote down the correct answer for Q13 (b), but a surprising number stated n = 100.

Candidates who did well in Q13 (c) used their calculator efficiently to obtain the probability distribution. They then multiplied by 100 to obtain the expected frequencies, which they quoted to at least one decimal place. The best candidates realised that the expected frequencies had to sum to 100 and successfully found the expected frequency for 5 or more. Candidates who did less well calculated each probability discretely and generally gave up before completing the table.

Candidates who did well in Q13 (d) commented on the closeness of fit between the theoretical and observed frequencies.

Common misconceptions

	Misconceptions	**Pure** A significant minority of candidates did not seem to be familiar with the concept of a one-way stretch in the *x*-direction. Similarly, a significant minority of candidates were unable to successfully find the angle between the two vectors in Q6 (b) or to convert between parametric and cartesian form in Q7 (a). Only a small minority of candidates understood that when the second derivative is zero at a stationary point, the test is indecisive. **Statistics** Many candidates resorted to the binomial distribution in Q9, not seeming to understand that 4 different puppies were being selected, and that it was not possible to select the same one 4 times. Many candidates used the distribution for X rather than $\bar{X}$ in Q11 (b) when calculating the critical region. Many candidates confused s and σ when asked to calculate the standard deviation in Q13 (a).

Key teaching and learning points – comments on improving performance

Pure

Candidates should practise unstructured questions. Some, but not all, of these should draw on different areas of the specification.

Candidates should practise modelling questions in a variety of contexts.

Statistics

Candidates should work with a variety of spreadsheet and software output such as statistical diagrams and tables, practise extracting information from these diagrams and commenting on it in context.

They need to make efficient use of their calculators to find sample statistics and probabilities. They also need to be able to comment sensibly on what these results might mean in the context of the question.

Guidance on using this paper as a mock

It would perhaps be fair to delete Q12 as the candidates using this paper as a mock will be working with a different large data set. It could perhaps be replaced with a suitable question from a different past paper.

When it comes to assessing performance, it would be advisable to refer to the grade thresholds published by OCR for this component.

In general terms, section A and most of section B should be accessible to all candidates. Q9 (c) and (d), 15 and 16 may be regarded as useful material for stretching higher ability candidates.

It would be advisable for candidates to prepare for this by working through at least some of the practice papers and 2018, 2019 and 2020 papers.

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