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LEVEL 3 CERTIFICATE

Examiners' report

FREE STANDING MATHEMATICS QUALIFICATION: ADDITIONAL MATHS

6993

For first teaching in 2018

6993/01 Summer 2024 series

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

The paper assessed a wide range of topics within the specification and some high marks attained by candidates indicated a wide understanding of the specification. A few candidates scored full marks, and the graph of the marks showed a nice normal distribution with a negative skew and high mean and median scores for the cohort.

Some topics overlap the content of Higher Tier GCSE and it is expected that questions on these topics will be tackled well. Questions 1, 3, 4, 5, 6, 7 and 9 are all questions that could be attempted with knowledge of GCSE Higher Tier content. These were generally answered well, but marks occasionally dropped due to not reading the question properly.

Some topics are designed to provide some more depth to the understanding of the GCSE content. Question 8 uses the Factor Theorem to factorise a cubic equation, questions 12 and 13 use formal numerical methods to find approximate solutions to algebraic problems and question 16 applies inequalities to solve a linear programming problem. These are more challenging questions, but most candidates made good attempts on these.

The specification also includes some acceleration into post 16 maths content that will be useful for either AS Maths or other subjects with numerical requirements. Questions 2 and 14 focused on logarithms, with the former a routine algebraic manipulation and the latter a more involved modelling problem. Questions 10, 11 and 15 focused on calculus, again the first two were routine with the third a modelling problem. It was pleasing to see so many successful responses.

The FSMQ is designed to offer a challenge for all candidates, and the final question on the paper required careful thinking to bring together trigonometry and algebra techniques to find the solutions.

Candidates who did well on this paper generally:	Candidates who did less well on this paper generally:
• set out their responses well • had a grasp of all the topics being tested.	• did not think through the question properly and so did not set out their responses well or appropriately • demonstrated a lack of confidence in some of the topics being tested.

Question 1

1 Solve the inequality $2-(x+1)>7$. **[2]**

This proved to be an easy start to the paper. However, not all candidates obtained full marks. The main error occurred when candidates obtained the answer $-x > 6$ but were unable to manipulate this correctly to give $x < -6$.

Exemplar 1

1	$2 - x - 1 > 7$	
	$1 - x > 7$	
	$-x > 6$	
	$x < 6$	$x < 6$

This response typifies the work of many candidates in completing much of the algebraic manipulation correctly but failing in the last line to deal with the negative signs.

Question 2

2 Write $\log_{10}2a+2\log_{10}b$ as a single logarithm. **[2]**

This question required the use of the laws of logarithms. There are two steps involved, so it is good practice to do each step in a separate line of working, both to help avoid making errors, but also to make it easier to award partial credit if an error is made.

An incorrect answer with no sight of one of the laws being used gained no marks.

Question 3 (a)

3 You are given the quadratic polynomial $f(x)=x^2+6x-11$.

(a) Write $f(x)$ in the form $f(x)=(x+a)^2+b$ where a and b are integers to be found. **[3]**

This part was well answered with most candidates understanding how to complete the square, but a small minority of candidates used $(x + 6)^2$ rather than $(x + 3)^2$.

Question 3 (b)

(b) Using your answer to part **(a)**, solve the equation $f(x) = 0$, giving exact answers. **[2]**

The instruction to candidates was supposed to indicate that what they have just done is a help for this part. However, some candidates used the quadratic formula for the solution of the equation, one or two even carrying out some algebraic work to convert their answer to part (a) back to the question format. A significant minority did not seem to understand the word 'exact'. Those who wrote both the exact form and the decimal equivalent were given full marks but those who only gave their answers in decimal form received no marks.

Question 4 (a)

4 A group of 68 students was asked about their preference for pop music or classical music.
10 said they did not like either pop music or classical music.
20 said they liked classical music.
50 said they liked pop music.

(a) Draw a Venn diagram to illustrate this information. **[2]**

Many candidates demonstrated a correct understanding of a Venn diagram with two rings overlapping but omitted the rectangle to indicate the universal set. Candidates need to understand that the answer space is not the rectangle. A third, separate but overlapping, circle was sometimes seen inside the rectangle for the 'neither' category. This is incorrect.

Question 4 (b)

(b) Determine the number of students who said they liked both pop music and classical music. **[2]**

This part was well answered overall but some candidates achieved 1 mark only, as they added four sets to make 68 or three sets to make 58 but did not reach 12 as the final answer.

Question 5

5 You are given the recurrence relationship $x_{n+2} = x_{n+1} + 2x_n$ for all positive integers n where $x_1 = 1$ and $x_2 = 1$.

