General Certificate of Education

Mathematics 6360

MPC4 Pure Core 4

Report on the Examination

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General

There was a full range of performance from the candidates, varying from some excellent scripts with near full marks on all questions to those candidates who were ill prepared and showed little knowledge of the specification. Most candidates attempted all the questions although some, in the later questions, omitted part (c) of Question 7 and attempted part (c)(ii) of Question 8 only, or first. Some of these candidates had spent some time at the start of the paper unnecessarily, for example, checking their factorisation in Question 1(b)(ii), or manipulating their cartesian equation in Question 2 part (c).

Questions that were answered well included most parts of Question 1, Question 2, Question 3, Question 4 and Question 5 with candidates most likely to lose marks in the last parts of these questions. The implicit differentiation of the $\cos(\pi y)$ term in Question 6 defeated many candidates, and the last part of the vectors Question 7 was omitted or only superficially attempted by many. All parts of Question 8 relating to various aspects of differential equations were in general not answered well.

Presentation and communication was generally good and it was easy to follow most candidates' solutions with clear setting out and explanations where appropriate. Some made use of circles and arrows when they lost their way in the working to indicate where they wanted the examiner to continue following their work; however this wasn't always clear. Some candidates scrawled heavily through work they were deleting, which made it very difficult to read. It should be noted that deleted work may gain some credit if it can be read by the examiner.

Question 1

Part (a) Most candidates used the remainder theorem correctly, with just the occasional arithmetic error. Those candidates who attempted long division were generally less successful through making an error in the division. Some misinterpreted their correct result of –4 as a remainder of 4.

Part (b)(i) Most candidates here used the factor theorem and solved $g(x) = 0$ to find the value of d, usually successfully. Again, those candidates who used long division were more likely to make an error, particularly in interpreting the last line of working. Some candidates seemed to either not notice, or chose to ignore, the difference between $f(x)$ and $g(x)$ and used $d \pm 4 = 0$ from part (a); for which they gained no credit.

Part (b)(ii) Many candidates were just able to write down the required factorisation from their earlier work, particularly if it involved a correct long division,. Division here was the preferred method by those who hadn't used this technique in part (a) or part (b)(i), rather than equating coefficients; although this method was seen. Some who had made an error in part (b) (i) often didn't notice they had an inconsistency between their value of d and their value of c.

A few candidates did part (b) backwards. They used a hybrid of methods, including trial and improvement to get a correct factorisation, realising c had to be -3 for it to work, and thus for part (b)(i) d had to be 3. This was quite acceptable.

Question 2

Part (a) The vast majority of candidates completed this question successfully and as expected, by finding the two derivatives with respect to t and combining them using the chain rule. The more common errors were to omit the squared powered from $6t^2$ or the negative sign in -3. Some candidates lost a mark through not simplifying their final result. Relatively few candidates made the error of multiplying the derivatives or having the chain rule upside down. Very few candidates took the approach of eliminating t and seeking an equation $y = f(x)$. Of those who did, hardly any were successful in differentiating their expression.

Part (b) The vast majority of candidates was successful here too, substituting $t = 1$ immediately and obtaining the gradient of the normal correctly and then a correct form of the equation of the normal. Those few candidates who made no attempt to find the gradient of the normal and just used the tangent gained no credit. The fairly rare error in finding the gradient of the normal was to omit the negative sign. Some candidates also failed to substitute for the given value for t and gained no credit.

Part (c) Various correct approaches were seen with the most efficient being to obtain t in terms of x and substitute into $y = f(t)$, and many candidates did this correctly. The common errors were to omit or have an unclearly positioned negative sign, or to make an error in the power. Other attempts at elimination were generally not so successful. Many candidates wasted time through proceeding to expand their cartesian equation, or just generally and unnecessarily manipulating it algebraically. Once t is eliminated, the resulting equation is a cartesian equation.

Question 3

Part (a)(i) The vast majority of candidates found the partial fractions correctly, most substituting the two expected values of x. Some proceeded by setting up and solving simultaneous equations and some a hybrid of both methods, but few errors were made. A few lost all the marks here through having an algebraically incorrect opening line.

Part (a)(ii) Here too, most candidates knew these were log integrals with relatively few showing no knowledge of this. The common error was to omit the $\frac{1}{3}$ and a few candidates didn't have their log expressions in brackets and were penalised.

