Examiners' Report
Principal Examiner Feedback

January 2018

Pearson Edexcel International A Level
In Core Mathematics C12 (WMA01)

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General Introduction

Students found this paper accessible although it was not clear whether the number of blank responses to Q15 was indicative of students running out of time. The quality of many responses seen was high, showing that students had been well prepared by their teachers. Questions 2(b), 10(ii), 11(c), 13(c), 14(b), 15 were found to be the most challenging on the paper. Some students are clearly relying heavily on their use of calculators, as correct answers to quadratic equations in surd form and answers to definite integrals appear too often with no working. Errors were common throughout when dealing with negative or fractional powers – this was particularly evident in question 3. There was sometimes a lack of explanation given by some students in making their methods clear, particularly in show that questions. Students need to be aware that when asked to produce, or prove, a given result they must be careful to include all the necessary steps.

Reports on Individual Questions:

Question 1

This was a straightforward start to the paper and most of the students were able to gain method marks at the very least, with a significant number going on to gain all five marks. Most students realised that in both parts (a) and (b) some re-arranging was useful before differentiating and integrating.

In general students who rewrote the function in the form $y = ax^{\frac{2}{3}} + b$ first, coped well with this question. In part (a) most were able to reduce the power of x by one, although there were occasional errors in evaluating the $\frac{2}{3} - 1$ and in splitting up the initial fraction, for example $2x^{2/3} + 3(6)^{-1}$. The common reasons for loss of the A mark were either for not simplifying the result, or for errors in simplifying the coefficients, common wrong answers being $\frac{4}{9}x^{-\frac{1}{3}}$ and ${}^{4}/_{3}\, x^{-1/3}$. Once a correct answer was found, students were not penalised for errors in any subsequent work.

In part (b) most students were able to gain marks, a significant number gaining full marks, although a few integrated the numerator and denominator separately and did not score. For those students working towards an answer of the form $kx^{5/3} + bx + c$, many went on to form a correct un-simplified answer and so gained the first two marks. However the final mark was lost by about a quarter of the students who failed to gain a fully correct, simplified answer including + c.

Many students scored full marks on this question, with the majority writing y as two terms and perhaps simplifying before differentiating or integrating.

Question 2

In part (a) the vast majority of students were successful in finding the first 2 terms.

Part (b), however, caused more problems. Many were able to obtain the 4th term correctly, often by implication in their calculation of the sum. Although many correct solutions were seen for $\sum_{r=1}^{4}(r - u_r)$, misunderstanding was common. Typical mistakes were to put $\sum r$ = 1+1+1+1 or to completely omit $\sum r$. A few students mistook this for an arithmetic series and attempted to use the sum formula.

Question 3

Part (a) was well done by the majority of students. Most achieved an answer of the form ax^2, with the correct answer $81x^2$ being the most common, although some students appeared to simplify $3(x^{1/2})^4$ or $\{(3x)^{1/2}\}^4$ giving $3x^2$ and $9x^2$. Occasionally students having found $81x^2$ reduced it to $9x$ or $9x^2$ which lost both marks.

Although there many correct answers to part (b), this part did prove more troublesome. Usually the problem arose in dealing with $(4y)^{-2}$; it was often written as $4/y^2$ resulting in a very common incorrect answer of $(8/3)\, y^4$. Some students, unfortunately, having negotiated that hurdle correctly, to give $2y^7/(3y \text{ x } 16y^2)$, or even $2y^7/48y^3$, did not go on to complete the simplification.

Question 4

In part (a) the majority of students realised that they needed to use the discriminant, with only a handful using the quadratic formula and even fewer including x in their expressions. Most then wrote the inequality the correct way round. There were a few sign errors and instances of poor bracketing but most students successfully managed the proof. The most common mistake was to use $b^2 - 4ac > 0$ and then to try to manipulate, usually obtaining the printed answer via a further error.