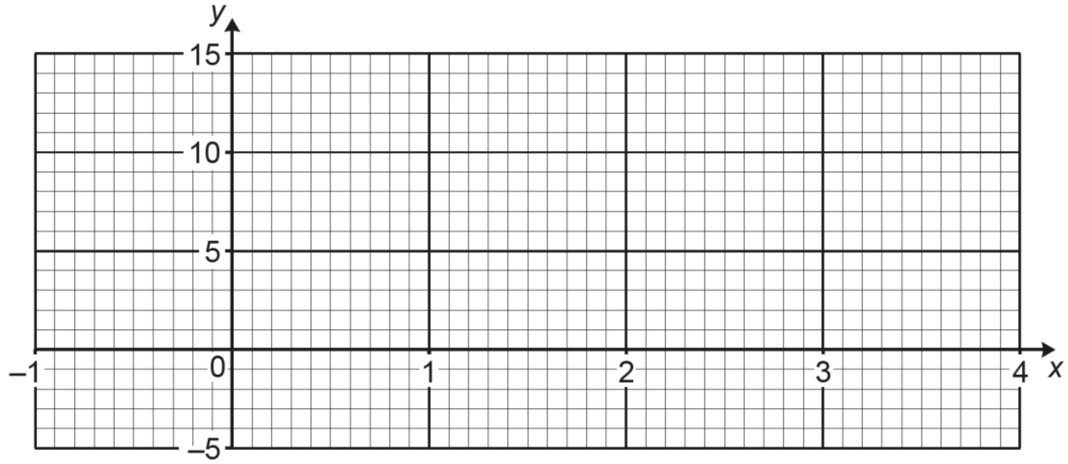
Determine the value of x_5. **[3]**

Most candidates were familiar with the concept of a recurrence relationship and were able to score all 3 marks on this question. Some candidates lost marks through arithmetic slips or doing all the work on the calculator and hence making errors in the calculation. Candidates should be encouraged to set their working out in a formal way even when attempting relatively straight forward questions. Some less successful candidates were obviously unfamiliar with the term recurrence relationship and hence were unable to score any marks on this question. Others seemed unfamiliar with the idea of a recurrence relationship which calculated a term in the sequence from the two previous terms.

Question 6 (a)

6 **(a)** On the grid, plot the graphs of $y = x^2 - 4x + 1$ and $y = 2^x - 2$. **[4]**

6(a)



The vast majority of candidates understood what was required from the question but carelessly drawn graphs on occasion led to lost marks even though the candidate went through the correct process.

Question 6 (b)

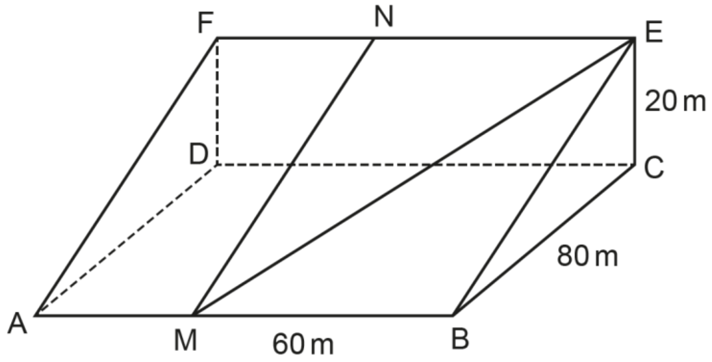
(b) Hence write down the root of the equation $2^x = x^2 - 4x + 3$, giving your answer correct to **1** decimal place. **[1]**

Those candidates that successfully plotted the graphs generally wrote down the intersection correctly. In this series candidates were not penalised for giving the root as part of a coordinate pair, but strictly speaking the root of the given equation should only be 'x = …'.

The 'Hence' means that candidates must use their previous work on the graph, answers obtained solely from using the solve function on the calculator would not gain credit (although it is good practice to check answers if time permits).

Question 7 (a)

7 A hillside can be modelled by a wedge as shown in the diagram.



The base ABCD is a horizontal rectangle with BC = AD = 80 metres.
The back of the wedge is a vertical rectangle CDFE with DF = CE = 20 metres.
M is a point on the line AB where BM = 60 metres.

A straight path goes up the hill from M to N where N is a point on FE such that MN is a line of greatest slope.

(a) Calculate the angle that the path MN makes with the horizontal, giving your answer correct to **1** decimal place. **[2]**

Both parts indicated that some candidates were not confident in working in three dimensions and finding the appropriate right-angled triangle to find the angle required.

In part (a) many successfully recognised that the angle was the same as that between BE and BC and were able to correctly use the lengths given to find tan of the angle. Some misinterpreted it and found the angle between the line and the vertical. Many used the sine rule on a right-angled triangle. Those that did, generally did so successfully. Some found the length of the hypotenuse and then applied the sin ratio.

