Examiners' Report
Principal Examiner Feedback

October 2020

Pearson Edexcel Advanced Subsidiary
In Mathematics (9MA0)
Paper 01: Pure Mathematics

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In October 2019 we informed customers that all papers from summer 2020 onwards will enhance student experience when sitting examinations.

The improvements to papers will focus on:

- **ensuring early questions are accessible to** all and then steadily ramp in demand to encourage engagement and help build students' confidence through the papers
- **dividing questions into parts** so students are clear where marks can be achieved and can manage their focus and exam timings accordingly
- **using clear, concise language** to better enable all students to access the questions and understand the type of response expected.

The October 2020 paper was the first one to showcase these changes within an examination series. Early questions did prove to be very accessible with the prepared candidate scoring high marks in questions 1 to 6. Later questions offered restarts to candidates who could not complete the part (a) 's. Examples of cases where restarts were offered are Qu 9b&c, Qu 10 b, Qu 11b, Qu 13b &c and Qu 15 b.

Question 1

As hoped for, this proved to be a gentle and accessible start to the paper. The majority of prepared candidates scored all available marks in part (a). Errors, although rare, were mainly seen in the failure not to square the 8 of $(8x)^2$. Part (b) was found to be more demanding. Successful students substituted $x=\frac{1}{32}$ into $(1+8x)^{\frac{1}{2}}$ and noted that the result was $\frac{\sqrt{5}}{2}$. It then became a simple task of stating that you merely needed to substitute $x=\frac{1}{32}$ into the expansion in (a) and multiply the result by 2. Concise explanations are still a weakness in the early years of this specification.

Question 2

As with question 1 there were many fully correct answers here. Of these, most took logs or lns of both sides, then used the power law on each side and the correct order of operations before proceeding to the correct answer of 81.6. There were a few candidates who failed to put brackets around (3*p* -1) but they were usually able to recover.
There were several cases of candidates failing to apply the power rule to both sides, usually not dealing with the '210'. Some candidates misapplied the power rule, multiplying first for example by 3, rather than 3*p* -1.
Common errors were

- after applying the power rule correctly changing log5/log 4 to log(5/4).
- taking either $\log_4$ of one side or $\log_5$ of the other without any application of the power law

Question 3
In part (a) most candidates were able to successfully subtract vectors the correct way round gaining both marks. Very few candidates added the two vectors together.
In (b) those who gained both marks were able to compare the two vectors *AB* and *OC* to show that they were parallel and conclude that *OABC* is a trapezium. Usually candidates made a sketch of a trapezium so they could visualize which vectors or sides they would compare. This is a very good idea and should be encouraged by centres.
Marks were lost when

- candidates did not give a minimal conclusion after finding *OC* and *AB* were parallel.
- candidates incorrectly stating that $\overrightarrow{AB} = 2\times\overrightarrow{OC}$
- candidates finding the length of each side *OABC* rather than their directions

Question 4
This was a relatively straightforward test on function notation.
In part (a) most candidates opted to find the inverse function $f^{-1}(x)$ before substituting in $x = 7$. Very few attempted the more straightforward method of solving $f(x) = 7$. Most candidates achieved some success, with some slips being made by those attempting to find $f^{-1}(x)$. Of those gaining no marks, the majority came from a misunderstanding of the notation with some substituting $x = 7$ into $f'(x)$ and others into $[f(x)]^{-1}$
In part (b) most candidates understood the notation and gained the first mark by forming an expression of the correct form. Many were then able to multiply both numerator and denominator by $(x-2)$ to form a single fraction of the required form. This part is where most errors crept in; some having problems with the bracketing but most with the process of multiplying all terms on both numerator and denominator by the (x – 2) term.

