Examiners' Report

Summer 2016

Pearson Edexcel GCE in Core Mathematics 2 (6664/01)

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Mathematics Unit Core Mathematics 2

Specification 6664/01

General Introduction

The paper worked well and most questions were found to be accessible, with many students answering accurately with good presentation. The later questions; Q06, Q08 and Q09 proved more discriminating than the earlier questions. Some students avoided the trigonometry (Q06) and the log question (Q08) but most made some attempt at the proofs in Q9(b) and Q9(c), sometimes making several attempts. Most students showed that they had benefitted from the course and that they had been well prepared for the examination.

Report on Individual Questions

Question 1

This proved to be an accessible start to the paper with a majority of students gaining the full seven marks and only a small number losing just one mark. Only a very small minority gained less than half of the marks.

Q01(a) was a “show that” question. Full marks were obtained by most students, but the final mark was lost by some because they showed insufficient working and jumped straight from an initial equation for the sum of four terms, to $a = 64$ with no simplification or rearrangement. A few lost the final mark for using rounded decimals and hence not obtaining $a = 64$ exactly, as required. The alternative method of adding terms in a was usually completed successfully. Many students who used the reverse method of substituting $a = 64$ failed to write a conclusion and so lost the final mark.

In Q01(b) the S_n formula was used correctly by almost all students, with only a very few arithmetic errors. A very small minority of students worked with a value of a other than 64 and these were able to pick up the method mark.

Q01(c) was completed correctly by the majority of students, with the most common error being to round their answer to 2, rather than the required 3 decimal places. Some students found the 10th and 11th terms difference as they used the wrong formula, $u_n = ar^n$, for the nth term. A small minority divided rather than subtracted terms. A significant proportion found the difference between the **sum** of the first 9 terms and the first 10 terms.

Question 2

This proved accessible to everyone with only a small number of students failing to achieve full marks on Q02(a) and Q02(b).

Q02(a) was answered successfully by almost all students. The requirement was to calculate a value for $8 - 2^0$ and to complete the table with the value 7.

In Q02(b) students generally completed the trapezium rule correctly, however some made errors. These inaccuracies fell into two categories: miscalculating h as $\frac{4}{5}$ (thinking 5 strips because there were 5 ordinates), giving an answer of 16.6; or omitting the large brackets and giving an answer of 37.75. Students who found the value of h from the table of values for x and y rather than from the formula were more successful. There were some students who did not bracket their work. The majority of students reached the answer of 20.75, which was an exact answer. Some then rounded to 20.8 which caused problems for Q02(c).

Q02(c) was well answered by the majority, who correctly calculated the 15 for the area of the triangle to subtract. There was, however, a varied approach to this question with a large number of students not seeing or using the area of a triangle and instead using more complicated approaches like integrating. A number of students attempted to integrate the original equation of the curve rather than use their previous answer. A number of students failed to realise that they had the dimensions of the required triangle, preferring instead to try and calculate where the curve crossed the axes by putting x and y equal to zero.

Question 3

Overall this circle question was well attempted by the majority of students.

In Q03(a) most students used the distance formula or Pythagoras theorem correctly to find the length of *PQ*, and wrote it exactly, as $\sqrt{34}$. However, a number of students went on to write this as a rounded decimal, while some lost the second mark by writing their answer as a rounded decimal only. Only a minority of students had neither, having made arithmetic errors, with the most common error being the answer of 6 (coming incorrectly from $\sqrt{(25 + 9)} = \sqrt{36}$).

In Q03(b) the correct equation for the circle was given by the majority of students who had Q03(a) right, and at least the method mark was available for those who did not achieve the correct radius.

Q03(c) was also very well attempted with many students achieving full marks. Way 1 on the mark scheme, the expected route, was used by the vast majority. Attempts at Way 2 were uncommon, and usually involved invalid attempts at differentiation, though the very small minority who used implicit differentiation did evaluate the gradients correctly and gain full marks.

The common errors in this part were twofold: some miscalculated the gradient, usually having $\frac{\text{change in } x}{\text{change in } y}$, while for others the algebraic rearrangement to the required form was omitted or incorrect with $3x + 5y - 35 = 0$ being a common answer. Occasionally the wrong point on the line would be used, taking the centre rather than point *P*.

Most demonstrated correct knowledge of the need to reciprocate and negate their radial gradient to give the gradient of the tangent and formed a correct line equation. The $y - y_1 = m(x - x_1)$ equation for a line was by far the most common method and usually gave a correct answer.

Question 4

This question was attempted very well with a significant number achieving either full marks or losing just one or two marks of the 8 available.

