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Examiners' report

MATHEMATICS A

H230
For first teaching in 2017

H230/01 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. Full copies of the question paper and the mark scheme can be downloaded from OCR.

Paper H230/01 series overview

This is the first example of the AS Pure Mathematics and Statistics paper produced for the new Specification. It differs slightly in style from papers in previous years in the following ways.

- There is a greater emphasis on proof.
- There is a greater emphasis on interpretation, rather than calculation, especially in Statistics.
- It reflects the fact that candidates are expected to have used the Pre-release Large Data Set as a tool for studying statistical concepts and techniques.
- It assumes the use of more powerful calculators than in the past. This affects the paper in two ways.
    1. There are fewer marks for certain types of skill, such as calculating binomial probabilities and solving quadratic equations.
    2. Some questions contain the instruction '**In this question you must show detailed working**'. In these questions, candidates are required to demonstrate their understanding of the relevant concepts by showing their working, rather than by presenting an answer gained simply by pressing a few buttons. Consequently, in these questions, marks will not be credited unless correct working is seen. Remember that this does not preclude candidates from checking their working using the calculator.
- The paper is divided into separate Pure Maths and Statistics sections. In each section, the questions are placed approximately in order of increasing difficulty. Consequently, some candidates would be well advised to attempt the first few (easier) Pure Maths questions and the first few (easier) Statistics questions, before attempting the more difficult questions in each section.

Section A overview

It was pleasing to note that the majority of candidates had a firm grasp of algebra, although careless manipulation mistakes were commonly seen. The following topic areas proved problematic for a significant number of candidates.

- Questions involving proof (questions 5 and 7(ii))
- Coordinate geometry of the circle (question 8)
- Interpretation of statistical diagrams. (Question 13)

In question 6(i), many responses showed inadequate care in sketching the graph.

In both questions 5 and 8 many candidates did not make any progress because they attempted to start with the form in which the question required the answer to be given. For this type of question (such as Q5 and Q8) the marks are credited for developing a mathematical argument that progresses to the given form.

There was a surprisingly large amount of incorrect rounding and over-rounding. The safest strategy is to give the answer to at least five significant figures as the calculator provides and then give the same answer rounded (not truncated!) to three significant figures (except where otherwise instructed).

Centres should note that since papers are now marked online, particular care must be taken when drawing graphs and diagrams. A rubbed out section of graph may well appear on the screen as not rubbed out. Candidates should be advised to indicate clearly in their diagram if a section has been rubbed out.

For answers to all the questions, centres should refer to the published final mark scheme.

Question 1(i)

1 In this question you must show detailed reasoning.

(i) Express $3^{\frac{7}{2}}$ in the form $a\sqrt{b}$, where a is an integer and b is a prime number. **[2]**

Many candidates answered this question correctly. A few made a correct first step, for example $\sqrt{3^7}$, but could not continue correctly. Some candidates gave the correct answer with no working or with incorrect working. These scored no marks.

Question 1(ii)

(ii) Express $\frac{\sqrt{2}}{1-\sqrt{2}}$ in the form $c+d\sqrt{e}$, where c and d are integers and e is a prime number. **[3]**

Many candidates answered this question correctly. A few made a correct first step, multiplying numerator and denominator by 1 + $\sqrt{2}$, but made a subsequent error. Some candidates gave the correct answer with no working or with incorrect working. These scored no marks.

Question 2(i)

2 **(i)** The equation $x^2 + 3x + k = 0$ has repeated roots. Find the value of the constant k. **[2]**

This question was answered well. Use of the discriminant was the more popular approach, but some candidates used the "completing the square" method. . A few candidates started with $9 - 4k > 0$. Others used $b^2 + 4ac$. In general the "completing the square" method was less successfully applied, with mistakes in the algebraic manipulation more common.

Question 2(ii)

(ii) Solve the inequality $6 + x - x^2 > 0$. **[2]**

Many candidates were unable to deal with the signs. Some wrote $(x - 3)(x + 2) > 0$ or $(-x - 3)(x + 2) > 0$. Many eventually obtained either $\{x < -2$ and $x > 3\}$ or $\{-3 < x < 2\}$. A few candidates gave correct working, but gave their solution as two separate regions: $x > -2$, $x < 3$.