Question 5
This question on modelling the speed of a car using arithmetic and geometric sequences proved popular. Many candidates answered both parts well and gained full marks.
In (a) the most common errors were to divide $(115-28)$ by 6 in finding *d*. In part (b) errors were mainly due to a lack of accuracy and prematurely rounding their value for *r*. A small number of candidates used the sum formula in both (a) and (b) and as a result scored no marks. Additionally other candidates used their answer from (a) as one of the terms in (b), leading to an incorrect value of *r*. The second method mark was made available to these candidates.

Question 6
This was the second modelling question on the paper.
Part (a) was generally well done, with few errors on giving the exact value of *R* or the angle in radians to the required degree of accuracy. A very small number of candidates gave *R* as a decimal or the angle in degrees.
Part (b) was also well done with most of those candidates giving the exact answer for the temperature. Occasionally candidates obtained an answer of 8° C from 5 + 1 + 2, which they obtained from taking the maximum values of sin and cos.

Part (c) was more challenging. The correct answer could be obtained fairly quickly by solving $\frac{\pi t}{12}+1.107-3=\frac{\pi}{2}$ but often the 1.107 and/or the 3 were omitted. Stating the time in an acceptable format also proved surprisingly difficult.

Question 7

A very significant majority of the candidates did not seem to know how to define a region using inequalities. It was common to see a response where the area of region *R* was attempted using integration. It was only a small minority of candidates who made a correct inequality statement at the end, even with the allowance of follow through on their quadratic curve and their line equations. It was often the case that this final mark was lost due to a candidate using the letter *R* rather than *y* in their inequality.

Finding the equations of the boundaries of the region is essential when defining the inequalities, so candidates who went on to find an area were mostly still trying to do this and if successful would have only lost the final mark. A very small minority of candidates found the area below the line by using a trapezium area formula and so did not manage to gain the marks for the line equation.

Finding the line equation correctly was achieved by a majority of candidates, although a slip with the line gradient did occur occasionally even if the diagram showed a convincingly positive gradient. Finding the equation of the quadratic curve was found to be more difficult, with a common error being $f(x)=(x+2)^2+13$. Occasionally a candidate spotted that this was not consistent with the curve going through (0,25) and tried to adjust their answer, but not often in a correct way. Attempts at using $f(x)=a(x+2)^2+13$ were often successful at finding a, whilst attempts at using $f(x)=ax^2+bx+c$ were much less often correct.

Question 8

Candidates were expected to realise that "**when the rate of change is proportional to the *y* value, an exponential model should be used.**" The question seemed to take a great many candidates by surprise and many assumed that '*n* was proportional to *n*' or that '*n* was proportional to *t*', not that the rate of growth of '*n* was proportional to *n*'. Those that did interpret the situation correctly could write down an equation very quickly whereas others attempted to solve a differential equation.

Equations scoring one of two marks were common and included $n = Ae^{t}, n = e^{kt}$ and $n = Ae^{kt} + b$

Question 9

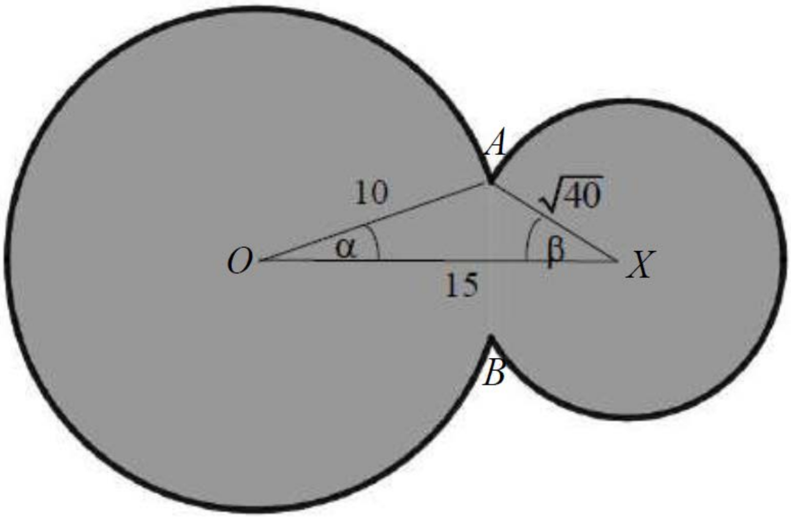
Parts (a) and (b) of question 9 were standard bookwork involving the product rule of differentiation using an exponential function. Well rehearsed candidates were very successful here scoring the majority of marks. The diagram should have helped in determining the maximum and minimum points of the function.

