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Examiners' report

MATHEMATICS A

H230

For first teaching in 2017

H230/01 Summer 2024 series

Version 1

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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. A selection of candidate answers is also provided. 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 and the mark scheme can be downloaded from OCR.

Paper 1 series overview

Candidates' overall performance on this paper was similar to 2023 (and 2022), with a similar range of scores obtained. Few candidates scored below 20% or above 90%.

The 'explanation' questions were often not answered within the context of the question, or omitted entirely by candidates (especially Q12).

As in previous years, many candidates dropped marks for not showing sufficient working. Centres should continue to make sure candidates are aware of the specific meaning of command words – in particular 'Determine', and the significance of 'Detailed Reasoning', as discussed on the next page.

Candidates who did well on this paper generally:	Candidates who did less well on this paper generally:
• carefully addressed what each question was asking for • understood the level of written response necessary to meet the requirements of the command words used in the question • worked carefully where the answer is given (e.g. in 'Show That' questions) • made appropriate use of their calculator to offload numerical working, while still showing sufficient working to support their answer • gave explanations that were clear and evidence-based.	• omitted key steps in their written working • used their calculator (and especially in-built methods) where the question gave an instruction for a particular method • gave explanations that were too generic, or not well-argued.

Assessment for learning

How much working needs to be shown to gain full marks?

Some candidates seemed unsure as to how much working was required for any given question. This problem arises from what might seem a dilemma. On the one hand, candidates are expected to be able to use calculator functions that 'short cut' techniques such as solution of equations, mean and standard deviation. On the other hand, candidates are also expected to show understanding of precisely the techniques that these functions make unnecessary. This dilemma is resolved by the careful use, in questions, of certain command words, whose definitions are found in Section 2d of the H230 and H240 specifications. This was illustrated in the 2022 series Examiner's Report for H230/01 by comparing Questions 4 (b) and 8 (b) on that question paper.

Question 4 contains the instruction '**In this question you must show detailed reasoning**'. This means that, when solving the quadratic equation that arises in the solution of part (b), candidates are expected to show a method (either factorisation, or the formula, or completing the square) for obtaining the solutions. Candidates who obtained the quadratic equation and then just wrote down the correct solutions lost 1 method mark. In contrast to this, Question 8 (b) starts with the word 'Find'. This command indicates that, while working may be necessary to answer the question, there is no requirement to show all the working. A solution could be obtained from the efficient use of a calculator instead. A further clue is that there are only 2 marks available for two answers. In fact, it was expected that candidates would use the statistical functions on the calculator to write down the two answers without explanation. Many candidates did this successfully. Many other candidates, however, showed working and in some cases made arithmetical errors and lost the relevant mark. Of course, candidates are free to show working if they wish to. When using one of the 'short cut' functions in questions like 8 (b), candidates would be well advised to carry out the technique twice as a check.

In the Pure section of this 2024 paper, candidates are instructed to show 'Detailed Reasoning' for Questions 1 and 7. In Questions 3, 5 and 6 the command word 'Determine' is used. Questions 2, 8 and 9 do not explicitly require working to be shown, with the command words 'Find' and 'Express' used, however it is still good practice to set out a neat mathematical argument in order to gain partial credit if an error is made.

In the Statistics section of this paper, 'Determine' is used in Questions 10 (c) and 11 (a)(ii).

A useful poster can be found in the assessment section of the qualification pages on the website.

Section A

Overall, performance in Section A was slightly stronger than in 2023, with more candidates making an attempt at the more challenging questions towards the end of this section.

Question 1

1 **In this question you must show detailed reasoning.**

Solve the equation $\ln\left(x^3\right) - \ln\left(5x^2\right) = \ln 2$, where $x > 0$. **[3]**

This question was only answered correctly by a minority of candidates – who seemed to find this question challenging. Common errors include $\ln 5x^2 = 2\ln 5x$ and mixing up log rules for subtracting/dividing. A number of candidates gave $x = 0$ as an extra solution without noting that the question specified $x > 0$ – on this occasion this was not penalised but in general candidates should specifically exclude solutions outside the given range. Candidates who attempted to combine terms were generally more successful than those who attempted to 'split'. However, having combined the left-hand side correctly a small, but significant, number of candidates did not notice that $\ln\frac{x}{5} = \ln 2 \rightarrow \frac{x}{5} = 2$ can be implied directly.

