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Oxford Cambridge and RSA

AS/A LEVEL GCE

Examiners' report

MATHEMATICS (MEI)

3895-3898, 7895-7898

4752/01 Summer 2018 series

Version 1

Contents

Introduction

Our examiners' reports are produced to offer constructive feedback on candidates' performance in the examinations. They provide useful guidance for future candidates. The reports will include a general commentary on candidates' performance, identify technical aspects examined in the questions and highlight good performance and where performance could be improved. The reports will also explain aspects which caused difficulty and why the difficulties arose, whether through a lack of knowledge, poor examination technique, or any other identifiable and explainable reason.

Where overall performance on a question/question part was considered good, with no particular areas to highlight, these questions have not been included in the report. A full copy of the question paper can be downloaded from OCR.

Paper 4752/01 series overview

4752 is one of the two Pure Mathematics components for the modular AS Mathematics specification. It builds upon the skills in 4751 and its purpose is to introduce candidates to a number of topics which are fundamental to the advanced study of mathematics.

The paper was accessible to the majority of candidates, with significantly fewer ill-prepared, low-scoring candidates than previous years. This is likely to be the nature of this year's cohort who in the main will have sat this paper before.

All questions were attempted, with fewer candidates than usual appearing to be short of time. Those who did struggle to complete the examination seemed to spend a disproportionate amount of time on low mark questions earlier on in the paper. This reflects on their examination performance more than their application of mathematical skills.

Candidate performance overview

Candidates who generally did well on this paper:

- Showed good algebraic structure and sound use of mathematical annotation and language.
- Considered the accuracy of their responses, choosing an appropriate degree of accuracy for the context or demands of the question, e.g. Q2(ii), Q3(i), Q7, Q9(ii).
- Showed insight into the processes they had carried out when asked to justify or explain the context of their answers, e.g. Q3(ii), Q9(i), Q11(i)(ii)(v).
- Produced responses to questions that showed they had prepared specifically for this paper, tackling familiar questions with confidence.
- Presented clear and complete mathematical arguments in 'show that' questions.

Candidates who generally did less well on this paper:

- Carried out algebraic manipulation poorly, especially in the use of brackets in Q5, Q7.
- Didn't answer all parts of a question, e.g. missing the requirement to find the area of the segment in question Q4.
- Struggled with the use of fractions and index notation in Q1, Q10i.
- Prematurely rounded in calculations, often leading to inaccuracies in final answers.
- Showed poor setting out of work in less structured questions, e.g. Q4, Q9(i), Q10(iii)(B).
- Struggled to explain things in appropriate terms when asked for explanations or interpretations.
- Missed steps or did not show complete working in 'show that' questions.

Section A

Question 1(i)

1 (i) Find $\frac{dy}{dx}$ when $y = 6\sqrt{x}$. **[2]**

Question 1(ii)

(ii) Find $\int 35x^{\frac{5}{2}}dx$. **[3]**

This question was very well answered. A small minority of candidates did not score with most errors in changing the original function to index form correctly. A few others incorrectly simplified the coefficients. As always, a significant minority of candidates neglected to add "+ *c*" in (ii), thereby losing an easy mark.

Question 2(i)

2 (i) An arithmetic progression (AP) has first term 3.5. The sum of the first 50 terms of the AP is 910. Find the value of the common difference. **[2]**

This question was best attempted by using one of the formulae given in the formula book; successful candidates chose appropriately and rearranged competently to get the correct answer. Some candidates used the formula for the *n*th term instead of the sum to *n* terms which didn't give them a chance to score.

Question 2(ii)

(ii) A geometric progression (GP) has first term 25 and common ratio 1.6. Find the sum of the first 12 terms of the GP, giving your answer correct to the nearest integer. **[2]**

Most candidates approached this successfully, using the given sum formula. It wasn't uncommon though for candidates to miss the request to give their answer correct to the nearest integer thereby losing a mark.