Question 7 (b)

(b) A second straight path goes up the hill from M to E. Calculate the angle that this path makes with the horizontal, giving your answer correct to **1** decimal place. **[4]**

As in part (a) most realised that they needed to find the length MC but many then overcomplicated the question by also finding ME and applying the sine rule. Again, many found the angle between the line and the vertical. Some lost the final mark by giving their correct answer to more than 1 decimal place. Others were trying to find angles in incorrect triangles – such as MBE.

Question 8 (a)

8 In this question you must show detailed reasoning.

You are given the cubic polynomial $f(x) = x^3 - 5x^2 + 2x + 8$.

(a) Using the factor theorem, factorise $f(x)$. **[4]**

Most candidates who used the factor theorem recognised the need to use the factors of 8 in their factor theorem trials. However, many did not use the factor theorem – or did not demonstrate sufficiently that that was what they were doing. Those candidates that only wrote the answer $f(x) = (x + 1)(x - 2)(x - 4)$, with no working at all, scored zero.

Having found (or stated) a first factor, most candidates were successful in finding the quadratic, usually by successful long division. Almost all then successfully went on to give the three factors.

A small number of successful responses were seen using the factor theorem repeatedly.

Detailed reasoning

Some questions will demand detailed reasoning. That does not mean to say that calculators must not be used, but that all the steps in a reasoning question must be seen.

The fact that some candidates may have found the roots of the cubic using their calculator as a short cut for trial and error is not an issue. This question says, 'using the factor theorem…' so those candidates that demonstrated they understood that $(x - a)$ is a factor when $f(a) = 0$ could score marks. Those candidates that did not demonstrate that they understood how the factor theorem could be used as the first step to factorising the cubic could not score full marks.

Having found $(x - a)$, the detailed reasoning requirement means that the quadratic factor needs to be found before, in the case of this question, stating the 3 linear factors. The alternative, for this question, would be to demonstrate the use of the factor theorem for at least 2 terms.

Question 8 (b)

(b) Hence solve the equation $f(x) = 0$. **[1]**

This was almost always well done by those who had managed to factorise the initial expression.

Question 9 (a)

9 Two fair six-sided dice are rolled. If they both display the same number, then that number is recorded in the table below. When they display different numbers the higher of the two numbers is recorded in the table below.

(a) Complete the two way table showing the number that would be recorded. **[2]**

9(a)

1st dice \ 2nd dice	**1**	**2**	**3**	**4**	**5**	**6**
1						
2						
3						
4						
5						
6						

Virtually all students answered all parts correctly. The few who lost marks either added or multiplied the scores suggesting that they had not read the instructions carefully.

Question 9 (b) (i)

(b) Write down the probability that:

(i) a 1 is recorded **[1]**

The majority of candidates were able to write down the answer using their two way table.

Question 9 (b) (ii)

(ii) a 6 is recorded. **[1]**

The majority of candidates were able to write down the answer using their two way table.

Question 10

10 Determine the coordinates of the stationary points on the curve $y = x^3 - 6x^2 + 9x + 4$. **[5]**

The vast majority of students scored full marks on this question or missed the final mark for not finding *y* to give the coordinates.

A few students did not understand that differentiation was needed and so they either could not start or tried to find values from their calculators. Those who did differentiate rarely made a mistake with the process and the vast majority could then factorise the equation correctly to obtain the *x* coordinates.

The command word 'Determine' was used, which indicates that justification should be given for any results found including working where appropriate but does not require a detailed and complete analytical method to be written out.

Exemplar 2

10

$\frac{dy}{dx} = 3x^2 - 12x + 9$

$\frac{dy}{dx} = 0$ (stationary) $3x^2 - 12x + 9 = 0$ $)(\div 3)$

$x^2 - 4x + 3 = 0$

$(x-3)(x-1) = 0$

$x = 1$ or 3

$x = 1,\ y = 1^3 - 6(1)^2 + 9(1) + 4 = 8$

$x = 3,\ y = 3^3 - 6(3)^2 + 9(3) + 4 = 4$

$(1, 8)$ and $(3, 4)$

The command word 'Determine' indicates that some working should be seen, partly to ensure an answer is not read from a calculator without any mathematical understanding, but also to encourage candidates to set out their work neatly enough to avoid introducing their own transcribe errors.

This exemplar has all the mathematical notation correct, making clear when the equation '*y* = …' is being used and when 'd*y*/d*x*' is being used. The first step is to find the gradient function which has been clearly labelled as such. This candidate has then explicitly stated that the gradient function should be equal to 0. It was not necessary to show the factorising step, and having found the *x* values, it was not necessary to show the substitutions when stating the *y* values. However, writing out these steps does help avoid careless mistakes.

Question 11

11 The gradient function of a curve is given by $\frac{dy}{dx} = 4 + 6x - 3x^2$ and the curve passes through the point (1, 5).

Determine the equation of the curve. **[4]**

This question was answered well by most candidates. Very few did not know that the solution required integration, so could earn M1. The overwhelming majority did this accurately, with few arithmetic errors. The '+c' was sometimes omitted, but often rescued in the second part.

