A-LEVEL

Mathematics

MPC4 – Pure Core4
Report on the Examination

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General

Most students made an attempt at answering all the questions and a full range of marks was seen in the students' overall performance. There were some very good scripts where students demonstrated a sound knowledge and understanding of the specification, and some very poor scripts where students demonstrated little knowledge or understanding, with the vast majority of students somewhere in between. Presentation of solutions was generally good with students making it clear which part of a question they were answering and when they had deleted an attempt. Many students gave part of their answer to a question on an additional sheet, where it was sometimes difficult to see which question part they were answering; sometimes solutions ran into each other. There was little evidence of students misreading signs or coefficients from the questions or of miscopying their own work.

Questions that were done relatively well were Q2 part (a), Q3, Q4 parts (a) and (b) and Q6 parts (a) and (b)(i) and some of Q5. Questions that were not done well were Q2 part (b), Q4 part (c) and Q6 part (b)(ii). There was a mixed response to Q1, Q7 and Q8.

Question 1

This question wasn't done as well as expected with only about 25% of the students gaining the full 5 marks. Many students made errors in both the differentiation required in part (a) and the algebra required to find a Cartesian equation in part (b).

Part (a). The coefficients of t^2 and $\frac{1}{t}$ seemed to confuse many students, although most could differentiate $\frac{t^2}{2}$ even if they didn't simplify the result. However many errors were seen in the attempts to differentiate $\frac{4}{t}$ both in the resulting power and the coefficient, and a number of students thought a ln function was involved, apparently attempting to integrate instead of differentiate. Virtually all students made an attempt at the chain rule, but unless their derivatives were of the correct form, no further marks were available. There were few attempts at finding the Cartesian equation first, then differentiating.

Part (b). Most students attempted to find y in terms of x and almost invariably omitted the $\pm$ expected on the $\sqrt{\ }$. Perhaps most students think a Cartesian equation has to be of the form $y = \mathrm{f}(x)$. Those students who chose to find x in terms of y were generally more successful. However, in both versions, many algebraic errors were seen in handling the $+1$ and -1 terms. Many unnecessarily tried to simplify to their equation.

Question 2

Part (a). Most students had this correct, but by varying methods. Some were able to just write down the values of A and B by inspection, whereas others cross-multiplied or used long division. Many of those who cross multiplied spent time unnecessarily multiplying it all out, when a mix of inspection and the substitution $x = 0$ leads readily to the required values. Those who used long division were generally successful. Errors resulted from carelessness, rather than in not knowing what to do.

Part (b). A surprising number of students either misread the question, or misunderstood the phrase ‘equation of the curve’, as they proceeded to find an equation for the tangent of the curve using the derivative given in part (a). They didn’t seem to consider that the equivalent algebraic form they had been asked to find in part (a) was relevant here, although some used it to find the gradient. Some students realised they had to integrate this expression, and wrote down a correct integral but made no attempt to do it, not even integrating $2x$. Although some spotted the required ln integral by inspection, many attempted to use substitution and their working went awry. Of those who got to some form of result for the integration, they often made an error in finding the constant. In substituting the given coordinates, some had x and y the wrong way round, and some substituted $x=1$ rather than $x=-1$. Some who otherwise had the integration all correct gave their constant numerically, rather than in exact form, and so didn’t actually give the equation of the curve.

Only about 25% of the students achieved the full 7 marks for this question.

Question 3

This question was done well with the majority of students showing they can expand binomial expressions accurately with about 75% of the students scoring 5 or more of the 7 marks. Of these, 1 or 2 marks were usually lost in part (c).

Part(a). Most students answered this correctly. For those who did not, the error was usually a sign error, omitting the minus sign on $-4x$, rather than in the coefficients, although some did not simplify the fractions involved correctly.

Part (b). This was actually done better than part (a), probably because the index was an integer, rather than a fraction. Most took the 2 out of the expression correctly, and then clear and accurate expansions generally followed, with only the occasional error in the fractions. Very few students attempted to use a formula from the formula book.

Part(c). There was a mixed response to this, but many realised they were to attempt to multiply the two expansions they had found, and this was often done correctly. The common error was to omit one of the x^2 terms when multiplying out. A few students added their expansions. A fairly common misunderstanding was to attempt to divide one expansion by the other term by term, these students apparently not responding to the index having changed sign or just not understanding what to do. Some students did expand $(2+3x)^3$, but then didn’t know that to do with their expansion.

Question 4

Parts (a) and (b)(i) were intended to help students get into the question and virtually all students answered them correctly.