Question 2 (a)

2 Points A and B have position vectors $\overrightarrow{OA} = 2\mathbf{i} + 3\mathbf{j}$ and $\overrightarrow{OB} = -\mathbf{i} + 5\mathbf{j}$, respectively, where O is the origin.

(a) Find the position vector of the midpoint of AB. **[1]**

Most candidates seemed to know what to do here, but many gave the coordinates of the midpoint (0.5,4) rather than a vector, which was not an acceptable answer. Common errors include -1.5**i+j** (from halving the vector $\overrightarrow{AB}$) and or giving an attempt at *AB* or ½ *AB* rather than the midpoint.

Question 2 (b)

(b) Find the exact magnitude of the vector $\overrightarrow{AB}$. **[3]**

This was generally well answered. As this was a 'Find' question marks could be gained without working (provided the answer was not from incorrect working), but candidates should still be encouraged to show their method in full. Most candidates were able to reach the required answer, but often their vector $\overrightarrow{AB}$ was unclear and potentially inaccurate. Many candidates indicated '3**i**' and '2**j**' or gave $\overrightarrow{BA}$ as 3**i** −2**j**. The method mark could not be gained for finding the magnitude of an irrelevant vector (e.g. those given in the question).

Question 2 (c)

(c) Find the angle between the vector $\overrightarrow{OA}$ and the positive x-axis. **[2]**

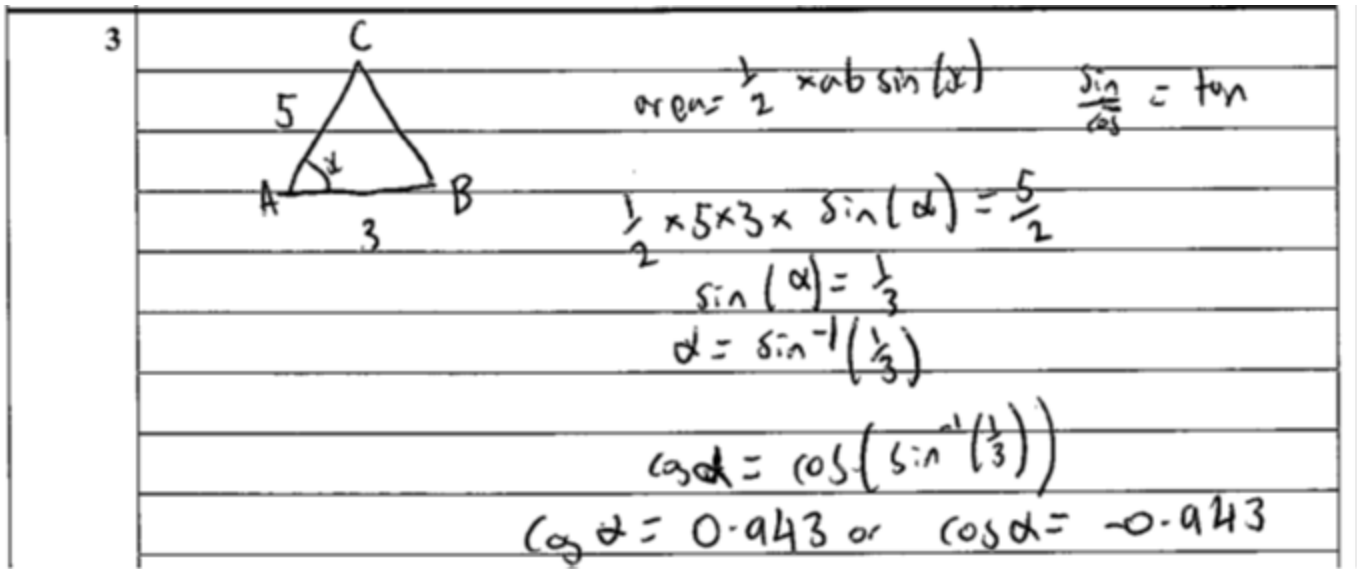
This was generally well answered, with most candidates taking the direct route shown in the scheme. A few candidates used the cosine rule, which was more onerous. Many candidates were able to obtain the correct angle of 56.3° but a few candidates stated the angle as 33.7°.

