Pearson Edexcel

Examiners' Report
Principal Examiner Feedback

Summer 2019

Pearson Edexcel GCE AS Mathematics In Pure Mathematics Paper 1 (8MA0_01)

Edexcel and BTEC Qualifications

Edexcel and BTEC qualifications are awarded by Pearson, the UK's largest awarding body. We provide a wide range of qualifications including academic, vocational, occupational and specific programmes for employers. For further information visit our qualifications websites at www.edexcel.com or www.btec.co.uk. Alternatively, you can get in touch with us using the details on our contact us page at www.edexcel.com/contactus.

Pearson: helping people progress, everywhere

Pearson aspires to be the world's leading learning company. Our aim is to help everyone progress in their lives through education. We believe in every kind of learning, for all kinds of people, wherever they are in the world. We've been involved in education for over 150 years, and by working across 70 countries, in 100 languages, we have built an international reputation for our commitment to high standards and raising achievement through innovation in education. Find out more about how we can help you and your students at: www.pearson.com/uk

Summer 2019
Publications Code 8MA01_01_1906_ER

Introduction

This was the second AS level Pure paper for the new specification. The paper seemed of an appropriate standard being accessible to the vast majority of the candidates. The paper stretched the brightest of candidates but gave less strong candidates the opportunity to score a reasonable number of marks. Centres had clearly prepared their candidates for the new style questions with good responses seen on questions 4, 9 and 13 although a lack of understanding in the required demand on questions 14, 15 and 16 was also evident.

Candidates need to take care in writing down their answers to 'modelling' questions. In questions 4 and 9, for example, units were required to score all available marks.

The answers to questions requiring explanations were often the weakest. Clearly this will improve over time as centres gain more experience in preparing candidates for this type of question. There were many examples where candidates had a vague idea of ‘the answer’, but many were unable to express themselves with sufficient accuracy or clarity to gain any credit. This was particularly relevant in questions 9d.

It is also important that candidates don't rely on calculator technology too much, as certain questions require them to show full methods in order to score full marks. Examples of this included question 2 (ii), 11b and 13.

Question 1 (Mean Mark 3.39 out of 4)

This question was generally well answered.

(a) Most candidates attempted to rearrange the equation of l_1 into the form $y = mx + c$, with only a small minority stating that the gradient was 2. In a few cases a sign error crept in when the terms in the original equation were rearranged. Most candidates attempted the negative reciprocal, although a significant minority failed to change the sign. Relatively few candidates lost a mark by leaving the gradient unsimplified (as 4/2).

(b) Marks were lost owing to slips in the rearrangement of the equation of l_1 by either a sign error or, more frequently, a failure to divide the constant by 4. Most candidates attempted to equate two equations rather than substituting their $y = 2x + 7$ into the original equation. Sign errors, particularly with the constant, were a frequent cause of lost marks as the candidates attempted to solve their equation for x. Many candidates continued, unnecessarily, to find the y-coordinate. A few candidates, who erroneously had parallel lines, still tried to find a point of intersection.

Question 2 (Mean Mark 3.42 out of 8)

(i) Many candidates approached this question well and were able to manipulate the indices correctly to achieve $a = 0.25$. Several candidates who derived a fractional index of x on one side of the equation were unable to successfully ‘undo’ the index e.g. $x^{3/2} = k$ often became

$x = \sqrt{(k^3)}$. Few managed to deduce a =0 due to cancelling a factor of a instead of factorising it out. Many candidates squared both sides of the given equation to have integer indices, though they frequently did not square the coefficients as well. Depending on how they processed their equation was key to whether they got both solutions. Those who factorised or used calculator methods to solve the quartic equation were more likely to get both solutions. A significant number of candidates displayed very poor algebra skills when attempting to isolate a in this part and for the most part the same candidates also tackled (ii) poorly.

