Examiners' Report

October 2016

Pearson Edexcel International A Level in Core Mathematics 12 (WMA01_01)

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IAL Mathematics Core 12 Specification WMA01/01

This was the first Core 12 paper in the new October series for the IAL specification. It contained a mixture of straightforward questions that tested a candidate's ability to perform routine tasks, as well as some more challenging and unstructured questions that tested the more able candidate. Most candidates were able to apply their knowledge on questions 1 to 9. Questions 10 to 15 required a deeper level of understanding. Candidatess should be encouraged to set their work out in a logical manner. Points that could be addressed by centres for future examinations are;

- insufficient evidence was given by some candidates on "show that" questions
- a failure to give exact answers or answers to the required degree of accuracy
- an over reliance on graphical calculators when answering questions that state "show your method clearly", "solutions based entirely on graphical or numerical methods are not acceptable" or "use algebra/use calculus to show..."

Comments on Individual Questions

Question 1

This was an accessible question. The most common errors seen were when dealing with the fractional or the negative powers. For example it was not uncommon to see $-\frac{4}{\sqrt{x}}$ appearing as $-4x^{\frac{1}{2}}$. Other reasons for candidates losing marks were on the sign of either term three or term four, or through the omission of the constant of integration.

Question 2

This was an accessible question. Those candidates who did lose marks did so in Q02(a) due to failing to divide by 2 or failing to give sufficient accuracy (0.68 was common) or in Q02(b) due to their failure to 'undo' the log correctly therefore writing their second line as $(3x+1)=-2^5$ rather than $(3x+1)=5^{-2}$

Question 3

Despite the rubric at the start of this question, many candidates still lost marks for showing insufficient method or due to a lack of clarity in their work. Centres may need to help candidates understand what steps are required in proving a statement.
In Q03(i) many candidates scored only the method mark as a consequence of going from the question $\sqrt{45}-\frac{20}{\sqrt{5}}+\sqrt{6}\sqrt{30}$ to the given answer via $3\sqrt{5}-4\sqrt{5}+6\sqrt{5}$. The demand of the question required candidates to show their method clearly so, for example, it was important to see $\sqrt{45}=\sqrt{9\times5}$, $\frac{20}{\sqrt{5}}=\frac{20\sqrt{5}}{5}$ and $\sqrt{6}\sqrt{30}=\sqrt{6}\sqrt{6}\sqrt{5}$ before $3\sqrt{5}-4\sqrt{5}+6\sqrt{5}$
Q03(ii) was on the whole, more straightforward to prove than Q03(i). Most candidates understood that they needed to multiply both the numerator and denominator by $\pm\left(\sqrt{2}-6\right)$.
It was also important however to show some intermediate working with the minimum number of steps being

$$\frac{17\sqrt{2}}{\sqrt{2}+6}\times\frac{\sqrt{2}-6}{\sqrt{2}-6}=\frac{34-102\sqrt{2}}{-34}=3\sqrt{2}-1$$

Question 4

This was an accessible question to all but the weakest of candidates. The better approach in Q04(a) was via the remainder theorem. Candidates who used algebraic division were usually successful, but this approach did require them to identify which of the two terms produced was the remainder. Most candidates correctly identified (x-3) as a factor of the cubic then used either algebraic division or equating coefficients to correctly identify the quadratic factor in Q04(b). The final two marks for this question were sometimes lost to candidates who used a calculator to find the roots of the quadratic factor, as some incorrectly factorised $6x^2+11x-10$ to $\left(x-\frac{2}{3}\right)\left(x+\frac{5}{2}\right)$

Question 5

The binomial expansion seems to be well known by most candidates. In Q05(a) having gained B1 for 243 nearly all earned at least the method mark for terms of the expansion. A variety of acceptable forms of the coefficients were seen such as ${}^5C_2, \binom{5}{2}, \frac{5!}{3!2!}$ or just the numbers appearing from Pascal's triangle. Accuracy marks were lost due to errors in signs or just as often due to a lack of bracketing. In Q05(b) candidates usually went on to equate their coefficients of x and x^3 . Those with full marks in Q05(a) usually went on to gain full marks in Q05(b) for $a=3\sqrt{2}.$ Candidates with sign errors in Q05(a) were able to pick up the accuracy marks in Q05(b) for valid work leading to the correct answer.