Question 3

3 In the triangle ABC, $AB = 3$, $AC = 5$ and angle $BAC = \alpha$.
The area of the triangle is $\frac{5}{2}$.
Determine the **two** possible values of $\cos\alpha$. Give your answers in exact form. **[5]**

The majority of candidates correctly applied $\frac{1}{2}ab\sin C$ to form an equation in alpha, although some candidates made errors when recalling this formula (writing cos instead of sin, or omitting the ½ were both common). Of those who had the equation correct, most reached the equation $\sin\alpha = \frac{1}{3}$ but very few proceeded correctly beyond this point. Noting that the instruction on this question was 'Determine' and that exact answers were required, none of the final three marks could be given to candidates who used their calculator to find an (inexact) value for $\cos(\sin^{-1}(\frac{1}{3}))$. Some candidates used a triangle with opposite side 1 and hypotenuse 3 to correctly deduce the required answer.

Exemplar 1



This is a typical example of a candidate who has completed the first few steps in the working correctly, but then uses their calculator to obtain an inexact pair of values, scoring M0A0A0 for the final three marks.

Question 4 (a)

4 **(a)** Write down the term in b^5 in the expansion of $(a+b)^{12}$. **[1]**

Most candidates answered this correctly, although quite a few misinterpreted the question and attempted to give the coefficient rather than the term in b^5 (giving either 792 or $792a^7$). Some candidates selected the wrong term, or an incorrect term – for instance writing a^8b^5 or a^8b^6. The coefficient 924 was often seen.

Question 4 (b) (i)

(b) A variable X has a binomial distribution such that $P(X = 5)$ is given by the term in part **(a)**.

(i) State a condition that must be satisfied by a and b. **[1]**

Around half of candidates answered this question correctly, noting that answers in words were condoned even if slightly imprecise (e.g. 'they add up to 1'). However, many candidates misinterpreted the question as referring to probabilities - for instance stating that 'they must be independent' (it's worth noting that this question fell in Section A – Pure Maths, not Section B – Statistics, and mentioned a variable with a binomial distribution but not probabilities).

Question 4 (b) (ii)

(ii) State the distribution of X. Give the values of any parameters. **[2]**

Relatively few candidates achieved both marks here. Quite a few candidates obtained the first B1 for B(12,…) but only a small number of candidates correctly identified the probability.

Question 5 (a)

5 A curve has equation $y = 4x^2 + \frac{1}{x}$.

(a) Determine the coordinates of the stationary point on the curve. **[5]**

This question was again 'Determine', requiring candidates to show their working in full – answers obtained without this (e.g. from a calculator) could not be credited. Most candidates who showed working were able to differentiate the given equation correctly and set this equal to zero, going on to find the coordinates of the stationary point. Some candidates who had the correct solutions for x did not find the correct y value as required for the final A1.

Question 5 (b)

(b) Use $\frac{d^2y}{dx^2}$ to determine whether this turning point is a maximum or a minimum. **[2]**

This 'Determine' question was generally not well answered. Most candidates who had made progress in part (a) were also able to gain the method mark for attempting to find the second differential. However, they could only be given the accuracy mark if this – and their subsequent method to deduce the nature of the stationary point – was fully correct, including specific consideration of the sign of the second derivative. A number of candidates confused the method and set $\frac{d^2y}{dx^2} = 0$ and attempted to solvethis new equation.

