Examiners' Report
Principal Examiner Feedback

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Pearson Edexcel International Advanced Level
In Pure Mathematics P3 (WMA13) Paper 01

General

This WMA13 paper had a number of very accessible and familiar questions (1, 2a, 4a, 9c&e and 10a&b) which afforded candidates the opportunity to practice well rehearsed skills. Although many candidates are now adept at mastering questions on log graphs (Qu 3), others still seem to be struggling in this area of the specification. Questions towards the end of the paper were very discriminating, even at the high grades. The paper was of an appropriate length with little evidence of students rushing to complete the paper.

Points to note for future exams are:

- Candidates should be encouraged to show sufficient working to make their methods clear. Answers without working may not gain full credit. This is true of all questions but seen in particular on questions 5b and 10c
- Candidates need to be careful to show all the steps in "show that" questions. This was seen in questions 5a and 7a

Report on Individual Questions

Question 1

This question on functions and function notation was not unexpected and candidates generally scored good marks here.

(a) Most candidates knew what to do, but errors were common here. Incorrect answers seen were $y \geqslant 9$, $y < 9$ and $x \leqslant 9$.

(b) This was a very useful source of marks for all candidates. Errors were rare and were mainly due to premature rounding of the exact answer.

(c) Finding an inverse of a function is a well-known skill. It must be pointed out that to fully define a function both an equation and a domain must be given. Many candidates are still omitting the domain of the inverse function which can be found by finding the range of the function. Consequently 2 out of 3 marks was a familiar score in this part.

Question 2

This question on changing a trigonometric function into the form $R\cos(x-\alpha)$ is well known. Part (b) required the ability to problem solve and many candidates were unable to make progress here. A common score was 3 or 4 out of 6.

(a) Most candidates knew the required process, some just quoting a formula for R and α, and others working through the identity. Errors were rare with the most common being using tan α = ½ to find α. A few other candidates gave only a decimal value for R.

(b) Only the best candidates made real progress in this part.

(i) The most common (and yet incorrect) answer was $3-7\sqrt{5}$. To find the correct answer candidates needed to deduce that the maximum value of the expression $3-7\sqrt{5}\cos(2x-\alpha)$ occurs when $\cos(2x-\alpha)=-1$ giving a maximum value of $3+7\sqrt{5}$.

So in part (ii) they needed to find where $\cos(2x-\alpha)$ would have a minimum value which would be where $2x-\alpha=\pi$. Even when candidates showed some evidence of a correct approach to the problem they often made errors through solving only $x-\alpha=\pi$ or $2x-2\alpha=\pi$. Full marks in part (b) were very rare.

Question 3

Questions on log graphs still seem to be very much centre dependent. Many candidates find them straightforward whilst others struggle to make a start. The key starting point is using the information correctly.

In part (a) many candidates failed to spot that the vertical axis was $\log_{10} y$ and used *y* instead. Finding the gradient and intercept of the line was less of an issue given the diagram. As a result of confusing $\log_{10} y \leftrightarrow y$, an equation of $y=\frac{5}{16}x+1.5$ was common.

A few candidates realised this error and started part (b) with the correct line $\log_{10} y=\frac{5}{16}x+1.5$. It is vitally important to show correct steps in a solution especially when the form of the answer is given. The expected minimum working required here was:

$$\log_{10} y=\frac{5}{16}x+1.5 \Rightarrow y=10^{\frac{5}{16}x+1.5} \Rightarrow y=10^{\frac{5}{16}x}\times 10^{1.5} \Rightarrow y=31.6\times 2.05^{x}$$

Unfortunately, intermediate working such as $y=10^{\frac{5}{16}x}+10^{1.5}$ was often seen before the correct answer of $y=31.6\times 2.05^{x}$ thereby losing the candidate at least 1 mark.

Question 4

This question on algebraic division and integration was a very useful source of marks for all candidates.

