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Examiners' report

MATHEMATICS A

H240

For first teaching in 2017

H240/02 Summer 2024 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. 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 2 series overview

Overall, candidates performed slightly better on this paper than in 2023, with a higher mean mark and greater spread. This perhaps reflects a slightly lower level of demand at the very top end of both Sections A and B.

Many of the same themes continue to appear – as shown in the table below:

Candidates who did well on this paper generally:	Candidates who did less well on this paper generally:
• demonstrated strong understanding and showed evidence of good mathematical practice in their use of notation and working • read and followed the instructions in each question closely, paying attention to command words • showed a good grasp of a balance of skills across the pure and statistics sections, including assumed knowledge from GCSE • laid out their working clearly and provided logical evidence that led to the required answer (especially in detailed reasoning questions).	• missed key instructions or command words in the question • offered generic facts in 'explain' questions which did not sufficiently address the specific request • did not show sufficient working, especially where the command is determine, show that or detailed reasoning.

Section A overview

Most candidates did very well on the first few questions in this Pure section, with many candidates accessing parts of the more challenging Questions (5, 6, 7). Some candidates lost marks for basic algebraic errors (such as rearranging an equation) or by incorrectly interpreting information given in the question (e.g. Question 7).

Question 1 (a)

1 Differentiate the following with respect to x.

(a) $3x^4 - \frac{2}{x^2}$ **[2]**

Almost all candidates answered this correctly, scoring both marks. Occasionally candidates made an error in reducing the power -2 to -1 or attempted to integrate instead.

Question 1 (b)

(b) $4\sqrt{x} - 9$ **[2]**

A majority of candidates answered this correctly, scoring both marks. A very small number did not differentiate the '9' term, scoring B1 only.

Question 2

2 The vector $\begin{pmatrix} a \\ b \end{pmatrix}$ has magnitude 6 and direction 60° above the positive x-axis.

Determine the exact values of a and b. **[4]**

This question was well answered by most candidates. The alternative method using cos and sin was most popular, with many candidates immediately writing down the two correct expressions for a and b as required and calculating the values correctly. A small number of candidates gave a and b the wrong way around or did not label them (neither of which could be given accuracy marks). Of those who used the main method (Pythagoras, etc.), most of the responses were successful, but quite a few candidates made an error when combining their two expressions to solve (for instance, square rooting both terms separately). There were others that used a mixture of both methods, which was acceptable provided sufficient working was shown (noting the 'Determine' instruction).

Question 3 (a)

3 The function f is defined by $f(x) = x^3 - x^2 - 5x - 3$.

(a) Show that $(x-3)$ is a factor of $f(x)$. **[1]**

Nearly all candidates achieved this mark. A few omitted the '=0' which was required as a (minimal) conclusion.

Question 3 (b)

(b) Factorise $f(x)$ completely. **[2]**

Almost all candidates correctly factorised the cubic expression. Long division was probably the most popular method, and a few errors were seen in the final response (for instance giving $(x+1)(x-1)$)).

Question 3 (c)

Three students attempted to draw the graph of $y = (x-a)(x-1)(x+1)$, each using a different value of the constant a. Not all of their graphs were correct. Their graphs are given in the diagrams below. Copies of the diagrams are provided in the Printed Answer Booklet.

(c) Underneath each diagram in the Printed Answer Booklet,

- **either** give the value of a for which this is the correct graph of $y = f(x)$,
- **or**, if there is no value of a for which this graph is correct, write "No value of a". **[3]**

Fig. 1.1

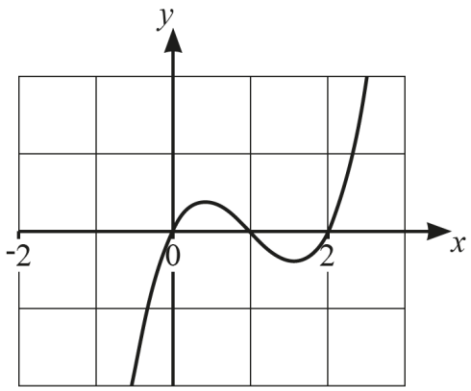


Fig. 1.2

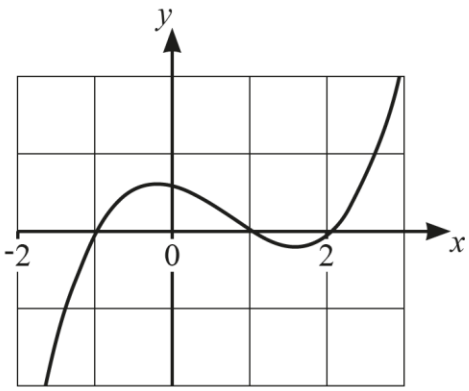
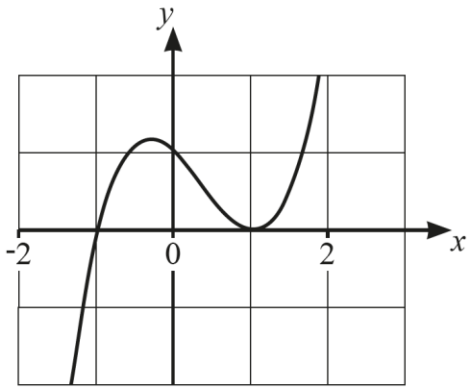


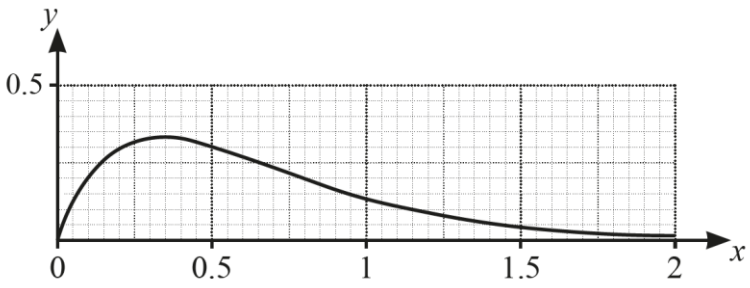
Fig. 1.3



Around half of candidates scored all 3 marks here. Most correctly identified that Fig 1.1 had 'no value of a', the most common errors were with Fig 1.3 – giving either 'no value' or '$a = -1$' incorrectly.