Part (b) Various attempts at this question were seen, ranging from no attempt to a time consuming approach involving setting up simultaneous equations in P, Q and R following substitution of values of x, usually 0, 1 and 2. Most candidates who attempted this either set up just two equations, and thus found it was insoluble, or simply made errors in the algebra. The most successful and efficient method was algebraic long division. Relatively few candidates showed any knowledge of the technique of manipulating the numerator, as anticipated in the mark scheme. Some attempted to factorise either the numerator or denominator, or both, and made no further progress because these expressions did not factorise.

Question 4

Part (a) Virtually all candidates demonstrated confidence with the binomial theorem, and most completed part (a)(i) correctly, with only a few making either sign or coefficients errors, and then usually in the x^2 term. In part (a)(ii) most attempted the technique of taking out the factor 16, with many doing this correctly. The common errors were to just leave it as 16 rather than 64, or to leave 9 in the bracket rather than $\frac{9}{16}$. Most candidates then used their result from part (a)(i) to attempt the expansion, whilst some started the binomial expansion again. Although some mistakes were made, the most common being omitting to square the $\frac{9}{16}$, many candidates obtained the correct expansion. Those few candidates who attempted to use the expansion given in the formulae book were rarely successful, especially those who attempted to use nCr to find coefficients.

Part (b) Most candidates who had the correct expansion in part (a), worked out that they needed to substitute $x = -\frac{1}{3}$ and obtained the correct values for a and b. Others who had an incorrect expansion in part (a) also often worked out that $x = -\frac{1}{3}$ was the value to substitute, but got a result nowhere near $13^{\frac{2}{3}}$, and either didn't notice or just commented that it "didn't work". There was little evidence of checking back for an error. Those few candidates who proceeded by trial and improvement using a calculator gained no credit. Many candidates omitted part (b) altogether.

Question 5

Part (a)(i) Most candidates either knew the appropriate identity for $\cos 2x$ to use, or worked it out in terms of $\sin x$ from $\cos^2 x - \sin^2 x$. The common error was to attempt to use an "identity" $\cos 2x = \sin^2 x - 1$ or similar, and candidates did gain credit for attempting to get an expression in $\sin x$. Most candidates, who had used a correct identity, went on to convincingly obtain the given equation. Others, who had an incorrect identity, chose to ignore inconsistencies and just wrote down the given result. Those few candidates who had "invented" an identity that led to the result by working backwards from the answer given, gained no credit.

Part (a)(ii) Most candidates used factorisation correctly to get the required results. Those who attempted to use the quadratic formula were more prone to making an error. Some candidates attempted to solve their equation from part (a)(i) rather than the given equation, and gained no credit. Many candidates wasted some time here by proceeding to find the angles, which had not been asked for.

Part (b)(i) The technique for finding R and α was well known and most candidates did this correctly. The common error was to find α as 56°, and less so a numerical error in finding R. Some candidates appeared not to notice they were given $R > 0$, and gave $\pm R$ in their result. Another error sometimes seen was for candidates to confuse $2x$ and α, and thus get half the expected value for α.

Part (b)(ii). Although most candidates knew they were to use their result from part (b)(i) to solve this equation, many made an error in manipulating the given equation to a soluble form. Either 0 or 1 appeared on the right hand side rather than -1 and such candidates could gain no further credit. Whilst many candidates proceeded to solve the equation for one correct angle, relatively few got both correct and some got neither correct. Those who drew a sketch of the cosine curve, usually found it helpful in realising there were two solutions. Those few candidates who did not attempt to use the result from part (b)(i) to solve the equation gained no credit. Attempts just by using a calculator were very rare, and there had to be evidence of using part (b)(i) to gain any credit.

Question 6

Part (a) There was a mixed response to this question with most candidates able to solve for x correctly algebraically but with their calculator in degrees mode. Some thought the cube root could be positive or negative, and some found the square root. Many left their answer as $\sqrt[3]{7 - \cos\pi}$ presumably regarding this as exact, rather than evaluating to the value 2.

Part (b) The vast majority of candidates attempted to differentiate the expression as given. Those few who manipulated the equation and solved it for x or y, and then attempted differentiation usually made little successful progress, being unable to cope with the quotient rule and chain rule involved. Of those candidates who took the expected approach, most could differentiate $x^3 y$ correctly, the common errors being $\frac{dy}{dx}$ attached to the wrong term, derivatives multiplied rather than added, or an incorrect power of x. Many candidates couldn't differentiate the $\cos(\pi y)$ term correctly, apparently often not realising that π is a number when using the chain rule, some turning π into $1/\pi$ and some just making a sign error. Most knew that the 7 differentiated to 0, although most didn't make this explicit, it was just implied in their solution for $\frac{dy}{dx}$. Most attempted to solve for $\frac{dy}{dx}$ before substituting values for x and y, and although unnecessary, gained credit as long as the 7 was no longer present.

