Examiners' Report
Principal Examiner Feedback

Summer 2017

Pearson Edexcel International GCSE
In Mathematics B (4MP0) Paper 01

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Summer 2017
Publications Code 4MP0_01_1706_ER

The two papers here were fairly well matched in difficulty. Candidates scored slightly better on paper 2 compared with paper 1. However, it is impossible to know whether this was due to paper 2 being slightly more accessible or due to there being an extra week available for revision, specifically targeted at topics not tested on paper 1. Perhaps the inclusion of log equations on paper 1 caused candidates to omit log theory from their final revision and hence find the final question to be harder than it really was. Candidates should be reminded that any part of the specification can be tested on either paper, or sometimes even both.

Candidates must also remember that, as stated on the front of the paper, "without sufficient working, correct answers may be awarded no marks". This is always true in a "show" question but can also happen in other questions, particularly if the word "hence" appears where a link to a previously obtained result must be shown to justify the "hence" demand.

There were fewer cases of incorrect rounding or use of incorrect angle units than are often seen. However, far too often candidates were seen to be using a previously rounded answer in further working, thus losing accuracy.

Question 1

Candidates had varying degrees of success with this question. Many arrived at the correct answer but went on to give an approximation – they were fortunate enough not to be penalised for this, but there is clearly still work to be done out there regarding students' understanding of "exact".

Although there were the general manipulation errors in multiplying by e^x, most candidates were aware that this was the first step to take but were unable to correctly simplify $e^x \times e^x = \left(e^x\right)^2 = e^{2x}$ and too many thought this was $2e^x$. Other common manipulation errors were multiplying only two terms instead of three and the usual incorrect factorisation of their quadratic expression.

A substantial number of candidates simply stopped once they had found $e^x = -2,\ 8$ and failed to take logs to achieve x = …., so M1A1M1M0A0 was a common pattern of marks. Those candidates who went on to take logs mainly did so successfully, yet a substantial number incorrectly dealt with the negative solution and simply stated that $x = \ln(-8)$ without considering its non-existence.

It was also fairly common to see a solution of $x = 0.69$ ... with no indication of how they arrived at this and as such they lost the final 2 marks for this question.

Question 2

Although there was the usual substantial number of non-starters for this chain rule question, most candidates could construct a correct chain rule expression for the middle M mark. Many candidates used $h = 3r$ to achieve $V = \pi r^3$. These candidates often differentiated this

dimensionally correct expression correctly and, with correct substitution, scored the 3 method marks. B0M1M1M1A0 was a very common marking pattern.

Further success or otherwise then was dependent on them reaching $V = \frac{1}{9}\pi r^3$ for the first B mark. If they did, then 5/5 usually followed. The answer had to be given to 3SF but rounding errors were rare.

A substantial minority of candidates attempted to differentiate $V = \frac{1}{3}\pi r^2 h$ to find $\frac{\mathrm{d}V}{\mathrm{d}r}$. No marks could be awarded for these effort and as the 3rd method mark was dependent on both former M marks, then unless a candidate also quoted a correct Chain Rule, no marks were scored in this question.

It was possible to answer this question by working in terms of *h*, although for this the Chain Rule was more involved as it involved finding $\frac{\mathrm{d}r}{\mathrm{d}h}$, and it was necessary to find this as well as $\frac{\mathrm{d}V}{\mathrm{d}h}$ to gain the first M mark. No successful attempts were seen.

The most sophisticated method was using implicit differentiation (which is beyond the specification) and just a few students solved this question quickly and easily using this method.

Question 3

(a) and (b) Virtually every candidate scored full marks in these two parts.
(c) There were a variety of approaches in the last part of this question. The question started with the word 'hence' so giving a hint that the best approach is to use the vectors candidates found in parts (a) and (b), show that $\overrightarrow{CE} = 3\overrightarrow{CD}$ where *C* is common. This was the most common approach, although only a few also stated that point *C* is common. It is important that candidates state a conclusion in a 'show' question so that writing $\overrightarrow{CE} = 3\overrightarrow{CD}$, after showing that $2\mathbf{b} - \frac{3}{2}\mathbf{a} = 3\left(\frac{2}{3}\mathbf{b} - \frac{1}{2}\mathbf{a}\right)$ without writing 'therefore the lines are collinear' or similar, will only gain M1. Other candidates found the vector $\overrightarrow{DE} = \frac{4}{3}\mathbf{b} - \mathbf{a}$ and showed it

was a multiple of $\overrightarrow{CD}$, and other approaches found the 'gradient' of $\overrightarrow{CD}$, $\overrightarrow{CE}$ or $\overrightarrow{DE}$ and showed they were equal. These were all credited with M1A1 in (c) provided they were correct. Many candidates achieved full marks in this question.