Substitution presented few issues for the second M1. The most common error was forgetting '*y* = …' in the final answer, with some candidates stating 'equation =...' or just writing the expression.

Question 12 (a)

12 The table below gives the coordinates of six points.

x	0	1	2	3	4	5
y	1	1.13	1.43	2.11	3.69	7.30

The points are plotted on a grid and a smooth curve is drawn to pass through the points.

(a) Using the trapezium rule with 5 strips, find an estimate for the area between the x-axis, the y-axis, this curve and the line $x = 5$. Give your answer correct to **1** decimal place. **[3]**

The use of the trapezium rule to estimate the area under a graph is in the specification, but many candidates, aware of what they needed to find, added 5 separate trapezia rather than use the formula, which is given on the formulae sheet.

The most significant error in the question was putting $h = 5$ into the formula. In these cases, some candidates reached an answer of 60 or more without questioning the size in comparison to the original data.

Question 12 (b) (i)

(b) (i) Calculate an estimate for the rate of change of y with respect to x for this curve when $x = 3$. Give your answer correct to **1** decimal place. **[2]**

Most candidates seemed to understand how best to find an estimate, gaining the M1, but did not discern what should be done to obtain the best estimate with the data provided.

Question 12 (b) (ii)

(ii) Explain how this estimate could be improved. **[1]**

Some reference to the strips, or ordinates, having to be closer together (or for instance 'smaller strips') could earn the mark here.

Question 13 (a)

13 Tom has been asked to solve the equation $x^3 - x - 7 = 0$.

(a) Show by sign change that $x^3 - x - 7 = 0$ has a root, α, in the interval [2, 3]. **[2]**

In part (a), many candidates demonstrated correct substitutions to achieve one mark but did not write a valid conclusion. It was necessary to see a conclusion which indicates a change of sign and therefore a root occurs in the interval.

Show that

Candidates are generally given the result in a 'show that' question so the explanation has to be sufficiently detailed to cover every step of their working.

Candidates need to make clear what calculations have been done, but also what the calculations have shown.

Question 13 (b) (i)

(b) Tom decides to use the iterative formula $x_{r+1} = \sqrt[3]{x_r + 7}$ to find α.

(i) Explain how he obtained this iterative formula. **[2]**

This part was also well answered, but some candidates did not show full and complete working, which was necessary for 2 marks.

A small number of candidates wrote their explanation in words rather than an algebraic solution.

Question 13 (b) (ii)

(ii) Using this iterative formula, with $x_0 = 2$, find α correct to **3** significant figures. **[2]**

This is another question where the question has explicitly asked for a specific method to be used, so candidates need to show sufficient working to make clear that this method has been used.

The quality of candidates' responses varied greatly. Candidates did not show full working on occasions, so for example incorrect solutions included:

- candidates writing x_1 = 2.08 but then just stating 2.09 as the answer with no other working
- candidates just writing 2.09 with no working.

Candidates must be encouraged to show full and complete working in these questions working to at least 4sf until giving a conclusion to 3sf.

Question 14 (a)

14 Layla is given the following data.

n	1	3	5	7	9
x	0.5	1.1	2.5	5.7	12.8

She believes that the relationship between n and x can be modelled by the equation $x = ka^n$ where k and a are constants.

(a) Show by taking logs of both sides of this equation that a straight line will be obtained by plotting $\log_{10}x$ against n. **[3]**

Almost half of the cohort scored all 3 marks on this part of the question. Errors that were seen regularly included simplifying $\log_{10}ka^n$ to $n\log_{10}ka$ or $n\log_{10}k + n\log_{10}a$, both of which scored 0. Some candidates obtained $\log_{10}x = \log_{10}k + n\log_{10}a$ but then did not compare this to $y = mx + c$ to obtain the third mark in this section.

