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Examiners' report

# MATHEMATICS B (MEI)

H640

For first teaching in 2017

## H640/02 Autumn 2020 series

Version 1

# Introduction

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

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|  | Reports for the Autumn 2020 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 answers. |

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 the A Level assessment. 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 large data sets and to have routinely used spreadsheets, graphing software and calculators when studying this course. This paper included questions that assumed knowledge of Large Data Set 2 (2020 series).

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

| ***Candidates who did well on this paper generally did the following:*** | ***Candidates who did less well on this paper generally did the following:*** |
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| • Set out their working clearly and with all necessary details.<br>• Made efficient use of their calculators, displaying a clear understanding of how to use appropriate statistical functions as necessary.<br>• Knew how to interpret spreadsheet and other software output.<br>• Demonstrated a clear understanding of information in statistical diagrams.<br>• Recognised whether their answers were sensible in the context of the question.<br>• Were able to relate their knowledge of the pre-release material to the context of the question. | • Presented incomplete or no working.<br>• Used their calculator in the wrong mode – e.g. in degree mode when they should have worked in radians, and vice versa.<br>• Did not make efficient use of the statistical functions on their calculator.<br>• Misinterpreted information from software.<br>• Made (sometimes correct but) irrelevant comments when providing a critique of a diagram or an argument.<br>• Did not appreciate when an answer they had presented was clearly wrong and needed to be checked.<br>• Were not able to apply their knowledge of the pre-release material. |

## Section A overview

Section A consists of shorter questions of a more routine nature and on this paper proved accessible to most candidates, with many earning three quarters of the marks or more. Questions 1, 2, 3, 5 and 6 were on pure mathematics with Questions 4 and 7 focused on statistics.

### Question 1

Question 1 was very well done by most candidates. Those who did less well incorrectly rounded to 146 or presented their final answer to a different precision to the request for 3 sf. A few candidates appeared to have used their calculator in radian mode and did not correctly find $\sin(133°)$.

### Question 2

Question 2 was very well done indeed, with few mistakes.

### Question 3

Candidates who did well in Question 3 differentiated successfully in part (a) and set their derivative equal to 0 in part (b). They understood that the answer should be presented in radians.

Those who did less well made a slip in part (a)– usually omitting an 8 – or worked in degrees in part (b).

The very few candidates who did not do well were unable to differentiate either term successfully in part (a).

### Question 4

Candidates who did well in Question 4 were able to provide a realistic estimate of the median in part (a) and went on to make a correct statement in part (b) which was supported by a correct argument.

Candidates who did less well provided insufficient detail to support their (usually correct) statement in part (b), or mistakenly thought that the median time was 60 minutes.

### Question 5

Question 5 was generally very well done. Candidates who did less well made a slip in part (a) – usually giving $n$ as 25 – and then went on to earn the method mark in part (b).

### Question 6

Question 6 was generally very well done. Candidates who did less well made a slip in the expansion – usually in the third term – or were unable to answer part (b) correctly.

### Question 7

Question 7 was generally very well done.

Candidates who did less well were unable to explain why the events were independent in part (c).

Candidates who did not do well assumed that A and *B* were independent in part (a) or worked with 0.2 instead of 0.8, going on to achieve a probability greater than 1 in part (b) – only a very small number of candidates recognised that this would indicate a mistake and went back to correct their earlier work.

## Section B overview

Section B includes longer questions and more problem solving with an increasing gradient of difficulty. The majority of candidates were able to display a good knowledge of the syllabus material and were comfortable in applying this to the more routine parts of the questions. Some elements of the statistics content seem to be less well understood, and many candidates appeared less confident when asked to provide an interpretation or make an inference in context.

## Section B: Pure

There were many good answers to Questions 10 and 15, and even though 15c was quite difficult, a significant minority achieved full marks. This was perhaps because there was a clear structure to each of these questions. Question 14 proved more challenging. Those who did not think to use the compound angle formula – perhaps they did not expect to see it in this context – struggled with much more convoluted approaches and generally didn't reach a complete solution.

Future candidates would be well advised to practise longer, unstructured questions which draw on more than one area of the syllabus.

### Question 10

Candidates who did well in this question made efficient use of the small angle approximation for $\sin x$ and sensibly used $\sin 2x \approx 2x$ to obtain $\int \frac{1}{x}\,dx$, or used the double angle formula and then the small angle approximation for $\cos x$. Full marks in parts (a) and (b) was commonly achieved.

Those who did less well did not simplify their expression for $\frac{1}{x}$ fully before integrating and went on to make a slip (often integrating by parts) and similarly used the product or quotient rule in part (b) to differentiate $\frac{x}{x^2}$ for example.

Candidates who did well in part (c) were clearly familiar with spreadsheets and were able to give a clear and correct response to both requests. Candidates who did less well either didn't understand the spreadsheet notation, or didn't appreciate the significance of the change of sign in the table.

### Question 14

Candidates who did well either spotted the compound angle application or were able to derive the correct cubic in $\sin x$ when finding the points of intersection of the curve. They recognised how to apply integration and some were able to do this correctly. Those who did less well were unable to make progress with the integration or slipped up in forming the cubic in $\sin x$. Candidates who did not do well were unable to progress from setting the two equations equal or from stating the correct integration needed.

## Question 15

Generally this question was well received and proved to be a good discriminator. Candidates who did well scored full marks in parts (a) and (b) and knew how to approach part (c) – although they may have made a slip in differentiation or in the substitution.

Candidates who did less well were not able to apply the chain rule successfully in part (c), or substituted incorrect values in the penultimate step.

Candidates who did not do well incorrectly simplified their expression in part (a) and were unable to make meaningful progress in part (c), although they may have earned credit for a correct domain in part (a) and a FT calculation in part (b).