(ii) Many candidates were able to spot the quadratic equation in b^2 which then led to correct factorising and the elimination of the imaginary solutions. Reasons for losing marks were:

- giving only $+\sqrt{2}$, instead of the full solution $\pm\sqrt{2}$
- including the imaginary solutions $\pm 3i$ so losing the final mark.
- solving the equation using their calculator, a method forbidden by the question.

<u>Question 3 (Mean Mark 4.47 out of 6)</u>

In part (a) the majority of candidates found this part straightforward, although the omission of $+c$ remains a common flaw. Errors tended to lie with the first term; the minus sign was almost always present but the coefficient was sometimes left unsimplified or the index 'increased' to 4. In part (b) most candidates were able to substitute the correct limits into their result from part (a) in an attempt to find k from the resulting linear equation. Common errors in part (b) consisted of

- a lack of bracketing when substituting in 0.5
- equating their integrated expression equal to 0
- algebraic slips in solving their linear equation in k.

<u>Question 4 (Mean Mark 2.48 out of 5)</u>

This was a relatively straightforward question, but the success of candidates tended to be centre dependent, due to it being one of the newer aspects of the specification. In (a), candidates used a variety of successful methods to gain all three marks: the most commonly seen method involved using the given values to, first find the gradient, and then one of the straight-line graph forms to arrive at $H = mt + c$. Other methods included formation of simultaneous equations in m and c which could be solved in a variety of ways. The words 'Using a linear model', however, led some candidates to make the erroneous assumption of $H = at^b$ or $H = a(b^t)$.

In part (b), most candidates achieving a linear model in (a) were able to recognise that the tree's initial height, (consistent with their equation), was the value of 'c' in their linear model. The second mark was for a convincing statement suggesting that the values of 1.42m and 1.4m were similar and therefore supported the model. This mark was often lost due to lack of the correct deduction, or by thinking that these two values needed to be exactly the same and so rejecting the model.

Question 5 (Mean Mark 3.46 out of 5)

Almost all candidates were able to access some of the marks available in this question with many gaining full marks in (a). However, (b) was done with much less confidence with many candidates making little or no attempt.

(a) The majority of candidates achieved the first two marks (for the $6x$), with very few integrating instead of differentiating. Common errors with the $24/x$ term included rewriting the term as $+24x$ or $24x^{1/2}$ before differentiating. A few wrote the term correctly as $24x^{-1}$ but differentiated to -24.

(b) Some candidates seemed unfamiliar with what was meant by an increasing function and did not attempt to use $dy/dx > 0$. Common incorrect attempts included finding d^2y/dx^2 or treating the original function as a quadratic with attempts to complete the square or find the discriminant. Of those who constructed the correct inequality, a number lacked the algebraic manipulation skills to deal with inequalities with both positive and negative powers of x. Candidates should ensure they provide answers in the form requested by the question. It was very common to see final answers given as rounded decimals only, when an exact answer was required.

Question 6 (Mean Mark 4.01 out of 6)

This question was accessible to the vast majority of candidates, most of whom were able to, at the least, make a start in both part a) and part b).

In part a), most candidates could recall the correct formula for the area of a triangle. After a correct initial statement for the area of the triangle, a number of candidates lost a factor of x, simplifying $\frac{1}{2}.2x.3x$ to $3x$ thus obtaining a linear equation in x rather than a quadratic.

The rigour demanded in a 'show that' question tended to cost some candidates marks when they failed to demonstrate the individual steps in their calculations. In particular, it was quite common for candidates to fail to demonstrate that they had used $\sin 60° = \frac{\sqrt{3}}{2}$ within their calculation. Candidates should be made aware that for questions such as these where they are asked to 'show that', it is imperative that they demonstrate each step of their method on paper.

Part b) tended to be less problematic and candidates were often more successful here than in part a). The vast majority of candidates were able to correctly quote and use the cosine rule.

Occasionally, candidates became confused with the side lengths and errors arose in the substitution of x into the cosine formula. Other errors arose in the squaring, sometimes $(3 \times 2\sqrt{3})^2$ became $3(2\sqrt{3})^2$ for example. Finally, and worryingly, a very common mistake was not knowing about 'order of operations' with $156 - 144\cos 60° = 12\cos 60°$ frequently seen

Question 7 (Mean Mark 4.07 out of 8)

In general, parts (a) and (b) were well done with part (c) causing some issues.