In Q04(a) the vast majority of students gained full marks for this part, using the remainder theorem and coping well with the substitution of $x = -\frac{3}{2}$, though a few used $x = +\frac{3}{2}$. Calculation of the resulting expression caused problems for some students, usually because of a failure to deal with powers of the negative fractions correctly, ie failure to use extra brackets on the calculator. Loss of marks was caused by students using long division by $(2x + 3)$ when the question required use of the remainder theorem.

Q04(b) was answered well by those who used the factor theorem, though many wrote no conclusion, leading to the loss of the final mark. However, some used long division and hence received no marks for this part.

Q04(c) was well done, with full marks being frequently obtained. Students usually gained at least one mark for attempting algebraic division by $(x + 2)$, but the lack of a term in x in the original cubic expression caused some difficulties. Most managed to find the quadratic factor correctly and continued to factorise their quadratic, possibly making errors in signs. Some however, resorted to the quadratic formula or the calculator and ended up with an incorrect combination of final factors.

Many students found solutions of the equation $6x^3 + 13x^2 - 4 = 0$, which was not required. If correct factors had already been given, this subsequent work was ignored and marks were not lost. It is clear that for some students, the distinction between "factorise the expression..." and "solve the equation…" is not properly understood.

Question 5

In Q05(a) the main error appeared to be using $+9x$ rather than $-9x$, which gave the second term the wrong sign. Almost everyone used the correct binomial coefficients and used brackets correctly. Only a small group of students did their expansion by taking out the factor of 2^4. Errors seemed more likely to occur in this method as some students took out a factor of 2 and did not put it to the power 4.

In the later parts of the question some students completely missed the connection between Q05(a) and Q05(b) and seemed unclear how to proceed. Some students tried to multiply out $(1+ kx)(2 - 9x)$ or even $(1 + kx)(2^4 - 9x^4)$. The majority of students did multiply out $(1 + kx)(16 - 288x + 1944x^2)$ but not all then knew what to do with it. Students need to be aware how the terms of a polynomial are formed from the product of a linear with a quadratic expression.
Many students were able to write down the value of 16 for A in Q05(b). Some, however, put $16 + 16k$ for A.

A number of students were able to find the correct value for k in Q05(c). The main errors occurred in missing a negative sign in their expression $-288x + 16kx = -232x$.

The discrimination in this question was principally in Q05(d) where some students did not realise that there were two x^2 terms to consider. 1008 was a common incorrect answer.

Question 6

This trigonometry question was answered well by many students. A fair number gained full marks, with a similar number losing only one or two marks. Unfortunately, however there were some who gained no marks on this question.

Q06(i) should have been an accessible three marks but a number of students only got the first mark for correctly rearranging the equation to give $\cos\left(\theta - \frac{\pi}{5}\right) = \frac{1}{2}$. A mixture of graphs and CAST diagrams were seen and students who used the CAST diagram to find additional solutions usually fared better than those who attempted the graphical method. A small minority of students attempted the use of general formulae to find solutions.

Some re-arranged the equation to $\cos\left(\theta - \frac{\pi}{5}\right) = -\frac{1}{2}$ and were unable to gain any further marks. A number of students worked in degrees but failed to convert back to radians for the final two marks. Common mistakes included subtracting $\frac{\pi}{5}$ from their principal value instead of adding and many students found only one answer, usually $\frac{8\pi}{15}$

Q06(ii) was answered well with most students replacing $\cos^2 x$ with $1 - \sin^2 x$ and proceeding to a correct three term quadratic. They then mostly went on to factorise and solve the quadratic correctly to obtain $\sin x = -\frac{1}{4}$ and $\sin x = 2$. Some used the formula and some students introduced a dummy variable to replace $\sin x$ in order to solve their quadratic. However, it was not uncommon to see students defining x to replace $\sin x$ instead of introducing a different variable and then becoming confused when they had solutions to their quadratics, believing these to be their final answers and so not using arcsin.

Many had difficulty finding the required range of solutions which were in the third and fourth quadrants. A significant number found one solution but had an incorrect one as the second. As always, some lost a mark for including extra solutions inside the range. Rounding errors also lost the final accuracy mark in some cases.

Question 7

In Q07(a), although the vast majority had a completely correct integration, a few errors were evident, usually with the $x^{\frac{3}{2}}$ term. Incorrect simplification leading to $-\frac{5}{2}x^{\frac{3}{2}}$ was often seen and penalised if a correct unsimplified expression had not been shown previously.

There were students who made no attempt at Q07(b), which was largely due to being unable to determine the upper limit. Many students had difficulty in solving the equation $3x - x^{\frac{3}{2}} = 0$ as they were unable to deal with the indices. A variety of methods were used with factorisation being the most popular. Attempts at solving the equation by squaring both sides or approaches using logarithms were less successful. Many students were able to deduce $x = 9$ by inspection. A common mistake was to proceed to $x = \sqrt{3}$ from $x^{\frac{1}{2}} = 3$.

