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Examiners' report

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4721/01 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 that 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 4721/01 series overview

As befits a cohort largely made up of second year Advanced level candidates, many scored very highly on this paper demonstrating a good understanding of the mathematics tested and presenting their solutions in a clear appropriate manner. Nonetheless, receiving full marks was comparatively rare as many had difficulty with either 7(ii) or 11(iv), as described below. The number of candidates not prepared for the paper and scoring very low marks was much reduced from previous sessions.

Particular areas of strength were dealing with quadratic equations, (notably when disguised or needed within another process), differentiation, completing the square and finding the equation of a circle. The main cause of lost marks was arithmetic, with fractions and negatives both causing issues in both numerical and algebraic work. The main area for improvement would be explanation and interpretation of results, as described in 2(ii) and 5(ii) below.

Question 1

1 Solve the equation $(2+\sqrt{5})x = 6-\sqrt{5}$, giving x in the form $a+b\sqrt{5}$ where a and b are integers. **[4]**

Most candidates rearranged the equation successfully and were then able to rationalise the denominator. A few lost marks dues to arithmetical or sign errors.

Question 2 (i)

2 The velocity of an object, $v\,\text{m s}^{-1}$, at a time t seconds is given by

$$v = 20t - 4t^2, \qquad 0 \leqslant t \leqslant 5.$$

(i) Find the rate of change of the velocity of the object with respect to time when $t = 3$. **[3]**

The vast majority of candidates were able to interpret the question as a request to differentiate and substitute $t = 3$. This was then executed clearly and accurately in most cases, with arithmetical slips rarely seen. A small number found only the value of v, which earned no credit.

Question 2 (ii)

(ii) Hence state, with a reason, whether the velocity of the object is increasing or decreasing when $t = 3$. **[1]**

Many candidates gave clear explanations relating the negative rate of change in part (i) to the velocity decreasing. Some however, gave incorrect reasons such as "the velocity is negative", or no reason at all. Another fairly common error was to differentiate again and base their answer on the second derivative.

Question 3

3 Find the equation of the straight line that passes through the points (–1, 6) and (3, 4), giving your answer in the form $ax + by + c = 0$, where a, b and c are integers. **[5]**

This question was answered very well with a very large proportion of candidates securing full marks as a result of clearly laid out accurate solutions. Some arithmetical errors were made when finding the gradient and when the method was not clear, this proved costly. A significant minority found the mid-point of the line segment joining the given points and used this to find the equation rather than the points themselves. Although this extra work was unnecessary, it seldom resulted in error.

Question 4

4 Find the real values of x which satisfy the equation $3x^4 - 7x^2 - 20 = 0$. **[5]**

Candidates were very successful in earning the majority of the marks available in this 'disguised quadratic' question, with substitutions often clearly stated and full workings shown. A minority chose to use the quadratic formula rather than factorise, sometimes losing accuracy as a result. A significant number lost the final accuracy mark for omitting the negative solution or including non-real solutions.

Question 5 (i)

5 It is given that $f(x) = 2x^{\frac{5}{2}} - 2x^2 + 10x$.

(i) Find $f'(x)$ and $f''(x)$. **[4]**

Candidates answered this question generally very well, with the vast majority securing full marks. There were some slips with fraction arithmetic in a small number of cases.

Question 5 (ii)

(ii) Evaluate $f'(4)$ and $f''(4)$. Explain what your answers tell you about the graph of $y = f(x)$ at the point where $x = 4$. **[2]**

Without the aid of the calculator candidates have access to in all the other modules, this question proved challenging, with errors seen in both evaluations. A very small number corrected their work when they realised the question related to the nature of a stationary point. When the values were evaluated correctly, the comments were then largely correct.

Question 6 (i)

6 **(i)** Sketch the curve $y = \frac{3}{x}$. **[2]**

Graph sketching still proves challenging to may candidates, but most secured at least one mark for the correct shape in both quadrants. The second mark was often lost due to lack of clarity as to the axes being asymptotes. A small number performed translations of the graph of $y=\frac{1}{x}$ and this earned no credit.

Question 6 (ii)

(ii) The curve $y = \frac{3}{x}$ is translated by four units in the positive x direction. State the equation of the curve after it has been translated. **[2]**

Having often proved challenging in previous sessions, this question was answered extremely well with close to all candidates securing both marks.

Question 6 (iii)

(iii) Describe fully a transformation that transforms the curve $y = \frac{3}{x}$ to $y = \frac{2}{x}$. **[2]**

Again, nearly all candidates secured the first mark for identifying a stretch, with incorrect language such as "squash" or "enlargement" only rarely seen. There was some confusion as to the scale factor being $\frac{2}{3}$ or $\frac{3}{2}$, but most were able to describe the stretch as "parallel to the *y*-axis" (or the *x*-axis in this case) with incorrect statements such as "in the *y*-axis" only seen infrequently.

Question 7 (i)

7 **(i)** Express $-2x^2 - 16x - 9$ in the form $a(x + b)^2 + c$, where a, b and c are integers. **[4]**

The negative coefficient of the x^2 term did not challenge most candidates and this was generally very well done indeed. Almost all candidates secured the first two marks, with the majority securing all four, although difficulties in combining terms for the constant arose for lower-scoring candidates.

Question 7 (ii)

(ii) Write down the maximum value of $-2x^2 - 16x - 9$. **[1]**

This proved very challenging, with many candidates choosing to give the coordinates of the vertex rather than the requested maximum value of 23. It would appear that many candidates were thinking about requests of previous questions rather than noting the detail of this particular question.

Question 7 (iii)

(iii) State the equation of the line of symmetry of the curve $y = -2x^2 - 16x - 9$. **[1]**

This was answered more successfully than the previous part, but still proved to be one of the lowest scoring questions on the paper, with a wide variety of errors seen, including $x = 4$, $y = \pm 4$ or merely restating the equation of the curve.