Question 3(i)

3 A sequence has nth term $\sin\left(\frac{n\pi}{6}\right)$.

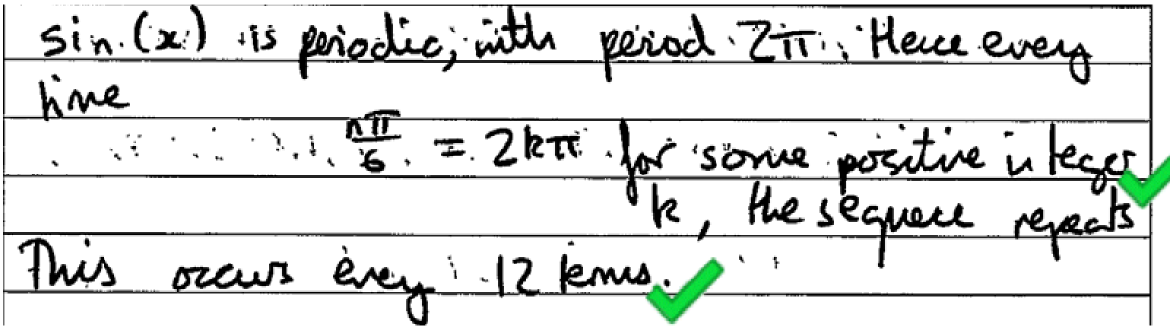
(i) Evaluate each of the first four terms of this sequence, giving your answers in exact form. **[2]**

Question 3(ii)

(ii) Show that this sequence is periodic, stating the number of terms after which the sequence repeats. **[2]**

This question brought together two familiar topics but in a more unfamiliar combination which caused a few problems in (ii). Most candidates were successful in evaluating the first 4 terms in (i), some missed the request for exact form, but many had more difficulty with the 'show that' in (ii). One approach used by the majority of successful candidates was to list the terms of the sequence until repetition happened but a mathematical argument based on the periodic nature of the sine function would have been more efficient. Whilst many candidates understood that 'periodic' had something to do with repetition, only a small proportion understood it in the context of this question.

Exemplar 1



sin(x) is periodic, with period 2π. Hence every time

$\frac{n\pi}{6} = 2k\pi$ for some positive integer

k, the sequence repeats

This occurs every 12 terms.

This response is excellent. It shows a good understanding of the periodic nature of the sine function and how that could be used in an argument to show why the sequence was periodic. It uses specifics to make the point effectively. Less successful responses just stated that sin$x$ is periodic which didn't meet the requirement to *show* that the sequence was periodic.

Question 4

4 A sector OAB of a circle centre O has arc length 12 cm and area 45 cm^2. Find the radius of the circle in centimetres and the sector angle in radians. Hence find the area of the segment bounded by the chord AB and the arc AB. **[5]**

This question required candidates to form a pair of simultaneous equations from the given facts and then solve to find the radius and sector angle. Remembering the formulae for arc length and sector area gave an advantage and simplified working. Candidates are encouraged to work with radians rather than degrees in this type of question as the change of units can lead to loss of accuracy.

There were two stages to this question and the second one was often missed. Re-reading the question after answering may lead to this happening less often.

Question 5

5 Fig. 5.1 shows the cross-section of a bus shelter, with measurements of the height, in metres, taken at 0.5 m intervals from O. O is at the front of the shelter.

