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Report on the Examination

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General

There were few very poor scripts and over 1000 students scored 70 or more marks. The median mark was at 45 (60%) and about half the entry scored between 40 (53%) and 60 (80%) of the marks.

Presentation of solutions was generally good with students making it clear when they had deleted an attempt. However, there did seem to be an increase in deleted work compared to previous years and also evidence of a lot of careless mistakes, including misreading a question or students miscopying their own work, so students should be encouraged to take more care in their work. Most students indicated the question part reference with their solution to it, although it tended to be the weaker students who did not always make it clear which part of a question they were answering. Many students gave part of their answer to a question on an additional sheet, where it was often difficult to see which question part they were answering; sometimes solutions ran into each other.
Questions that were done well were Question 3(a) and (b)(i), Question 4 and Question 5.
Questions that were not done well were Question 6 and Question 7. There was a mixed response to Question 1, Question 2 and Question 8.
Most students did attempt all the questions but sometimes omitted part of a question, usually the last part.

Question 1

After a successful start with the partial fractions many students went awry in later parts of the question, although fully correct solutions were seen from about 16% of the entry.

Question 1(a)(i) The partial fractions were found correctly by the vast majority of students. Virtually all students knew what to do and had a correct opening line and only the occasional arithmetic error followed in the finding of A and B. The most popular method was to substitute $x=-2 \text{ and } x=\frac{1}{3}$, although some used simultaneous equations and others a mix of the two methods, often choosing to substitute $x=0$.

Question 1(a)(ii) Again the vast majority of students had the correct form of the integrals but many errors were made in the coefficients, particularly with the $(1-3x)$ term, often given simply as $\ln(1-3x)$ or $+\frac{1}{3}\ln(1-3x)$ and the $(2+x)$ term was sometimes integrated to $\frac{3}{2}\ln(2+x)$. Most students went on to evaluate their integrals in the correct way, although it was not always clear how they used the given limits and many made a sign error to obtain $3\ln 2-\frac{1}{3}\ln 4$, although $\ln 1=0$ was well known. Many students who had the definite integral correct could not convert to the form of the requested answer. Several of those who got as far as $3\ln 2+\frac{2}{3}\ln 2$ did not see that all they needed to do was add $3 \text{ to } \frac{2}{3}$; the answer $\ln 8$ was common. The term rational may not have been sufficiently well known.

Question 1(b)(i) It was expected that students would require little work to find the value of C; it is immediate from the algebraic fraction by inspection from $-6x^2/-3x^2$. However, relatively few noticed this. Many chose long division and found the correct value, but some used inefficient and time consuming methods based on undetermined coefficients. Some found C to a function of x although most gave C as a constant. Some students did not attempt this part of the question.

Question 1(b)(ii). All those who attempted this part knew that the requested area was given by integrating the function from part (b)(i), and most students recognised that this linked the parts of the question together. They gained credit if they had an exact answer to part (a)(ii) and added 2 to it, although many had a sign error when applying the limits and subtracted 2. Some students did not see the connection and tried to do the integral again, this time often going awry with answers such as $\ln\left(2-5x-3x^2\right)$.

Question 2

The response to this question was very mixed, due to a student's understanding, or misunderstanding, of the term exact. Despite $\tan\alpha$ being given as a surd in the question, many students interpreted *exact* as meaning a number with many decimal places. As a result, many students, nearly 30% of the entry, scored at most 2 of the 8 marks available, only gaining credit for showing some knowledge of the required trigonometric formulae and nothing else. A similar proportion, however, had the question fully correct.

Question 2(a)(i) Angle α was given as acute and it was expected students would use a right angle triangle to show the requested value of $\sin\alpha$. Many did this, but many found the angle itself using inverse tangent and then its sine for no credit; similarly $\sin\left(\tan^{-1}\frac{2}{\sqrt{5}}\right)=\frac{2}{3}$ gained no credit. Many found $\cos\alpha$ from $\sin\alpha=\cos\alpha\tan\alpha$ which was accepted, if exact. Some students successfully derived the result using $\operatorname{cosec}^2\alpha=1+\cot^2\alpha$.

Question 2(a)(ii) The vast majority of students knew, or could derive, the double angle formula for $\sin 2\alpha$, and so obtained the correct exact value if they had $\cos\alpha$ correct.

Question 2(b) Most students knew the required compound angle formula, although occasionally there was a sign error and some thought the formula was $\cos\alpha-\cos\beta$. Many approaches were used to find $\sin\beta$ and $\cos\beta$. Some used the simplest method, involving a right angle triangle, whilst some noticed that $\sin\beta/\cos\beta=\frac{1}{2}$ and used this in conjunction with $\sin^2\beta+\cos^2\beta=1$ to find the values. Most students who had the four component parts correct could complete to the requested form; but some were unable to manipulate the surds as required, even from $\frac{2}{3}+\frac{2}{15}\sqrt{5}$. Many students who had worked with inexact values, wrote down $k=5$ as their final answer, but such students need to understand that using results from their calculator does not show this, as requested in the question.