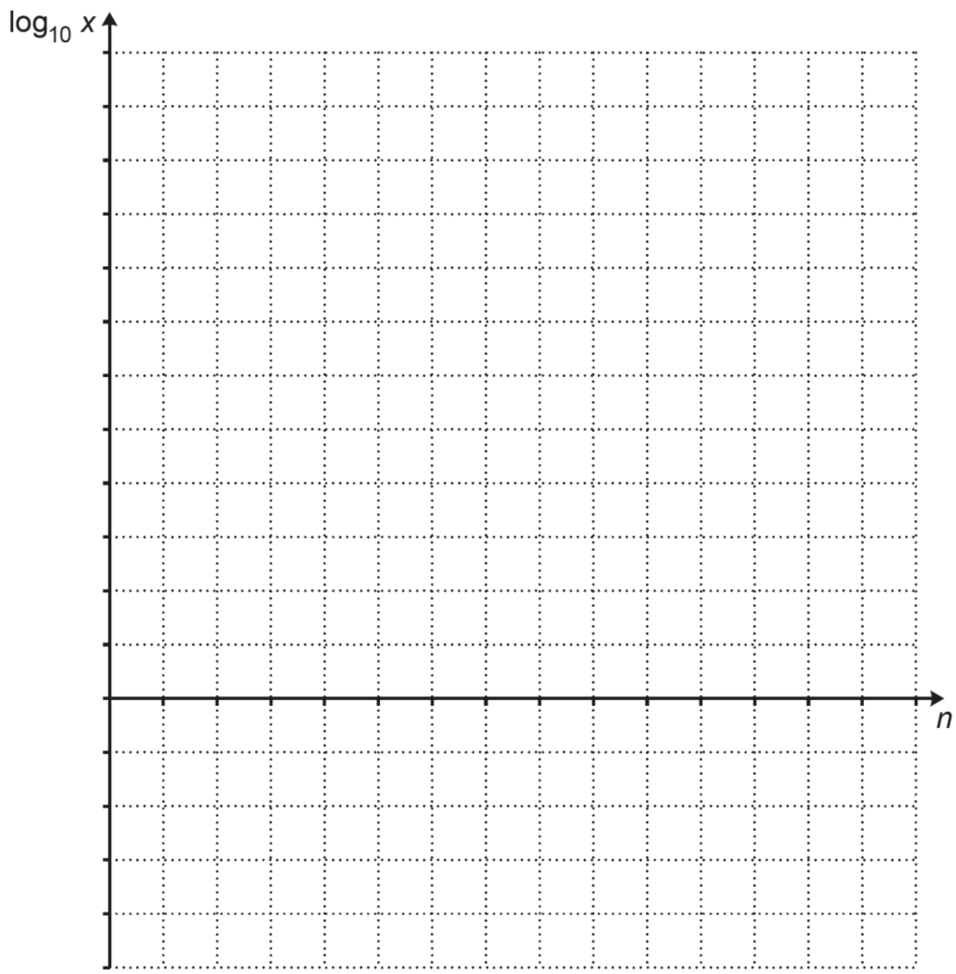
Some candidates appeared unfamiliar with this topic and made very little progress on this part of the question.

Question 14 (b)

(b) For the data given in the table, plot the points $(n, \log_{10}x)$ on the grid on page 13.

Use the spare row in the table above for any values you need to calculate. **[3]**

14(b), (c)(i)



Most candidates knew to find $\log_{10}x$ as this was implied in the question and most went on to plot $\log_{10}x$ against n. Some lost all the accuracy marks on this part as they did not use a linear scale on the horizontal axis simply plotting n = 0, 3, 5, 7, and 9 at equal intervals on the horizontal axis. Candidates should be encouraged to use the extra row on the table to list their values for (in this case) $\log_{10}x$ even if they feel they do not need them.

Question 14 (c) (i)

(c) (i) Draw the line of best fit for the points on the grid. **[1]**

The drawing of the straight line to pass through the points caused no problem except that some were a little wayward and outside the bounds of acceptability.

Question 14 (c) (ii)

(ii) Explain why the model is reasonable for these data. **[1]**

Those candidates that had scored well on the earlier parts of this question found this mark straightforward. However, some candidates struggled to articulate a clear justification for why the model was reasonable.

Question 14 (d)

(d) Hence estimate values for k and a. **[3]**

This proved to be a more challenging prospect; less successful candidates were unable to access this section at all. Some did realise that they needed to calculate the gradient and intercept but did not realise they had obtained log values and did not antilog to obtain the correct answers. Some candidates went back to the original equation, substituted two pairs of values and attempted to solve the two simultaneous equations. While this was not the intended approach, correct answers were given full marks, but the exponential simultaneous equations did prove to be beyond the abilities of many who went down this route.

Question 15 (a)