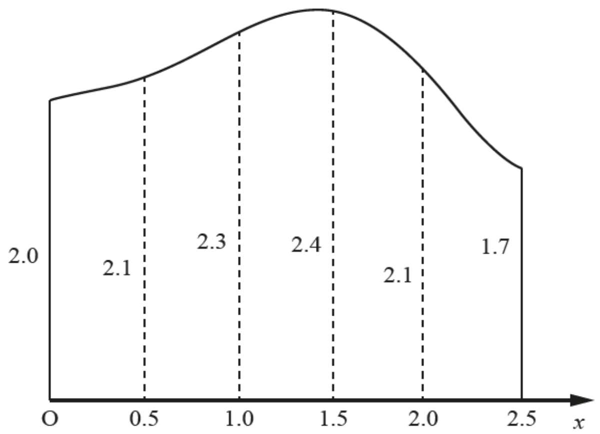


Fig. 5.1

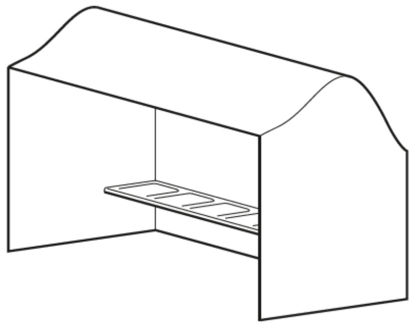


Fig. 5.2

Fig. 5.2 shows a sketch of the shelter, which has two identical side walls and a back wall but no front wall. The length of the shelter is 3.5 m. The outsides of the walls are to be painted. A litre of the type of paint to be used covers 15 m^2. Use the trapezium rule with 5 strips to calculate an estimate of the area of a side wall. Hence find the amount of paint that will be needed. **[5]**

The application of the trapezium rule was very successful in this question. Missing brackets were not uncommon but provided the working was consistent with brackets being present, candidates were able to gain marks. Excellent responses had clear structure and correct order of operations. Finding the total amount of paint needed for the outsides of the walls proved a challenge. There were issues with finding the total area and sometimes confusion between surface area and volume of paint. For those that went on to calculate the volume of paint needed, many assumed they were being asked for the number of cans of paint which wasn't the case. Provided they had stated the answer to an appropriate degree of accuracy first, this was fine but not if the number of 1 litre cans was the only response given.

Question 6

6 You are given that $\cos\theta + 5 = 6\sin^2\theta$ and that $0 \leqslant \theta \leqslant 2\pi$. Show that $6\cos^2\theta + \cos\theta - 1 = 0$ and hence find the values of θ satisfying this equation. **[5]**

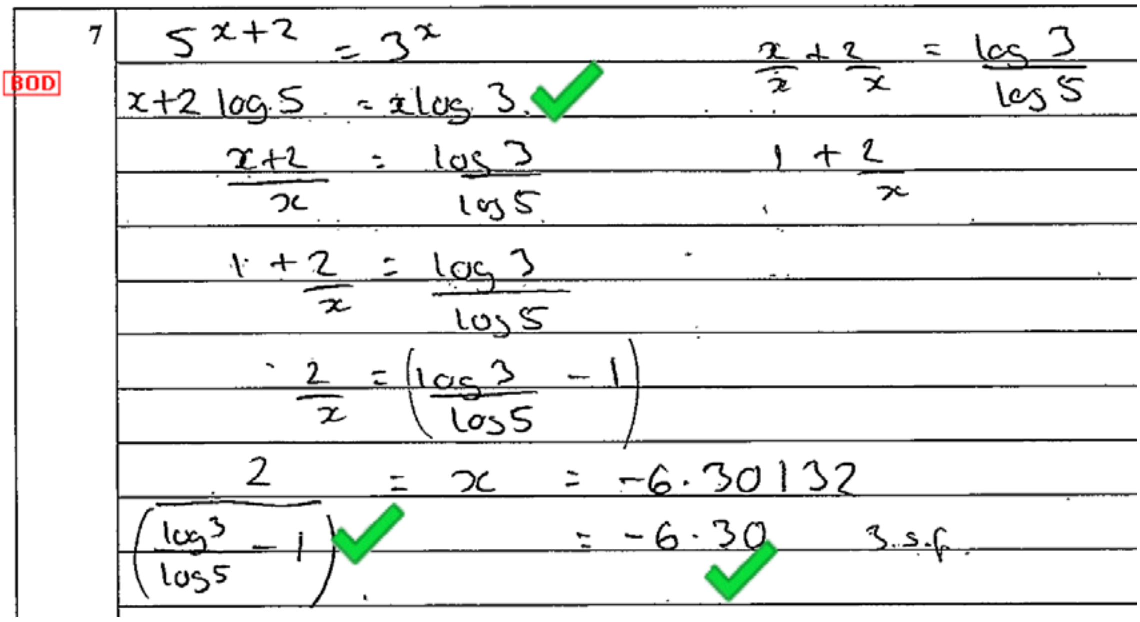
To gain full credit for the first stage of this question, candidates needed to be seen using the appropriate identity and showing at least one interim step to achieve the given result. This was generally very well done, as was solving the quadratic as the first step of finding the solutions. There are still some candidates who don't recognise they should be working in radians and some who work in degrees and then convert their answers which can lead to inaccuracies. A more useful approach would be to work with calculators in radian mode. Lower ability candidates have problems finding multiple solutions in range.