Question 3

The majority of the students showed competence with binomial expansions, with about two thirds of the entry scoring 5 or more of the 7 marks available.

Question 3(a) Very few students failed to score at least the method mark here.
One relatively rare error was to forget to square the 6 in the coefficient of the x^2 term.

Question 3(b)(i) Most students correctly left $\frac{6}{27}x$ in the brackets and took out the 27 to the correct power, even if later they wrote this as 3 rather then $\frac{1}{3}$. Most students chose to expand $\left(1+\frac{6}{27}x\right)^{\frac{1}{3}}$ and were usually successful; those who chose to use the result from part (a) mostly didn't realise they had to use $\frac{1}{27}x$ and not $\frac{6}{27}x$ with the part (a) coefficients. Few students attempted to use the result from the formula book, and of those who did, many made an error in evaluating the coefficients. A few mistakenly tried to use ${}_nC_r$ with $n=-\frac{1}{3}$.

Question 3(b)(ii) This was not answered well and was often not attempted. Those who did find $x=\frac{1}{6}$ as the required value of x made an error in their arithmetic after substituting it, or failed to double the result to get the correct answer. Other students found a whole miscellany of values of x, which led to answers which could not possibly be correct, as a quick check on the calculator would have shown. Some students just gave the result from their calculator.

Question 4

This question was generally done well with over 50% of the entry scoring 9 or more of the 12 marks available. Most students lost marks in part (c) by attempting to use an inefficient method.

Question 4(a) Virtually all students used parametric differentiation and most had the two required derivatives correct. Occasionally there was a coefficient error or a t was brought down, but most students knew the chain rule and used it appropriately. Most students had the correct unsimplified result, which was accepted for the marks, but some made an error in simplifying, usually dropping the negative sign and so lost two marks in part(b). Some students 'simplified' $1/16\mathrm{e}^{-2t}$ to $16\mathrm{e}^{2t}$.

Question 4(b)(i) Most students had this correct, either by use of their calculator or by hand, although there was evidence that some students were not using the exponential button on their calculator correctly.

Question 4(b)(ii) Although again most students had these coordinates correct, a number dropped the 4 from one of the given equations, usually from the x equation, so lost a mark here and another in part (iii) as they could not then get the correct answer.

Question 4(b)(iii) Most students used their results from parts (i) and (ii) to set up a correct equation of the normal, either using $y - y_1 = m(x - x_1)$ or $y = mx + c$. Some went on to complete the question successfully but others confused the axes and substituted $x = 0$ and found y. Some students misunderstood the question and substituted $y = 0$ into the parametric equation for y and found t, seemingly ignoring the reference to the normal given in the question.

Question 4(c) There were many different approaches to finding the Cartesian equation. The most straight forward way was to substitute into the given expression and show that it simplified to the requested constant. The common error in this approach was a sign error, often resulting in $k = 0$. The result $\mathrm{e}^{2t}\mathrm{e}^{-2t} = 1$ was generally well known although occasionally the product became $\mathrm{e}^{\pm 4t}$. The other fairly common approach was to solve one of the equations for $\mathrm{e}^{\pm 2t}$ and substitute in the other equation, and then simplify. This often resulted in algebraic errors. Some students carried out an unnecessary further stage and actually solved for t in terms of x and/or y using logarithms. This often resulted in some rather cumbersome expressions when substituting back and students made many sign and algebraic errors in trying to convert their logarithm expressions into the requested form.

A typical error was $\mathrm{e}^{-\ln\left(\frac{x+4}{8}\right)} = -\left(\frac{x+4}{8}\right)$. Some students did however derive the required result through insightful manipulation of the parametric equations.

Question 5

This question was generally done well with about 35% of the entry gaining 10 or 11 marks. Often the mark lost was in part (a) for failure to show any processing or to give a conclusion.

Question 5(a) Virtually all students knew they were to substitute $x = -\frac{3}{2}$, and evaluate. However, those who just substituted into $\mathrm{f}(x)$ and wrote $= 0$ without showing any stages in the arithmetic did not score the accuracy mark, nor did those who did not interpret the $= 0$ result.

Question 5(b) Most students had this correct and virtually all scored at least the method mark. Some students did the factorisation by inspection whilst long division was also a popular method. Those students who chose to use undetermined coefficients often did much unnecessary work, as at least the values of a and c should be apparent from inspection.

Question 5(c)(i) This part of the question was also generally done well with most students able to quote the cosine double angle formula or derive it correctly, and convert it to sines.
A rare error was a sign error or the dropping of the 2. Some students did not handle multiplying out the expression convincingly, and as the required result was given, they were penalised. However, most did convert their trigonometric expression into the required equation in x.

