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AS/A LEVEL GCE

*Examiners' report*

# *MATHEMATICS*

**3890-3892, 7890-7892**

## 4722/01 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 4722/01 series overview

As a largely resit cohort, the vast majority of candidates were well prepared for this examination, and able to make an attempt at every question within the allocated time. Candidates were familiar with the topics being tested and could apply their knowledge to a variety of situations, including the unstructured questions.

Candidates should ensure that there is sufficient detail in their methods to allow partial credit to be awarded should the final answer not be fully correct, e.g. If candidates are attempting to solve an incorrect quadratic equation then method must be shown; simply writing down roots will get no credit, whether or not they follow. Equally, in Q6 method marks could be awarded for correct use of their incorrect initial angle, but only if a clear method was provided. In a question on proof each step should be clearly detailed. In Q7(iii) a number of candidates attempted to apply several log laws in one step, resulting in either an error occurring or the proof not being fully convincing.

Candidates should ensure that their solutions are clearly legible, both by themselves and the examiner. There were a number of instances of candidates miscopying their own work from one line to the next. Candidates should also ensure that brackets and fractions clearly convey their meaning, with irrational answers to quadratic equations being a noticeable issue. It seems to be quite common for candidates to present one of the roots with a negative sign in front of the entire fraction. For example, in Q9(ii) the two roots could be given as $\frac{-4+\sqrt{40}}{4}$ and $-\frac{4+\sqrt{40}}{4}$ but care must be taken with the exact positions of the negative sign and the fraction line for the roots to be written correctly.

If multiple attempts are made at a question then candidates must identify which attempt they wish to be credited, otherwise the examiner will make that decision by marking the final attempt.

## Question 1(i)

**1** The first three terms in the expansion of $(2 + kx)^5$ are $32 - 40x + cx^2$, where $k$ and $c$ are constants.

**(i)** Find the values of $k$ and $c$. **[4]**

This question was well answered with many candidates gaining full credit. The most successful candidates showed each step of their method clearly, which allowed examiners to award partial credit should the final correct answer not be obtained. This included showing the numerical value for the binomial coefficient, and making effective use of brackets when finding the third term. The most common error was to equate 80*k* to 40 rather than – 40.

## Question 1(ii)

**(ii)** Determine the coefficient of $x$ in the expansion of $(2x - 3)(2 + kx)^5$. **[2]**

The majority of the candidates were able to consider the sum of the relevant two terms, and many did so correctly. There were some sign errors, either from incorrectly evaluating the product of the two negative terms or from using 40*x* rather than the given – 40*x*.

## Question 2

**2** The seventh term of an arithmetic progression is 3 and the sum of the first twenty terms is 165. Find the first term and the common difference. **[5]**

This question was very well answered, with many candidates gaining full marks. Most candidates were able to quote two correct equations, although there were occasional errors when substituting the numerical values. They were then able to attempt to solve the equations simultaneously, either by substitution or balancing. This was nearly always correct but there were some slips seen, the most common being – 12*d* + 19d becoming – 7*d*.

## Question 3(i)

**3** **(i)** Sketch the graphs of $y = 2\cos x$ and $y = 3\tan x$ for $0° \leqslant x \leqslant 360°$ on the axes provided. **[2]**

The standard of graph sketching was very varied. Most candidates seem to have the correct intention but showed a lack of precision and detail; only the best candidates gained full credit on this question. The *y* = cos*x* graph was generally the better of the two graphs, although common errors included failing to mark a scale on the *y*-axis and not having a gradient of 0 at the extremities. Candidates who included the asymptotes were generally able to produce an acceptable *y* = tan*x* graph, avoiding the overlap of different sections of the graph. Other common errors on the *y* = tan*x* graph included lines that were too straight, lines that showed very restricted *x* values and only drawing the graph for the same range of *y* values as the other graph.

## Question 3(ii)

**(ii)** Show that the equation $2\cos x = 3\tan x$ can be expressed in the form $2\sin^2 x + 3\sin x - 2 = 0$. **[3]**

In contrast to part (i), part (ii) of the question was very well answered with the majority of candidates gaining full credit. Most solutions showed suitable detail of the identities used, along with the relevant steps in manipulating the equation to produce the given answer.

## Question 3(iii)

**(iii)** Hence solve the equation $2\cos x = 3\tan x$, giving all values of $x$ between 0° and 360°. **[4]**

Part (iii) was also very well answered, with most candidates gaining full credit. Candidates appreciated the need to solve the quadratic in sin$x$ and were able to use this to find at least the principal angle. There was the occasional error when finding other angles, either through incorrectly using the symmetry of the sin$x$ curve or through providing additional, incorrect, angles in the third and/or fourth quadrant.

## Question 4(a)

**4** **(a)** Find $\int_1^4 (3\sqrt{x} + 5)\,dx$. **[4]**

This question was very well answered, with the vast majority of candidates gaining full credit. They were able to write the integrand in index form, correctly integrate it and then attempt the correct use of limits. The very occasional error was usually a numerical slip when evaluating the definite integral.