Question 8

This proved to be one of the more challenging questions on the paper for students.

In Q08(a) most students applied the subtraction law and made the connection between the base of the log (3) and 3 to a power, but many lost the final accuracy mark either due to an algebraic error, when making 'a' the subject, or not sufficiently simplifying their final expression for 'b'. One noteworthy common error was the move from $3b + 1 = \frac{1}{3}(a - 2)$ to $b + \frac{1}{3} = (a - 2)$, with many failing to divide through both sides by 3 correctly.

Others misapplied one of the two laws. The most common failing was making an incorrect connection between $\log_3$ and 3 to a power, (with $-\log_3 3$ becoming -3 rather than 3^{-1}, for example). Another common error was to try and split the logarithms ($\log_3 b + \log_3 1$, etc), rather than trying to combine, and these attempts generally led to no marks being scored.

The mistake $\frac{\log(3b+1)}{\log(a-2)} = -1$ was rare this time.

Q08(b) was a discriminating question. Although many got the first method mark (from a variety of valid methods), they failed to get the first accuracy mark and hence could not successfully proceed any further. There were at least 5 valid approaches to this question, two of them being commonly used (Way 1 and Way 2 on the mark scheme) while the others were generally rare; but usually more successfully carried through if used.

Of those who attempted Way 1, only around half of the students managed to express the equation as $32(2^x)^2 - 7(2^x) = 0$ in order to solve a quadratic in 2^x, which gave $2^x = \frac{7}{32}$. This tended to be the most successful approach, but many failed to evaluate 2^5 as 32. Many students attempting this approach were not able to deal with the 5 in the index correctly, giving various of the incorrect examples shown on the mark scheme, yielding equations such as $y^7 - 7y = 0$ or $y^2 + 32 - 7y = 0$.

In the other most attempted method, Way 2, many wrote 2^{2x+5} correctly as $(2x + 5)\log 2$ (mostly with the brackets, though some did omit them), but then wrote $\log(7(2^x))$ as $x \log 14$, or $7(2^x)$ as 14^x, thus disregarding either the addition law of logarithms or equivalent rules for working with indices.

It is also noteworthy that many appeared to be taking logarithms of each term, proceeding directly from $2^{2x+5} - 7(2^x) = 0$ to $\log(2^{2x+5}) - \log(7(2^x)) = 0$ without appreciating that this should be achieved via the step $2^{2x+5} = 7(2^x)$ first. Students would be well advised to avoid such approaches, since though they work in this instance, should the equation not be equal to 0, such an approach would be erroneous. The remaining Ways on the scheme were seen less often, but generally had more success, with Way 4 being the most common of these.

Question 9

In Q09(a) most students knew and quoted a formula for area of a sector, and they were able to use this successfully with either radians or degrees as appropriate. However a significant minority tried to use degrees in the formula appropriate for radian measure.

In Q09(b) a majority of the students realised that they needed to find the total area of the shape and so needed to sum the areas of the three portions (triangle *ABF*, sector *AFE* and rectangle *BCDE*) and set the given total equal to 1000. A correct expression for the area of the rectangular portion was far more common than that for the triangular portion. Many students did not use the formula $\frac{1}{2}ab \sin C$ for the area of the triangle, choosing instead to find the perpendicular height of the triangle and then attempting the algebra.

Those students gaining all three marks on this part were in the minority, although most of those with a correct initial expression for the total area could deal with the ensuing algebraic manipulation and gain these marks. Many had only two areas correct and some made arithmetical errors particularly with the signs. Students need to be aware of the need to write down sufficient intermediate steps for proofs where the final answer is given.

Q09(c) was the most commonly omitted part of the question. Many students failed to gain a correct expression for the perimeter of the shape, with some unable to gain a correct expression for the length of arc *AE*. An answer of $120x$ for those who worked in degrees was common. Many of the students who gained a correct expression for P in terms of both x and y made errors trying to eliminate y and obtain the printed answer. Those who gained full marks in this part often gained full marks for the whole question.

Q09(d) was possibly the best attempted part of the question with many students attempting the differentiation. Some struggled with the linear term. Successful students were able to deal well with the differentiation of both terms and go on to gain all five marks in this part; weaker students often did not recognise the need for differentiation, trying instead to gain a minimum value of P by substituting the minimum allowed value from the given valid range. Many students who found x correctly, omitted finding the value for P, in effect, failing to answer the question asked.

Most students who reached Q09(e) were able to gain, express and use the second derivative to gain the first if not both marks for this part. Substituting P instead of x was a common error as was using a value of x outside the given range. Some students did not draw a clear conclusion and so also lost the final mark.

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