AQA

Level 2 Certificate
Further Mathematics

83601 Paper 1

Report on the Examination

Specification 8360

June 2018

Version: 1.0

General
The time allowed for the examination seemed to be sufficient for all students to be able to complete the paper. Most students were well prepared and presented their work in a clear way. There were exceptions to this, some working was difficult to decipher, often untidy, and, although the space allowed for each answer was generous, some candidates needed additional pages to continue or, sometimes, re-start their answers. Often, work done on additional pages is a copy of what appears on the actual paper. Sometimes there are various attempts at solutions and students should make it clear which solution they intend to be marked. A choice of solutions can lead to a loss of marks if one of the choices shows incorrect method. There were also instances of many good responses to questions being let down by careless arithmetic, resulting in the loss of marks.

The increase in difficulty of questions towards the end of the paper meant that some students struggled with the concepts involved, but there were still some very good attempts at these questions, with some elegant solutions. Questions asking for 'proof' require all steps to be clearly shown and supported by correct mathematical reasoning. It is worth re-iterating that students always need to ensure that they show sufficient working whether or not the question specifically asks them to do so.

Topics that were well done included:

- finding missing coordinates involving a midpoint
- matrix multiplication
- ratio problem
- working out a missing coefficient of an expansion of terms
- identifying the equation of a circle
- expanding brackets involving surds
- solving simultaneous equations involving a quadratic equation
- factorising a cubic expression

Topics which students found difficult included:

- circle geometry calculation
- solving an equation written using function notation
- expanding a bracket involving powers of 3
- using a quadratic graph and deducing the appropriate straight line to solve an equation
- drawing a sketch graph from information requiring calculus skills
- formal geometry proof

Question 1
This question was not well answered. The presence of fractions made it difficult for some students, many of whom just ignored them and carried out the differentiation on the remaining terms, never re-instating the fractions. A few students spoilt their otherwise correct answer by incorrect further working.

Question 2
This question was well answered. A very popular approach was to sketch a diagram and realise that the distance between the x-coordinates of *P* and *R* was 18, and the distance between the y -coordinates of *Q* and *R* was 6. Some straightforward arithmetic then led to the values of a and b.

Question 3
This question was well answered. Most students multiplied the matrices the correct way round, although some found BA instead of AB. Answers were not always finished correctly, products of terms not being added together. A few did incorrect further work by combining a previously correct answer into a single 2 by 1 matrix.

Question 4
This question was well answered. Increasing $4x$ to $5x$ caused few problems, but decreasing $7x$ by 40% was less well handled. Answers of $9.8x$ (increasing) and $2.8x$ (40% instead of the 60% required) were the most common mistakes. There were also some errors in setting up an equation, the 28 term sometimes being on the 'wrong' side of the equation. Then there was the small matter of solving $0.8x = 28$, a step too far for some, although there were very many correct answers of 35. Those students who tried a trial and improvement method were in a very small minority and often failed to set out their work in a way which was easy to follow.

Question 5
Almost all students expanded the brackets correctly and many could see that the coefficient of x^2 was 2, but some then thought that $k = 2$ was the correct answer, forgetting that they had to equate the x coefficient to 2. It is important to remember that when equating coefficients, it is necessary to drop any terms involving x. So $2x^2 = kx - 15x$ is not sufficient, we want $2 = k - 15$, and then $k = 17$

Question 6
This question was very well answered.

Question 7
This question had a very mixed response. Students who realised that the circle theorem connecting the angle at the centre with the angle at the circumference was crucial to success usually set up their equation correctly and solved to get the correct answer of 57°. There were many different approaches, some found the reflex angle *AOC* and used angles at a point add to 360°; others created a cyclic quadrilateral and used the fact that opposite angles are supplementary. However, there were common misconceptions such as thinking that (x + 75°) and $2x$ were opposite angles of a cyclic quadrilateral or that (x + 75°) = $2 \times 2x$, and there were elementary sign errors when handling brackets, or leaving out the bracket altogether.

Question 8
The main problem with the expansion was getting the $2\sqrt{5}\sqrt{5}$ term (or equivalent) correct. There were some sign errors when collecting terms, but there were very many fully correct answers.