Question 5 (c)

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

Most candidates who had scored in part (a) deduced this correctly (albeit with minimal working, but as the command word here was 'Find' this was acceptable). Those who hadn't scored in (a) rarely made a creditable attempt.

Question 6

6 A curve has the following properties:

- The gradient of the curve is given by $\frac{dy}{dx} = -2x$.
- The curve passes through the point $(4, -13)$.

Determine the coordinates of the points where the curve meets the line $y = 2x$. **[7]**

Most candidates made a good attempt at this question, although relatively few received all 7 marks. The majority of candidates were able to score 2 or 3 of the first 3 marks from integrating (although a few omitted the constant and therefore received 0 as they could not progress). As this question was 'Determine' candidates were required to show working for forming and solving their quadratic. A Special Case was included here for candidates who provided answers unsupported by working in the second part, but this should not be assumed for future exam series. Errors in deducing c were common, but candidates who obtained the correct equation were mostly able to correctly deduce that they needed to set this = 2*x* and solve the resulting quadratic for *x*. Some candidates obtained *y* = 12 or *y* = −12 instead of *y* = −6 where *x* = −3.

Question 7 (a)

7 In this question you must show detailed reasoning.

(a) Show that $(x+2)^4 - 6(x+2)^2 - 16 \equiv x^4 + 8x^3 + 18x^2 + 8x - 24$. **[1]**

As this question was 'Detailed reasoning' and a 'Show that' (where the answer is given) candidates needed to provide a convincing demonstration of the result with no errors or missing steps. Although only 1 mark, candidates needed to show a fully convincing method and the correct conclusion. A number of candidates lost the mark because their working did not adequately support the given result – for instance, omitting the final '-16' or claiming equivalence between two lines of working that are not equivalent. Candidates should be encouraged to show their method in full and – if they choose to multiply out terms separately – to recombine these in a logical way so that it is absolutely clear their working leads to the given answer and is not reverse-engineered.

'Show that' and Detailed Reasoning questions

Where the answer is given, candidates should be encouraged to take extra care to make sure that their working leads clearly and unambiguously to this answer. Answers where this isn't clear (e.g. if a term is missing and 'reappears' just before the final answer) are unlikely to be credited.

When working with complex algebraic expressions (as in Question 7 (a) on this paper), it's entirely acceptable to split the expression and consider parts of it separately. However, if candidates do this then the 'recombining' must be clear and unambiguous (for instance, vague arrows leading to the given answer are unlikely to be sufficient).

Question 7 (b)

(b) Hence solve the equation $x^4 + 8x^3 + 18x^2 + 8x - 24 = 0$. **[4]**

Many candidates did not appear to know how to approach this question, despite the LHS of the equation being in identical form to the identity given in part (a). Some attempted long division without applying the given identity, which was not fruitful. Candidates should be reminded that the instruction 'Hence' means that the result from the previous part must be used (and, as in this case, it is helpful to do so). A number of candidates (not noting the Detailed Reasoning instruction) gave the solutions without working (from their calculator) or 'retro-fitted' incorrect working to try and justify these. Neither could be credited. As a reminder, the Detailed Reasoning instruction means that all steps in the working must be shown, and that calculators may be used to check or verify results only. Candidates who attempted an analytical method were generally successful, with relatively few errors seen – a few candidates did not provide sufficient justification of the quadratic form (and were marked under the Special Case), others did not state that the $(x+2)^2 = -2$ case leads to no solutions, and a few made an error generating false extra solutions.

Question 8

8 A circle, C, has equation $x^2 - 6x + y^2 = 16$.

A second circle, D, has the following properties:

- The line through the centres of circle C and circle D has gradient 1.
- Circle D touches circle C at exactly one point.
- The centre of circle D lies in the first quadrant.
- Circle D has the same radius as circle C.

Find the coordinates of the centre of circle D. **[5]**

Most candidates successfully completed the square to correctly obtain the centre and radius of circle *C* (although a number did not do so in full and assumed that the radius was 4).