Question 3(i)

3 **(i)** Solve the equation $\sin^2\theta = 0.25$ for $0° \leqslant \theta < 360°$. **[3]**

Many candidates omitted $\sin\theta = -0.5$, usually obtaining 30° but not always 150°. Some of those who included $\sin\theta = -0.5$ only gave one of the two other answers. Some candidates found $\sin^{-1}(0.25) = 14.5^\circ$. Some of these then found 14.5^2 or $\sqrt{14.5}$.

Question 3(ii)

(ii) **In this question you must show detailed reasoning.**

Solve the equation $\tan 3\phi = \sqrt{3}$ for $0° \leqslant \phi < 90°$. **[3]**

Most candidates obtained $3\phi = 60^\circ$ but not all included $3\phi = 240^\circ$. A few started with $\tan\phi = \frac{\sqrt{3}}{3}$ and hence $\phi = 30$. Some thought that $\tan^{-1}(\sqrt{3}) = 30^\circ$. Some gave extraneous answers obtained by, for example, $(180^\circ - 60^\circ) \div 3$. Others gave answers outside the given domain. Some gave answers in radians.

Question 4(i)(a)

4 **(i)** It is given that $y = x^2 + 3x$.

(a) Find $\frac{dy}{dx}$. **[2]**

Almost all candidates answered this question correctly.

Question 4(i)(b)

(b) Find the values of x for which y is increasing. **[2]**

A significant minority of candidates appeared not to understand what is meant by "increasing". Some did not appreciate that they could use their answer to part (i), and started from scratch. Some of these found the minimum point, but could not proceed from this to the answer. Some common incorrect answers were $x \leq -1.5$, $x < -1.5$ and $x > 1.5$. A few found the second derivative, but did not know how to proceed.

Question 4(ii)

(ii) Find $\int (3 - 4\sqrt{x})\,dx$. **[5]**

Many candidates answered this question correctly. A few candidates omitted "+ c".

A few obtained $x^{\frac{3}{2}}$ correctly, but with an incorrect coefficient. Some thought that $4\sqrt{x}$ meant $4x^{-\frac{1}{2}}$ or $4x^{-2}$ or $x^{\frac{1}{4}}$. A few candidates "integrated" 3 to become $\frac{3^2}{2}$ or "integrated" $4\sqrt{x}$ to become $4\frac{(\sqrt{x})^2}{2}$. Some candidates integrated correctly and then attempted to find the value of c.

Question 5

5 N is an integer that is not divisible by 3. Prove that N^2 is of the form $3p + 1$, where p is an integer. **[5]**

This question tests "proof by exhaustion" as included in paragraph 1.01a of the specification. This method of proof involves either considering all possible values or all possible categories of values. This question tests the latter. It was not well answered on the whole. Many candidates started with, for example, $N = 3k + 1$ and gave a partly correct argument based on this (although most omitted to say "where k is an integer"). Then many of these omitted to consider either $N = 3k + 2$ or $N = 3k - 1$ as well. Some candidates started with $N = 3p + 1$ and gave an otherwise correct argument, ignoring the use of "p" in the question. Some candidates tried to work from $N^2 = 3p + 1$. These all failed. Some verified the result in a few numerical cases. These scored no marks.

Question 6(i)

6 Sketch the following curves.

(i) $y = \frac{2}{x}$ **[2]**

Most candidates knew what the graph looked like but many sketched it carelessly, with one or more "tails" moving slightly away from the axis instead of towards it. Some candidates drew the curve in only one quadrant. Others drew two curves, but in the first and second quadrants. The use of calculator "table functions" could be used to check that the sketch represents the actual numbers.