Question 7

7 Use logarithms to solve the equation $5^{x+2} = 3^x$, showing your method and giving your answer correct to 3 significant figures. **[3]**

To be successful with this question, candidates needed to bring together correct use of log laws, good algebraic skills and effective use of calculator functions. With a choice of which base to use, there were several different routes through to a correct answer. The majority of candidates used logs to the base 10 but there were many successful responses with using logs to the base 5, which gave a slightly shorter approach. As in Q5, missing brackets were not uncommon when using log laws and some struggled to make *x* the subject.

Exemplar 2



This response illustrates a frequently seen example of missing brackets. This candidate's subsequent working indicates they knew they were working with a product so full marks were credited; many others didn't. Whilst the working of this candidate is correct, approaches that collected the terms in *x* on one side and then factorised offered fewer opportunities for error. A lot of the attempts to take the reciprocal of both sides after isolating $\frac{2}{x}$ went wrong.

Question 8(i)

8 An arithmetic progression (AP) and geometric progression (GP) both have the same second term, which is 40. They also have the same fourth term, 250.

(i) Find the first term of the AP. **[2]**

Question 8(ii)

(ii) Find the possible values of the first term of the GP. **[3]**

Parts (i) and (ii) shared the same information at the beginning of the question and this caused some overlap of working for the lower ability candidates. That aside, this question was successful for the majority of candidates and a variety of approaches was seen. The most successful ones used the formulae for *n*th terms and solved the pair of equations simultaneously in both parts. A significant minority of candidates lost sight of the objective in (ii) and gave values for *r* instead of *a*.

There were also some very successful approaches that were more deductive and less formally structured but candidates need to be aware that in these instances it is harder to gain partial credit if they are not entirely successful.

Section B

Question 9(i)

9

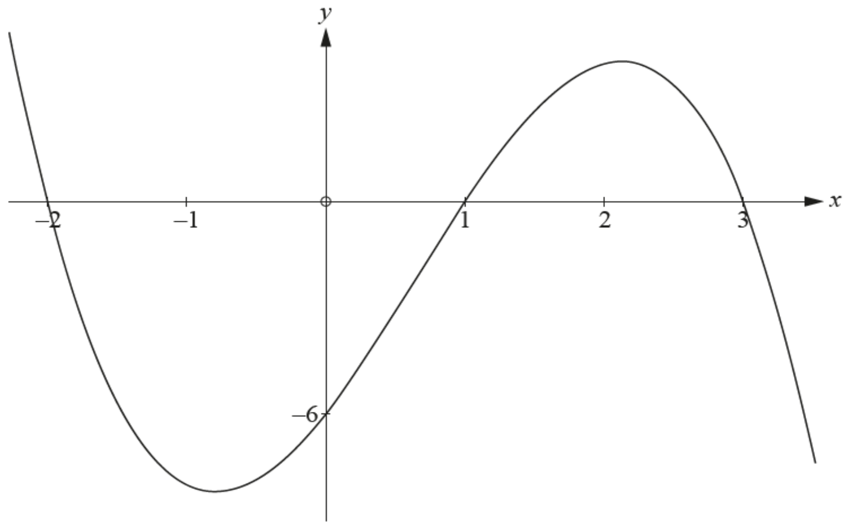


Fig. 9

Fig. 9 shows the curve $y = \mathrm{f}(x)$, where $\mathrm{f}(x) = -x^3 + 2x^2 + 5x - 6$.