Question 4 (a)

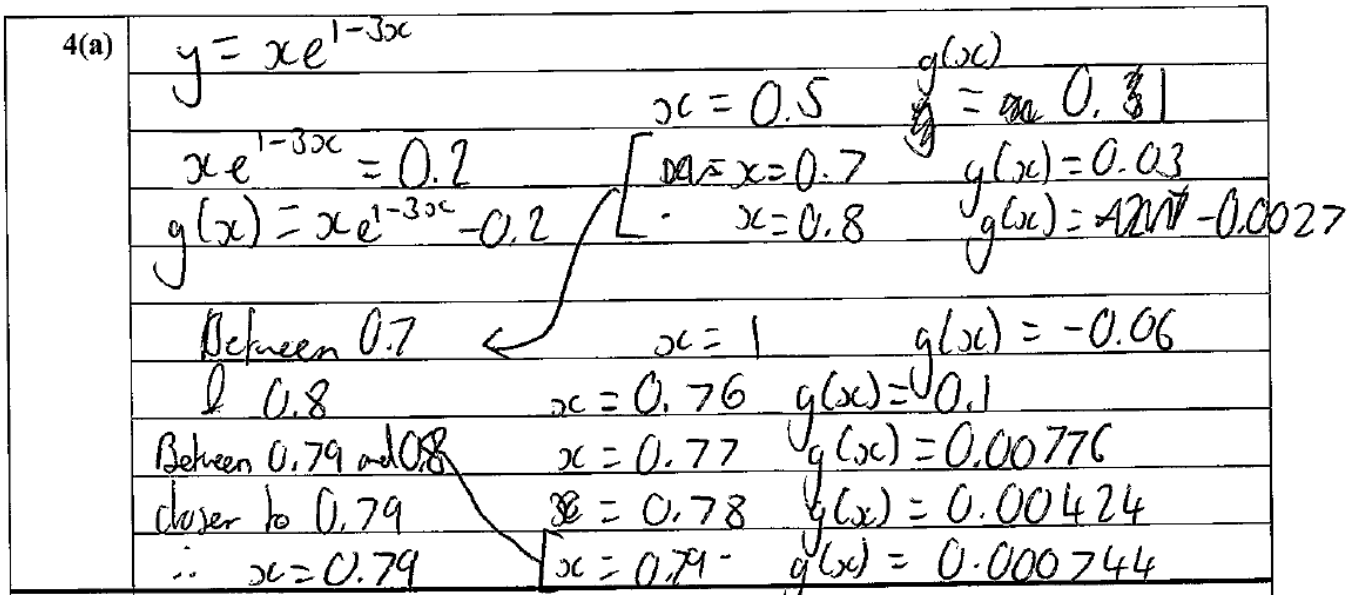
4 The diagram shows part of the graph of $y = xe^{1-3x}$.



(a) Use the sign change method to determine, correct to **2** decimal places, the root of the equation $xe^{1-3x} - 0.2 = 0$, that lies between $x = 0.5$ and $x = 1$. **[3]**

A minority of candidates scored all 3 marks in this part, although many candidates scored at least 1 and often 2. Most candidates correctly substituted 0.5 and 1 into the given expression to show a change of sign within the given interval, although quite a few stopped at this point (which could only score M1). Many candidates gave the correct value x=0.79 to 2dp - and this is an excellent example of a question where a calculator can be used effectively to verify a solution (or to give an idea of where to 'look' for the root). However, this root alone could only score B1. In order to achieve the final accuracy mark (and demonstrate that this is the correct root to 2dp) candidates needed to show a change of sign using a pair of iterates within the interval [0.785,0.795] with opposite signs, which very few did. Quite a few candidates gave a collection of iterates and claimed that led them to this conclusion but could only gain credit for two correct iterates in that interval. Note that informed choices of iterates, e.g. 0.79 and 0.793 could be credited, as could the boundary values of 0.785 and 0.795. Some candidates used Newton-Raphson to obtain an initial value (which is of course acceptable, but earned no credit on its own as the question specified a sign change). Candidates did not need to write down the value of the expression for their iterates, but if they did it needed to be correct to 1sf - some made a place value error when copying.

Exemplar 1



This is a (typical) example of a candidate's response where they have made a very good attempt at their sign change, with many correct iterates and the correct value to 2dp given. However, their iterates do not fully justify the solution to 2dp (there is only one in the range [0.785,0.795] and their explanation 'closer to' is not sufficient) so this response scores M1B1A0 for a total of 2/3.

Question 4 (b)

(b) Determine the exact x-coordinate of the maximum point of the curve $y = xe^{1-3x}$. **[3]**

This question was well answered. Most candidates made an acceptable attempt at differentiating the given expression and noticed that they needed to use the product rule to do so (those who didn't scored M0). Of those who differentiated correctly, most were able to go on to solve =0 and reach the required response for A1. Relatively few candidates explicitly considered (and excluded) further roots from $e^{1-3x} = 0$ but the B1 mark could be implied by only giving a single value for x from the other factor. Some candidates attempted to find a further root (or incorrectly deduced x=0) which meant they scored B0. Other candidates attempted the second derivative and mistakenly set this equal to zero.

Question 4 (c)

(c) In this question you must show detailed reasoning.