Unsurprisingly candidates found part (c) more challenging, especially (c) (ii) where the significance of x=0 was rarely understood. It was however a good discriminator for stronger candidates.

Question 10
This question proved to be more discriminating than expected with many failing to notice the partial fractions in part (b), thereby losing 6 marks.
Part (a) was well answered by many candidates, particularly those who opted to calculate d*x*/d*u* rather than d*u*/d*x*, as the latter proved harder to substitute correctly into the expression in terms of *u*. Some students lost the final accuracy mark for not showing a correct intermediate line with integral signs and some did not finish their working with an expression showing the given integral. A few candidates made arithmetic slips in finding the limits or did not attempt to change them at all.
Of those who did use partial fractions in part (b), most found the values of "*A*" and "*B*" correctly. Unfortunately many integrated $B/(3 + 2u)$ to $B \ln(3 + 2u)$, failing to divide the coefficient by 2. The final Method mark was still available for these candidates, but a number failed to simplify their numerical logs to an expression of the required form and so did not gain this mark.
A pleasing number of well prepared candidates did gain full marks in this question.

Question 11
This proved to be a challenging question with very few candidates achieving full marks overall, and with many more difficulties encountered in (b) rather than (a).
(a) Candidates used a variety of approaches. The most common started by using algebra to find the coordinates of the points where the circles meet. This was achieved correctly by a majority of those who did the question this way. Then the required angle was found either by trigonometry in a right angled triangle and doubling an angle, or by the cosine rule in triangle *AOB*. Errors in this approach included processing $x^2+y^2=100$ into $x+y=10$. Although a minority of candidates' answers stopped after finding coordinates for *A* or B, there were a significant number who went on to score the remaining 2 marks. However, some did not seem to realise that length $OA=10$ as it is a radius of C_1, and had to use the distance formula to find this length.
Another approach that was seen, but not so frequently was to use knowledge of circle equations in finding the radii and centres, to establish the lengths of the sides of triangle *OAX*, with *X* being the centre of circle C_2. Using the cosine rule then led to half of the required angle. When used, this method often gained all four marks. (See relevant diagram below)
(b) It was very common to see just the first mark scored in this part. This was due to many candidates wrongly assuming that the given angle $AOB=0.635$ was the same size as the angle *AXB* at the centre of circle C_2. For the minority of candidates who tried a correct method to find the size of angle *AXB*, or half of it, most of these achieved the correct values of either 1.03 or 0.516. Even for the minority of candidates who found one of these angles correctly, getting the final answer correct proved a challenge and only a very small minority managed this.

Note that it was possible to do part (b) even if (a) was not attempted. However, it seemed that failure to find a way to do (a), led in nearly every case to no valid attempt at (b).



Question 12

Part (a) was generally answered well and there were remarkably few solutions containing missing variables. On this occasion, candidates who started with the RHS fared better as those who worked from the LHS occasionally missed the required step between $cos^2\theta/\sin\theta$ and $\cos\theta\cot\theta$, while those who worked from both sides would often get confused or, if they progressed correctly they simply failed to make the necessary conclusion.

Part (b), however was very often left completely blank. Many who attempted it failed to see the connection with (a) and got lost in complicated trig expansions which led nowhere. Of those who did use part (a) to answer part (b), the most common solution was simply x=25 after cos x had been cancelled, thus losing the solution given by cos x =0. Only a small minority of the most able found all 3 solutions.

Question 13

This question on sequences proved very discriminating, with weaker candidates scoring only the first mark. As with many questions on this paper however, there were some excellent and well written responses.

