Examiners' Report

Principal Examiner Feedback

Summer 2018

Pearson Edexcel International GCSE

In Further Pure Mathematics (4PM0)

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4PM0 PE report 1806 (Both Papers)

As last year, candidates scored slightly better on paper 2 compared with paper 1. There is no intention to make paper 1 harder than paper 2 – in fact if one paper is thought to be noticeably more difficult it is usual to use this as paper 2. Therefore it seems reasonable to conclude that candidates have benefitted from the extra week's revision time they now have between the two papers.

Candidates must 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. Candidates should also remember that "show" questions need a conclusion to indicate that the required fact has indeed been shown.

If candidates find they have not got sufficient space to complete a question they should ask for extra sheets. Completing the work in the spare space in another question is risky as examiners sometimes overlook work from other questions. The extra sheet(s) should be fastened at the back of the question booklet, as indicated in the general instructions.

There are still some candidates who are reluctant to use radians when required in trigonometrical questions. Some of these work in degrees and then convert their answers to radians. Setting the calculator to radian mode and getting straight to answers in radians is far more efficient and the time gained may, in some cases, allow more marks to be gained elsewhere.

Paper 1

Question 1

The vast majority gained all 4 marks in this question.

However, a significant number of students did not use the formulae for area and arc length for radians and worked in degrees. Weaker candidates often quoted incorrect formulae such as $C = 2\pi r^2$.
Candidates who worked in a mixture of degrees and radians rarely achieved complete success, although we allowed 0.499 radians or better for part (a) and 4.99 cm or better for the length of arc in part (b).
It is disappointing to note that a significant minority of candidates taking this paper still seem to cling to degrees.
(a) Those candidates who achieved 28.647…° rarely made an attempt to change their answer to radians. In order to achieve the M mark, candidates working in degrees were required to make a correct attempt to convert degrees into radians.
Given that angle *AOB* was defined as θ radians it was clear that some candidates had not read the question
(b) Candidates working in degrees often achieved 4.99…(cm) instead of 5 but we allowed an answer of 4.99 (cm) or better.

Question 2

The overall impression of this question was one of a lost opportunity for too many candidates. The vast majority of candidates achieved the first B1 for the value of $\alpha\beta$ and $\alpha + \beta$. The majority of errors from a minority of candidates occurred by applying a negative value to $\alpha + \beta$.

The next section of the question was disappointing for many candidates as it was a relatively simple and predictable algebraic simplification. In the case of both simplifications a failure to complete the number part of a multiplication was a common error i.e. $2\alpha \times 2\beta$ was very frequently simplified as $2\alpha\beta$ rather than $4\alpha\beta$. In the simplification of the sum of roots many candidates lost their way as they forgot that the purpose was to arrive at a format that allow direct substitution of their values from the first part.

In the multiplication of the roots the failure to recognise that $\frac{\alpha}{2\alpha} = \frac{1}{2}$ and $\frac{\beta}{2\beta} = \frac{1}{2}$ was the key to most errors of simplification.

Although many candidates were able to write down a correct equation for their values of the sum and the product a few candidates lost this M mark by not recognising that the negative sum must be applied to the quadratic equation. Occasionally candidates forgot that the question asked for an equation so needed an = 0 as part of the answer. The common marking patterns in this question were either B1M1A0M1A0M1A0 (4/7 marks) or even B1M0A0M0A0M1A0 (2/7 marks)

Question 3

Most candidates were comfortable using the sine (and cosine) rule/formula and few lost marks rounding. The problem for the majority was the inability to recognise the ambiguous case in a triangle.

(a) On the whole, candidates answering this question were able to correctly obtain the first angle *BCA* of 63.1°-63.2° and correctly follow through to find the first size of angle *ABC*. Most candidates did not find a second angle of *BCA* and so did not achieve a second value of *ABC*, or found a second angle incorrectly, e.g. by subtracting 74.9° from 180° to get 150.1°.
(b) Because the significant majority of candidates only found one correct angle *ABC* (in every case the larger angle of 74.9°, it was not possible to find the correct area of the smaller triangle. However, credit was given for the use of an angle *ABC* with the correct sides, or alternatively another angle **provided** the correct sides were used.