Determine the exact area of the region enclosed by the curve $y = xe^{1-3x}$, the x-axis and the line $x = 1$. **[4]**

Most candidates made a very good attempt at this question, with the integration often fully correct. Some candidates lost the first M mark for not setting up their integration by parts correctly (for instance, omitting the '-' sign or limits). A few candidates made sign errors in the intermediate steps, but most were successful with the two steps of integration to obtain A1A1. On this occasion unsimplified responses (after limits substituted in) were allowed, although many candidates left their response as, e.g. $-\frac{1}{3}e^{-2} - \frac{1}{9}e^{-2} + \frac{1}{9}e$. Candidates should always be encouraged to simplify their responses, combining terms where possible. Some candidates gave a decimal response (which scored A0), but there were very few cases of 'answers only' which indicated that most candidates had paid attention to the detailed reasoning (DR) instruction here. Some candidates assumed that $x = 0$ meant both terms in the final integral would 'disappear', meaning that they omitted the term in e^1 from their final response (A0). A few candidates attempted integration by substitution, which was only very rarely successful.

Question 5 (a)

5 A scientist is monitoring the decline in the population of a certain endangered species of animal in an area where their natural habitat has been damaged.

As a model, the scientist proposes that the rate of decline per year of the population is given by $\frac{1}{80}P^2$, where P is the size of the population t years after the start of the modelling.

(a) Explain how this model gives rise to the differential equation

$$\frac{\mathrm{d}P}{\mathrm{d}t} = -\frac{1}{80}P^2.$$ **[1]**

This part was generally well answered, with the majority of candidates providing a sufficiently clear explanation.

Question 5 (b)

The scientist notes that at the start of the monitoring the population is 120.

(b) Use the model to determine an expression for P in terms of t. **[4]**

Most candidates were able to correctly (or acceptably for M1 only) separate variables and integrate (which was almost always done correctly). Of these, the majority went on to find a reasonable value for *c* (although some candidates simply assumed that *c*=120 without working, which was not normally corrected for their integrated form). However, many candidates either did not give their answer in terms of *P* (as required in the question) or made an error in doing so - for instance, assuming that the reciprocal of separate terms could be added together and losing the final A mark. Many candidates lost this mark through simple algebraic errors, often following near-perfect integration.

Question 5 (c)

(c) Use the model to determine the time it takes for the population to reach 10. **[2]**

Almost all candidates substituted *P*=10, gaining M1. Those who had lost the final A mark in (b) for incorrectly rearranging (or not rearranging) often still went on to gain M1 here by substituting and rearranging for t.

Question 5 (d)

The model predicts that the population will never reach zero.

(d) By considering the case when $t \geqslant 160$, or otherwise, comment on the validity of the model for large values of t. **[1]**

This part was much less well answered, with less than half of candidates providing a sufficiently detailed explanation in context. Most candidates correctly identified that with the given model 'for large *t*, *P* is small', but this was implied in the question so couldn't be credited alone. Some candidates incorrectly went on to state that the model gave negative values for *P*. The key understanding this question was testing is that there is an implied discrepancy between the behaviour of the model and the actual population when *t* is large, which makes the model invalid. Candidates needed to explain this in context, for instance making reference to the fact that non-integer populations are not appropriate, or by stating that once the population has dropped below 1 that implies it is actually 0 (extinct). Some candidates gave irrelevant suggestions such as "humans will not allow an animal to go extinct" which could not be credited.

Question 6 (a) (i)

6 In this question you must show detailed reasoning.

(a) (i) Use the formula for $\cos(A+B)$, and the double angle formulae, to show that $\cos 3\theta = 4\cos^3\theta - 3\cos\theta$. **[2]**

This part was well answered, with most candidates completing the proof successfully and almost all gaining at least the first B1 for using identities to rewrite in terms of theta only. Noting the DR instruction, quite a few candidates lost the second mark for making an error (e.g. omitting a bracket) in their working or by 'jumping' to the given response. Candidates should be reminded that 'Detailed Reasoning' means that every step in the working needs to be clearly shown.

Question 6 (a) (ii)

(ii) Use this result to solve the equation $4\cos^3\theta - 3\cos\theta - \frac{\sqrt{2}}{2} = 0$ for $0° \leqslant \theta \leqslant 180°$. **[3]**

This question was fairly well answered, with many candidates correctly observing that $\cos 3\theta = \frac{\sqrt{2}}{2}$ and proceeding to solve. However, quite a few candidates (not heeding the DR instruction) jumped directly to solutions for theta without showing an intermediate step - this could only score a maximum of 2/3 marks (assuming all three solutions in the range were present). Candidates should be reminded that DR means that all steps in the working need to be clearly shown and that, while computation can (and should) still be offloaded to a calculator, the mark scheme will still reflect this. A small number of candidates only gave two of the required three solutions. Some candidates (perhaps from looking ahead to later parts of the question) attempted to find values of θ by another method (for instance, matching the roots of the equation in *x* as in part (c)). This was rarely successful but, in any event, could not be given marks because the question specified 'Use this result…' so the method starting with 3θ needed to be seen.

Question 6 (b) (i)

(b) (i) Show that $\left(x + \frac{\sqrt{2}}{2}\right)\left(4x^2 - 2\sqrt{2}x - 1\right) = 4x^3 - 3x - \frac{\sqrt{2}}{2}$. **[1]**

Almost all candidates scored the B1 mark for this question, correctly multiplying out. Candidates should be reminded (especially in a DR question) to make sure that their working clearly leads to the given response. A small number of candidates lost this mark following correct work because they did not give a conclusion. Ideally candidates should demonstrate that their multiplied-out form simplifies to the given response (and write this out) although in this case an equivalent statement such as 'QED' or 'Shown' was condoned.

Detailed Reasoning

Candidates should be reminded that the instruction '**In this question you must show Detailed Reasoning**' sets a higher bar for the level and detail of working that will be required to support responses. It is an explicit instruction to candidates to demonstrate that they have fully understood the method that leads to the answer by showing all the steps, and credit will not normally be given for responses that are unsupported by correct working in these questions.

A full list of command words can be found on pages 10-15 in the specification. There is also a command words poster that can be printed and displayed in the classroom.