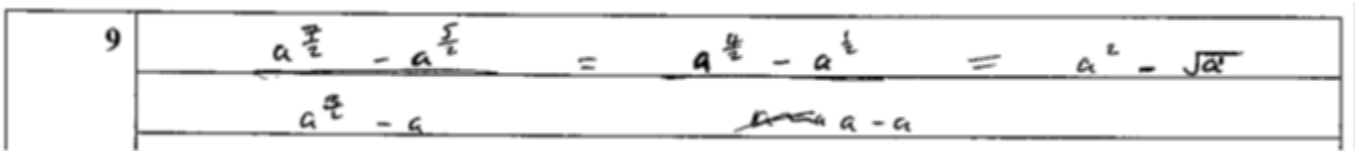
Many candidates correctly interpreted the 'gradient 1' statement and deduced an equation of the line between the two centres, although often did not progress this into the deduction about the difference in the coordinates of the centre of *D* being 3. Fewer candidates used the other information to deduce that the distance between the two centres was 2*r* (=10), but those who did were then able to apply Pythagoras, or trigonometry, to compute the *x*- and *y*- change.

Question 9

9 Express $\dfrac{a^{\frac{7}{2}} - a^{\frac{5}{2}}}{a^{\frac{3}{2}} - a}$ in the form $a^m + \sqrt{a^n}$, where m and n are integers and $a \neq 0$ or 1. **[5]**

Very few candidates obtained more than 1–2 marks on this question. Some candidates were able to correctly 'rationalise' the denominator and simplify to the required form but rarely progressed beyond there (typically because they did not spot the common factor that allowed simplification). Many candidates attempted to find a shortcut to the given form, which was rarely successful. Trying to complete multiple steps of working in one go will often lead to mistakes. Unusually in this case, dividing the first term in the numerator by the first term in the denominator (and again for the second terms) happened to give the final answer, but clearly this incorrect method could not be credited. Candidates should be reminded that it is best practice to be showing full working at every step. The alternative method from the mark scheme was seen relatively rarely but, when attempted, was often correct.

Exemplar 2



This candidate has made an incorrect attempt to simplify the given expression, and then divided the first term in the numerator by the first in the denominator (etc.) to obtain an answer of the correct form, but from wrong working. This is incorrect work and so was not credited, scoring 0.

Section B

Most candidates scored well in the first questions of the Statistics (Section B), however candidates obtained fewer marks in Q12.

Question 10 (a)

10 There are 60 members in a sports club. The table shows the numbers of members in various categories.

	Beginner	Advanced
Junior	35	5
Senior	7	13

A member of the sports club is chosen at random.

(a) Find the probability that this member is a Beginner. **[1]**

Almost all candidates answered this correctly. An occasional incorrect answer was 35/60, and a few candidates simplified incorrectly; the ignore subsequent working (isw) means this was not penalised.

Question 10 (b)

A Junior member of the club is chosen at random.

(b) Find the probability that this Junior member is a Beginner. **[1]**

Most candidates answered this correctly, with a few attempting 35/60 or similar numerical errors, such as dividing by 42 (the total number of beginners) rather than 40 (the total number of Juniors).

Question 10 (c)

Two different members of the club are chosen at random.

(c) Determine the probability that both these members are Juniors and exactly one is a Beginner. **[2]**

This was less well answered, with quite a few candidates mistakenly giving the 'with replacement' cases (M0) or forgetting to double their answer (M1A0). A few candidates found the probabilities via the indirect route using intersections (i.e. $\left(\frac{35}{40}\times\frac{40}{60}\right)\times\left(\frac{39}{59}\times\frac{5}{39}\right)\times 2$). Other common errors included giving the denominators as 60 and 60 or 40 and 39.

Question 11 (a) (i)

11 A biased six-sided dice is thrown several times. The results are shown in the table, where a is a constant.

Score x	1	2	3	4	5	6
Frequency f	1	3	10	9	0	a

You are given that the mean score is 3.4.