(i) Use calculus to find $\int_{-2}^{1}(-x^3 + 2x^2 + 5x - 6)\,\mathrm{d}x$ and state what this represents. **[5]**

This integration question was dealt with very competently by the majority of the candidates and the notation was usually sound. As calculators will evaluate definite integrals, candidates need to be aware that they must show sufficient working to support their answers. Whilst sight of the subtraction of correct values for F(1) and F(-2) is sufficient, if one or the other is incorrect then that can't imply a correct method. It is better to show the substitution into the integral function. The solution to the integral was negative but there was some confusion here when candidates thought they were being asked to find area at this stage, and lost an accuracy mark by giving the answer as + 15.75 only.

When asked to interpret the integral in the context of the graph, many were unable to give a precise explanation of what the answer represented and lost the final mark.

Question 9(ii)

(ii) Find the x-coordinates of the turning points of the curve $y = \mathrm{f}(x)$, giving your answers in exact form. Hence state the set of values of x for which $\mathrm{f}(x)$ is a decreasing function. **[5]**

This question was very well attempted by the majority of candidates. Most knew they had to differentiate, set equal to zero and solve. Any valid approach for solving a quadratic was acceptable but the answers needed to be in exact form, which was missed by a minority of candidates. Attempts at the set of values for which f(x) is decreasing were less successful. This part of the question was not attempted by some which could be due to not picking up on the 2nd demand of the question. Others tried to join the two separate regions together in a single inequality.

Question 9(iii)

(iii) You are given that $g(x) = f(2x)$. State the x-coordinates of the turning points of the curve $y = g(x)$ and also the coordinates of the curve's intersection with the y-axis. **[2]**

The most successful candidates realised they were being asked for a stretch parallel to the *x*-axis and correctly identified the scale factor. Follow through was allowed at this stage for non-exact solutions in part (ii). Less successful approaches included substituting 2*x* into f(*x*) and attempting to solve a quadratic. Being asked to *state* along with the number of marks allocated to this part of the question should be used to help determine the most appropriate approach. Candidates were asked for coordinates for the 2nd mark so a commonly seen answer of *y* = - 6 only didn't score.

Question 10(i)

10

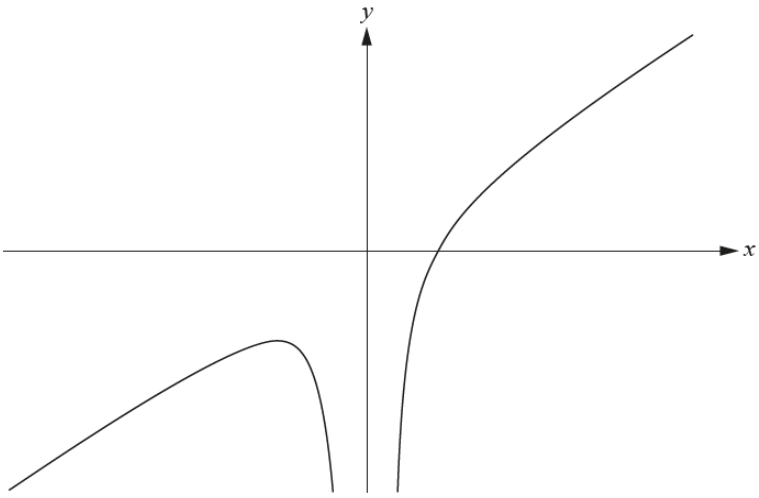


Fig. 10

Fig. 10 is a sketch of the graph of $y = x - \frac{1}{2x^2}$.

(i) Find $\frac{dy}{dx}$ and show that $\frac{d^2y}{dx^2} = -\frac{3}{x^4}$. **[2]**

Successful candidate responses to this question correctly rewrote the second term in index form, differentiated both terms correctly and then showed an interim step before achieving the given result for the 2nd derivative.