(a) There were many well drawn sketches with the correct equation of the asymptote either stated on the graph or below it. A common mistake was for the lower branch not to cross the x-axis, thus demonstrating a lack of understanding of the relevance of the asymptote (in effect $y = 0$ became another asymptote). One observation from part (a) is that many candidates ignored the blank section of the paper and attempted to draw their graph on the line page. Whilst this is not an issue, too many candidates failed to use a ruler and had dubiously shaped curves, often curving away from the asymptotes for larger values of x and y.

(b) This part was answered well, and most candidates, realising that a proof was required, took care over their presentation and showed all their steps. A few lost the final mark for failing to show how they had multiplied by x, or for small algebraic errors.

(c) Candidates who identified the link between the discriminant and the fact that l was a tangent, generally secured full marks. Those who attempted the alternative method of completing the square were often defeated by the algebra. Attempts using differentiation tended not to gain any credit.

Question 8 (Mean Mark 3.9 out of 5)

This question was generally well answered with many candidates scoring full marks in part (a). Candidates had been clearly well rehearsed with binomial expansion and were able to make an attempt at applying the correct technique. For those that had some success with the question, the '64' to score B1 was almost always seen, as was the '$144x$'. The most common mistake was with '$135x^2$', with many candidates not including the coefficient of x when squaring and using $3x^2/4$ instead of $9x^2/16$. Seeing more than three terms calculated was rare. Occasionally candidates did not sum the terms, but this was condoned for the question. Finally, there were some candidates who failed to simplify their expressions fully, which was penalised in the final accuracy mark.

In part (b) candidates had less success. While the vast majority had some idea what to do, frequently the language used was unclear and candidates did not always fully explain what to do, often omitting the detail of substituting the value of x into their binomial expansion. Ambiguous phrasing, such as, "substituted into the previous equation" was penalised here. Many candidates went beyond the requirements of the question and calculated x, with some going further and substituted their value in to the binomial expansion. As usual, a common misconception was to let $x = 1.925$ and substitute it into the expansion.

<u>Question 9 (Mean Mark 2.38 out of 6)</u>

Most were able to attempt this question, but lack of units cost a significant minority a mark.

(a) All but the weakest candidates produced a correct value.

(b) Again, the majority of candidates found this value. However, many did not appreciate the form of the given equation and embarked on differentiation, thus expending much effort for a single mark.

(c) Most candidates could not distinguish between 'in 2023' and 'up to the end of 2023' and offered 432 as their final answer (from $n = 4$). Those who had some understanding of the requirement of the question were about equally split between the correct $T_5 - T_4$ (= 93) and $T_4 - T_3$ (=99).

(d) Whilst some candidates realised the model could not work after 20 years (or 40), most could not explain why. The second mark was rarely awarded as candidates failed to appreciate that it was the **total** mass mined (T) that could not decrease. Many responses commented on the context of the question rather than the model and went on to discuss the logistics of mining and how the tin might or might not run out over time.

<u>Question 10 (Mean Mark 3.14 out of 5)</u>

(a) This was generally answered successfully with candidates able to complete the square and set the equation in the correct format. Usual numerical errors when manipulating equation led to sign errors and a wrong value for r^2.

(b) Candidates need to use the marks available as a guide to how much work they need to be doing. The most common error was to fail to recognise that $x = k$ is a *vertical* straight line. Those who sketched a diagram were able to deduce the values of k by adding and subtracting their radius from the centre's x-coordinate. However many, many candidates opted to equate the line $x = k$ with the circle equation using substitution which led to a complicated manipulation and use of the discriminant to achieve their final answer. Of those who attempted this method, few were successful with most abandoning their method before reaching a conclusion.