In part (a) the majority of responses were completely correct. Most candidates opted to divide rather than via setting up an identity. Errors, when made, tended to result in a linear remainder rather than a constant term.

Part (b) was rather less well done. To score marks candidates needed to know that $\int \frac{D}{(x+3)^2}\,\mathrm{d}x \to \frac{k}{x+3}$.

When errors were made versions of $\frac{k}{(x+3)^3}$ and $\ln(x+3)$ were common. If the correct form of the integral was seen then many candidates went on to score all 3 marks here.

Question 5

This question tested a candidates ability to prove a trigonometric identity and use the result to solve an equation. The proof was quite challenging depending upon the route taken but the equation was relatively straightforward.

In part (a) there were many different approaches that candidates could take and certainly the majority of candidates were able to, at least, make a start here. Most often, candidates began with the left-hand side of the identity and were successful in obtaining a single trigonometric fraction in sine and cosine. Some candidates came unstuck at this point as they failed to spot the difference of two squares or struggled to apply the double angle formulae accurately. Unfortunately, some candidates lost the final mark in this part for failing to show sufficient work in their proof. Candidates should be reminded that in a 'show that' question, all steps should be demonstrated in order to secure full marks. Candidates beginning with the left-hand side of the identity were often more successful than those beginning with the right-hand side. Many of these though were confident with the definition of the reciprocal trigonometric functions and were often able to accurately apply the double angle formulae to obtain a trigonometric fraction in single angles. However, the stumbling block seemed to be the separation of the fraction into two separate fractions and often candidates seem to get stuck in a loop of trigonometric identities.

In part (b) most candidates used the given identity from part (a) and successfully converted their equation into an equation in just $\tan\theta$. From there it was a fairly straightforward task to find the correct values of θ. A common error, losing just one mark, was omitting the negative answer. Candidates losing more marks generally did so for one of the following reasons:

- trying to work in $\sin\theta$ or $\cos\theta$ which required the solution of a quartic equation
- starting the equation afresh without using the given identity

Another point to note is that candidates should not use their calculators to produce answers to equations such as $\cot^2\theta - \tan^2\theta = 2\tan^2\theta$. Warnings given on the question paper state that intermediate working as can be seen in the mark scheme must be shown.

Question 6

This question was a fairly typical one on the modulus function, but was made a little more demanding due to the addition of the constant "*a*". In part (a) candidates were required to find key coordinates of points on the graph and in part (b) solve an equation.

In part (a) there were many very good responses. Occasionally candidates became mixed up on the *x* and *y* intercept, but these were in the minority. Key learning points for centres to take away are:

- when coordinates are asked for, give both coordinates not just one. E.g. don't write $P = 3a$ or just $y = 3a$ when $(0,\ 3a)$ was required
- it is important to give simplest form when asked to do so. E.g. $(0,\ 5a - 2a)$ or $(0, |5a| - 2a)$ is not acceptable for $(0,\ 3a)$

In part (b) most candidates were able to pick up 2 marks for correctly solving $3x - 5a - 2a = x - 2a$ giving an answer of $x = \frac{5}{2}a$. Only the best candidates could produce an efficient answer producing **only** the two valid solutions of $x = \frac{5}{2}a$ and $x = \frac{1}{2}a$. Many candidates resorted to solving all four cases with both positive and negative versions of the modulus giving four solutions. Despite wasting valuable time, they could go on to score all four marks provided the two false solutions were discarded

Question 7

This question on differentiating a trigonometric function in the form x = f (y) was one of the more demanding questions on the paper. It was very discriminating even at grade A/A* with fully correct solutions seen from only the best candidates.

In part (a) the most popular and successful method was that seen in the main scheme. Many candidates were able to achieve the first two marks for a valid attempt at differentiating followed by taking the reciprocal of their dx/dy. The second two marks and proceeding to the required result proved a little more challenging.