Part (b)(ii). Most students answered this correctly as far as finding a correct expression or value for the numbers of years required. This was done by a variety of methods, some making more conventional use of the rules of logarithms, and some using the logarithm base facility on their calculator, but most were able to convert the information given in the context into appropriate mathematics. Some found the value of p explicitly, whist others left it in an appropriate index form.

Weaker students tended to get lost in attempting to use the rules of logarithms or made an error mixing base e and base 10 logarithms. Many incorrectly concluded the year was 2017, possibly automatically rounding down, instead of noting that 16.8 years after April 1st took them into the following year.

Part(c). Most students who attempted this seemingly did not notice, or ignored the 10 year time gap in the given information and could score no marks. Those students who started with a correct expression, often instead of following their mathematics step by step were too determined to get to the given result, and made an error before just writing down the given result. Students who had made use of ± 10 in an expression involving p or q could score some marks for correct manipulation of the logarithms, but errors of the form $p^t = Aq^{t\pm 10} \Rightarrow t \ln p = (t \pm 10) \ln Aq$ were common. Those relatively few students who noticed that Ap^{-10} gave the value of the first painting in 1991 usually completed part(c)(i) successfully.

Part (c)(ii) This was often not attempted but of those students who did attempt it, many after substituting $p = 1.029q$ as expected, got the arithmetic wrong. Some attempted to find the value of q and ended up making the question far more involved than intended. Many of those who used correct arithmetic, failed to interpret the result as a year, or rounded up to 2024, not noting that 32 years after April 1st 1991 is 2023.

Question 5

Many fairly standard trigonometric results were built into the different parts of Q5, and students generally did well on most of them.

Part(a)(i). Most students answered this correctly. The common error was to have the sine and cosine the wrong way round; these students obtained $\alpha = 36.9°$, and thus could not get the correct angles in part (a)(ii). Another error was to write $\sin\alpha = 4$ and $\cos\alpha = 3$, leading to loss of marks. Most students obtained the value of R correctly.

Part (a)(ii). Many students had difficulty in identifying part (ii) with the result from part (i) correctly. Some used x for 2θ throughout and scored no marks, although some did recover to halve their answers at the end. A common error was to write $\sin 2(x+\alpha)$. Of those students who had a correct expression, many only found one correct solution, or an extra solution in the interval as well as the correct two solutions.

Part (b) (i) Most students got as far as writing down a correct expression for $\tan 2\theta$ and substituting in the given equation, and of these many were able to show the required manipulation to the given answer. Some got confused and made errors in their cross-multiplication whereas others just didn't know how to proceed.

Part (b)(ii). Although most students attempted to use the given answer from part (b)(i), many made an error in the square root, often with the negative root missing. Other errors included the 'square root' being taken as $\pm\frac{1}{2}$ and $\pm\frac{1}{4}$, although again the negative sign was sometimes missing. However, many students did give the two correct solutions. Solutions out of the given interval were ignored.

Part (c) (i) Most students found $x=\frac{1}{2}$ and gave a convincing explanation. Some gave unconvincing explanations through showing little or no detail when evaluating $\mathrm{f}\left(\frac{1}{2}\right)$, not showing the evaluation came to nought, or not giving the required conclusion.

Part(c)(ii) This was generally done well with most students just writing down the required trigonometric identity, or deriving it 'in situ'. Relatively few students made an error but mishandling the 4 was the common one.

Part (c)(iii). This was often omitted. However, of those students who attempted the question most noted that $x=\frac{1}{2}$ gave them 60°, so the requested result must come from factorising the cubic expression. Many did this successfully either by long division, or manipulating the coefficients. Some made sign errors in the attempt. Most then attempted to solve their quadratic equation, and most of these realised they needed the quadratic formula although some abandoned an attempt to factorise. A few students attempted to use the quadratic formula on the cubic expression. Many students who were otherwise correct failed to score the final mark because they didn't bring their argument to the required conclusion; that is the given result is $\cos 72°$. Some just wrote down the given result, and some left it as x, or some still had the $\pm$ in their result. Misuse of the = sign was fairly common here. It was good to see some students justify rejecting the other root, with some saying it was 144°, but some saying it was negative so invalid, without explaining how.

Question 6

Part (a) Most students answered this correctly showing accurate arithmetic to find the vector $\overrightarrow{PQ}$. Even those who did make an error in their arithmetic claimed their vector was parallel to the given vector. However, most took out the multiple of 6 and gave a clear conclusion. Some failed to do this and so lost the last mark, whereas some incorrectly divided by 6 instead of showing, or referring to, multiples.