Most students achieved the two critical values in part (b), usually by factorisation with very few sign errors, but many initially wrote the answers wrongly using inequalities rather than with equals signs as $p > 4$ or $p > -6$, leaving this as their answer. Of those that used a sketch the majority scored full marks. Most chose the ‘outside region’, but some lost the final mark by trying to combine the two inequalities into one. Some students simply gave $p = 4$ and $p = -6$ as their answer, showing no inequalities.

Question 5

As is common with questions on solving trigonometric equations, the quality of response was varied; there were many completely correct and well-presented solutions, with almost 60% of students gaining full marks or just losing one mark, but there were also many who made no attempt, or just a minimal attempt. Generally the question was answered well, with most well-prepared students able to attempt both parts, although of the two parts (ii) was the better attempted. CAST diagrams were commonly seen to obtain the solution sets and were usually used correctly. Graphs were quite rare, as were general solution formulae. It was good to see that students heeded the warning about the use of graphical or numerical methods.

Part (i)

The expected, and most common approach by far, to solve $5\sin3\theta - 7\cos3\theta = 0$, was to use $\tan3\theta = \sin3\theta/\cos3\theta$ to simplify to $\tan3\theta = k$. Students were in the main able to obtain a correct value for $\tan3\theta$ and successfully solve for 3θ and then θ, and find both values in the required range of 0 to $\pi/2$ for θ. A few solved in degrees which potentially lost only one mark. Some students gave $\tan3\theta = \frac{5}{7}$, losing 3 marks of 5. It was quite common to see $\tan3\theta$ become $\tan\theta$ during the solution, leading to $\tan\theta = \frac{7}{5}$, an error which meant that only 2 marks of the 5 were available. The most disappointing error seen was in replacing $\sin3\theta$ or $\cos3\theta$ by $1 - \cos3\theta$ or $1 - \sin3\theta$, respectively, which obviously led to no marks being gained. Most who had obtained $\tan 3\theta = \frac{7}{5}$ were able to achieve the correct first solution of 0.317, but some students made no attempt to find a further solution. Other reasons for loss of marks in this method were rounding errors, and occasionally for using the wrong order of operations, by adding π to θ rather than adding π to 3θ prior to division by 3. A small number of students replaced $\sin3\theta$ with $\cos3\theta\tan3\theta$ and factorised – producing the extra incorrect value of $\theta = \frac{\pi}{6}$ from $\cos 3\theta = 0$.

The other approach seen was squaring to produce an equation in $\cos^2 3\theta$ and $\sin^2 3\theta$. Those who did square correctly and used the identity "$\cos^2 3\theta + \sin^2 3\theta = 1$" to obtain a value for $\sin3\theta$ or $\cos3\theta$ were able to gain full marks, but had the potential for obtaining spurious solutions within the range. Students who worked in degrees just lost one mark if both answers were correct.

Part (ii)

This required transforming an equation in $\cos^2 x$, $\sin^2 x$ and $\cos x$ into a 3 term quadratic in $\cos x$ using the identity $\cos^2 x + \sin^2 x = 1$, and then solving for x in the range 0 to 360 degrees. This was extremely well done on the whole and the correct three term quadratic was nearly always found. Slips in factorising or from using the quadratic formula were not widespread, but sign errors or mistakes such as $4\cos x + 3 = 0 \Rightarrow \cos x = -\frac{4}{3}$ were seen. Those who had achieved both correct values for cos x usually scored at least one of the last two A marks. There were some errors in dealing with the negative root, with the wrong quadrants being selected. As in part (i), some students did not look for further solutions from their principal values. Some students used $\cos x = \frac{3}{4}$ rather than $\cos x = -\frac{3}{4}$, leading to $\alpha = 41.4°$; this did not necessarily lead to error for those who could use a CAST diagram correctly but $41.4°$ was sometimes included as one of the solutions. Rounding errors were rare although answers given to the nearest degree were occasionally seen. A costly error for some, as it lost all six marks, was to replace $3\sin^2 x$ with $1 - 3\cos^2 x$.