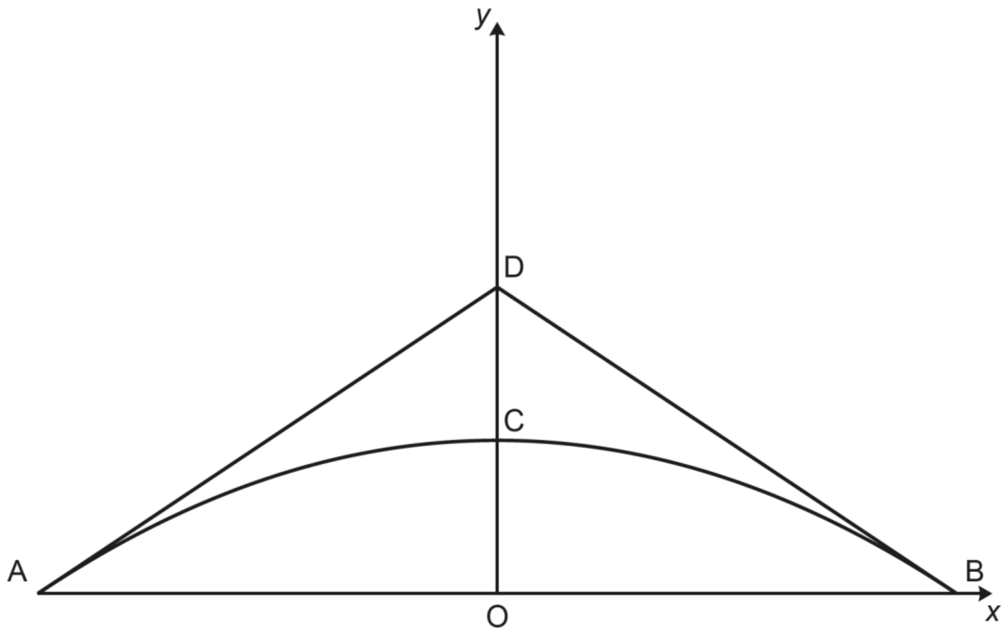
15 In this question you must show detailed reasoning.

The diagram shows a symmetric, triangular cross-section of a roof, ADB, where AB is horizontal. Under this roof is the ceiling, ACB, of a room.

In a coordinate system the mid-point of AB is the origin, O, with the x-axis passing through A and B and the y-axis passing through C and D.

With respect to this coordinate system the equation of the curve ACB is $y = 2 - \frac{1}{18}x^2$.

The lines AD and BD are tangents to the curve at A and B respectively. Units are metres.



(a) Find the coordinates of the points A, C and B. **[3]**

Most candidates recognised the need to explain their work in this 'detailed reasoning' question.

This was generally well done, with any errors being in failing to solve the quadratic correctly. Almost all were able to give the coordinates of C having correctly substituted $x = 0$ into the equation of the curve.

Question 15 (b)

(b) Find the equation of the line AD. **[4]**

Most candidates differentiated the equation of the curve successfully. However, some then considered that to be the first part of the equation of the tangent rather than substituting in $x = -6$ for the true gradient. Almost all recognised the need to substitute the coordinates of A to find the constant. A small number guessed the coordinates of D by assuming that OC = CD; this was not credited as being an appropriate method.

Question 15 (c)

(c) Find the coordinates of the point D. **[1]**

This was straightforward for those who had obtained a correct equation in (b).

A small number found $y = 4$ but stated their answer as (4,0).

Question 15 (d)

(d) Find the cross-sectional area of the space between the roof and the ceiling. **[5]**

The most successful responses were those where the candidate found the area of the triangle ADB using the half base times height, and separately finding the area under the curve. Those who chose this method were usually successful in correctly integrating and in substituting the correct limits (usually from −6 to 6 rather than for half the space). The less successful method was to subtract the equation of the curve from that of the tangent. There were also sign errors – again rendering the expression incorrect before the integration attempt. This method also caused problems for those who did not recognise the need to integrate from −6 to 0 and then to double their answer. Unreasonably large answers resulted for those who forgot that the equation of the line was only valid for one half of the diagram, although a few did obtain the answer by calculating the equation of the other tangent, DB.

Question 16 (a) (i), (ii) and (iii)

16 Two drugs, X and Y, are used in combination to treat dogs with a particular dietary condition. Both drugs can have a positive effect and this is measured by "curative" units per mg of the drug. However both drugs can also have a negative effect and this is measured by "toxic" units per mg of the drug.

The table summarises the number of curative and toxic units per mg present in the two drugs.

Drug	Curative units per mg	Toxic units per mg
X	2000	40
Y	1000	50

A dog is given x mg of drug X and y mg of drug Y.

(a) **(i)** The dog needs at least 5000 curative units.

Write this condition as an inequality in x and y. **[1]**

(ii) The dog must not receive more than 190 toxic units.

Use this information to write down a second inequality in x and y. **[1]**

(iii) Write each of the inequalities you found in **(a)(i)** and **(a)(ii)** in their simplest form. **[1]**