Question 6 (b) (ii)

(ii) Hence find the exact roots of the equation $4x^3 - 3x - \frac{\sqrt{2}}{2} = 0$. **[2]**

This part was also well answered, with almost all candidates deducing the first root of $x = -\frac{\sqrt{2}}{2}$. Many candidates went on (e.g. using the quadratic formula) to find the other two solutions correctly. Some candidates made sign errors (e.g. applying +/- to the wrong term). In some cases, candidates' writing meant that their solutions were ambiguous: for instance writing or implying $\pm\frac{\sqrt{2}+\sqrt{6}}{4}$ (when in fact the +/- should apply to the $\sqrt{6}$ only. Candidates should be reminded to make sure (especially in a DR question) that their responses are clearly written using correct, unambiguous notation.

Question 6 (c)

(c) Use the results from parts **(a)(ii)** and **(b)(ii)** to show that $\cos 15° = \frac{\sqrt{2}+\sqrt{6}}{4}$. **[2]**

In this part candidates needed to (as guided by the question) deduce the connection between parts (a) and (b) and use this to reach the given result. For the first B1 mark, candidates needed to show that they had understood and used this connection - for instance by writing $x = \cos\theta$. For the second, candidates needed to unambiguously show that $\cos 15° = \frac{\sqrt{2}+\sqrt{6}}{4}$. As this response was given it was not enough just to write this statement down, candidates needed to show this - either by deducing that cos 15 must be the only positive root (because cos 105° and cos 135° are negative) or by explicitly matching each root for the equation in *x* with a value of θ from part (a). Many candidates did not do this with sufficient rigour, and so could not be given this mark. Candidates should be reminded that, where a response is given, they need to clearly demonstrate that they have reached this by providing clear working.

Reading and following the sequence of the question carefully

This was a structured question designed, with appropriate scaffolding, to guide students through several different approaches to related problems in order to demonstrate their knowledge of different techniques. While candidates can of course answer the questions in any order they choose, many candidates did not score as many marks as they could have because they did not follow instructions such as "Use this result" or "Hence" which direct the candidate to use a specific method.

Question 7 (a)

7 Two arithmetic progressions, A and B, each have 100 terms denoted by a_i and b_i respectively, where $i = 1, 2, 3, \ldots 100$.

The common difference of A is d, where d is a positive integer.

The two progressions have the following properties.

- $a_1 = b_{100} = 4$
- $b_1 = a_{100}$

(a) You are given that there is at least one value of i for which $b_i = 10 + a_i$.

Show that, in this case,

$$i = \frac{101}{2} - \frac{5}{d}.$$ **[6]**

Although few candidates scored all 6 marks in this part, most candidates were able to interpret part of the information in the question to deduce the expression for $b_1 = 4 + 99d$ (B1). Fewer candidates identified that the common difference of B is $-d$, either assigning another letter or attempting to use d (and only a few of those deduced later that this needs to be $-d$). This meant that, while many of these candidates were able to set up the required equation (M1M1) they could not score either accuracy mark. Many candidates attempted to 'fudge' the given response and a few misinterpreted the $\frac{101}{2}$ term as implying that they needed to use the summation formula. Some candidates demonstrated excellent understanding by making clear use of the given set up (for instance using reverse indexing).

Question 7 (b)

(b) Hence show that it is impossible for the equation $b_i = 10 + a_i$ to hold unless d takes certain values, which should be stated. **[2]**

Very few candidates achieved either mark here, despite it relying only on the given answer to part (a). Some candidates identified that i needed to be an integer and this restricted the values for d, but very few gave both values correctly. This question had a very high omit rate, even though it did not depend on part (a).

Section B overview

Similarly to Section A, many candidates scored near-full marks on the first few questions in this section. Performance on the more challenging questions (Questions 13 and 14) was better than in 2023, although Question 12 was less well answered – with many candidates losing marks through not correctly calculating probabilities.

Question 8 (a) (i)

8 Sweets from a certain manufacturer are sold in packets. Thirty per cent of the sweets are orange, and these are randomly distributed amongst the packets. Each packet contains 15 sweets.

The number of orange sweets in a randomly chosen packet is denoted by X.

(a) Find the following probabilities.

(i) $P(X = 4)$ **[1]**

Almost all candidates answered this correctly.

Question 8 (a) (ii)

(ii) $P(X \geqslant 4)$ **[2]**

Nearly all candidates answered this correctly.

Question 8 (b) (i)

(b) (i) Write down an expression for $P(X = r)$. **[1]**

Most candidates answered this correctly, although some did not give a fully correct expression. Common errors included '1-r' instead of '15-r', using a different letter (question specifies *r*) or omitting the coefficient ${}^{15}C_r$.

Question 8 (b) (ii)

(ii) Explain the connection between the expression in part **(b)(i)** and the binomial expansion of $(0.7+0.3)^n$, for a specific value of n which should be stated. **[2]**

Few candidates gave a fully correct response here. Candidates were required to explain the connection by stating that this is for the case when n=15 (more candidates scored this B1 mark) and then specifying that P(X=r) is a term of the expansion (B1). Ideally it should have been observed that this was the $r\pm1^{th}$ term, but responses that did not specify this were condoned. Many candidates appeared to recognise the connection but gave vague explanations such as 'it is the expansion' or 'it is one of the probabilities' - the key idea here was to demonstrate the connection between the Binomial probability and the terms in the Binomial expansion.

Question 9 (a)

9 **(a)** The masses, M grams, of bags of flour are modelled by the distribution N(1002, 2.25).

Find $P(1000 < M < 1005)$. **[1]**

The majority of candidates answered this correctly.

Question 9 (b)

(b) The masses, in grams, of bags of sugar are modelled by the distribution $N(\mu, \sigma^2)$.