Question 6

Generally this question, involving use of the Factor and Remainder theorems, was answered very well by the majority of students, with nearly 60% scoring full marks, and most students gained some marks.
In part (a) the majority of students attempted to calculate f(-1) = 0 and/or f(2) = - 12, using the Remainder Theorem but there was a significant minority who equated f(2) to 0. A small number of students made slips, mainly sign errors, in simplifying their correct equations, but of those who simplified the equations correctly nearly all found the correct values for a and b. The students who attempted long division here found the algebra challenging and they were rarely successful in finding the correct equations in a and b.

Success in part (b) depended heavily on the results in the first part. Those who had the correct values of a and b invariably went on to score full marks, although the final two marks were sometimes lost by (i) leaving their final answer as $(x+1)(3x^2 - 11x+6)$, (ii) after using the calculator to 'solve' the quadratic equation, either stopping at that point, or giving their factorisation of f(x) as $(x + 1)(x - 2/3)(x - 3)$. Those who had incorrect, mainly fractional, values of a and b, often did not progress beyond their division of f(x) by $(x + 1)$, but sometimes gained the first method mark. Some students with incorrect a and b were able to gain the second method mark; a particular example of this was the case for those with $a = 5$ and $b = -7$, after setting f(2) = 0, which gave a factorisation of f(x) as $(x + 1)(x-2)(5x - 3)$.

Question 7

Part (a) of this question was sometimes poorly answered. Whilst there were many correct responses there were also many incorrect attempts. Some students struggled to write down the side lengths of the box and some thought that splitting the printed answer into smaller bits then adding them up again constituted a proof. Some tried to work out the surface area. Bracketing errors and other algebraic slips were common.

In part (b) the vast majority were able to differentiate the volume expression correctly. Most students were able to recognise that they needed to set $\frac{dV}{dx} = 0$ and solve the three term quadratic. It was common to see the x solutions written down without indication of method, presumably direct from a calculator. Many students wrote both values of x, but many thought that the 10.3 would lead to a maximum. However, those who were able to continue with the question soon spotted that this was the wrong value and corrected their work accordingly. Very few students were able to explicitly state why $x = 3.03$ was the required value.

Most students found the second derivative $\frac{d^2V}{dx^2}$ for part (c), but some then solved $\frac{d^2V}{dx^2} = 0$ and used this value for the remainder of the question, scoring no further marks. A significant number of students substituted both values of x and were able to discern the maximum from this. A common error was not to give a full conclusion that $\frac{d^2V}{dx^2} < 0$ (or 'negative'), hence the value was a maximum.

Most students scored at least the method mark in part (d) for attempting the maximum value of V. This required use of a value of x found from solving $\frac{dV}{dx} = 0$.

Question 8

This was an accessible question where very few blank responses were seen.

It was common for full marks to be scored for clearly labelled correct sketches. The standard of sketching varied, with some a bit wobbly, or only just crossing an axis, or nearly vertical in parts – but these were a small minority. Some students unnecessarily drew axes numbered carefully 0, 1, 2, 3, 4, ... as if using graph paper. In both parts, students were good at labelling their points of intersection and their maximum and minimum points, as asked for in the question. In general, writing down lists of before and after coordinate pairs made no difference to the accuracy of the transformations. Most students clearly knew how to answer the questions and what was expected of them, though a small minority failed to realise that the transformations still gave a ‘cubic’ curve and drew graphs of a completely different shape, which usually prevented them from scoring.

In part (a) the most common mistake was to reflect in the x-axis instead of the y- axis. Where marks were lost for incorrect coordinates, it tended to be for omission of minus signs.

Part (b) proved more challenging, and the most common mistake was to sketch $f(\frac{1}{2}x)$ instead of $f(2x)$ making 1,0,0 a common mark profile.

Question 9

Almost all students used the appropriate formulae; very few used the formulae for arithmetic progressions or a mixture of both, and there were relatively few examples of listing seen. In parts (c) and (d), where inequalities were involved, more errors were made.