Question 7

Part (a) Although many candidates found the vector $\overrightarrow{AB}$ correctly, many made an arithmetical error which cost marks both in part (a) and subsequently in part (c). A common error in attempting to calculate the vector $\overrightarrow{OB}$ was just to multiply the direction vector of l_2 by 2. The method to find $\overrightarrow{AB}$ was generally well known. Candidates who gave their answer as coordinates, rather than as a vector, were penalised.

Part (b)(i) The vast majority of candidates demonstrated they knew what was required here and set up appropriate simultaneous equations and attempted to solve them for λ and μ, with most doing it correctly. Most went on to do an appropriate check, either in a third independent equation, or showing there is a common point on both lines. Some did this, without stating why, and lost a mark through not making the appropriate conclusion that they had shown the lines do intersect. Some candidates proceeded by taking scalar products of the direction vectors, apparently thinking if they showed there was an angle between the lines, then they intersected.

Part (b)(ii) Most found the coordinates of the point P correctly if they had λ and μ correct from part (b)(i), but not in all cases. The result was often given as a column vector rather than as coordinates, but this was condoned. A few candidates repeated the work of part (b)(i), or omitted part (b)(i) and did all the required work in part (b)(ii). If successful, they still only gained one mark.

Part (c) Many candidates did not attempt this question. Of those that did, those who drew a diagram were the more successful. Numerical accuracy was essential here and candidates could only find point C correctly, if they had points A, B and P with correct coordinates. Although many candidates did have a correct method to find one of the points C, many lost a mark through miscopied components in the vectors or arithmetical errors. There are many possible approaches to this question, and a few candidates wrote down two correct answers having shown considerable geometrical insight as to how to use the parallel vectors. Others gave up after a large amount of work involving more intersecting lines. Some pursued a scalar product approach based on parallel vectors having a scalar product of 1, although some took this as 0; neither approach resulted in much progress. Fully correct solutions to part (c) were rare.

Question 8

Part (a) Attempts at this question varied from no attempt, through superficial attempts to some fully correct solutions. Most could separate the variables correctly, although a few did attempt "integrals" of $f(x)dt$. Some candidates inverted the given differential equation and so could attempt direct integration, which was a quite acceptable method. Most integrated $k dt$ correctly, but the integral of $(x+1)^{-\frac{1}{2}}$ defeated many. Often there was an error in the power, before or after integration, and also in the coefficient. However, most candidates did include a constant and attempted to find it from the given initial conditions, for which they gained credit. However, some did some algebraic manipulation before adding a constant, and so could gain no credit, as this was then incorrect. Many candidates who had correctly integrated the expressions failed to gain the last mark, which was for giving the answer in the form $x = \mathrm{f}(t)$, because they couldn't square their expression correctly, often omitting the "middle" term.

Part (b) Candidates who had interpreted the context correctly could gain at least one mark here by substituting $t = 60$ into their result from part (a) and solving for x. However, many confused the given $t = 60$ with the given initial condition $x = 80$. Relatively few correct answers were seen, with many candidates obtaining results of over 100% or indeed negative results. These were not apparently queried, with little evidence of checking for errors.

Part (c)(i) Very few candidates wrote down a correct differential equation. Some who had seemingly understood the context, wrote down the correct expression in A, but did not include the constant of proportionality. Many candidates mixed up the variables with x, and less so y, appearing, although most had a "differential equation" of some sort. Some candidates even included units in their differential equation, which was condoned if at the end of a correct expression.

Part (c)(ii) For many candidates this was the only part of Question 8, they attempted. Candidates who had understood the context and started with $A = 4.5$ could mostly solve the equation for t successfully. The relatively rare error was in the algebraic manipulation or in attempts to take logarithms, such as $\log(1 + 4\mathrm{e}^{-0.09t}) = \log 1 - 0.09 \log 4t$ or similar. Some made an error in miscopying -0.09.

Those candidates who commonly started with $A = 50$ or $A = 0.5$ encountered the need to take the logarithm of a negative number in their working or obtained a negative value for t, which most then chose to ignore. They gained no credit. Some did realise their error in interpreting the context, and reverted to the correct value for A.

Mark Ranges and Award of Grades

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