The second term caused the most problems, with most issues centred on how to deal with the 2.

Common mistakes included rewriting as either $2x^{-2}$ or $(2x)^{-2}$ and a small minority lost the first term in $\frac{dy}{dx}$.

Use of techniques taught in the second year of the A Level is obviously acceptable but candidates should note that they are likely to be approaching the question in a more complicated way than necessary. Those who rewrote the second term as $(2x^2)^{-1}$ and then used the chain rule could have been successful.

Having the second derivative given wasn't as much of a help as it should have been. Many candidates tried to get to $\frac{d^2y}{dx^2}$ from an incorrect $\frac{dy}{dx}$ which led to even more inaccuracies in their working. Others knew they weren't getting a correct 2nd derivative so tried to work back from that instead of differentiating to find $\frac{dy}{dx}$.

Question 10(ii)

(ii) Show that this curve has only one turning point and verify that it is a maximum. **[3]**

Candidates are encouraged to use all the evidence in front of them. The graph was given which showed the turning point occurring when $x < 0$ and an asymptote at $x = 0$. Candidates therefore should be expecting a negative solution to $\frac{dy}{dx} = 0$ and, if they had a single term $\frac{dy}{dx}$ from (i), know that a solution of x = 0 couldn't be correct which gave them an opportunity to correct this earlier.

Successful candidates set their $\frac{dy}{dx} = 0$ and solved to get a negative value of *x*. They then showed the substitution of their negative *x* into the second derivative, calculated it correctly and stated it was < 0, hence a maximum. Approaches that checked the gradient either side of the turning point were also successful.

Question 10(iii)(A)

(iii) (*A*) Show that the equation of the tangent to the curve at the point where $x = 1$ is $y = 2x - 1.5$. **[3]**

This was another 'show that' question so candidates need to be aware that they must show sufficient working to achieve the given result. Just stating that the gradient at $x = 1$ is 2 was insufficient, it needed to be calculated from their $\frac{dy}{dx}$. This part gave another opportunity to verify that their $\frac{dy}{dx}$ was correct but the chance was often missed. A small minority misread *normal* for *tangent* so ended up using the wrong gradient for their straight line.

Question 10(iii)(B)

(*B*) Show that where this tangent meets the curve, $2x^3 - 3x^2 + 1 = 0$. Hence find the coordinates of the point where this tangent meets the curve again. **[4]**

To show the given cubic, candidates needed to equate the given equations for the curve and the tangent and show sufficient working. Those that did this were generally very successful. The most common error was to equate the cubic and the equation of the tangent. Some bypassed the first part and went straight into solving the cubic equation with mixed results. This was a good question for testing algebraic manipulation; higher ability candidates could answer it correctly in a few lines whereas others took the whole page.

A significant number of candidates were unable to solve the cubic equation. One of the roots was already known, $x = 1$, but this wasn't often recognised or used to help factorise. Those who successfully found $x = -\frac{1}{2}$ usually went on to find the corresponding *y* value.

Question 11(i)

11 This question is about the Gross Domestic Product (GDP) of China. G, in billions of US dollars, is the GDP in year t after 2010. So, for example, $t = 5$ gives the year 2015.

Year	2011	2012	2013	2014	2015
t	1	2	3	4	5
GDP (G billion US$)	7573	8561	9607	10482	11010

G can be modelled by the equation

$G = 6100 \times \left(1 + \frac{r}{100}\right)^t$, where $r\%$ is a constant representing the average annual growth rate of the GDP.