<u>Question 11 (Mean Mark 5.67 out of 10)</u>

As a general point, it is worth noting that a good examination technique is to look at the mark allocation in a question. Some candidates submitted virtually no work in part (b) where there were 4 marks, yet produced half a page of work in (c) or (d) which had an allocation of just 2 marks. The number of marks allocated to any part of a question is a good hint to the depth and detail of work required.

(a) Almost every candidate gained the first mark by either substituting $x = 4$ into f(x) and finding that f (4) = 0, or by dividing f(x) by (x – 4) and achieving a remainder of 0. However, in a proof, a conclusion is **always** required. Therefore, candidates were required to state that (x – 4) is a factor because f(4) = 0. However, it was pleasing to note that many more did follow this protocol than in the preceding year.

(b) As in part (a), a ‘show that’ question always needs a concluding statement. Most candidates were very adept in algebraic division and did so clearly and accurately gaining the first two marks. The majority went on to factorise the 3TQ successfully. What too many candidates failed to do at this stage was to refer back to f(x), write it out in its complete factorised form of $\mathrm{f}(x)=(x-4)(x-4)(2x+3)$, and then state that because there was a repeated factor, the equation $\mathrm{f}(x)=0$ had only two roots. Confusion between roots and factors cost some candidates the final mark as they incorrectly referred to $(x-4)$ as a root. Quite a few candidates found $b^2 - 4ac$ for the quadratic expression, stated that as it was > 0 and therefore two roots, clearly thinking that they had answered the question. There was also clear evidence of use of calculators to find the roots followed by an attempt to work backwards to obtain the factors; this was unacceptable.

(c) Those who noticed that the value of the constant had changed from 48 to 46 recognised that the new equation had three roots. Only a few went on to explain that f(x) had been transformed by the vector $\begin{pmatrix} 0 \\ -2 \end{pmatrix}$, or even just 2 places downwards cutting the x-axis in three places. A large number of candidates did not spot the difference between the equation in (c) and f(x) = 0 and many of those merely explained what they had done in (b).

(d) This part of the question was generally either missed out entirely, or else the correct answer was given. Infact quite a few candidates, who had scored only a few marks in parts (a) (b) and (c) combined, achieved both marks here.

Question 12 (Mean Mark 3.11 out of 7)

(a) This was a straightforward proof. Most candidates recognised the need to use $\sin^2\theta+\cos^2\theta=1$ but there were many instances where $10\sin^2\theta$ became $10-\cos^2\theta$ or the $7\cos\theta$ was adapted. There were many well written out proof however with few candidates being penalised marks for incorrect notation eg cos for $\cos\theta$ or $\sin\theta^2$ for $\sin^2\theta$.

Part (b) was, on the other hand, very badly done. Many candidates failed to heed the use of the word "Hence" and started again wasting valuable time. Of those who did use part (a) failed to have a reliable method of solving $4-5\cos x=4+3\sin x$ with may failing to eliminate the 4's. Of those who did reach $-5\cos x=3\sin x$ many had solutions that involved variations of $-\frac{3}{5}\tan x=0$. Better candidates found the manipulation straightforward and proceeded to find both solutions without any difficulty. As a result this question was an effective discriminator.

Question 13 (Mean Mark 4.3 out of 7)

This was an open ended question, types of which are expected in the new specification. Almost all candidates were able to achieve some credit in this question. Poor notation (usually the omission of dx from the integral) caused many to forfeit the final mark. Some candidates seemed unaware that it was unacceptable to rely entirely on a calculator and that they needed to show detailed working in this "show that" question.

Many candidates attempted to integrate (usually correctly) but with no other work of any value, some using 0 and k as limits and some even showing the substitution of k and 0 and subtracting. But without a value of k found via differentiation, only the second B mark was available to them. Other candidates thought they could find k by finding the roots of the original cubic despite it being clear from the diagram that the origin was the only root.

Of those who realised differentiation was required, most arrived at $x = 5/3, 4$. Some of these candidates spotted from the graph that $k = 4$, but many wasted time, either by finding the corresponding y-coordinates (and using the x value corresponding to the lower of these) or using the second differential (where $d^2y/dx^2 > 0$) to determine which was k. A few candidates having found the second differential, equated this to zero and erroneously used the resulting value as k.