In parts (a) and (b) any loss of marks was generally due to not giving the answers to the required level of accuracy; in (a) the exact answer was expected, and in (b) one decimal place was required. Occasionally in (a) students misread “fifth” term as “fifteenth” or “fiftieth” but this was addressed in the mark scheme.

In part (c) many students scored the first 3 marks for forming the correct inequality, but there were two common errors, (i) writing $20(0.9^n)$ as 18^n, and (ii) failing to change the inequality signs when dividing by a negative value.

Students who simplified $20/(1 – 0.9)$ to 200 throughout and then further simplified $200 – 200(1 – 0.9^n) < 0.04$ to $200(0.9^n) < 0.04$ produced a very neat solution, which avoided any manipulation of inequalities. Those who chose to multiply or divide by a negative number were often caught out by not reversing the inequality sign.

In part (d) most students gained M1, in forming log 0.0002/log0.9, or equivalent, but many did not realise that the inequality then became $N >$ log 0.0002/log0.9 , so the answer $N = 80$ was as common as the correct answer $N = 81$, with a non-integer answer also common. Trial and error to obtain the result was also seen occasionally.

Question 10

It was very common here for students to gain all the marks in (i) and none in (ii).

In part (i) most students were able to achieve full marks. Where this was not the case most students achieved both B marks. This was usually for dealing with $3log_8 2$, converting this to either 1 or $log_8 2^3$ and then dealing with the subtraction of logs to give $log_8 \frac{(7-x)}{x}$. The most common error type was attempting to remove logs without first dealing with the addition or subtraction, and another was splitting $\log(7-x)$ as $\log 7 - \log x$. Some students lost the final mark due to a careless mistake or an inexact answer such as 0.78

In part (ii), however, most students launched straight into taking logarithms of each individual term and scored no marks. Of those who formed the quadratic equation correctly, most went on to score full marks with only occasional loss of the final mark for not rejecting the -5 solution.

Question 11

This question was found to be quite challenging with many attempting parts (a) and (b) but omitting part (c).

In (a)(i) the most popular method was to attempt a conversion of the given equation to the form $(x-a)^2 + (y-b)^2 = r^2$.This was done with limited success, caused by a lot of basic errors in the associated algebra, mainly in the process of completing the square. Many students did obtain (4, 5) for the co-ordinates of the centre, but (-4, -5) and (8,10) were common incorrect answers.

In (a)(ii) if the equation of the circle was correct $r = 5$ usually followed, but $r = \sqrt{57}$, from $r^2 = 4^2 + 5^2 + 16$, and r or $r^2 = 16$ were also quite common.

Part (b) was well answered. Most students gained the M1 for using the correct formula with (20, 12) and their centre, but those with the correct centre often lost the A mark for giving a decimal answer rather than the exact answer √(305).

In part (c) a good clear, carefully labelled diagram was the key to success. Most students realised MTP was a right-angled triangle but it was so common to see the area given as 0.5 x √(305) x 5 (i.e. ½ x MT x *r*), suggesting a wrongly labelled diagram or the right-angle in the wrong position.

Those who used the alternative trigonometric method usually achieved the answer 41.8 losing the final mark as the answer was not in surd form. Some students spent much time and effort with equations of lines and in finding the co-ordinates of *P*, with often very limited success.

Question 12

This proved to be a straightforward question for students of all abilities, and most achieved very good marks. Techniques were generally well known and applied with sufficient working to make methods clear.

In part (a) most solutions were correct. Only occasionally were wrong methods used or careless arithmetical errors made.

In part (b) incorrect length formulae were sometimes seen and a just few students left the answer as √40. Students should be reminded to quote formulae they are using in a question like this before substituting their values.

Methods in part (c) were also generally correct, though some students failed to apply the perpendicular gradient rule correctly or made mistakes in finding the mid-point of *AB*. Sometimes the equation of a perpendicular through *A* or *B* was found instead of the perpendicular through the mid-point.