## Question 4(b)

**(b)** Find $\int \frac{6x^4 + 4}{x^2}\,dx$. **[3]**

Many fully correct solutions were seen to this part of the question as well. The majority were able to manipulate the given expression, and use laws of indices to rewrite it in a form that could then be integrated. There was the occasional slip with indices, such as $6x^4 \times x^{-2}$ becoming $6x^{-8}$. Some candidates attempted to use integration by parts, with varying degrees of success. A few candidates spoilt an otherwise correct solution by omitting the constant of integration.

## Question 5(i)

5 A sequence $S$ has terms $u_1, u_2, u_3, \ldots$ defined by

$$u_1 = 20 \quad \text{and} \quad u_{n+1} = 0.8u_n \text{ for } n \geqslant 1.$$

**(i)** Find $u_2$ and $u_3$. State what type of sequence $S$ is. **[2]**

Solutions to this part of the question were mostly fully correct, with candidates able to generate the first two terms in the sequence and identify that it was geometric.

## Question 5(ii)

**(ii)** Use logarithms to find the smallest value of $N$ such that $S_N > 99.3$. **[5]**

There were many good solutions seen to this question, but only the best were able to gain full credit. Candidates were able to quote a correct expression for the sum of $N$ terms, link it to 99.3 and attempt to find $N$. Some candidates displayed a lack of understanding of indices, with $20 \times 0.8^N$ becoming $16^N$, and others introduced logarithms before the expression had been reduced to two terms. However, many candidates were able to arrive at 22.236 which most then rounded up to the integer value of 23. It was expected that the inequality signs should be correct throughout the solution, and errors such as not reversing the sign when dividing by a negative value were penalised. Some candidates arrived at a final inequality of $N < 22.2$ and then concluded with $N = 23$, with no consideration of the inconsistency of this final statement. Working with an equation throughout was condoned, but for full marks candidates were expected to check both $N = 22$ and $N = 23$ before making a final conclusion, which only a few did.

## Question 5(iii)

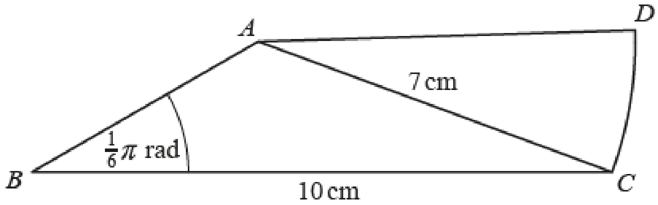
**(iii)** Find $\sum_{n=1}^{\infty} u_{2n}$. **[3]**

This part of the question proved to be very challenging and many were unable to gain any credit. The most common error was to find the sum to infinity of the original sequence and then either double or halve it. Some candidates were able to identify that the first term in this sequence should be 16, which gained some credit, but then still used $r = 0.8$. The most successful candidates started by writing out the first few terms of the $u_{2n}$ sequence and hence correctly identified the required values for $a$ and $r$. A few otherwise correct solutions were spoilt by giving the final answer as a decimal approximation rather than the exact value.

## Question 6(i)

**6**




The diagram shows a triangle $ABC$ and a sector $ACD$ of a circle with centre $A$. It is given that $AC = 7$ cm, $BC = 10$ cm and angle $ABC = \frac{1}{6}\pi$ radians.

**(i)** Find, in radians, the obtuse angle $BAC$. Give your answer correct to 4 significant figures. **[3]**

Most candidates were able to use the sine rule correctly to find the principal angle of 0.7956 radians, but many then struggled to make further progress. Many candidates did not even consider that this was an acute, as opposed to the requested obtuse, angle and simply left it as their final answer. Those who worked in degrees were more likely to realise that further work was needed. The more astute candidates appreciated the need to subtract their angle from $\pi$, and were able to do so, usually giving their final answer to the required degree of accuracy. A significant minority of candidates, having realised that the principal angle was acute, decided that it must be the third angle in the triangle that was obtuse and subtracted from 5/6 $\pi$, thus ignoring the help given in the diagram.

## Question 6(ii)

**(ii)** Find the area of triangle $ABC$. **[3]**

Candidates were able to gain two of the three marks available for correctly using their angle from the first part of the question. However, in order to award these marks examiners must be able to see that the correct method has been used and not just deduce it from stated values.

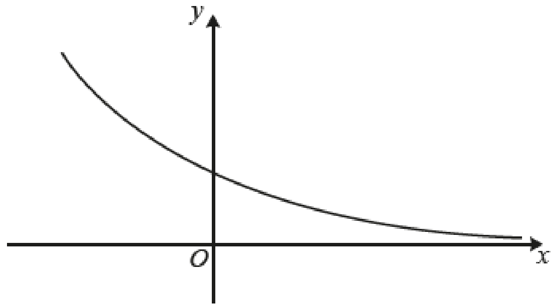
## Question 6(iii)

**(iii)** Given that the area of the sector $ACD$ is equal to the area of the triangle $ABC$, find the length of the arc $CD$. **[3]**

Similarly in this part of the question, candidates who showed explicitly that they were using the correct method with their incorrect area were able to gain two of the three marks available.