Question 4

(a) Some candidates realised $\tan\theta = 3$ or -2 quickly from the given factorised equation, but far too many expanded and then used the formula or even more strangely, re-factorised their expanded equation, wasting much time and often losing marks as they made mistakes in manipulation.

Predictably, weaker candidates then often answered in degrees and so could not gain the A marks for angles.

However, in the majority of responses the first solution of 1.249 was generally successfully achieved but the negative solution from $\tan\theta = -2$ was often dismissed as out of range or rounded prematurely so that the final answer was incorrect to 3 significant figures. This was the persistent culprit in this question as far as rounding errors are concerned, giving 2.035 instead of 2.034, arising as a result of rounding the calculator value of $\tan^{-1}\theta = -2$ to 4sf prematurely before adding π. This was a mark lost needlessly due to a rounding error. Centres must encourage their students to work to full calculator accuracy and round to the required accuracy only at the end.

(b) This was generally completed very well. Almost all candidates realised they needed to use a rearrangement of the identity $\cos^2\theta + \sin^2\theta = 1$ to form a quadratic equation in $\sin\theta$, and solved their 3TQ either by factorisation or by using the formula to achieve the correct values for $\sin\theta$ of $\frac{1}{3}$ and $-\frac{1}{2}$ for M1M1A1. The answers given in part (b) were usually free from rounding errors.

Question 5

(a) More successful candidates sensibly started with a sketch, although surprisingly many attempted the question without. Almost all correctly found acute angle *C* using the sine rule. Where candidates lost marks on this part it was generally for not proceeding to find the value of obtuse angle *C* by subtracting their previous answer from 180°, or not rounding correctly to 1decimal place as specified. A significant minority gave angle *B* of the acute-angled triangle *ABC* in place of obtuse angle *C*.

(b) The vast majority of candidates proceeded to find the two possible values of angle *B* following through their two answers in part (a), successfully applying the sine rule again in both cases, evaluating the lengths of *AC* and subtracting to give the required difference. Cosine rule using two values of angle *B* was clumsier and generally allowed more errors to creep in. Cosine rule using angle *C*, or better still the given angle *A*, at first sight appears to be an even more clumsy method, except for those candidates spotting that the square root of the discriminant of the resulting quadratic gives the required difference directly. A more elegant solution still, pursued by a handful of candidates, achieves M1 just for noticing the isosceles triangle *BCC*' and the remaining three marks for finding half of the base length 7cos 66.67^{o} and doubling. Too many candidates did not understand difference in its mathematical sense as the result of subtraction and achieved only M1 M0 A1 A0 even where they found both possible lengths of *AC* and stated "The difference is that one is 10.4cm and one is 4.89cm". Furthermore too many lost the final A0 by rounding prematurely, and 10.4 – 4.89 = 5.51cm was a very common final answer. Centres should encourage their students to work to full calculator accuracy until rounding for the final answer.

Question 6

(a) The majority of candidates handled the first part of this question efficiently, with many gaining full marks. Most were able to set up the two equations correctly at the beginning and a fair number of these were able to eliminate a in order to form an equation to be solved in r. Some took a more difficult and error-prone route, rearranging the first equation making a the subject and substituting $a=\frac{250}{1+r^2}$ into $ar+ar^2=150$ rather than factorising and dividing the two equations.

The attempts using formulae for an arithmetic series were very rare indeed.

(b) Most of the candidates who were successful in (a) made at least some progress in this part. Candidates found the value of a either in part (a) or (b) and it was credited in either. Virtually every candidate knew and applied the correct formula for the sum of a GP and applied the inequality correctly at this stage. Few students had all the inequality signs correct throughout because very few realised that $\log(0.5)$ is a negative number and therefore it is necessary to reverse the inequality when dividing through by a negative. The most common error seen in attempting to solve the equation in n was $\frac{200\left(1-0.5^n\right)}{1-0.5}\Rightarrow\frac{200-100^n}{0.5}$.

Many candidates abandoned inequality signs after their $S_n>399.99$ but recovery was allowed for n > 15.28 seen. We did not allow the final A mark however, for $n<15.2...$ or $n=15.2...\Rightarrow n=16$ as that statement is a contradiction.

Question 7

It is very pleasing to report how well this question was answered throughout with even less able candidates managing to score up to 7 marks in this question. It is clear that knowledge of logarithms is well established for those candidates who are entered for this paper.

(a) Virtually every candidate was able to just write down a = 4 without any further work.