Question 13

The parts of this question that required trigonometry were generally negotiated successfully but the correct interpretation of direction bearings proved troublesome for a large number of students. This was highlighted in part (c) where there were often no attempts or only partial attempts.
In part (a) those students that understood how a direction bearing is defined gave very clear solutions but a few left this blank. The clear majority of students gained this mark by simply writing 360-314 = 46, 46 +52 = 98, in separate statements or combined as one, sometimes with 46 and 314 shown on the diagram.

As with all questions where there is a given answer, the required result often appears totally unjustified, and that was often the case here. There were also a small number of students who used their correct answer to part (b), using AB = 9.8 with the cosine rule, to show that angle APB = 98º.
The solution to part (b) required an application of the cosine rule using the angle given in part (a) to find the 3rd side in the triangle and this was solved correctly by most students to gain the two marks.

There was a wide range in the quality of response to part (c). Using the length found in (b) students had to apply trigonometry to find one of two unknown angles in the triangle, and then from that obtain a correct direction bearing. In the main, students correctly found one of the two unknown angles to obtain two marks, but then a significant proportion did not correctly identify the angle giving the required bearing, or simply did not attempt this and so a very common mark profile for this part was M1A1M0A0.

Question 14

This question elicited some excellent attempts at a challenging problem. It differentiated well between students, with almost all able to attempt something, and full marks gained by a minority. The best students usually annotated the diagram with coordinates and split the shaded area into the parts required.

In part (a) most students knew to equate the curve and the line and usually proceeded to score full marks. Algebraic or arithmetic errors were rare.

In part (b) almost all students scored the two marks for integration, though many just integrated with no clear idea of what was to be done with the result. A large number saw the most straightforward way (Way 1) and used correct values and integration to arrive at an answer succinctly. A small number of these lost the last mark because they worked in decimals, although most coped well with the fractions. At the other extreme some students did not even realise that at some point they needed to use integration, mistakenly identifying parts of the required area as triangles. The most frequently seen error in (b) was to use inappropriate limits, perhaps leading to a combination of two or more areas that simply did not make up the shaded region required.

Ways 2 and 3 in the scheme were less commonly seen and it was sometimes difficult to be convinced that progress was being made towards an acceptable method.

It should be noted that in this type of question the requirement for ‘algebraic integration’ means that numerical integration straight from a calculator is not acceptable.

Question 15

There were many instances when this question was not attempted. This was possibly because of lack of time, although by the confused thinking and poor presentation, with much crossing out, of many students who tackled this, it appeared to be a more unusual test of the binomial expansion than expected. However, good, neat solutions were seen by some students.
In part (a), to gain the method mark students needed to give a correct expression for the x^2 term in the expansion of $(1 + kx)^n$, allowing for a slip in giving $(kx)^2$ as kx^2, and equate it to $126k$. It was very disappointing that this mark was not gained by a majority of students who attempted it. Students should be aware that in a “show that” question they must show all steps clearly.

Part (b) was more accessible to many students and there were many who found the correct values for n and k. However, Examiners reported that often there were several attempts, often very poorly presented, with much crossing out, and that it was often very difficult to follow a candidate’s work, with results often emerging mysteriously. Students needed to form the equation $nk = 36$, by comparing the coefficients of x, and use it with the result in (a) to find n and k. The neatest solution, was to substitute $nk = 36$ to give $36(n – 1) = 252$, which produced $n = 8$, $k = 4½$ succinctly. Those who chose to substitute $k = 36/n$ or $n = 36/k$ often made heavy weather of it, especially in the second case. It was common to see $n = 36$ used, which gave $k = 0.2$ and this was treated as a special case and awarded one mark.
Part (c) required values of n and k used in a correct expression for the coefficient of x^3 in the binomial expansion. This was straightforward for

students who had performed well earlier in the question, although using k rather than k^3 was costly.

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