## Question 7(i)

**7**




The diagram shows the curve $y = a \times b^x$, where $a$ and $b$ are positive constants. The curve passes through the points $(0, 4)$, $(1, \frac{4}{3})$ and $(2, \frac{4}{9})$.

**(i)** Use the trapezium rule, with 2 strips each of width 1, to find an approximate value for the area enclosed by the curve, the $x$-axis, the $y$-axis and the line $x = 2$. **[2]**

The majority of candidates were able to gain both marks for correctly using the trapezium rule with the given *y* values. The most common error was to give an answer in terms of *a* and *b*, which gained no credit. Some candidates appeared to have initially worked with *a* and *b*, and then used the values found in part (ii) to give a final numerical answer in part (i).

## Question 7(ii)

**(ii)** Find the values of the positive constants $a$ and $b$. **[2]**

This part was answered correctly by nearly all of the candidates. Some were able to simply state the two required values whereas others set up and solved equations.

## Question 7(iii)

**(iii)** The curves $y = a \times b^x$ and $y = a^{3x-1}$ intersect at the point $P$. Use your values of $a$ and $b$ from part **(ii)** to show that the $x$-coordinate of $P$ can be written as $x = \dfrac{4}{6+\log_2 3}$. **[5]**

Most candidates were able to gain some credit on this part of the question, but fully correct solutions were in the minority. Candidates appreciated the need to introduce logarithms, some doing so as their first step with others deciding to do some algebraic manipulation first. Too many candidates ignored the given answer when deciding on their strategy and chose to use logarithms to a base other than 2, which limited the progress that could be made. The two most common errors were attempting to drop the index before the logarithm of the product of two terms had been split, and not using brackets to convey intent. Hence $3x–1\log_2 4$ will not gain credit unless recovered in later working. Candidates should appreciate the need to clearly detail each step in a proof. In this way a convincing solution will be produced, and it also allows partial credit to be given for a correct step in an incorrect solution. A number of candidates attempted to apply several log laws in their first step of working, often going wrong straight away, which resulted in little, if any, credit being awarded. However, the more able candidates were able to produce elegant, well-reasoned and fully correct solutions.

## Question 8

**8** A curve passes through the point (1, 8) and has an equation which satisfies $\dfrac{dy}{dx} = 2x + \dfrac{a}{x^3} + 3$ for all non-zero values of $x$. The area enclosed by the curve, the $x$-axis, the line $x = 1$ and the line $x = 3$ is 30 square units. Find the value of the positive constant $a$. **[9]**

To be successful in this unstructured question, candidates had to devise an appropriate strategy and then apply it accurately, and a number of fully correct solutions were seen. Most candidates identified that the first step was to integrate the given gradient function, and attempted to do so. The most common error was to have an incorrect coefficient in the second term; in some cases it went wrong immediately whereas in other cases it was incorrect as the result of a simplification attempt. Nevertheless, candidates could gain further credit for continuing to work with their incorrect coefficient. The other error was the omission of the constant of integration, which resulted in no further credit being available. Most candidates appreciated the need to integrate for a second time, although some simply applied the limits to their first integral. Candidates were fairly evenly split between those carried out their second integration in terms of *c* and later used simultaneous equations, and those who had already used the given point on the curve to obtain an expression for *c* in terms of *a*. The more able candidates were able to handle the fractions and brackets with ease to obtain the correct answer. However numerical slips were fairly common and candidates should organise their work clearly so as to avoid these.

## Question 9(i)

**9** **(i)** Show that $x = 2$ is a root of the equation $\frac{x}{x-1} = \frac{6}{2x^2-5}$. **[1]**

Candidates were expected to show clear detail of substituting into both expressions, evaluating both expressions and concluding that $x = 2$ was a root. Most solutions showed some elements of this but only a minority of candidates were able to satisfy all of the requirements.

## Question 9(ii)

**(ii)** Use an algebraic method to find the other two roots of the equation $\frac{x}{x-1} = \frac{6}{2x^2-5}$, giving your answers in an exact form. **[7]**

This final part of the question was generally very well answered with many fully correct solutions seen. A few candidates struggled to rearrange the equation and remove fractions, but most were able to attempt this, albeit with the occasional slip when expanding the brackets. Candidates could invariably use the information from the first part of the question to identify that $(x – 2)$ must be a factor and then use this in an attempt to find the quadratic quotient. A variety of strategies were seen, with the most common being algebraic division, and these attempts were usually correct. Using the grid method is becoming more common, and candidates are using this effectively. Whilst inspection is an acceptable strategy, with minimal, if any method required, it is difficult to award partial credit should the quotient be incorrect. Candidates appreciated that the quadratic quotient must have irrational roots and most attempted use of the formula to find these, with a few completing the square instead. The answers were usually correct, but a lack of care with the fraction line and the positioning of the negative sign sometimes spoilt an otherwise fully correct solution.

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