(b) Although this required a little more work, virtually every candidate understood that $6c+9=3^4$ so that c =12. The most common error, and there were only just a few of these, was $3^4=27$ for which M1 was awarded.

(c) There were two general approaches to this question; applying the power law

$4\log_b 5+6\log_b 5=5$ or the addition law $2\log_b\left(25\times125\right)$ to combine the two logs for the first M mark. Some candidates used a combination of both power and addition laws to achieve $\log_b 5^4+\log_b 5^6=\log_b\left(5^4\times5^6\right)$.

The second M mark (dependent on the first M mark) was awarded for achieving a single log expression = constant.

The final M mark was an independent mark awarded for 'undoing' **their** log expression so that it was possible to achieve M0M0M1A0 in this question.

It was very pleasing to note that the majority of responses were fully correct.

(d) This part required candidates to solve a pair of simultaneous equations involving logarithms. There were two possible approaches, (by elimination or by substitution) both applied in approximately numbers. Errors in this part of the question rarely arose from incorrect log work, but rather from incorrect manipulation of two simple simultaneous equations, with numerous sign errors and a failure to multiply **both** sides of an equation when solving two equations by elimination.

As in part (c), credit was given for correctly log work on an incorrect expression, so a common pattern of marks for less able candidates was M1A0A0M1A0A0. As in other questions, the final A mark was lost for poor or premature rounding.

Question 8

Very many candidates were successful in gaining the marks for parts a, b, c, & d and at least the first B mark in part e. Too many candidates attempted this question without drawing a sketch; these were usually the unsuccessful attempts.

(a) Pythagoras was successfully applied in the great majority of responses to find the distance between two points. Some candidates however gave their answer as 13.416… instead of the exact value of $\sqrt{180}$ or $6\sqrt{5}$. The erroneous attempts usually involved the following calculation $\sqrt{\left(13+1\right)^2+\left(7+1\right)^2}$.

(b) Again, most candidates were successful in finding the coordinates of C but some seemed to think that C was the mid-point of AB. The most successful approaches involved a sketch and used an informal type of linear interpolation as opposed to a formula without a diagram to help, which is always susceptible to sign errors (though not so much here, as everything is in the positive quadrant).

(c) Candidates were generally confident in finding in the gradient of AB and converting this to a gradient of the perpendicular using $m_2=-\dfrac{1}{m_1}$. Virtually every candidate reached the correct equation in the correct form if they had the correct coordinates of C. Even without the correct coordinates of C, candidates were able to achieve M1M1M1A0.

Nearly every candidate with the correct equation from the previous part gained the mark in (d) since all it involved was $y=2\times9-5$.

(e) Candidates who applied the determinant method correctly were successful in most cases when finding the area of *ADBE* and most gained 4/4 for finding the area here. This method is however beyond the specification of 4PM0 and indeed 4PM1. However, the method fails, giving 0/4, if the order of the coordinates in the matrix is incorrect. The order of coordinates must be given in consecutive order. Candidates can start and finish at any coordinate but some candidates did not realise that the consecutive order is crucial. In many responses a decent diagram would have helped immensely.

Of the other methods used, $\text{Area} = \Delta ADB - \Delta AEB$ was the most common, although $\text{Area} = \Delta AED + \Delta BED$ was also seen. The candidates who were successful generally used the simplest method of finding the area of a triangle (area = base × height ÷ 2). Some candidates made themselves considerable unnecessary work by first finding the size of angles DEB and DEA and then used $\frac{1}{2}ab\sin C$.

Question 9

This question proved to be a real discriminator of ability.

(a) This was a 'show' question and yet the number of candidates just writing down the common identity $\cos 2\theta = 2\cos^2\theta - 1 \Rightarrow \cos^2\theta = \frac{1}{2}(\cos 2\theta + 1)$ and nothing more was quite surprising. The word 'show' indicates that a complete method must be in evidence and the fact that this part was worth 2 marks, should inform candidates that the first M mark will only be awarded for a **complete** method. That is, the given identity must be used as well as the Pythagorean identity $\cos^2\theta + \sin^2\theta = 1$ leading to $\cos^2\theta = ...$.

(b) The first M mark was awarded for substituting the given identity into both $\cos^4\theta$ and $\cos^2\theta$ in $\mathrm{f}(\theta)$. This was all that was required for this mark, and a missing −5 was even condoned. Most candidates managed to achieve at least this mark. The next M mark was awarded for expanding $\left[\frac{1}{2}(\cos 2\theta + 1)\right]^2$ **correctly**. This is where errors began to creep in with an inability to deal with $\left(\frac{1}{2}\right)^2$ correctly, so more than a few candidates lost this mark by writing $4(\cos^2 2\theta + 2\cos 2\theta + 1)$ and a significant minority thought that $(\cos 2\theta)^2 = \cos 4\theta$. Again, the absence of −5 was also condoned for this mark. The final M mark was awarded for substituting $\frac{1}{2}(\cos 4\theta + 1)$ for $\cos^2 2\theta$. Although this part of the question appeared to be daunting at first sight, careful algebra usually led to a successful final answer.