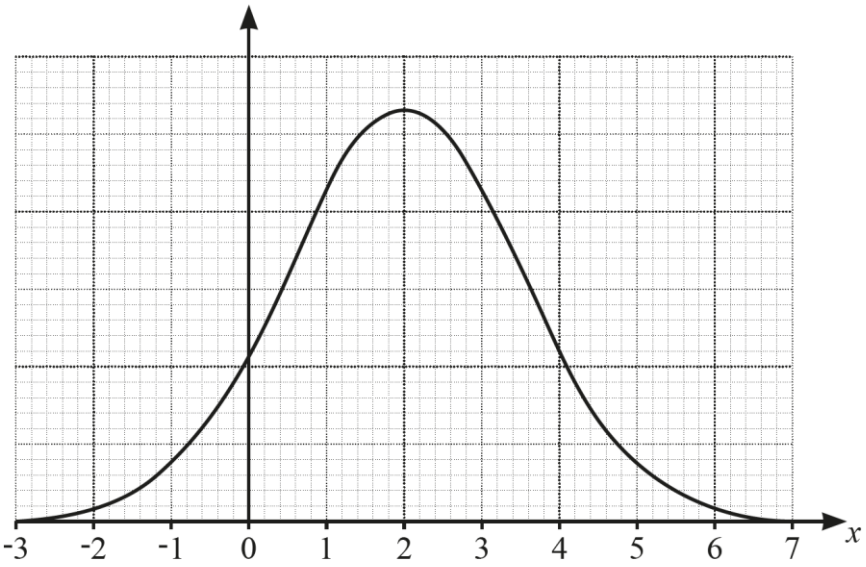
You are given that 20% of bags have masses greater than 502 g and 30% of bags have masses less than 499 g.

Determine the values of μ and σ. Give your answers correct to **2** decimal places. **[5]**

Most candidates answered this question well. The majority of candidates correctly identified the values required and setup correct equations in μ and σ (with a few making a sign error at this point scoring M1A0). Many then went on to solve these equations simultaneously and reach values for μ and σ. Quite a few candidates made errors in solving (or did not retain sufficient accuracy) - so that their responses were not correct to the 2dp required (or did not state their answers to this degree of accuracy).

Question 9 (c) (i)

(c) The diagram shows the probability distribution of a normal variable, X.



(i) Write down estimates of the x-coordinates of the points of inflection on the graph. **[1]**

Most candidates were able to write down estimates of the points of inflection with sufficient accuracy. Some candidates appeared not to have understood the question and gave a single value (perhaps trying to estimate the mean).

Question 9 (c) (ii)

(ii) Hence write down an estimate of the standard deviation of X, explaining your method. **[1]**

Most candidates appeared to know what to do, and many were able to reach an acceptable estimate for σ from their values. However, many candidates did not provide a sufficient (or any) explanation as required by the question and therefore could not score. The term hence in the question specified that inflection points needed to be used, so other methods of estimation (e.g. the 'rule of thumb') could not be given marks.

Question 10 (a)

10 Each month, the manager of a large store records the number, c, of customers who visit the store, and the amount, £h, spent on heating during that month. The manager wants to test whether there is linear correlation between c and h.

For a randomly chosen year the value of Pearson's product-moment correlation coefficient, r, between c and h was -0.798, correct to 3 significant figures.

(a) Using the table below, carry out the test at the 1% significance level. **[5]**

As in previous years, the mark scheme for these hypothesis testing questions is often instructive as to what is required. Most candidates appeared to know the overall structure and approach required, although very few scored all 5 marks.

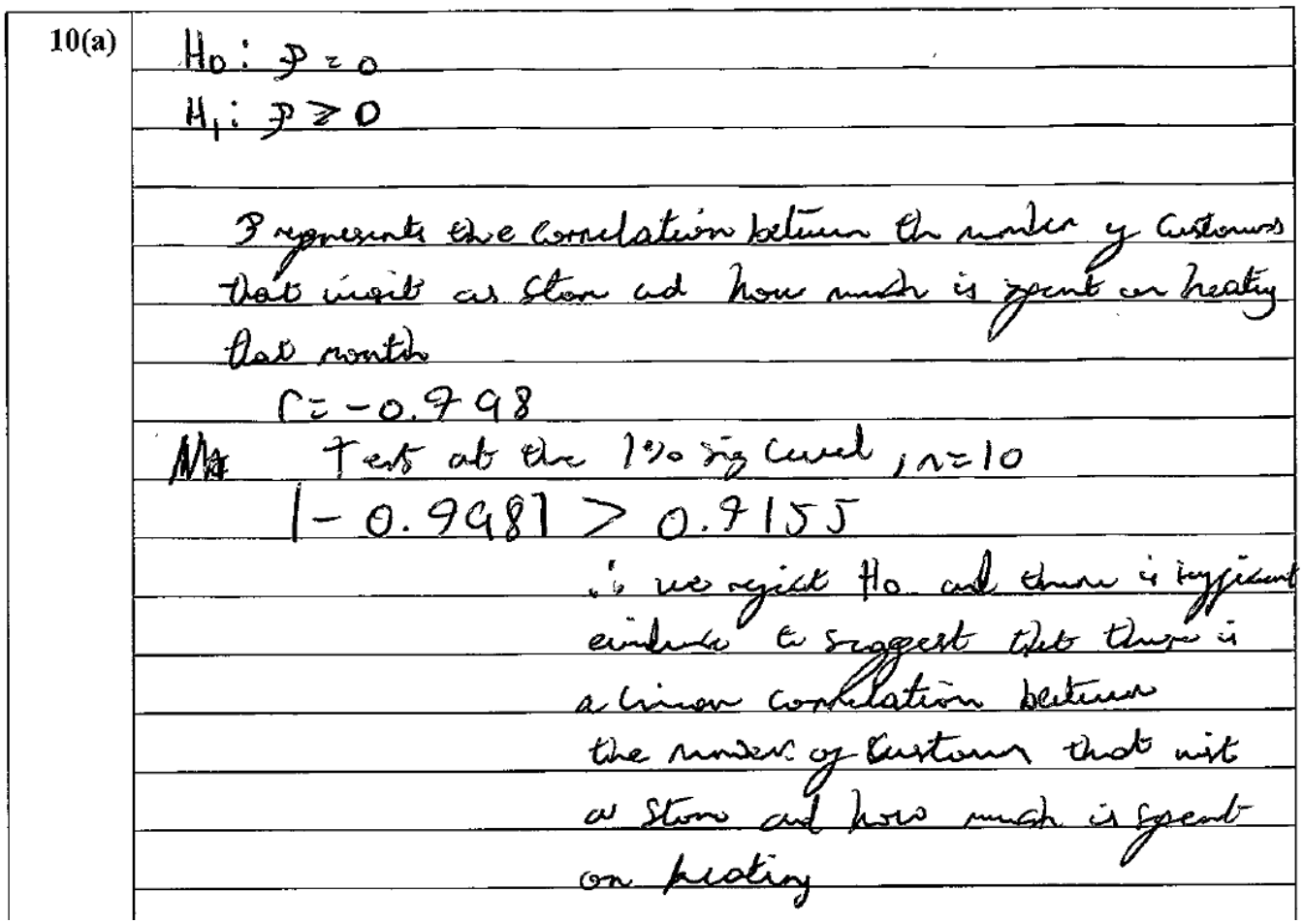
Common errors included:

- Setting up the hypotheses wrongly - either not giving them in terms of a parameter, using a letter that was already defined in the question or not defining their parameter sufficiently carefully (for instance, omitting 'coefficient' or not setting it in the context of the question). More candidates than in previous years gave very inaccurate hypotheses, for instance using 0.798 instead of 0, which could not be given marks.

- Selecting the wrong value from the table, or 'hedging their bets' and attempting to argue that any value would work. As in previous years, a specific comparison with a stated probability value is required (which needed to be for n=12 and at the correct significance level).

- Providing a conclusion that was too definite or not in context.

Exemplar 2



This is a typical example of a response where the candidate has shown understanding of the structure that is required but made several errors. In this case the candidate scored B0B0 for their hypotheses (because they have given a '1 tail' version and their definition of the parameter ρ is incomplete), B0 for their comparison (because they have selected an incorrect critical value) but then gains M1A1 for an appropriate conclusion that is (broadly) consistent with their hypotheses and comparison. Total 2/5.

Question 10 (b)

(b) Describe briefly two main features of a scatter diagram that could be drawn to illustrate the values of c and h for this year. There is no need to draw a diagram. **[2]**

This part was not well answered. Many candidates either gave generic features of a scatter diagram (that were not specific to this scatter diagram with the values of c and h for this year) or repeated information from the question such as 'negative correlation'. Candidates needed to demonstrate that they understood what the information in the question tells us about the appearance of a scatter diagram for the given data - in particular, saying something about the (relative) strength of the correlation (e.g. 'points lie close to a straight line') and about the negative sign of the correlation (e.g. 'with negative gradient'). Candidates should be reminded that 'explain' and 'describe' questions need to be answered carefully and rigorously, and then citing generic facts is unlikely to be given marks. Here, many candidates did not give two specific points in their response as requested in the question.

Ensure that candidates read and answer the full question in Describe/Explain questions

Many candidates lost marks on this paper for not directly addressing the request in the question when the command word is Describe/Explain. For instance, Question 10(b) asked candidates to describe **two** main features. It would be best practice for candidates to offer **two** distinct points in their response.

Question 10 (c)

(c) The manager makes the following statement.

"The value of r shows that when we spend more on heating, fewer customers visit the store. So we should spend less on heating."

Comment briefly on this statement, making reference to the context. **[2]**

This part was better answered than (b) with most candidates scoring at least 1 mark. Many candidates gave an adequate explanation as to why the given conclusion might not be correct, although fewer stated (or implied) that 'correlation does not imply causation' which is the factual recall this question was testing. As above, candidates should be reminded of the need to provide detailed explanations - for instance, here, stating 'there may be another factor' was insufficient (as this is a generic fact). Candidates needed to suggest in context, a possible third factor and any reasonable suggestion could be given marks.

Question 10 (d)

(d) Give a statement about a probability to explain the meaning of the value 0.7155 in the table below. **[2]**

Critical values of Pearson's product-moment correlation coefficient

	1-tail test	5%	2.5%	1%	0.5%
	2-tail test	10%	5%	2%	1%
n	10	0.5494	0.6319	0.7155	0.7646
	11	0.5214	0.6021	0.6851	0.7348
	12	0.4973	0.5760	0.6581	0.7079
	13	0.4762	0.5529	0.6339	0.6835

Very few candidates scored either mark in this part. Many gave a (valid) explanation of the meaning of this value in the context of hypothesis testing (as in part (a)) but did not provide a statement about probability as required. Others confused the values in the table as probabilities rather than critical values.

Question 11 (a) (i)

11 The chart below represents the percentage increases (PI) in the numbers of employees using four different methods of travel to work from 2001 and 2011, in five different Local Authorities (LAs) in Wales.

Local Authority	Method of transport			
	Work mainly at or from home	Underground, metro, light rail, tram	Train	Driving a car or van
Caerphilly				
Merthyr Tydfil				
Neath Port Talbot				
Rhondda, Cynon, Taff				
The Vale of Glamorgan				

Key:	$-10\% < PI \leqslant +10\%$	$+10\% < PI \leqslant +30\%$	$+30\% < PI \leqslant +50\%$	$+50\% < PI \leqslant +90\%$	$+90\% < PI$

(a) (i) State, with a reason, which of the four methods of transport probably had the greatest overall percentage growth in these LAs between 2001 and 2011. **[1]**

Overall, this question was better answered than the equivalent question in 2023. As in previous years, candidates needed to give reasonably precise responses that address the question in context. Generic facts or irrelevant information were not given marks.

In part (a)(i), most candidates provided an acceptable answer, with sufficient justification. Some responses would have benefited from being more specific - and some candidates appeared not to have noted that the Underground/Metro category had a higher percentage increase in one LA.