Question 9
This question was not well answered, almost entirely due to the lack of brackets when substituting $2x$ for x in the expression for f(x). So using $14 - 2x^2 = 5$ rather than $14 - (2x)^2 = 5$ usually meant there was no chance of recovery. Quite miraculously, $14 - 2x^2 = 5$ became $2x^2 = 9$ which in turn became $2x = 3$, $x = 1.5$, one of the correct answers ... but from completely wrong working. Those who started correctly either solved $4x^2 = 9$ (sometimes forgetting the negative square root) or factorised $4x^2 - 9$ using the difference of two squares, achieving both of the required answers.

Question 10

This question proved to be a good discriminator. It was extremely well answered (in about two or three steps) by many students and answered correctly (with multiple lines of algebraic manipulation) by many others. Some managed a correct first step, multiplying by y or xy or xy^2 or making a correct algebraic fraction, on either side of the equation, but then often made a careless mistake when trying to simplify. The final answer could take on many forms and even though some of them looked a little clumsy, if they were correct they gained full credit.

Question 11

This question was quite a good discriminator. Differentiating and equating to −5 gave rise to a very simple equation in x, and then substituting $x = -2$ into the equation of the curve gave $y = -7$ However, $4x + 3$ was often equated to $-5x$, or 5, or $\frac{1}{5}$, or 0, all of which meant the end of any chance of success. There were other common mistakes, such as the equation $4x + 3 = -5$ being solved as $x = -0.5$, and the correct x value of −2 being substituted into the equation of the straight line to find the value of y.

Question 12

This question proved to be a good discriminator. Using the given tangent value usually led to a y-coordinate of 25 for B, and although many students used this correctly to find the gradient of AB as $-\frac{25}{15}$ or $-\frac{5}{3}$, others dropped the negative sign, never to recover it. This inevitably led to an error in the gradient of the perpendicular line BC, which clearly ought to have been positive (the diagram gives this away, even though it isn't drawn accurately). The final answer does require an equation, so it has to be $y = \frac{3}{5}x + 25$ not just $\frac{3}{5}x + 25$. Some common mistakes were in thinking that the y-coordinate of B was 5, and making sign errors in the gradients. A small number of students used decimals, which made things a little awkward when finding the negative reciprocal gradient. One very clever solution was to use congruent triangles to deduce that C must be the point (25, 40), which makes finding the equation of BC a relatively simple task.

Question 13

This question was well answered. Most students went down the route of eliminating y from the two equations and arriving at a quadratic equation in x, which proved to be quite easy to factorise correctly, giving answers of $x = \frac{1}{3}$ and $x = -2$ The complete solution needs the corresponding y values to be calculated. Solutions using the quadratic formula and completing the square were less common. Eliminating x and getting a quadratic in y was just as good, if not better, since it was easier to factorise. Some students struggled to eliminate a variable, and some re-wrote the first equation, incorrectly, as $y = 2 - x$ or $x = 2 - y$, and then substituted into the second equation.

Question 14

This question was not well answered. The first step for many was to include the index inside the bracket and write $3^1 + 3^3 = 3 + 27 = 30$, or, equally wrongly, the terms inside the bracket were 'collected together' as 3^2, which then became $(3^2)^2 = 3^4 = 81$. Powers of 9 were seen too.
Expanding the bracket was one approach, leading to a variety of terms, sometimes powers of 3, sometimes powers of $\sqrt{3}$, and often with an error in one of the terms, but still able to gain some credit. Perhaps the most successful method was to spot that the second term in the bracket could be re-written as $3\sqrt{3}$, thus giving $(4\sqrt{3})^2$, which was then usually correctly evaluated.

Question 15

This was the least well answered question on the whole paper. It required students to manipulate $x^2 - 4x + 2 = 0$ so that it could be written as an equation with $3x - x^2$ on one side and a linear expression on the other. Very few students managed to do this. Those who successfully deduced that the graph of $y = 2 - x$ needed to be drawn, then almost always drew an accurate graph and found the two correct solutions. There were instances of inaccurate manipulation giving rise to linear graphs of $y = x - 2$, but by far the most common, incorrect, method was to draw the graph of $y = x^2 - 4x + 2$, often giving correct answers but not answering the question that was asked. Attempts to solve $x^2 - 4x + 2 = 0$ by using the quadratic formula or by completing the square were not acceptable, although some students used these methods to check their answers, having previously done the question as it was intended.