(a) (i) Find the value of a. **[3]**

As this was a 'Find' question a correct answer without working could obtain all 3 marks through typing directly into the calculator. However, candidates should be encouraged to show some working since they risk receiving 0 marks if their unsupported answer is incorrect. Some candidates misunderstood the question and assumed that $\Sigma f = 6$ (rather than 23 + *a*), which received 0 marks. Quite a few candidates made errors when solving the equation in *a*, but if this was setup in the correct form they could still score M1M1A0. A small number of candidates appeared to have obtained the correct answer via Trial & Improvement, which was condoned if correct – however, their working in doing so was often unclear and they would have received no method marks had their answer been inaccurate. Some candidates (incorrectly) reached a non-integer value for *a*, but did not appear to notice that this was not an appropriate solution.

Question 11 (a) (ii)

(ii) Determine the standard deviation of the scores. You should use one of the formulae given on page 2. **[3]**

This part was 'Determine' so in contrast to part (a)(i) a correct answer without working could not score full marks. Quite a few candidates used their calculator's in-built functionality despite the instruction to use a formula from page 2 (and, if correct, obtained the SC B1 only). Many candidates did not seem confident in selecting and applying the correct formula for standard deviation of grouped data – centres should note that this remains 'on specification' and that papers will often ask candidates to do this in a way that requires knowledge of the method rather than a calculator. Common errors included attempting to use the formula for non-grouped data (i.e. omitting f in the numerator) or again assuming that $\Sigma f = 6$. Some candidates provided working which did not lead to their given answer (perhaps suggesting that they had used their calculator and then retro-fitted an attempt to apply the formula).

Question 11 (b)

A fair 6-sided dice with faces numbered 1, 2, 3, 4, 5, 6 is thrown a large number of times, and the standard deviation s of the scores is found.

(b) Without calculation, explain whether s is likely to be larger, smaller, or about the same size as the standard deviation found in part **(a)(ii)**. **[1]**

Relatively few candidates scored the mark in this part. The key idea was that a fair dice will have a more even spread of scores (because the probability of each is the same) and so the standard deviation will be larger than for the biased dice. Many candidates assumed that a 'fair' dice would have a smaller or identical standard deviation. Some others correctly explained that there would be an equal chance of scoring each value, but concluded that this would result in a smaller standard deviation. Many thought that the standard deviation *s* would be smaller and others thought that the values of the two would be similar.

Question 12 (a)

12 The table gives the percentage increases in the numbers of usual residents in five Local Authorities (LAs) in the West Midlands between 2001 and 2011.

	Age ranges					
LA	**0 to 9**	**10 to 19**	**20 to 59**	**60 to 64**	**65 to 74**	**75 or above**
Lichfield	−1%	0%	0%	33%	50%	29%
Redditch	2%	−7%	3%	77%	31%	14%
Rugby	11%	11%	12%	33%	29%	17%
Stafford	4%	1%	3%	35%	28%	19%
Stratford-on-Avon	−2%	8%	−1%	40%	34%	29%

(a) Use the data to suggest, with a reason, which of these LAs was likely to have the most urgent need for more provision for elderly people in the years from 2012 to 2020. **[1]**

Many candidates did not score many marks throughout Q12. These types of questions require careful and rigorous work to provide a precise explanation as shown in the mark scheme, and 'generic' answers are rarely credited.

In part (a), many candidates were able to identify one of the plausible LAs for this question, but fewer could provide a sufficiently clear reason why. Quite a few candidates showed a misunderstanding of the data by describing Redditch or Lichfield as having the 'largest proportion' rather than the largest increase. Candidates needed to refer to a specific age group in their answer – simply stating 'elderly people' or 'over 60s' was not sufficiently specific, especially because the values varied between the different groups. Some candidates attempted to sum the percentage increases. The best responses gave a clear answer, referred to the data and provided a conclusion in context, e.g. 'Lichfield as they have the highest increase in 65–74 year-olds so will need the most provision for them in the coming years'.

Question 12 (b)

In 2011, local government officers in the West Midlands attempted to judge which LAs would be most in need of extra provision for secondary schools in the years from 2012 to 2020.