Part (b). Most students answered correctly although the amount of work involved varied considerably. From the information given, the value of λ or μ can be found immediately, but many students set up simultaneous equations and solved those. Some saw the relatively quick way to do this of adding the first and third equation, whereas others did rather more work, often resulting in an error. Many students found both the values of λ and μ and confirmed from both lines that they had found the intersection point, although this wasn't necessary as they were told the lines intersected.

Part (c). This was not done well and only about 20% of the students scored 7 or more marks. Many students confused the position vector $\overrightarrow{OS}$ of the point S on the line, with vector $\overrightarrow{PS}$. Many made no relevant progress because they failed to identify the point P with the vector they had found in part (a) and used a different point, some using one of the originally given lines. Most showed they knew they had to form a scalar product and equate it nought, but many did this with the wrong vectors, $\overrightarrow{OS}$ being commonly used instead of $\overrightarrow{RS}$. Some students used column vectors without identifying them, making it difficult to follow what they were attempting to do. Some students had this all correct until they evaluated their scalar product, where a simple arithmetical error in finding the value of the parameter lost them the last two marks. However, there were some very good solutions, particularly from some who used (x, y, z) for point S and then found (x, y, z) in terms of the appropriate parameter.

Question 7

Part (a)(i). Most students obtained at least one of the required derivatives with many continuing to find a correct expression for $\frac{\mathrm{d}y}{\mathrm{d}x}$. About 50% of the students scored 6 or more marks. The common errors in differentiating $\cos 2y$ were omission of the minus sign, coefficient $\frac{1}{2}$ instead of 2 and dropping the 2 from $2y$, although most included the required $\frac{\mathrm{d}y}{\mathrm{d}x}$. Many used the product rule correctly, but some wrote their attempt as just one term and some others omitted the $\frac{\mathrm{d}y}{\mathrm{d}x}$. Most showed explicitly or implicitly that they knew the derivative of the constant 2π is zero. Many factorised correctly and gave an expression for $\frac{\mathrm{d}y}{\mathrm{d}x}$, although some neglected to do this. Some who had a correct expression decided unnecessarily to try and simplify it and often made a sign error in doing so.

Part (a)(ii). Many students had problems evaluating their expression correctly, and some didn't actually find a numerical value for the gradient let alone an exact one. However, there were also many correct answers.

Part (b). Most students attempted to find the negative reciprocal of their answer to (a)(ii), in whatever form they had that answer, although some proceeded to find the equation of the tangent rather than the normal. A common error in finding a reciprocal from those who had an answer to part (a)(ii) of form $\frac{a}{b}\pi$ was to give $-\frac{b}{a}\pi$. Although many students went on to successfully find the equation of the normal, some students appeared to be confused and went back to the original equation and substituted the given (x, y) coordinates in that or returned again to their expression for $\frac{\mathrm{d}y}{\mathrm{d}x}$ and substituted in that, before abandoning the attempt.

Question 8

Part (a). This was generally done well, with most students choosing to use $x = \frac{1}{3}$ to find the value of A, and $x = -1$ to find the value of C. Those who then chose $x = 0$ to find the value of B were usually successful, although others who chose a different value of x often made an error. Common errors in multiplying through by the denominator were to have an extra $(1+x)$ term on the right hand side, or to drop the x from $16x$. There were relatively few attempts to find the values of A, B and C by equating coefficients and solving the resulting simultaneous equations, although most who did it this way were correct if their original expression was correct. There was little evidence of the cover up rule being used.

Part (b). The vast majority of students knew they had to separate the variables, and they could attempt this either on the given differential equation or on their partial fractions version. There were many notation errors with missing integral signs or a missing $\mathrm{d}y$ or $\mathrm{d}x$ being common. Some students made an error in handling the exponential term, often not inverting it or with a sign error in the index. This then meant they were unable to integrate this term correctly. Most students attempted to use their partial fractions to integrate the x terms, with very few 'nonsense' attempts being seen.

Most obtained the two $\ln$ integrals correctly with the occasional coefficient error. The third term caused the most problems. Some did this by inspection, whereas others achieved success after using integration by substitution. A sign error was common, as was changing the index to 3, and some students thought this too was a $\ln$ integral. Most students included a constant in their integral and proceeded to find its value.

About 15% of the students gave a fully correct solution to this question.

Mark Ranges and Award of Grades

Grade boundaries and cumulative percentage grades are available on the Results Statistics page of the AQA Website.

Converting Marks into UMS marks

Convert raw marks into Uniform Mark Scale (UMS) marks by using the link below.

UMS conversion calculator www.aqa.org.uk/umsconversion