For part (b) most students who achieved an answer in (a) went on to score all possible marks here (or 4 out of 5 if (a) was incorrect.) Students demonstrated good knowledge and execution of finding the equation of the tangent and furthermore where it intercepted the x-axis. Where an answer was not reached in (a) most candidates were still able to achieve the B mark for finding $x=\sqrt{3}$.

Question 8

This question on integrating $(2\cos x-\sin x)^2$ required the double angle formulae for sin2x and cos2x as well as some problem-solving skills. Most candidates were able to make some progress, but errors were common.

Most candidates scored the first mark for attempting to expand the bracket. Many could then integrate the $4\sin x\cos x$ term either by inspection as $2\sin^2 x$ or via the double angle formula for sin2x. The $4\cos^2 x$ and $\sin^2 x$ terms proved more of a challenge with many making errors when converting to cos2x or else incorrectly thinking that they could be integrated in that form.

Typical low scoring traits were:

- 0 marks $\int(2\cos x-\sin x)^2\,\mathrm{d}x \rightarrow \frac{(2\cos x-\sin x)^3}{3}$
- 1 mark $\int(2\cos x-\sin x)^2\,\mathrm{d}x=\int\left(4\cos^2 x-4\sin x\cos x+\sin^2 x\right)\mathrm{d}x$
- 2marks $\int\left(4\cos^2 x-4\sin x\cos x+\sin^2 x\right)\mathrm{d}x=\frac{4}{3}\cos^3 x-2\sin^2 x+\frac{1}{3}\sin^3 x$

Question 9

Although parts (a) and (b) of this question on an exponential function were demanding, parts (c), (d) and (e) were straightforward. Some candidates struggled to cope with the function e^{x^2} and started using e^{2x} in its place.

In part (a) candidates were required to differentiate $y=\sqrt{3+4\mathrm{e}^{x^2}}$ using the chain rule. This was well done by the better candidates, but many weaker candidates omitted the extra e^{x^2} term in $4x\mathrm{e}^{x^2}\left(3+4\mathrm{e}^{x^2}\right)^{-\frac{1}{2}}$.

Part (b) was the most demanding aspect of the paper. The inclusion of the diagram should have led candidates to deduce that, at *P*, $\frac{dy}{dx}=\frac{y}{x}=\frac{\left(3+4e^{x^2}\right)^{\frac{1}{2}}}{x}$. Using this result and their gradient from part (a) would lead candidates to the given result.

In part (c) candidates were on familiar ground and almost all scored at least one mark. Reasons for the loss of a mark was mainly as a result of omitting one of the reasons, usually the fact concerning "continuity".

Part (d) was another very accessible part for the careful candidate. The only real barrier to success, was not making $4x^2$ the subject of the equation.

The use of an iteration formula to produce roots is a familiar and well-known skill amongst almost all candidates and there was no exception here. Many candidates scored all 3 marks, but all candidates would be well advised to write down all of the results of the early iterations to ensure the award of the method mark.

Question 10

Parts (a) and (b) of this question on an exponential model was standard WMA13 bookwork and many candidates scored all four marks. The last part was more demanding but provided grade B to A* candidates a chance to show their talents.

In part (a) candidates simply used $e^0=1$ to find the initial number of fruit flies. Errors were rare but $\frac{350}{9}=38.9$ was seen on multiple occasions.

Full marks in part (b) was also common with the majority of candidates knowing which steps were required to prove the given result. A common error, regularly seen amongst weaker candidates in this topic, was attempting to take lns at too early a stage. E.g at $1800+200e^{15k}=350e^{15k}$

The majority who attempted part (c) knew that the quotient rule was required, but many found the function too demanding, especially those who had $F=\frac{350e^{\frac{1}{15}\ln 12t}}{9+e^{\frac{1}{15}\ln 12t}}$. Those who stuck with $F=\frac{350e^{kt}}{9+e^{kt}}$ or even $F=\frac{350e^{0.166t}}{9+e^{0.166t}}$ fared much better. The attempt at differentiation was as far as many could go but the best could recognise a quadratic in e^{kt}, solve and produce two values for *T*.