Question 11 (a) (ii)

(ii) Explain why your answer to part **(a)(i)** is **not** definite. **[1]**

This part was also well answered, with many candidates providing an acceptable reason. Some candidates did not show full understanding of the relevance of sizes for combining percentage increases, and others gave irrelevant facts (e.g. referring to other categories not included in the chart). Generic statements such as "because the data is grouped" were not sufficient to gain the B1. LSEP

Question 11 (b)

(b) A student suggests that the chart can be used to estimate the total percentage change for these methods of transport in each individual LA.

Give **two** reasons why the student is likely to be wrong. **[2]**

Fewer candidates scored full marks here than in part (a), although many scored at least 1. Most gave a point referencing the width of the ranges or the fact that exact ranges are not known, but many did not make a sufficiently specific second point. Some confused what the chart shows and suggested that the size (or relative population) of each LA would improve the estimate - which is not correct. Others demonstrated good understanding of what the chart shows by stating that either initial or final values need to be known. However, a few gave irrelevant information (e.g. criticising the data or the sample size) - which could not be credited with marks because the question specified 'the chart'. As above, candidates should be reminded that these types of questions merit careful reading (and that, although they may appear similar, subsequent questions are unlikely to be asking for a repeat of the same information).

Question 11 (c)

(c) A student wants to investigate the trend from 2001 to 2011 in numbers using underground, metro, light rail or tram. The actual numbers of people using these methods in these LAs in 2001 were all less than 50 (and in one case was 4).

Explain why this means that the chart does **not** provide very helpful information for the student. **[1]**

This was also less well answered than part (a). Less than half of candidates gave a correct response. To do this they needed to use the idea that a small increase from a small starting value may give a misleadingly high percentage increase. There were others that appeared to have misunderstood the information given and referred to "small sample size" (perhaps interpreting the '50' and '4' as sample sizes rather than actual values).

Question 11 (d)

(d) Let D denote the number of people in the Vale of Glamorgan whose usual method of travel to work is "Driving a car or van", and let H denote the number of people in the Vale of Glamorgan who "Work mainly at or from home".

Between 2001 and 2011 the increase in D was approximately 3.5 times the increase in H.

Use this fact and the information in the chart to estimate the ratio $D : H$ in 2001. **[3]**

Many candidates started this part well, correctly identifying sensible starting estimates (e.g. the midpoints 0.2 and 0.4), but then struggled to proceed and/or to set up an appropriate equation using the information given in the question. Some used 1.2 and 1.4 here which led to incorrect responses. A few candidates reached a sensible estimate but gave their ratio the wrong way around, which could not gain the final A mark. Some candidates appeared unsure about how to 'use' the factor of 3.5 (or used it on the wrong side of their equation). Others attempted a ratio using lower bounds only (or only using the 3.5x). Using different methods of estimation, e.g. interpolation, were rarely seen but would have been acceptable (the suggested alternative of 8.15 in the mark scheme is based on 'stretching' the interval by 3.5 and taking the midpoint).

Question 12 (a)

12 Ryan has to choose one student at random from a group of 11 students. Ryan makes the choice using a single throw of two fair, six-sided dice, together with the following table.

Total score on the two dice	2	3	4	5	6	7	8	9	10	11	12
Student chosen	A	B	C	D	E	F	G	H	I	J	K

(a) Show that this sampling method is **not** random. **[2]**

Only a minority of candidates scored both marks on this question, as the responses only stated generic facts or cited the definition of random (equal probabilities). The command 'Show that' indicates that some rigorous working was required; and that a general explanation alone is unlikely to be sufficient. In this case, candidates needed to demonstrate (either using probabilities or combinations) that some scores are more likely to occur than others, and clearly state this conclusion to prove the given statement. Many did not correctly compute the probabilities for one or more outcomes from two dice, and therefore lost both marks. Some candidates made reference to the 'sample' of 11 students or other generic factors which were not relevant.

Question 12 (b) (i)

Sasha suggests making the choice using a single throw of two fair, six-sided dice, together with the following table.

Scores on the two dice	1, 1	1, 2	2, 1	1, 3	3, 1	1, 4	4, 1	1, 5	5, 1	1, 6	6, 1
Student chosen	A	B	C	D	E	F	G	H	I	J	K

Ryan says that a further instruction is needed to complete the method.

(b) (i) Write a suitable further instruction. **[1]**

Most candidates provided an appropriate instruction here. The response needed to focus on the need to distinguish the two dice (to obtain an ordered pair of scores) or to handle the fact that a number of possibilities are not included in the table (e.g. 'roll again'). Some candidates appeared not to have recognised that (despite the sub-stem and emboldened text) this was a new part of the question, with a new sampling method (Sasha's) and made incorrect references to their work in (a) (which related to Ryan's method). Some candidates suggested instructions which were not compatible with the given method (e.g. 'add the two scores'). A few candidates suggested extending the list of possibilities - but this could only be credited with marks if it maintained the structure of the table (i.e. candidates needed to say 'assign a further 2 pairs to each student and the remaining 3 to 'throw again'').

Question 12 (b) (ii)

(ii) Using Sasha's method, state the probability of choosing student E. **[1]**

The majority of candidates provided an acceptable response here.

Question 13 (a)

13 At an election last year, 20% of voters in Aytown voted for the Now Party. A researcher plans to test whether the proportion of voters in Aytown who support the Now Party this year is greater than 0.2. The hypotheses for the test will be $H_0: p = 0.2$ and $H_1: p > 0.2$.

The researcher surveys a random sample of 200 voters in Aytown and notes the number X who say they support the Now Party.

The random variable Y has a normal distribution which is a good approximation to the distribution of X when the null hypothesis is correct.

The significance level of the test is 5%.

(a) Find the value of y such that $P(Y > y) = 0.05$. **[2]**

Many candidates obtained the correct response here. Common errors included giving a value for P($Y < y$)=0.05 instead of $Y > y$, or incorrectly using the Binomial rather than the Normal distribution. Some candidates went on to round their value to the nearest integer, perhaps suggesting that they had not appreciated the distinction between X and Y.