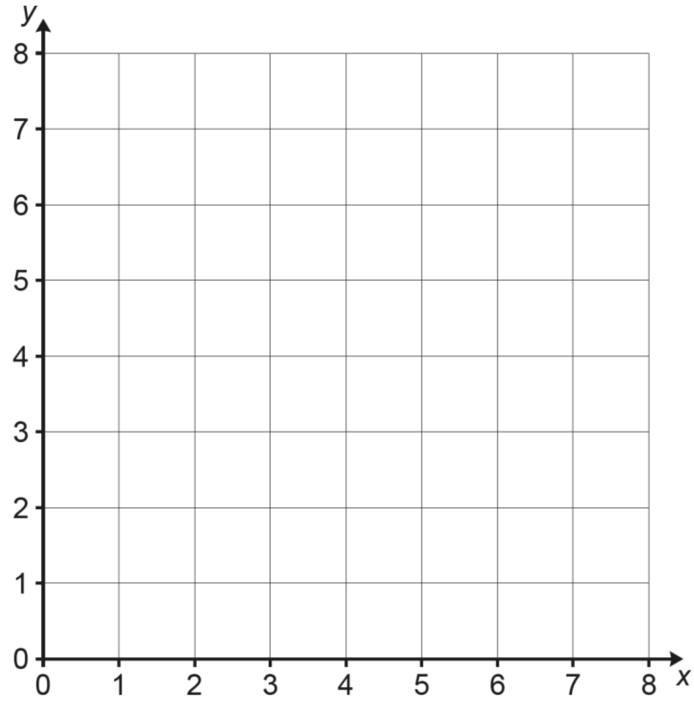
Parts (a) (i) and (a) (ii) were successfully answered by most candidates. Those who were not successful either did not use the correct inequality symbol or were clearly unfamiliar with the type of expression needed, trying instead to find particular values of x and y.

Part (a) (iii) followed on from the two previous parts and most candidates could simplify their inequalities successfully. Questions which use the phrases 'at least' and 'no more than' imply that the symbol 'greater than or equal to' or 'less than or equal to' be used.

Question 16 (b)

(b) On the grid below illustrate the two inequalities. You should shade the region that does **not** satisfy the inequalities. **[4]**

16(b)



Most candidates had suitable inequalities and could draw the required lines and shade appropriately.

Question 16 (c) (i)

(c) **(i)** Find the combination of X and Y that will minimise the total intake of the two drugs in mg given the restrictions above. **[2]**

This question required a minimum value for $x + y$. This would be at the vertex (2.5,0) but the point (2,1) was also allowed as some may have understood the question to mean that neither value could be 0.

Additionally, a common wrong answer was (3,0) presumably because these candidates thought that the quantities had to be integers.

Question 16 (c) (ii)

(ii) The vet prescribing the drugs decides that the dog should receive equal quantities of X and Y.

With this extra restriction, what combination of X and Y will minimise the total intake of the two drugs in mg? **[2]**

This question required equal quantities of *x* and *y* and a minimal amount in total. Few found the correct amount but many gained some credit for equal amounts of *x* and *y*.

Question 17 (a)

17 In this question you must show detailed reasoning.

You are given that $\tan\theta = \frac{n+1}{n-1}$ where n is a number greater than 1.

(a) Determine the ranges of possible values of θ, given that θ can only take values between 0° and 360°. **[4]**

This proved to be the most challenging question on the paper, with even those candidates that scored highly across the paper having some difficulties here.

A common approach was to substitute values into the expression and find the resulting tan ratio, with candidates awarded the M1 for considering large *n* and finding $tan\theta > 1$ (soi by identifying 45º). Unfortunately many candidates assumed that *n* was an integer and so finding their first value as $tan\theta = \left(\frac{2+1}{2-1}\right)$ and getting a value of 71.565º as one of their limits.

Answers were rarely given as an appropriate inequality range, with 71.6 < θ < 45 often seen.

Some candidates did sketch a tan graph and used this to make an attempt at a second range. However, many candidates just considered where $tan\theta > 0$.

A few candidates made attempts at algebraic manipulation involving *n* + 1 and *n* - 1, but these did not yield any credit worthy progress.

Question 17 (b)