(b) One officer said

"In Rugby, the figures for 0 to 9 and 10 to 19 are the same, so there will be no need for extra provision for secondary schools in Rugby in the years 2012 to 2020."

Explain whether you agree with this statement. **[1]**

Candidates needed to give a clear 'Yes/No' (Agree/Disagree) here and support this with evidence from the data, correctly explained. Most candidates did not do this sufficiently to earn a mark, with many making vague statements. As the percentage increases for the 0–9 and 10–19 age groups were the same (this being the premise of the question) candidates needed to be very specific as to which age group they were referring to. Many candidates made irrelevant comments about other age groups (which did not address the question). The scheme includes a very specific form of answer that could be credited (based on the premise that more information might be needed) but this should not be assumed to set a precedent. Many candidates simply wrote answers along the lines of 'more information is needed' and this was not sufficient. In general candidates should construct an argument that addresses the question using the data provided. Some candidates again confused percentage increases for proportion and argued that the proportions were the same between the two age groups.

Question 12 (c) (i)

(c) Use the data to explain the issues likely to have affected provision for secondary schools in 2012 to 2020 in the following LAs.

(i) Redditch **[1]**

Many candidates were unable to score here because they did not refer to both age groups. Some appeared to confuse 'school places' with 'provision' for the elderly (in part (a)) and discussed transferring funding from one to the other, which did not adequately address the question.

Question 12 (c) (ii)

(ii) Stratford-on-Avon **[1]**

A significant number of candidates did not refer to both the 0–9 and the 10–19 age ranges, with a small number referring instead to the older age ranges. Many gave answers that related only to the 2001 – 2011 period and not directly to the 2012–2020 period.

Question 12 (d)

(d) State an assumption you needed to make in answering parts **(a)**, **(b)** and **(c)**. **[1]**

This part was better answered, with some candidates offering either of the correct answers in the scheme. Some candidates were too vague, or provided assumptions that only related to one part of the question (e.g. 'all children aged 10-19 attend school' which is not an assumption needed for part (a)). Other common incorrect answers included 'the population sizes of all the LAs are similar' (they need not be) or 'these percentage increases are assumed to continue in 2012–2020' (which is not assumed).

Question 13 (a)

13 Some students at a large school are doing a survey about attitudes to school uniform. They want to give a questionnaire to a random sample of 50 students at their school.

The school has three entrances. Gabi suggests giving the questionnaire to the first 50 students who arrive at a particular entrance on a randomly chosen morning.

(a) Give **two** reasons why this method of sampling will **not** produce a random sample. **[2]**

This was generally well answered, although some candidates were not specific enough or did not provide two clearly distinct reasons. Creditable answers needed to refer specifically to the sampling method as described in the question (which, in summary, meant criticising either the choice of entrance, day/time or the 'first 50' principle). Generic answers such as 'not random' or 'not equal chances' or 'opportunity/convenience sampling' could not be credited.

Question 13 (b)

