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Examiners' report

MATHEMATICS A

H240

For first teach in 2017

H240/02 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.

i	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

There was a small entry for this paper. There was a good spread of marks, including a few very good scripts and some poor ones.

Two of the questions included the '**In this question you must show detailed reasoning'** instruction. In some cases, candidates did not include all the essential steps and so did not gain full credit. An example is Question 4. Some candidates wrote down the roots of the quadratic equation, without explanation. The '**detailed reasoning**' instruction means that candidates have to show a method (e. g. how they have dealt with the 'disguised quadratic') in order to gain the relevant mark, rather than just using the 'poly-solve' function on their calculator. Candidates are also required to explain why they reject one of the roots of the equation ($\sin^2 \phi = -\frac{4}{3}$).

Eight questions included the command word "Determine". This also implies the need to show full working. An example is Question 5(a). A correct answer following from muddled working, or with no working at all, was likely to score, at most, 2 marks out of 3. This is in contrast to Questions 1(c) and 3(a)(i) where the command word is "Find". In these questions, correct answers were likely to score full marks even if the working was inadequate or omitted.

The explanations of words such as 'determine', 'find' and 'hence', given on pages 9 to 11 of the specification, would repay careful reading.

i	**OCR support**	Candidates should understand the requirements expected where a question states '**In this question you must give detailed reasoning**' or uses a command word such as 'determine' or 'show that'. In these cases, the examiner will be assessing whether the candidate is explaining each step of their process; method marks are not given unless steps are clear. The command words are defined in the specification and a student summary guide can be found on the assessment tab of the H240 qualification page on the OCR website: A Level Maths command words poster.

In this paper, there is always at least one question requiring deduction from data, and written responses. In this case it was Question 14. There were some very good responses. However, some candidates seemed to misunderstand the questions. For example, Question 14(a)(ii) asks which of four LAs would have the greatest need for extra teachers. Some candidates chose Tameside because it had the greatest *percentage* increase in 0 to 4 year olds. In fact the greatest need for extra teachers would depend on the *absolute* increase in pupil numbers, rather than the percentage increase.

Many candidates wrote far more than was necessary when answering Question 14.

A significant learning point is the efficient and correct use of calculators, and in particular, calculator functions. As discussed above, in certain questions, the use of a calculator without explanation is not appropriate. However, in this paper it was clear that some candidates were not aware of situations in which it *is* appropriate, and indeed encouraged, to make use of calculator functions. An example is Question 11(a). Many candidates showed long calculations, often involving errors. Since the command word is "Calculate", rather than "Determine", it is quite acceptable to use the statistical functions on the calculator. One has only to input four values of x (the midpoints of the classes) and four frequencies and press the relevant buttons. This provides both answers immediately.

i	**OCR support**	Guidance on the use of technology to support teaching and learning and the use of calculators in the examination can be found in the qualification specification. A student summary poster can be found on the planning and teaching tab of the H240 qualification page on the OCR website: Maths calculator use poster

It is noteworthy that question that can be answered using calculator functions (such as solution of polynomial equations, definite integration, finding a mean and standard deviation) are given fewer marks than on older examination papers, in which more had to be carried out by hand.

Candidates who did well on this paper generally did the following:	***Candidates who did less well on this paper generally did the following:***
• They had good algebraic skills. • They were able to express themselves clearly. • They understood the relation between vectors and geometrical configurations. • They understood the significance of the modulus sign in the integral of $\frac{1}{x}$. • They had a good understanding of the logic of a hypothesis test. • They were able to find their way through a complicated probability problem.	• Some candidates had poor algebra skills. • Some had a poor grasp of vectors. • Many were unable to solve a differential equation by separating the variables. • Many were unable to work with a complex probability situation. • Some had not grasped the essential steps in a hypothesis test and the necessary form for the conclusion.

Comments on questions

Section A: Pure Mathematics

Question 2

Some candidates used their calculators to solve the equation obtained by setting the numerator equal to 0. This was an acceptable method where the command word is 'Simplify', however, many candidates kept a factor of $\left(x+\frac{3}{2}\right)$ and did not replace it by the correct factor of $(2x+3)$. Some candidates attempted long division of the cubic numerator by one of the factors of the quadratic denominator, however sign errors were often seen.

It is worth noting that the neatest way to factorise a cubic is probably to use the factor theorem (with perhaps the calculator solve function used to identify values), rather than either of the two methods mentioned above. Had the question contained the "**detailed reasoning**" instruction, or the command word "determine" then a written mathematical argument to confirm the factors would need to be seen.

Question 3(c)

This is a good example of the use of "Hence or otherwise". Those candidates who took the hint and used their answers to parts (a) and (b), obtained the required result quickly. Unfortunately, the majority of candidates opted for the "otherwise" route and, in almost all cases, did not obtain any marks.

Many candidates correctly obtained $\sin^2\theta = 1$ or $\sin^2\theta = -\frac{4}{3}$, but then deduced that $\sin\theta = 1$, omitting the case where $\sin\theta = -1$. Some also gave no comment about rejecting $\sin^2\theta = -\frac{4}{3}$, but merely crossed it out.