(c) Some candidates did not realise that $8\cos^4 x + 4\cos^2 x - 5$ needed to be substituted in to the given equation which then simplified very conveniently to $\cos 4x = -0.5$. There were some attempts involving changing $6\cos 2x \Rightarrow 12\cos^2 x - 6$ leading to a quartic equation, which led to $\cos^2 x = \frac{1}{4},\ \frac{3}{4} \Rightarrow \cos x = \pm\frac{1}{2},\ \pm\frac{\sqrt{3}}{2}$. This was longwinded, though completely acceptable, and just a few students managed to gain full marks for solving the equation this way. As is usual in this type of question, more than a few students made the common error of writing down $\cos 4x = -0.5 \Rightarrow 4x = 120 \Rightarrow x = 30^\circ$ and then writing that 300º etc is out of range, without properly considering the correct range of angles for 4*x*. However, reaching $4x = 120^\circ$ gave M1A1M1 and the final A mark was awarded for all four correct values of *x*.

(d) (i) Most candidates realised as in part (c) that a direct substitution for $\mathrm{f}(\theta)$ was required in this question although there were a small number of candidates attempting to integrate $\int 8\cos^4\theta\, \mathrm{d}\theta \Rightarrow \frac{8}{5}\sin^5\theta + c$ etc. Most candidates knew that $\int \cos\theta \Rightarrow \sin\theta$ but there was much confusion with sign errors and coefficients.

(ii) Credit was given in this part for the correct substitution of both π **and** 0 into candidates' integrated expression, provided it was not the given expression and for those who got this far in the question, most achieved at least M1 here. Some candidates, having achieved a correct integrated expression, just wrote down an answer of 2.38... losing all the marks in this part, as examiners must be satisfied this has not been achieved by plugging the given expression into a graphical calculator, and in any case, the question demand was for an **exact** answer.

Question 10

(a) Most got the B1 at the beginning, showing that they know what an asymptote is and how to find it. The instruction here was ‘write down’ and as there was only 1 mark available, this implies a minimal amount of work. Some candidates made quite hard work out of this part of the question.

(b) It is important to state in the outset that the *x* coordinates and nature of the turning points were given in the question.

The majority of candidates rearranged *y* into a single fraction before using the quotient rule to differentiate. Although this was far more awkward, it was generally carried out accurately but long-winded approaches invite errors in manipulation.

Many candidates arrived at $32x^2 - 32x + 6 = 0$ then simply stated *x* = 0.25, *x* =0.75, but did not show how they arrived at this **given** result, hence losing the method mark and resulting answer marks for a “show” question.

The same applied to the second part of (b). For those candidates who attempted to verify the nature of the turning points, many could only try applying the quotient rule again and then made manipulation errors because of the complexity of their $\frac{dy}{dx}$ $\left(\frac{dy}{dx}=\frac{32x^2-32x+6}{(2x-1)^2}\right)$ (arising from changing y into a single algebraic fraction) which usually resulted in incorrect values for the second derivatives. Others took one look at their expression for the second derivative and then just wrote if $x=\frac{1}{4}$ $\frac{d^2y}{dx^2}<0$ hence maximum etc. without substitution to show that this was the case. There was a limited number of candidates who attempted it as in the original mark scheme and in most of these cases, they were awarded full marks for this part of the question.

(d) It was nice to see a good number of candidates, who either had not attempted part (b) or had made a limited attempt, go on to achieve full marks in (c) using the information given in the question. Candidates often give up on the rest of the question if they encounter something they cannot tackle without looking for parts they could complete.

(e) There were very few full marks awarded in this part. Many were able to correctly draw the asymptote, and provided there was at least part of the curve, this gained the second B mark. It was common to see maximum and minimum points labelled but not being actual max/min points on candidates' curves. Some drew their max/min points the other way round. A larger number of candidates were unable to correctly deal with the y-axis intersection and did not successfully draw the LHS of the graph.

Many candidates do not understand the behaviour of a curve as it approaches the asymptote, with many responses showing their curve moving away from the asymptote. Whilst we accept these are hand drawn curves, and examiners are instructed to be generous here, far too many curves were blatantly moving away from the asymptote thus losing the mark for the shape and position of the curve.

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