(i) What does the 6100 in this equation represent? **[1]**

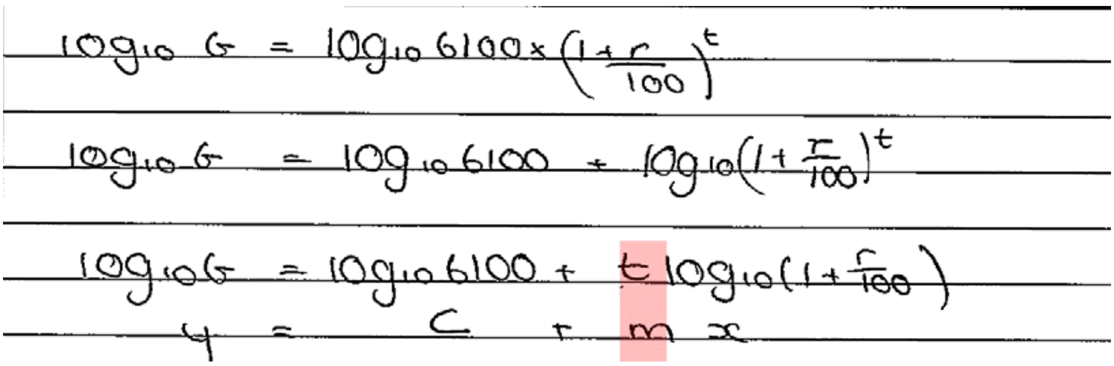
Very few gained this mark - the most common answer was to state that the GDP of China was $6100 in 2010, the fact that G was in billions of USD was generally lost. Often the 6100 was described as the initial GDP without referencing what initial meant in the context of the question.

Question 11(ii)

(ii) Use logarithms to show that, using this model, a graph of $\log_{10} G$ against t will be a straight line. **[2]**

If a candidate has worked through past papers, this is a very familiar request and there were a lot who found it accessible. Many successful attempts to use logs to form a correctly structured equation were seen but more had difficulty in justifying why this would be a straight line. Many approaches included incomplete or incorrect comparisons with $y = mx + c$. Candidates must indicate which part of their log equation is the gradient and which part is the y-intercept to gain the second mark.

Exemplar 3



This response illustrates a typical problem with the comparison. The candidate shows good knowledge of the approach to this question and has taken the step to rearrange $y = mx + c$ to partially fit but hasn't gone far enough. As it currently is, they are implying that plotting $\log G$ against $\log\left(1 + \frac{r}{100}\right)$ will give a straight line with gradient t. If they had gone on to state that, e.g. $m = \log\left(1 + \frac{r}{100}\right)$, $x = t$, they would have been credited the mark. In this candidate's subsequent working they used t as the gradient which led to further loss of marks.

Question 11(iii)

(iii) Complete the table in the answer book and plot the points on the grid provided. Draw by eye a line of best fit. **[3]**

Candidates scored well here and frequently went on to achieve full marks. Most completed the table successfully, points were plotted accurately and lines of best fit were better than in previous examination series which was good to see. A few candidates drew a curve of best fit - after justifying in (ii) that they should get a straight line - but fewer than before. The choice of accuracy for values in the table was sometimes confusing. It would be good practice to look at the accuracy of values already given, along with the scales on the graph when making that decision.

Question 11(iv)

(iv) Use your line of best fit to estimate the value of r. **[4]**

Most successful candidates went down the route of finding the gradient from a pair of points and then equating to $\log\left(1+\frac{r}{100}\right)$ to find r. There was only one unknown to find so candidates could have substituted a single pair of values into their log equation which would have been more efficient. The instruction to use your line of best really should mean that the values used come from the line itself but use of values from the table was allowed. One point that wasn't valid was the intersection of their line with the vertical axis as representing when $t = 0$. Several missed the break in horizontal scale so this is something to look out for.

It was hard at times to follow the structure of the working in this section so candidates are reminded that good structure and annotation can help them gain marks.

Question 11(v)

(v) Hence estimate the GDP of China in 2018, showing your method. Comment on the reliability of this estimate. **[2]**

If their calculation for r in the previous part was accurate enough then most candidates achieved the first mark in this part. The 2nd mark was trickier to achieve - the majority of successful candidates used an argument based on extrapolation. Less successful candidates got diverted into making extraneous comments on economic affairs rather than the parameters of the model itself. Others commented that their GDP was unreliable because their line of best fit was not good - this does not show good examination practice.

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