Question 8

8 The line $y + 2x = 1$ meets the circle $x^2 + y^2 = 13$ at the points A and B. Find the coordinates of the midpoint of AB. **[7]**

Many candidates secured all seven marks in this unstructured question, with clear and accurate solutions. Almost all substituted for y to obtain the correct quadratic in x and generally this was factorised correctly. Errors occurred more frequently with the substitution to find y and also in the calculation of the mid-point. In particular fourth-fifths was divided by two to give the incorrect eight-fifths was quite commonly seen.

Question 9 (i)

9 The equation $kx^2 - 4x + 3k - 1 = 0$ has no real roots.

(i) Show that $3k^2 - k - 4 > 0$. **[3]**

There were a lot of fully correct answers to this part with many clearly showing how to obtain the required result. Some candidates misinterpreted the question and tried to use the discriminant of the result rather than the original quadratic equation. Others had problems with the signs, starting with $b^2 - 4ac > 0$.

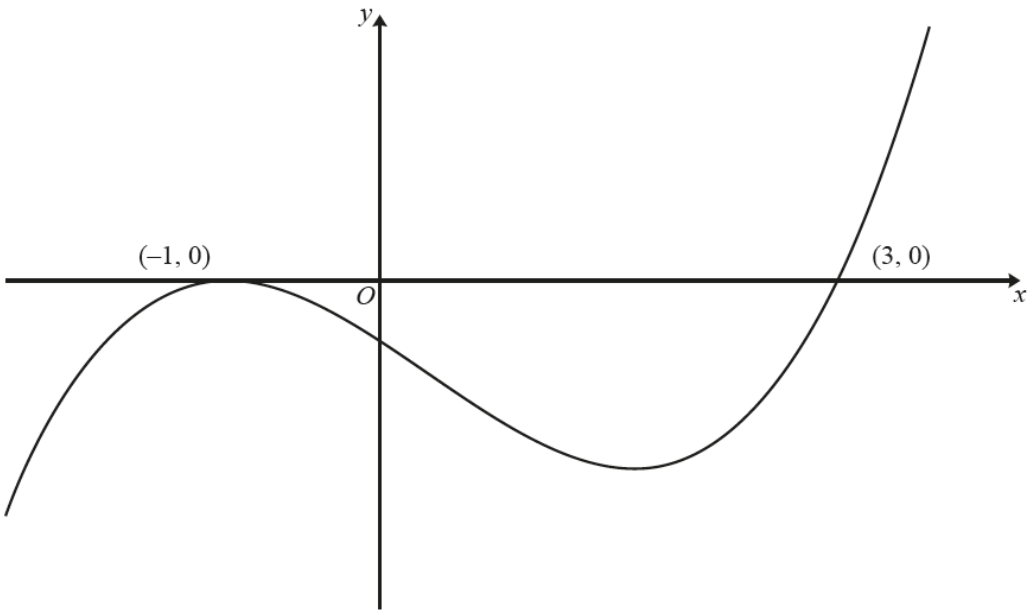
Question 9 (ii)

(ii) Determine the possible values of k. **[4]**

This quadratic expression was factorised well, with many then going on to choose the right region and solve the inequality completely correctly. There were some errors with signs.

Question 10

10



The diagram shows part of the curve $y = x^3 + px^2 + qx + r$. The curve passes through the point (3, 0) and there is a maximum point at (–1, 0). Find the values of p, q and r and hence determine the coordinates of the minimum point of the curve. **[9]**

A large number of candidates were able to answer this question with neat and clear solutions by firstly using the roots shown to obtain $y = (x + 1)^2(x - 3)$ and then expanding to find the values of p, q and r. These candidates then usually differentiated to find $x = \frac{5}{3}$ at the minimum point, although many found the subsequent evaluation of y difficult and this last mark was often lost. More commonly, however, candidates differentiated first and used the fact the repeated root was zero at $x = -1$ to form an equation in p and q as the first of three simultaneous equations to find the unknowns. This method was less successful with many using only $y = 0$ at $x = 3$ and omitting the third necessary equation based on the root at $x = -1$, or incorrectly getting a value for p from the second derivative. Even those with the correct three equations then found solving these difficult, although most of those who did succeed then went on to score 8 or 9 marks.

Question 11(i)

11 A circle has centre C (6, – 3) and radius $\sqrt{10}$.

(i) Find the equation of the circle, giving your answer in the form $x^2 + y^2 + ax + by + c = 0$. **[3]**

Most candidates secured at least two out of three marks for this part, with sign errors being the main the cause of any inaccuracy.

Question 11(ii)

(ii) Find an equation of the tangent to the circle at the point with coordinates (3, –2). **[5]**

It was common to see fully correct solutions for this part. There were occasional sign and/or fraction errors in finding the gradient and negative reciprocal. Others lost marks by using the coordinates of the centre rather than the given point, implying a misunderstanding to the word tangent.

Question 11(iii)

The point Q has coordinates $(10, 1)$.

(iii) Find the length of QC, giving your answer in simplified surd form. **[2]**

Almost all candidates obtained $\sqrt{32}$, but the simplification was fairly often seen as $2\sqrt{8}$ rather than the required $4\sqrt{2}$.

Question 11(iv)

(iv) A tangent from Q to the circle meets the circle at T. Find the length of QT. **[3]**

This proved to be appropriately challenging as the last question on the paper. Those candidates who drew a diagram were more likely to see the need to use the fact that the radius is perpendicular to the tangent and then apply Pythagoras' theorem to secure the three marks. Many tried to solve algebraically by substituting to create new equations, but these efforts led nowhere.

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