Question 6

Marks in this question were lost by candidates who failed to follow the instructions with "exact values" and "4 significant figures"
In Q06(a) almost all candidates were able to apply the rule for the sequence to find three terms but some lost a mark due to writing term four as 10.6 rather than $10\frac{2}{3}$
In Q06(b) the correct common ratio was stated in most cases but intriguingly some candidates used the correct value $2/3$ for "*r*" throughout the rest of the question but gave the common ratio here as 3/2.
In Q06(c) using the formula ar^{10} for the 11^{th} term was the most efficient way to answer this part. Many candidates, however, worked through term by term. A very common incorrect answer of "0.624 (4sf)" was frequently seen suggesting that the concept of significant figures is not properly understood.
For Q06(d) this part of the question was the one with which candidates had the most difficulty. Those who did not use the formula in Q06(c) usually added terms in this part, which for many resulted in a loss of accuracy, as rounded values were added together. The formula was usually correctly quoted and applied but the accuracy mark was often lost as a result of answers such as 98.5. Of those who gave an exact answer as required and gained both marks this was usually for the fractional form of the answer 2660/27.
In Q06(e) most candidates were able to answer this part of the question and marks were only lost where the value of "*r*" was incorrect or by an inability to divide by 1/3.

Question 7

Some candidates lost marks on Q07(a) for the sketch of $y = 3^{x-2}, x \in \mathbb{R}.$ Too many graphs were carelessly drawn and therefore failed to gain both marks. However some candidates had clearly spent considerable time and effort on very exact graphs based on the coordinates given in the table but then their curves usually stopped short of the *y*-axis, gaining no marks. Candidates who are generally very skilled in the use of their calculators seem to forget to use them to find the trend of the curve as $x \to \pm\infty.$ Although the exact value of the *y* intercept was required, many candidates gave this as 0.11 perhaps from their calculator display.
Q07(b) was well answered with many candidates gaining full marks, giving the correct answer to 2 decimal places. The most common error was in finding the value of "*h*", often giving it as 5/12 instead of 1/2 . Otherwise bracketing errors accounted for other errors and a few candidates ignored the instruction to use the trapezium rule and attempted to integrate the function.

Question 8

The most efficient way to tackle Q08(a) was use of the sine rule to find angle *ADB* and then use the fact that angles in a triangle add up to π radians. Candidates who chose this route were successful although a few failed to use inverse sine. There were many other alternatives which usually involved finding the length *AD* using the cosine rule. Accuracy errors were common, especially in those candidates who changed their angles into degrees, but usually the sine and cosine rules were used with the correct pairings of angles and sides. Some candidates incorrectly assumed that triangle *ADB* was isosceles with *AD*=6 cm.
Q08(b) proved to be more accessible for candidates than Q08(a) with many earning full marks for an answer which rounded to 48.9. Incorrect answers were mainly caused by incorrect combinations of sides and angles for the area of triangle *ABD* $\left(\text{Eg } \frac{1}{2}\times 5\times 6\times \sin 1.1\right)$ or the inability to calculate angle $DBC\left(\text{Eg } \theta = 2\pi - 1.20\right)$ when using area of sector = $\frac{1}{2}r^2\theta$. .

Question 9

In Q09(a) most candidates used a correct formula for the sum of an AP with appropriate values for *n* and *S* and proceeded correctly to the given answer. A few candidates used a listing method and usually gave sufficient detail for the mark to be awarded.
Similarly in Q09(b) most candidates were able to obtain a correct second equation using a correct formula for the sum of an AP. A few made a slip on the given total of 927, using 972 instead, and consequently losing all the following accuracy marks as this slip led to fractional values for '*a*' and '*d*' which, given the context of the question, had to be integer values.
In Q09(c) the majority of candidates gained the method mark for attempting to solve simultaneous equations. Most candidates with the correct pair of equations then went on to find the correct values for '*a*' and '*d*'.
In Q09(d) many candidates incorrectly used the formula for the sum of twenty terms rather than the formula for the twentieth term and so lost both marks. Those who used the formula for the n^{th} term did so correctly with their values for '*a*' and '*d*' and *n*=20 and so gained at least the method mark.