Question 16

This question was not well answered. The given expression for $\frac{dy}{dx}$ was intended to help students realise that all that was required of them was to factorise (or equivalent method) to find the x-coordinates of the stationary points, the y-coordinates having been given in the question. The rest of the given information was such that the x values of −3 and 1 could be correctly paired with the y values of 13 and $2\frac{1}{3}$. Students who followed these steps usually drew an accurate sketch graph, which had to cross the negative x-axis. Some students who did not manage to work out the x-coordinates of the stationary points drew a sketch of a cubic curve crossing the y-axis at (0, 4) but with no further detail. Some who successfully found the two x values −3 and 1 used them as the points where the cubic curve crossed the x-axis as opposed to the stationary points. There were some attempts to integrate the gradient function to find the equation of the curve and some quadratic curves drawn too.

Question 17a

This question was quite well answered, but not all students realised that the factor theorem simply requires substitution of an appropriate value in the cubic expression, and verification that the resulting calculation gives zero. Although using long division of the cubic expression by $(x - 2)$ does give the quadratic factor (and as such is one of the ways to answer part (b) of the question), it is not an illustration of the factor theorem and is inappropriate for part (a). When a value is substituted it needs to be worked out, so, for example, leaving 2^3 is not enough, it needs to be 8.

Question 17b

This question was well answered, most often by using long division of polynomials, as described above, but also by other valid methods such as 'by inspection' and by using the factor theorem to find another linear factor. Working out f(−5) and getting zero usually produced the required repeated factor of $(x + 5)$ but also occasionally the incorrect factor of $(x - 5)$. Many students used a common sense approach and realised that if $(x - 2)$ was a factor then the number term in the quadratic factor had to be 25, and from there the correct solution was just a short step away.

Question 18

This question was not well answered. Every statement linking angles must be supported by a correct reason, using correct mathematical language. So, for example, 'Z-angles' is unacceptable, it has to be 'alternate angles'. A proof breaks down as soon as there is an error in a statement or if there is an incorrect reason (or no reason) attached to that statement. Many of the students who made a reasonable attempt at a proof did not set out their work in a clear and logical manner.

Their proofs need only have taken three or four steps but they often took many more, not realising the point at which their working meant that a correct conclusion was possible.

There were a number of false assumptions made, such as angles *SDT* and *DSF* = 90°, or that triangle *DSF* is isosceles (it is, as it happens, but that fact cannot be assumed at the start). The alternate segment theorem was often misused ... angle *DST* = angle *FDS* is incorrect (it ought to be *DFS*) ... and any proof which started by assuming the result, using phrases such as "If *FD* is parallel to *RST* .....", was bound to fail. Cyclic quadrilateral properties were frequently quoted although they were completely unnecessary for a correct proof.

There were some very elegant solutions, the simplest of which was probably, *DST* = x (isosceles triangle *DTS*), *DFS* = *DST* = x (alternate segment theorem), *EDF* = *DFS* = x (alternate angles), so *EDF* = *DTS*, which means that *FD* must be parallel to *RST* (converse of corresponding angles).

Question 19

This question proved to be a good discriminator. Most students used the completing the square technique on the expression $2x^2 - 16x + 13$ rather than expanding $a(x + b)^2 + c$ and equating coefficients. Many started by writing $2(x^2 - 8x$ ....) and correctly followed up with an expression involving $2(x - 4)^2$, but the biggest problem proved to be getting the brackets in the right place ... a final answer of $2(x - 4)^2 - 3$ was quite common. There were some common errors, such as forgetting to halve the x-coefficient and writing $2(x - 8)^2$ as a first step, which was sometimes recovered if the final answer was multiplied out to check the result.

Question 20

This question also proved to be a good discriminator, and was reasonably well answered. Most students applied the sine rule correctly and many use the correct trig. ratios for sin 45° and sin 60°. The fact that there were surd fractions in both the numerator and the denominator of a correct expression for the side *AC* made the simplification slightly more difficult, and a significant number of students couldn't arrive at an expression which could be written correctly in the form $a\sqrt{b}$. Some students dropped a perpendicular from *A* to *BC* and did the question 'in two halves', often correctly. A small minority assumed that the triangle was right-angled at *A* and tried to use tan 45°

Use of statistics

Statistics used in this report may be taken from incomplete processing data. However, this data still gives a true account on how students have performed for each question.

Mark Ranges and Award of Grades

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