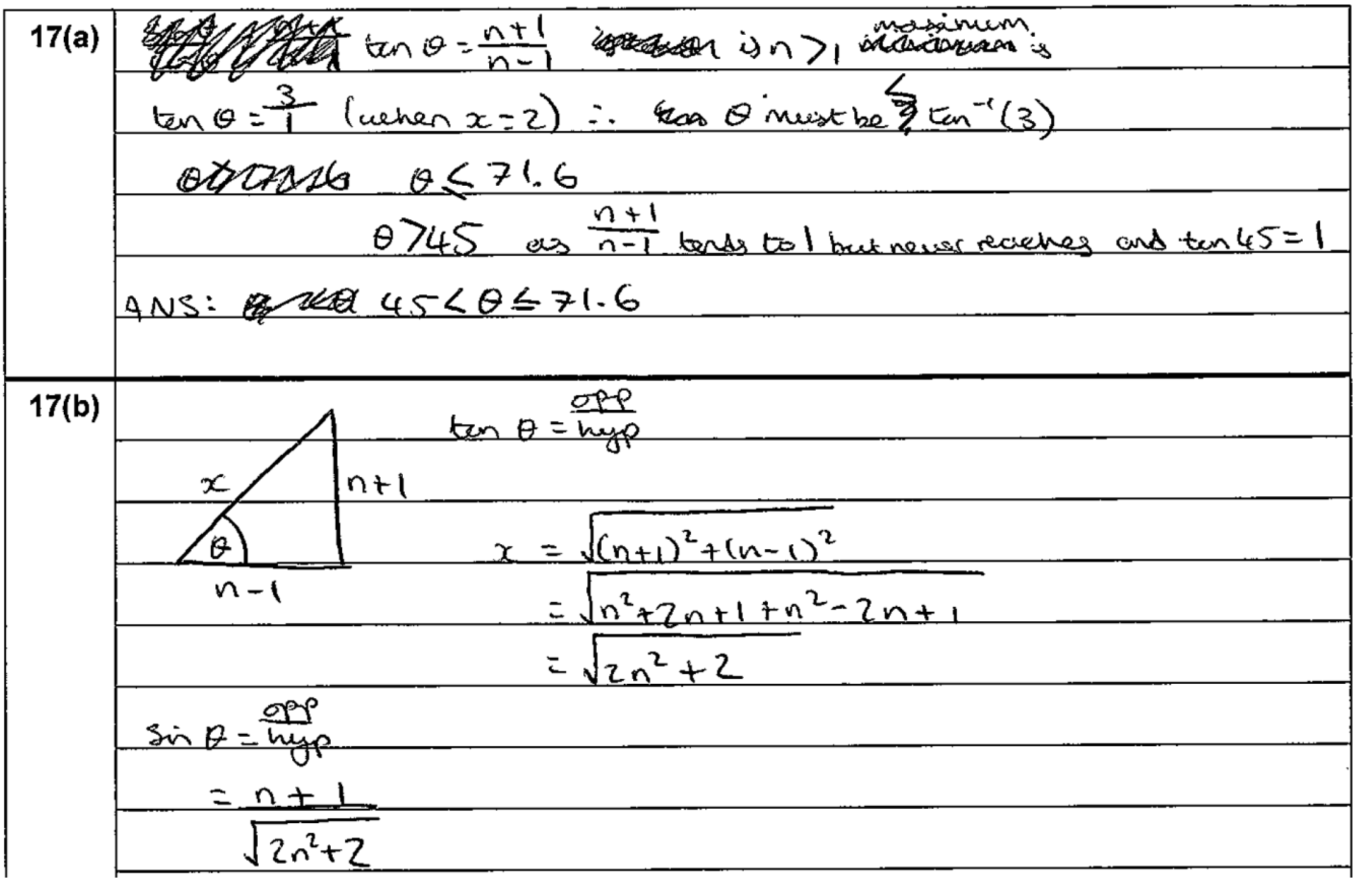
(b) Given that θ is acute, find an expression for $\sin\theta$ in the form $\dfrac{an+b}{\sqrt{cn^2+d}}$ where a, b, c and d are integers. **[4]**

Although also challenging, there were more fully correct solutions to part (b) than part (a).

Full marks tended to come from the main method using Pythagoras' Theorem having drawn a right-angled triangle. Errors here involved subtracting, rather than adding, the squares of the expressions. Some candidates attempted to find the coefficients by inspection.

Those who attempted the alternative method often only gained at most 2 marks, and rarely managed to simplify the algebra correctly to the desired answer. More generally, they formed the first line but did not square both sides, instead using $\sqrt{(1 - \sin^2 x)}$ and assuming that $\sin x = n + 1$. Manipulation thereafter rarely scored anything.

Exemplar 3


17(a) $\tan\theta = \frac{n+1}{n-1}$ maximum is $n>1$
$\tan\theta = \frac{3}{1}$ (when $x=2$) ∴ θ must be ≤ $\tan^{-1}(3)$
$\theta \leq 71.6$
$\theta > 45$ as $\frac{n+1}{n-1}$ tends to 1 but never reaches and $\tan 45 = 1$
ANS: $45 < \theta \leq 71.6$

17(b) $\tan\theta = \frac{opp}{hyp}$
$x = \sqrt{(n+1)^2 + (n-1)^2}$
$= \sqrt{n^2+2n+1+n^2-2n+1}$
$= \sqrt{2n^2+2}$
$\sin\theta = \frac{opp}{hyp}$
$= \frac{n+1}{\sqrt{2n^2+2}}$

In part (a) M1 can be awarded for finding $\tan 45 > 1$. Unfortunately, this candidate has assumed that n must be an integer so has found $\theta = 71.6°$, rather than looking at decimal values of n just larger than 1 (1.01, 1.001, 1.0001 etc). No attempt was made to consider the full $0 < \theta \leq 360$.

This candidate has answered part (b) fully. The clear diagram has been used to support the use of Pythagoras' Theorem. Careful manipulation of the algebra by squaring the brackets and collecting like terms is seen, and then they are able to substitute appropriately into the formulae for sine for the required expression.

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