Occasional mistakes with limits included using 5/3 instead of 0 as the bottom limit and subtracting the wrong way round (or even adding) after substituting.

Some candidates forfeited the final two marks for failing to show intermediate working.

Question 14 (Mean Mark 3.16 out of 9)

In general parts (a), (c) and (d) were well attempted, with many scoring the three available marks here and nothing else.

Part (a) was well answered by most. It was rare to see any working out – just the correct answer stated. Very occasionally £2300 was seen here.

Part (b) was the part candidates found most challenging, and many left it completely blank.

Of those that attempted part (i), most knew to multiply by -0.25, but many struggled to construct a sufficiently thorough explanation to support their work to arrive at the given equation. The most common mistake was getting confused by the negative sign. Some candidates didn't seem to have recognised that a decreasing rate of change would be negative, and quite often the negative sign was just ignored. Often the given equation was relied upon too heavily, with some appearing to work backwards – the mark scheme required some evidence that they had differentiated, and as a result, many scored no marks due to no reference to dV/dt (or at least dy/dx for the first M1). Occasionally candidates who had otherwise been successful here were not awarded the final accuracy mark due to a failure to replace t with T.

It was encouraging to see that even when candidates were unable to make progress with (b)(i), they frequently had a go at part (ii), often with some success. Candidates' use of logarithms was broadly good, with only a few forgetting to divide by 3925 before introducing logs. If attempted, most were able to get to T=8.24. There were several instances of this then being written as 8 years 2 months, instead of the correct 8 years 3 months, but the majority of those got to the decimal answer were able to convert it successfully.

A good understanding of the exponential graph was clear in part (c) as the vast majority scored the mark here for (£)2300. Occasionally 500 was seen here, perhaps misinterpreting the question.

Responses to (d) were many and varied. Frequent correct answers included mentioning damage to the vehicle, variability in mileage, and the potential for the car to become an antique. For those who weren't awarded the mark the most popular responses were that it only made predictions based on year, not months or days, claiming the car's value may not follow a linear pattern of decrease and predicting that the car's value will eventually become zero.

Question 15 (Mean Mark 0.48 out of 4)

It was very rare to see a response worthy of full marks and many candidates made no attempt to answer this question. It was clear that this new aspect of the specification was not well known by candidates.

It was expected that candidates would consider odd and even numbers separately using a logical or an algebraic approach as detailed in the mark scheme. Almost all the candidates who gained any marks used either approach, or even a mixture of both.

Marks were commonly lost by:

- using n (even) and n +1 (odd) which brought no success at all
- failing to appreciate the difference between "cannot be **divided** by 8" and "is not **divisible** by 8"
- errors in the expansion and simplification of $(2k + 1)^3 + 2$
- a lack of rigour in the explanation that $8k^3 + 12k^2 + 6k + 3$ is not divisible by 8
- failing to write a concluding statement (for the final mark)

There were also a few attempts at proof by contradiction, some of which were quite impressive, considering the more difficult nature of this approach. Many embarked on a completely numerical approach (in some cases claiming to have demonstrated proof by exhaustion) and did not, of course, score any marks.

Question 16 (Mean Mark 0.86 out of 5)

This was a poorly answered question at all levels. In part (a) it was expected that candidates would recognise the fact that the vectors would need to lie in the same direction but many attempted to write out the given expression in words. There was slightly more success in part (b) with most attempting a diagram of sorts to get a feel for the problem. Unfortunately a lack of understanding of vectors meant that $|\mathbf{m}| = 3$ and $|\mathbf{m} - \mathbf{n}| = 6$ was usually followed by $|\mathbf{n}| = -3$. There were however, some excellent and well thought out solutions showing a full understanding of the question,

Pearson Education Limited. Registered company number 872828
with its registered office at 80 Strand, London, WC2R 0RL, United Kingdom