Question 6(ii)

(ii) $y = x^3 - 6x^2 + 9x$ **[5]**

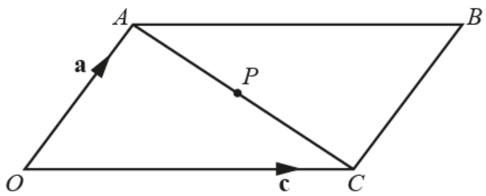
Some candidates attempted the inefficient method of differentiating and finding the stationary points. Others factorised incorrectly or ignored the factor of *x.* Algebraic "long division" was sometimes seen and it is worth noting that this long and ugly method is totally unnecessary. Some candidates factorised correctly but then drew the curve touching the *x*-axis at *x* = 0 instead of *x* = 3. A few drew the curve upside down. The use of calculator "table function" could be used to check that the sketch represents the actual numbers.

Question 7

In all three parts of this question, many candidates did not use correct vector notation.

Question 7(i)(a)

7 $OABC$ is a parallelogram with $\overrightarrow{OA} = \mathbf{a}$ and $\overrightarrow{OC} = \mathbf{c}$. P is the midpoint of AC.



(i) Find the following in terms of **a** and **c**, simplifying your answers.

(a) $\overrightarrow{AC}$ **[1]**

Almost all candidates answered this question correctly.

Question 7(i)(b)

(b) $\overrightarrow{OP}$ **[2]**

Most answered this question correctly. A few made a sign error, for example $\mathbf{c} + \frac{1}{2}(\mathbf{c} - \mathbf{a})$.

Question 7(ii)

(ii) Hence prove that the diagonals of a parallelogram bisect one another. **[4]**

This question proved challenging for a significant majority of candidates. Many assumed the result by starting with, for example, $PB = \frac{1}{2}(\mathbf{c} + \mathbf{a})$, instead of deriving this result. Some candidates considered the modulus of some vectors. Some candidates seemed unaware of the meaning of the word "bisect", in some cases confusing it with "perpendicular". Thus many wrote that $\mathbf{a} + \mathbf{c}$ is perpendicular to $\mathbf{a} - \mathbf{c}$, and that this somehow proves that the diagonals bisect one another. Perhaps the majority of candidates did not know how to start answering this question at all.

An example of a candidate's solution that suggested they had no understanding of proof by vectors was as follows:

"$BO = AC$. As they are the same length it means they would both meet in the centre, hence meaning they bisect one another."

Question 8

8 In this question you must show detailed reasoning.

The lines $y = \frac{1}{2}x$ and $y = -\frac{1}{2}x$ are tangents to a circle at (2, 1) and (−2, 1) respectively. Find the equation of the circle in the form $x^2 + y^2 + ax + by + c = 0$, where a, b and c are constants. **[6]**

A clear initial sketch proved to be extremely useful for the majority of candidates that successfully answered this question. Some failed to consider one or both normals and therefore were unable to make any significant progress. Some found the centre incorrectly, for example by finding the midpoint of the line joining (2, 1) and (–2, 1). Others treated (0, 0) as the centre of the circle. However, despite many false starts, many used their incorrect centre and radius in the equation of a circle, and gained at least one mark. However, some candidates found a centre (p, q) and radius r, and then wrote $x^2 + y^2 + px + qy + r$.

A great many candidates started from the equation $x^2 + y^2 + ax + by + c = 0$, given in the question, and attempted to find a, b and c by substituting coordinates and various other devices. Not surprisingly, these generally failed to gain any marks. (Although one candidate did actually succeed by this method, taking several pages to do so, and gained full credit.)

Section B overview

The following topic areas proved problematic for a significant number of candidates.

- Hypothesis testing (question 12)
- Questions requiring interpretation given in words (question 13 parts (i), (iii) and (iv)).

The new syllabus places an increased emphasis on interpretation. This inevitably involves questions requiring "wordy" answers, such as question 13 (i) (iii) and (iv). Many candidates' answers were written using inconsise language and the logic of the argument was difficult to follow. In many cases, there was some hint of a correct answer but the wording was so unclear that the relevant mark could not be credited. Centres would be well advised to devote time to training candidates in the techniques of answering questions of this kind. The best answers are about one or two lines long and focus only on the key point(s). Pithiness and clarity are the qualities to be encouraged.

Very poor handwriting was also a problem, leading to potential marks being lost because a possibly correct answer simply could not be read.

For answers to all the questions, centres should refer to the published final mark scheme.