In part (a) applying the iterative formula to find a_2 was achieved by almost every candidate. A significant number then attempted to find a_3 and also a_4 in many cases but failed to simplify expressions for $a_2 = \frac{4k}{2}$ and $a_3 = \frac{k(2k+2)}{2k}$. Setting $a_4 = a_1$ was often seen but fully correct proofs were rare.

In part (b) only a very small minority of candidates gave a correct and sufficient reason why k cannot be equal to 1. Although a larger minority did state the sequence would be 2,2,2, … only a small number of these pointed out that this is not a periodic sequence with order 3.

Part (c) could be done independently to (a) and (b), and many candidates took advantage of this. It was not uncommon to see the terms $2, -4, -1$ in (c) where only the first mark in (a) had been scored. Methods of finding the sum to 80 terms generally revolved around the calculation $26\times(2+-4+-1))+(2)+(-4)$. Incorrect attempts involved uses of both arithmetic or geometric sum formula or ones involving an average of the terms.

Question 14

Students found aspects of this question difficult despite the fact that the differential equation to be solved in (b) was not too demanding. Only high scoring candidates tended to make any significant progress in this question.

In part (a) many candidates failed to use the chain rule $\frac{dV}{dt}=\frac{dV}{dr}\times\frac{dr}{dt}$ with an acceptable $\frac{dV}{dt}$ and $\frac{dV}{dr}$. It was possible to proceed to the given answer without knowing the formula for a sphere, using $V=\lambda r^3$ but errors and blank solutions were common.

Common errors were;

- stating $\frac{dV}{dt}=-k$, and then failing to provide a minimal explanation of how their $k/4\pi$ was replaced with k.
- quoting an incorrect formula for the volume of a sphere. Attempts included $V=\pi r^3$, $2\pi r^3$, $4\pi r^3$ and even $4\pi r^2$.

In (b) students who attempted to solve the given differential equation often separated the variables correctly and integrated both sides with both indices correct. Marks were lost when students failed to give a constant of integration and as a result could not apply the given conditions correctly to their equation in r and t.

In part (c) many students were confused by the wording and did not realise that a limiting value for t was required. Many attempts merely stated that t could not be negative or that $t > 0$. Those candidates who did proceed to a limiting value for t generally had the right idea and most of these obtained a value of $t > 5$ and gained the A mark when their equation form part (b) was followed through.

Question 15

Although fully correct solutions to this question were very rare, many candidates were able to score marks from both parts.

In part (a) the first two marks for the implicit differentiation were very accessible for the prepared candidate. Proceeding to the required result for the second two marks proved a little more challenging. Only high achieving students noticed the relationship could be proven via the trigonometric identity $1+\tan^2 y=\sec^2 y$.

In (b) candidates often scored the M1 for an unsimplified second derivative or a correct structure with a sign incorrect. Where the first A1 was scored in (b), it was usually awarded for a correct simplified $\frac{d^2y}{dx^2}$, or solving $\frac{d^2y}{dx^2}=0$ to get $x=\sqrt[4]{27}$

Very few candidates seemed aware that they needed to show a change in sign of $\frac{\mathrm{d}^2y}{\mathrm{d}x^2}$ either side of $x = \sqrt[4]{27}$ to show a point of inflection.

Question 16

Marks on this question were only scored by above average candidates and many made little or no progress towards a proof. There were many blank responses.

Candidates who attempted to factorise $4p^2 - q^2$ were more successful than by other methods, although the large majority of these scored only the first mark, by stating the assumption and factorising to $(2p+q)(2p-q)$, but making no further progress.

Of those that did consider the factors of 25, many did set up and solve two relevant equations simultaneously, and so gained 3 marks, but very few considered both of the required pairs of equations and so did not all marks.

There were many discussions of odd/even integers but this was commonly followed by working in the same variable for *p* and *q*, which gained no marks

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