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| ? | **Misconception** | A significant minority of candidates appeared unclear how composite functions are formed and thought $\mathrm{fg}(x) = \mathrm{f}(x) \times \mathrm{g}(x)$.<br><br>There was also a surprising number of candidates that expressed $\sqrt{x^3 - x - 6}$ as $\sqrt{x^3} - \sqrt{x} - \sqrt{6}$ |

## Section B: Statistics

There was evidence that many candidates were less confident with the full statistics content than with the pure content. Many candidates did not appear familiar with the different sampling techniques identified in the specification, and very few were able to give a clear description in context. Very few candidates seem to understand that correlation is a measure of how close data points lie to a straight line. Similarly, the term *p*-value was often misunderstood.

It was also apparent that a significant minority had little, if any, experience of working with the pre-release material.

Most candidates were very competent when it came to performing the statistical calculations, however, a number of candidates confused *s* and $\sigma$ when presented in software output. Candidates appeared less skilled at extracting the relevant information from tables and diagrams.

There were many excellent responses to the hypothesis testing questions, although there were candidates that either did not initially define their test fully or finished with conclusions that were too assertive or not in context.

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|  | **OCR support** | Students may benefit from the hints and tips given in the recent blog: Hypothesis tests and the art of being non-assertive. |

### Question 8

Candidates who did well were able to identify Rosella's sampling method in part (a), and give a clear description of both techniques in part (c). They recognised the need to mention increasing sample size in conjunction with shape in part (d). They successfully used information from the table in part (e) to apply the correct Normal model, and gave a limitation in context in the final part.

Candidates who did less well gave a partial description of the sampling techniques in part (c), and often used 500 instead of 4960 in part (e).

Candidates who did not do well were unable to identify quota sampling in part (a) or to provide a coherent description of either technique in part (c). In part (e) they may have used incorrect parameters.

### Question 9

Candidates who did well in this question gave a clear description of how cluster sampling could have been used in this case. In part (b) they set out their hypothesis test clearly, using correct parameters from the information in Fig. 9, although they may have incurred a small penalty for using the wrong value for the standard deviation, or giving an incomplete definition of $\mu$ .

Candidates who did less well provided an inadequate description in part (a), and did not explain the nature of the alternate hypothesis in part (b). They may have presented an incomplete definition of $\mu$ or used the wrong value of the standard deviation. Some may have been too forceful in their final conclusion.

Candidates who did not do well may have used a different parameter for the population mean, or did not define it adequately. Some used the wrong distribution altogether, treating 4.8855 as the population mean or 2.7054 as the standard deviation, instead of $\frac{2.7054}{\sqrt{120}}$ .

## Question 11

Candidates who did well in this question made no slips in the routine tasks in parts (b), (c) and (d), and were able to make relevant comments which addressed the question in parts (a), (e) and (f).

Candidates who did less well did not refer to the pre-release material in part (a), compared the two models with each other in part (e) instead of with the data, and made speculative observations in part (f).

Candidates who did not do well in this question slipped up in one or more of the routine tasks in parts (b), (c) and (d).

## Question 12a

Candidates who did well in this question wrote down the two correct equations from the information given and solved simultaneously by substitution. They recognised the need to find both sets of values for $p$ and $q$ in order to justify their final answer.

Candidates who did less well often started with $pq = 0.06$ instead of $2pq = 0.06$. This leads to a quadratic with no real roots, but rather than go back and check earlier work most persisted with trial and improvement.

Candidates who did not do well were only able to form one equation from the information given, and made no further progress.

## Question 12b

Candidates who did well in this question used their calculator efficiently to calculate the correct probability for their value for $q$.

Candidates who did not do well calculated $\mathrm{P}(X = 5)$ or omitted the binomial coefficient when calculating the probability without reference to the binomial distribution.

## Question 12c

Candidates who did well in this question set out their hypothesis test clearly, using a correct parameter which was clearly defined. They calculated the correct probability and explained its significance in the context of the test. Their conclusion was suggestive rather than forceful.

Candidates who did less well calculated $\mathrm{P}(X \leq 28)$ instead of $\mathrm{P}(X \leq 27)$ or were over assertive in their conclusion.

Candidates who did not do well calculated $\mathrm{P}(X = 28)$ or were unable to set up correct hypotheses in the first instance.

## Question 13

Candidates who did well in this question were successful with the relatively straightforward requests in parts (b) and (d). They were able to make at least one relevant observation in part (a) – usually that the $p$-value should have been compared to 0.05 – and also in part (c) – usually that the pmcc would be closer to 0 in conjunction with correct reasoning.

Candidates who did less well on this question overall generally achieved full marks in part (b) but perhaps only some credit in one of the other parts.

## Key teaching and learning points – comments on improving performance

### Pure

Candidates should practise unstructured questions which draw on different areas of the syllabus.

Candidates should work with spreadsheets when applying numerical methods. They should make sure they understand simple spreadsheet output and that they are able to interpret it in context.

### Statistics

Candidates should work with a variety of statistical diagrams and practise extracting information from these diagrams and commenting on it in context.

They need to work with software output and use it in a variety of contexts, including applying standard models such as the Normal distribution. They need to be able to identify $s$ from software output.

They need to understand pmcc in the context of a scatter diagram, and how the removal of outliers may affect the pmcc and its associated $p$-value.

## Guidance on using this paper as a mock

It would perhaps be fair to delete Questions 11a and 13d, as the candidates using this paper as a mock will be working with a different large data set.

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 should be accessible to all candidates, and the majority of candidates should be able to access marks on Questions 8 – 12.

Questions 12a, 13, 14 and 15 may be regarded as useful material for stretching stronger candidates.

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

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