Question 10

Q10 (a) was done particularly well by the majority of the candidates who knew and applied the necessary trigonometric identities for $\tan x$ and $\cos^2 x$. Penalties for poor notation were applied to a small minority of candidates who wrote for example $\cos x^2$ or $\tan x = {}^{\sin}\!/_{\cos}$, therefore omitting the variable.
For Q10(b) candidates generally used the given answer to Q10(a), were able to solve the quadratic and achieve the correct value of -1/3. However it was only a small minority of candidates who then used this to achieve all four solutions accurately. The most significant reason for this was that candidates used the value -19·5 to obtain the four solutions. This has insufficient accuracy to achieve the final answers correctly to one decimal place. Candidates should be advised that when trying to obtain an answer to one decimal place, the working should be to at least **two** decimal places in order to get the final answers accurately. Another common issue occurred when candidates did not seem to realise that to achieve values of θ, they needed to divide their values of x from 0 to 720° by 2.

Question 11

For this question most candidates started by producing a quadratic equation although some made sign errors in the process, so that the values used when proceeding to an expression for discriminant were then incorrect. A degree of carelessness with regard to correct bracketing was often evident in the writing down the expression for the discriminant and setting it > 0. Those who had proceeded correctly to this stage then usually went on to reach the required inequality without further errors.
Q11(b) of the question was usually well done with many candidates scoring all four marks. Nearly all of the candidates solved the quadratic correctly. Occasional errors included wrong signs in the brackets leading to the values -1/3 and 5/2. Most then went on to achieve a solution set and only a comparative few found the inside region as opposed to the outside one. Some candidates lost the final mark as a result either of writing x instead of k or of linking the two inequalities with the word ‘and’.

Question 12

This is another question where candidates and centres need to be aware of the need to provide evidence. In Q12(a) the words "use algebra" were meant to encourage candidates to show working and at least set out a solution in a series of logical algebraic steps. In Q12(b), the words "use calculus" should have been sufficient warning that it was not acceptable to write down values from a graphical calculator.

In Q12(a) it was important to see a common factor of x or $\frac{x}{27}$ being removed first before seeing an attempt at solving the resulting quadratic. The quadratic formula then needed to be applied to find the exact *x* coordinates of *A* and *B*. Unfortunately many candidates used their graphical calculators to write down values without sight of any algebra being used.
Q12(b) was answered well by the majority of candidates. The cubic was differentiated accurately and the resulting quadratic was usually solved. Most candidates then went on to successfully find the coordinates of points *C* and *D*.
The following set of steps was frequently witnessed, again relying on graphical calculators.

$$\frac{1}{9}x^2 - \frac{2}{3}x - 3 = 0 \Rightarrow (x-9)(x+3) = 0 \Rightarrow x = 9, -3$$

Some weaker candidates did not seem to recognise the difference between Q12(a) and Q12(b) and thought that differentiation was required in Q12(a).
Q12(c) was more discriminating, with some candidates not attempting an answer and others giving an answer of -27 (the *y* coordinate of the minimum point).

Question 13

Q13(a) of the question proved to be accessible to most candidates with a majority producing fully correct responses. For those who failed to do so, common errors on the LHS of $(x-1)^2 + (y+3)^2 = 50$ included incorrect signs within the brackets and transposing the numbers. Additionally a few missed the power 2 from one or both brackets and a small number put *x* in both brackets. Common errors on the RHS included a sign slip in working out the radius, to get $\sqrt{74}$ or $\sqrt{82}$ as well as using $\sqrt{50}$ or 50^2 for r^2. There were a few weaker students who produced a linear equation from the two coordinates given.
In Q13(b) there were many fully correct solutions. The most common error was to find the gradient *AP*=1/7, but then fail to attempt the negative reciprocal proceeding to eg y = 1/7x – 22/7 so gaining the first mark only. Another common score trait was B0M1M1A0 for an incorrect initial gradient (eg 7, -1/7 or -5/7 were popular) but then proceeding with a correct method to find the equation of the tangent.
Q13(c) was less well answered with some completely blank responses. Nonetheless there were also many excellent attempts. A common incorrect approach was to solve simultaneously $y = x + 6$ with their linear equation from Q13(b). The minority who chose to substitute $y = -x - 2$ into the circle equation got two sets of coordinates, of which one needed to be rejected before full marks could be achieved.