Question 6

This question was very well answered by most candidates. A few had an incorrect sign in their trigonometric identities, despite these being given on the question paper. A few also did not make use of the fact that $\cos 45° = \sin 45° = \frac{1}{\sqrt{2}}$, perhaps not spotting that in this question θ was measured in degrees.

Question 8

This differential equation was difficult in that a correct solution depended on the correct use of the modulus sign when integrating $\frac{1}{P-100}$. The majority of candidates either did not include the modulus sign or included it but then just ignored it. These candidates then obtained an impossible value for the constant of integration, such as $c = \ln(-1900)$ or $e^c = -1900$. Some noticed this and just dropped the negative sign, while others ploughed on, seemly unaware of that this was a problem. Candidates who made errors such as these could, nevertheless, score 5 marks out of 7 if they made no other errors.

A few candidates made no attempt to separate the variables and "integrated" to obtain equations such as $P = 100t - Pt$.

Section B: Statistics

Question 9(b)

This was an unusual type of question, and many candidates did not understand what was required. Common incorrect answers were $\frac{\text{Frequency}}{\text{Class width}}$, $\frac{\text{Cars}}{\text{Price}}$ or $\frac{\text{Number ofcars}}{\text{Thousands of pounds}}$.

Question 10

The usual errors were seen, such as incorrectly stated hypotheses (including omitting to define *p*), the use of $\text{P}(X = 11)$ instead of $\text{P}(X \leq 11)$ and definite conclusions, such as "Pierre is not over-confident". Guidance on all these points can be found in section 2.05a of the specification.

	OCR support	You may wish to share the following blog with your students which highlights some common features to consider when tackling questions on hypothesis testing. Hypothesis tests and the art of being non-assertive

Question 11(d)

This question is best answered by noting that most (or almost all) the values of a normal distribution lie within 2 (or 3) standard deviations of the mean. However, many candidates who found these values did not explicitly compare them with the two values given in the question.

Question 12(a)

As in Question 10, many candidates omitted to define μ.

Question 15(b)

Most candidates were unable to find their way through the various calculations needed. Some obtained a correct product of three probabilities (e. g. for 2, 2, 5) but omitted to multiply by 3. Others omitted the case 3, 3, 3 altogether.

Question 15(c)

Most candidates did not recognise the need to consider the first 9 values separately before considering the 10th.

Some candidates seemed unfamiliar with the binomial distribution.

Common misconceptions

?	**Misconception**	In answering Question 7 (about vectors) some candidates appeared not to appreciate the different significances of *a*, **a** and *A*. Some candidates appeared not to understand the description "cartesian equation" and attempted to find some sort of vector equation of the circle in question 7(d). Many candidates did not appreciate the need for the modulus sign, and how to use it, after integrating $\frac{1}{P-100}$, in question 8. Many candidates used '=' instead of '≤' in the hypothesis test, as mentioned in Question 10. In answering Question 13(b), most candidates did not recognise that an infinite series was involved.

Key teaching and learning points – comments on improving performance

One way to answer hypothesis test questions successfully can be taught as a simple list of steps to be learnt by rote. For more information, see the OCR Maths blog A Level Maths – hypothesis tests and the art of being non-assertive.

It is difficult to teach candidates how to answer questions requiring deduction from data. Perhaps the best strategy is to look carefully at all the past papers and practice papers, for both AS and A Level. In particular, a close study of the published mark schemes, and examiner's reports, will help teachers and candidates to understand what kinds of answers are acceptable. Brevity is of the essence.

Teachers should advise candidates carefully about the meanings of the command words given in section 2d of the specification, such as 'Detailed reasoning', 'Exact', 'Determine', 'State' and 'Hence'. These words are intended to be pointers as to how particular questions should be approached, so candidates need to be familiar with these before sitting the exam. As an example, in Question 3(c), attention to the word "hence" made the question fairly simple, but most candidates missed this.

Factorisation of polynomials by means of the factor theorem is almost always useful in this type of exam paper.

Careful explanation of the need for the modulus sign when integrating $\frac{1}{x}$ would be useful to candidates.

Question such as 15(b) are common, involving the need to considers a list of all possible cases. It is necessary to recognise, for example, that 2, 2, 5 can be arranged in three different orders, but 2, 3, 4 can be arranged in six different orders. Practice of this type of question in the classroom would yield dividends.

Guidance on using this paper as a mock

This paper covers the following pure topics: simple calculus, algebraic factorisation and simplification, the binomial expansion for non-positive integer *n*, geometrical progressions, trigonometrical equations and identities, algebraic proof, vectors (position vectors, modulus, distance between points, mid-point), the cartesian equation of a circle, differential equations,

This paper covers the follow statistics topics: histograms, hypothesis tests for μ and for p, rejection region, calculation of mean and standard deviation, properties of the normal distribution, addition and multiplication of probabilities, inference from data and discrete probability distributions.

In general, the paper tested algebraic manipulation and application of calculus in several contexts, together with various statistical concepts and understanding of probability.

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