Question 13 (a)

(b) Use your answer to part **(a)** to determine the smallest value of X that would result in rejecting the null hypothesis. **[3]**

This part required candidates to select and compute (at least) two probabilities to deduce the critical value for the given hypothesis test. Many candidates attempted probabilities but gave incorrect values or associated them with the wrong inequality. A few candidates continued to confuse X and Y and gave probabilities from the Normal distribution (as in part (a)) rather than the Binomial, which could not be given marks. Many candidates were able to deduce the value $X = 50$ from their work in part (a) or by following incorrect probabilities - which was allowed as a Special Case B1. Although on this occasion the mark scheme did not require candidates to demonstrate probabilities either side of 0.05, candidates should be reminded that in a 'Determine' question this is the level of working that might be required.

Question 14

14 For a certain value of the constant p, the random variable X has the probability distribution given in the table.

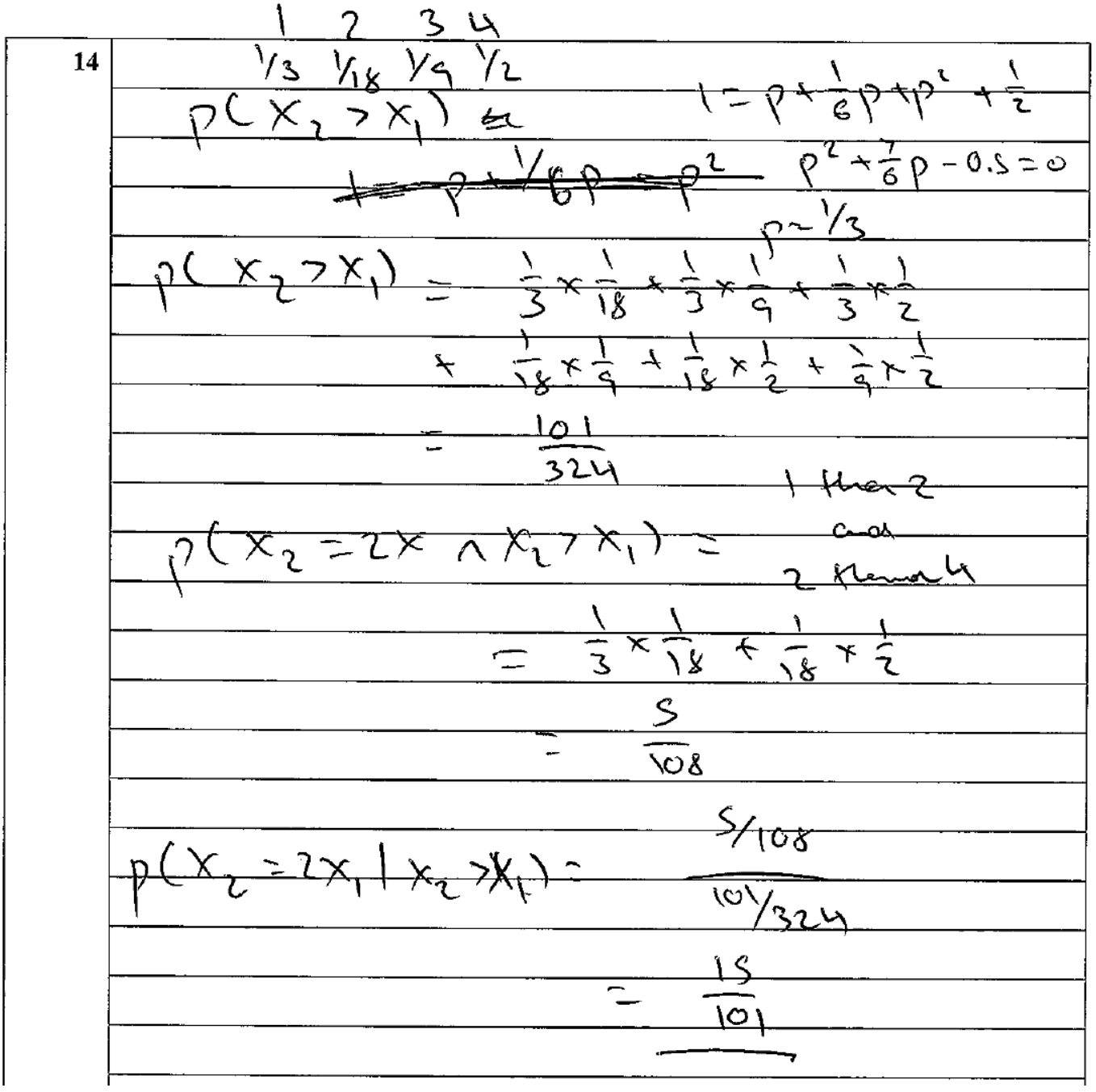
x	1	2	3	4
$\mathrm{P}(X = x)$	p	$\frac{1}{6}p$	p^2	$\frac{1}{2}$

Two independent values, X_1 and X_2, of X are found.

Determine $\mathrm{P}(X_2 = 2X_1 \,|\, X_2 > X_1)$. **[8]**

Most candidates obtained a number of marks in this question, although very few attained all 8. The majority of candidates approached the question in the order described in the mark scheme, first forming and solving a quadratic in *p*. This was almost always done correctly. Some candidates did not note or otherwise consider the $-\frac{3}{2}$ root and could not be given the B1. (This root did not need to be found, but candidates did need to explicitly consider it, for instance by stating 'the other root is negative'). Most candidates then went on to correctly find the conditional probability, but numerical errors were common - meaning that many candidates gained one or both method marks but not the final A1. Many candidates did not write down their probabilities once they had found a value for *p* (this mark could be implied, but only from correct responses or these values seen in working). A few candidates appeared not to have noticed the significance of the values in terms of *p* and started with a conditional probability formula in terms of *p*. This could gain M1M1 but nothing further unless they proceeded to work with the quadratic to find a value of *p*.

Exemplar 3



This candidate has provided an excellent response to Question 14. They lose a single mark (B0) for not showing (or otherwise excluding) the other, negative, root of the quadratic. Their response is otherwise correct and therefore scores 7/8.

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