Question 14

This question proved to be stretching for the candidates and, whilst a good proportion scored well on Q47(a), far fewer were successful on Q14(b).
In Q14(a) a number of candidates attempted to find the equation of the normal without differentiating the equation for the curve C and consequently scored no marks in this part of the question. Of those candidates who did differentiate, most did so correctly, but a minority, instead of substituting $x = 5$ to find the gradient of the curve at P, set their expression for the gradient function equal to zero (obviously getting confused with the process for finding stationary points). Of those candidates who reached the value - 4 for the gradient of the curve at the point P, most were able to proceed to find the equation of the normal.
In Q14(b) significant numbers of candidates were not really clear as to how to tackle this part. Some left this part blank, some attempted to calculate the area without using integration, some believed that the enclosed area was that of a triangle, and some used an approximate method such as the trapezium rule. However most candidates did integrate either the equation of the curve, or the difference between the curve and their line correctly.
The responses to the next part of the process, with the need to determine the correct limits for the integration and the corresponding values required to calculate the area of the required triangles, were very mixed.
The most common incorrect responses seen included:

- Calculating $\int_2^4 \left(-x^2+6x-8\right)\,\mathrm{d}x$ or $\int_4^{17} \left(-x^2+6x-8\right)\,\mathrm{d}x$ rather than the required $\int_4^5 \left(-x^2+6x-8\right)\,\mathrm{d}x$ for the area between the curve and the x-axis.
- Calculating $\int_4^5 \left(-x^2+6x-8\right)\,\mathrm{d}x$ but then calculating the area of the triangle as $\frac{1}{2}(3)(17-4)$ rather than the correct $\frac{1}{2}(3)(17-5)$
- Using an incorrect integral e.g. $\int_4^{17} \left(\frac{1}{4}x-\frac{17}{4}\right)\,\mathrm{d}x$ for the area of the triangle or using incorrect values such as 5 rather than the 3, when calculating the area of this triangle.

Many candidates did not show sufficient working in this final part and simply stated that $\int_4^5 \left(-x^2+6x-8\right)\,\mathrm{d}x = -\frac{4}{3}$ even though the question explicitly stated that such "graphical or numerical methods were not acceptable."

Question 15

This question challenged most candidates, and there were lots of scores with 3 or fewer marks on the whole question. Again presentation could be improved by candidates stating what their expression represents. Eg stating V= or S = or $\frac{\mathrm{d}V}{\mathrm{d}r} =$ before attempting algebraic manipulation would be helpful to an examiner.

In Q15(a) a typical score for this part was 10010 mainly due to a lack of appreciation of how to find the three faces that made up the surface area.

In Q15(b) the best solutions resulted from candidates who started by splitting V into 2 separate fractions. A common error in this process was the appearance of $200\pi r - \pi r^3$ or $200\pi r - \pi r^2$ on the numerator rather than $200\pi r - \pi^2 r^3$ Other methods that worked well were from candidates who wrote $V = 61.1r - 0.96r^3$ before differentiating. Poor algebra was seen by many candidates who attempted to simplify $V = \frac{\pi r\left(200 - \pi r^2\right)}{4 + 2\pi}$ to

$V = \frac{200\pi r}{4} + \frac{200\pi r}{2\pi} - \frac{\pi^2 r^3}{4} - \frac{\pi^2 r^3}{2\pi}$ or similar

For those who produced an answer in Q15(b), most went on to gain the method mark in Q15(c) for considering the sign of the second derivative. To score both marks, the candidate needed to differentiate correctly, use their value of r from part (b) and state that as $\frac{\mathrm{d}^2V}{\mathrm{d}r^2} > 0$, V is a maximum.

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