Question 9(i)

9 Jo is investigating the popularity of a certain band amongst students at her school. She decides to survey a sample of 100 students.

(i) State an advantage of using a stratified sample rather than a simple random sample. **[1]**

Many incorrect answers were seen, such as "It is more accurate" or "Not biased" or "It's easier" or "With stratified, she could ask people who were interested". Many inadequate answers were also seen, such as "It is more representative" or "More reliable". It is important to refer to the context and not simply provide a generic statement.

Question 9(ii)

(ii) Explain whether it would be reasonable for Jo to use her results to draw conclusions about all students in the UK. **[1]**

Here many inadequate answers were seen, such as "Her school might not be representative of schools in the UK". Some hint of a reason why the school might not be representative was required for the mark.

Question 10(i)

10 The probability distribution of a random variable X is given in the table.

x	0	2	4	6
$\mathrm{P}(X = x)$	$\frac{3}{8}$	$\frac{5}{16}$	$4p$	p

(i) Find the value of p. **[2]**

Most candidates answered this question correctly. A few tried to use Σxp instead of Σp.

Question 10(ii)

(ii) Two values of X are chosen at random. Find the probability that the product of these values is 0. **[3]**

Most candidates scored only one mark because they omitted one or two of the three possible routes to obtaining a product of 0.

Question 11(i)

11 The probability that Janice sees a kingfisher on any particular day is 0.3. She notes the number, X, of days in a week on which she sees a kingfisher.

(i) State one necessary condition for X to have a binomial distribution. **[1]**

Despite almost identical questions having been asked in many examples of paper 4732 over many years, most candidates did not score the mark. Many quoted from their textbooks, to no avail, for example "Repeated trials" or "Only two possible outcomes, seeing or not seeing a kingfisher" or "There must be a fixed number of days". Many gave a correct answer, but not in context, such as "Independent trials" or "Constant probability of success." None of the above scored the mark. Some came a little nearer, but confused the two correct conditions, e.g. "The probability of seeing a kingfisher on a certain day is independent of other days."

Question 11(ii)

Assume now that X has a binomial distribution.

(ii) Find the probability that, in a week, Janice sees a kingfisher on exactly 2 days. **[1]**

Most candidates understood how to calculate a binomial probability. Some used the formula, while others used the calculator function, giving only the answer. This is acceptable because "detailed reasoning" is not asked for. Many candidates truncated, rather than rounded, their three significant figure answer. A few candidates just found 0.3^2.

Question 11(iii)

Each week Janice notes the number of days on which she sees a kingfisher.

(iii) Find the probability that Janice sees a kingfisher on exactly 2 days in a week during at least 4 of 6 randomly chosen weeks. **[3]**

Many candidates understood that they needed to use their answer from part (ii), but many did not do so correctly. Some used the formula without the relevant coefficients.

Candidates should be aware that they can use the binomial distribution function on their calculator, thus avoiding the possibility arithmetic errors in binomial problems.

Some candidates found P(exactly 4 days) instead of P(at least 4 days). Others just found 0.318^4. A few candidates misunderstood the question and found P(at least 8 days out of 42).

Question 12

12 It is known that 20% of plants of a certain type suffer from a fungal disease, when grown under normal conditions. Some plants of this type are grown using a new method. A random sample of 250 of these plants is chosen, and it is found that 36 suffer from the disease. Test, at the 2% significance level, whether there is evidence that the new method reduces the proportion of plants which suffer from the disease. **[7]**

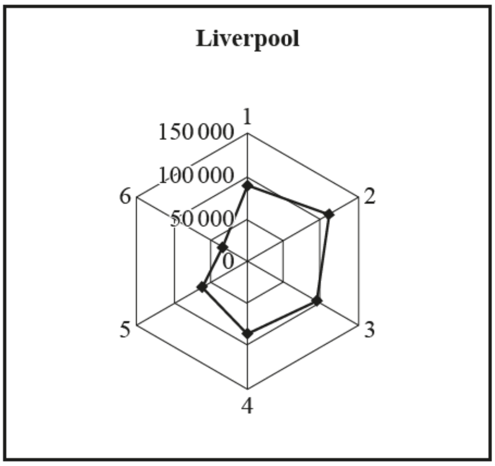
Many candidates had clearly been well prepared for a hypothesis test question. However, even these often made errors. Examples of such errors were as follows.