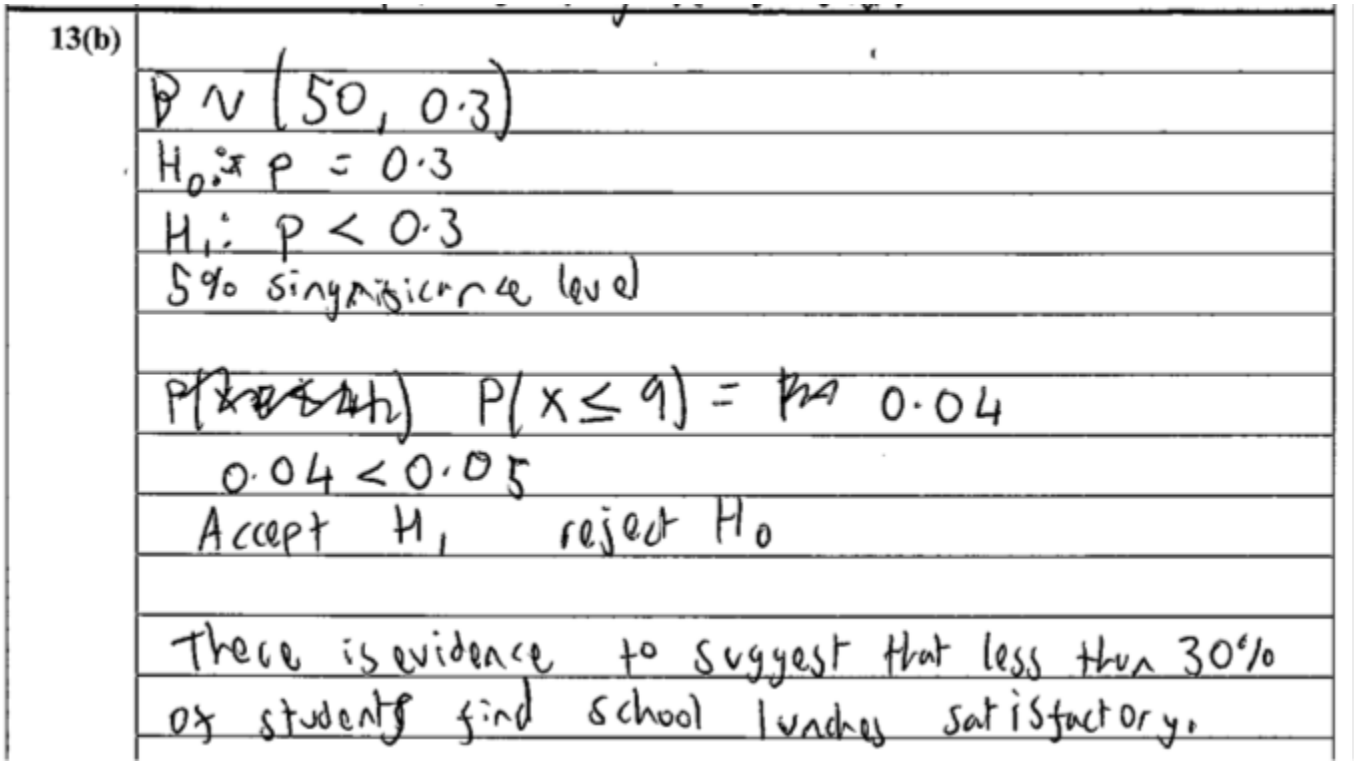
The students are also doing a survey about attitudes to school lunches. Jane claims that 30% of students think the lunches are satisfactory. Dev claims that the true percentage is less than 30%. The students decide to test Jane's claim by taking a **random** sample of 50 students and noting the number who think the lunches satisfactory.

Out of the 50 students in the sample, 9 said that they thought the lunches are satisfactory.

(b) Using a binomial distribution as a model, test Jane's claim against Dev's claim at the 5% significance level. **[7]**

The mark scheme demonstrates the standard setup that is expected for this type of hypothesis question, and most candidates demonstrated some understanding of this, achieving close to full marks. Some candidates did not define the hypotheses accurately and others gave no final conclusion, or too definite a conclusion. A number gave the probability to only one significant figure accuracy while others looked to find P(X=9) or P(X<9) rather than P(X≤9). Candidates should be reminded that 3sf are generally required (as per the rubric) although in this case the MS only required the probabilities to be correct to 2sf.

Exemplar 3



This candidate has made a good attempt at this hypothesis test, with most steps correct. However, they did not give a definition of their parameter p, and their probability value is only given to 1sf, so they score 5/7.

Question 13 (c)

(c) The sample used by the students was taken without replacement. One student suggests that this means that one of the assumptions underlying the model is **not** valid.

Explain whether you agree with this statement. **[1]**

This was quite well answered, although omitted by many candidates. Some candidates gave a correct statement but did not specify whether they were agreeing or disagreeing. Some candidates incorrectly argued that the probability of a given student being selected was not constant.

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