Question 5(c)(ii) Some students did not attempt to solve this equation, but of those who did they virtually all knew they had to solve the cubic equation in x. Many did this successfully, often following a failed attempt at factorisation. Some made sign or other errors in their use of the quadratic formula. Some students used the quadratic formula on the cubic equation itself. Students who had not used the quadratic formula correctly with the given equation, could gain no further marks. However, many did complete successfully and it was pleasing to see the inappropriate roots of the cubic equation carefully rejected. Some students did not correctly convert the $-16.3°$ they obtained from their calculator into angles in the required range.

Question 6

Although most students scored well on parts (a) and (b), many made little further progress and generally the question was not done well. However, about 15% of the entry did score 10 or more of the marks available. There were few fully correct solutions to part (d). Notation was often poor and many students did not make it clear which vectors they were working with.

Question 6(a) Most students answered this correctly. Many found $\lambda = -1$ explicitly or wrote a correct vector expression in which it was implied. Most demonstrated that this value satisfied the three components although a few students failed to carry out this step. The other rarely seen error was to find $\lambda = +1$. It was good to see some students writing a clear conclusion to their solution, although this was not required.

Question (6)(b) Most students knew they had to find the vector $\overrightarrow{AB}$ and apart from the occasional sign error they did so successfully. However, some thought this was the equation of the line. Many others had the correct form of the line but omitted $\mathbf{r} =$, or wrote $line =$ or something similarly inappropriate for the vector equation of a line.

Question 6(c) Although most students knew they were to use the equation of the line and equate a scalar product with vector $\overrightarrow{AB}$ or $\overrightarrow{AD}$ to zero, many used $\overrightarrow{OD}$ rather than $\overrightarrow{CD}$ and so could gain no further marks. Those who tried to find vector $\overrightarrow{CD}$ often made a sign or coefficient error, so could only score the method marks in finding the value of μ and the coordinates of *D*. Some got as far as $17 + 17\mu = 0$ and concluded $\mu = 1$.

Question 6(d) Many students did not attempt this part of the question. Success here would have been more likely if a correct diagram had been used, but most of those who attempted this part of the question did not draw one and many had the right angle in the wrong place, at C instead of at D. Many then used the sides AC and AD of the triangle ACD to attempt to find the area whereas the base and height are AD and CD respectively. Some students who chose this route, especially if they had an error in the coordinates of D, continued working with very unfriendly fractions and attempts at finding moduli before abandoning the attempt for no credit. The key to a successful solution lies in realising that CD is the height of both triangles ACD and ACE and as such there is no need to actually find its length, although students found that CD cancels if they did this correctly. Some students did give a concise and correct solution for both the possible positions of point E.

Question 7

Since the form of the required differential equation was given, students could decide the values of a and k quickly and then give their differential equation very quickly. Although some did this, many did some working before often coming to wrong conclusions about the values of a and k. Some calculated second derivatives whilst some tried to integrate their differential equation, all quite unnecessarily. It was disappointing that many did not realise that a has to be 1.3, corresponding with the maximum value of the cosine term being 1. Most students did write down $\frac{\mathrm{d}h}{\mathrm{d}t}$ and about 80% of the entry scored 1 or more of the 3 marks, but only about 5% got the question fully correct with relatively few students getting the value of k correct; the π was often missing from those who had shown some understanding, giving $k = \frac{1}{6}$ or $k = \frac{1}{12}$.

Question 8

There was a full spread of marks seen in this question with about a quarter of the students scoring 8 or more of the 10 marks available, but a similar proportion scoring 2 or less.

Question 8(a) Most students recognised that this required integration by parts, although some just 'integrated' the t term and the cosine term independently, for no credit. Some tried to use substitution, and indeed some students substituted $u = \frac{\pi t}{4}$ and then used parts. Most identified the parts the right way round but those who did not should have found the integral becoming impossibly harder but they were often determined to get a result, again for no credit. Of those who started correctly, many made a mistake in writing down the parts formula, often confusing the sine and cosine terms. Many had the required coefficient $\frac{4}{\pi}$ inverted. Many who had the coefficients correct at this stage then made an error when integrating the sine term, often getting $\frac{8}{\pi}$ or similar. Many made a mistake when simplifying a correct expression, which was not penalised until part (b).

Question 8(b) Most students separated the variables correctly, and usually used the correct notation. Occasionally the x was dropped or the $\mathrm{d}x$ or $\mathrm{d}t$ did not appear or was in the wrong place. A few attempted to 'integrate' the expression as given in the question to produce answers of no value. Most gained the mark for integrating x correctly, although some used logarithms due to incorrect separation. Most of the students also gained the method mark for using their result from part (a) in an attempt to find a constant of integration. Some students just substituted $t = 0$, $x = 4$ into the differential equation itself, which made no sense. Those who had the correct form of the integral from part (a) could then score the remaining method mark for calculating firstly x^2 and then x. Many were correct to this point and then misunderstood the request to give their answer to the nearest centimetre or they evaluated using degrees rather than radians. About 8% of the entry gave a fully correct solution.

Mark Ranges and Award of Grades

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

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