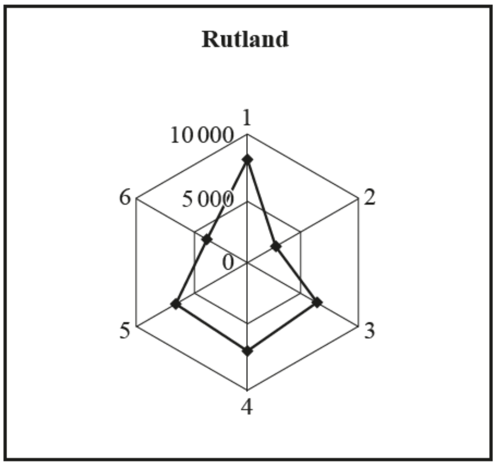
- Failure to define "p" in the hypotheses
- H_1: $p \neq 0.02$
- Finding P(X < 36) instead of P($X \le 36$)
- Finding P(X = 36) instead of P($X \le 36$)
- Writing P($X \le 0.2$) instead of P($X \le 36$)
- Comparing the probability with 0.2 instead of 0.02
- Omitting to state "Reject H_0" in the conclusion
- Giving a definite conclusion such as "Reject Ho. The new method reduces the proportion . . . ."
- Stating that because 0.0139 < 0.02, we do not reject H_0

There was a significant minority that could not access this question on Hypothesis Testing.

Question 13(i)

13 The radar diagrams illustrate some population figures from the 2011 census results.





Each radius represents an age group, as follows:

Radius	1	2	3	4	5	6
Age group	0–17	18–29	30–44	45–59	60–74	75+

The distance of each dot from the centre represents the number of people in the relevant age group.

(i) The scales on the two diagrams are different. State an advantage and a disadvantage of using different scales in order to make comparisons between the ages of people in these two Local Authorities. **[2]**

Many candidates gave correct answers here, although frequently they used far more words than were required. Some gave inadequate answers such as (for the advantage) "It's easier to see the results", "It's easier to compare the populations" or "Can compare ages in small and large populations". For the disadvantage some inadequate answers were "Can't compare results"; "Easy to make a mistake".

Many candidates wrote long essays which did not necessarily gain any marks.

Examples of brief, acceptable answers are:

Advantage: The different scales make it easy to compare the age group proportions in Liverpool with those in Rutland.

Disadvantage: The different scales make it hard to compare the age group numbers in Liverpool with those in Rutland.

Question 13(ii)

(ii) Approximately how many people aged 45 to 59 were there in Liverpool? **[1]**

Most candidates answered this question correctly. A few wrote 100 000 even though the dot is clearly below this value.

(iii) State the main two differences between the age profiles of the two Local Authorities. **[2]**

Question 13(iii)

Again, many answers were inadequate, such as "Rutland has a higher proportion of middle aged people". Answers that compared numbers (as opposed to proportions) of people in the two areas were not accepted. For example, "Liverpool has more people in the 18-29 age group than Rutland.

Question 13(iv)

(iv) James makes the following claim.

"Assuming that there are no significant movements of population either into or out of the two regions, the 2021 census results are likely to show an increase in the number of children in Liverpool and a decrease in the number of children in Rutland."

Use the radar diagrams to give a justification for this claim. **[2]**

Most candidates recognised the key point here, which was that children are being born during the 10 years from 2011. However, some only stated that Liverpool had a large proportion of people in the potential child-bearing group, and failed to state that Rutland has a small proportion in this group. Some candidates just argued about the sizes of the groups changing as people get older, without considering new births at all.

An example of an acceptable answer is:

People in age group 18-29 (and/or 30-44) are likely to give birth to children during the next 10 years. There is a high proportion of this group in Liverpool, but a low proportion in Rutland.

Acceptable answers to Question 13 parts (i), (iii) and (iv) can be found in the published mark scheme. Throughout this question, a common error was to write about "numbers", rather than "proportions", of people in the two areas.

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