There were a small number of candidates who chose to use the cosine rule to find the lengths of *AC* and then use this in the sine rule to find both angles *ABC*. Although this method was long winded it was usually successful because the quadratic obtained using cosine rule gave two values.

A diagram in this type of question is essential to see how the two possible angles at *C* and *B* were related. However, only about half of the total number of candidates actually drew a reasonable diagram.

The most common marking pattern was (a) M1A1A0M1A0 (b) M1A0A0.

Question 4

(a) Part (i) of this question was answered correctly for the first B mark by the vast majority of candidates. Thereafter, most of these candidates did not seem to understand what was required in part (ii) and failed to use the rearranged $y = \frac{2x^3 - 1}{2x^2}$ by substituting in $x = \sqrt[3]{0.5}$. Had they done so, they would have seen that $y = 0$, and thus the value required is where the curve crossed the *x*-axis. Most candidates just wrote down *x* = 0.8 from finding $\sqrt[3]{0.5}$ by using their calculators. The question specifically asked candidates to use their graph, and so the minimum acceptable working was *y* = 0 so *x* = 0.8.

(b) This part of the question was on the whole answered very much better, with many candidates rearranging the given equation to $4 - x = x + \frac{1}{2x^2}$ and drawing the correct line, $y = 4 - x$. The question specifically asked for an estimate to 2 significant figures, but unusually for this paper, rounding proved to be a problem in this paper with answers left as 2 or 2.05, implying that candidates were able to read the *x*-axis to $\frac{1}{50}$th of a square.

Question 5

A substantial percentage of candidates were able to answer this routine integration question with some if not always total success in both parts.

(a) A significant minority of candidates integrated the power of −3 to −4 and of those candidates many lost the second method mark because they didn't show the substitution of their limits. Also, sign errors in the integrated expression were not uncommon. Sometimes an answer of 15/8 was given after an incorrect integrated expression indicating use of a calculator. A correct answer without correct working receives no marks. In this type of question, showing full working, including the substitution of limits is essential to convince examiners that a correct method is being used.
(b)A small number of candidates differentiated rather than integrated and rather more struggled to get the correct coefficient of $\cos 3x$ in the integration. In a significant number of responses, everything was correct until the final evaluation (which should have been the easy part of the question) and was given as 4.17×10^{-4} instead of the correct value of 1. This was the result of putting radians unthinkingly into their calculators when in degree mode. However, candidates at this level really ought to know that $\cos\frac{\pi}{2} = 0$, and that $\cos\frac{\pi}{3} = \frac{1}{2}$ so $-2 \times -\frac{1}{2} = 1$.

Question 6

(a) The major problem in this part of the question was insufficient thought being devoted to obtaining the correct asymptotes. The question asked for the equation of the asymptote parallel to the *y*-axis and the *x*-axis. Therefore, an answer of just 2 for (i) and 3 for (ii) gained no marks, and the equation of a line parallel to the *y*-axis is *x* = ..., and the same goes for the equation of the line parallel to the *x*-axis.
(b) This part was answered correctly by virtually every candidate.

(c) The sketch was on the whole well done with the majority of marks being lost because of the absence of labelling; usually the points of intersection of the curve with the *x* and *y* axes. There was a direct correlation between the neatness of the sketch and marks gained. Candidates who took care with their sketches by drawing the axes and asymptotes with a ruler, and drew their lines as carefully as possible, frequently gained most of the most
The majority of candidates who drew the correct asymptotes, failed to revisit part (a)(i) to correct their work and collect these two marks. It is extremely likely that the candidates' focus was on the sketch which led them to rush an answer which was correct in their mind's eye but not mathematically.

Question 7

(a) Nearly every candidate succeeded in setting $5\cos 2t = 0$, although only a very small number were unable to find the correct value of $t = \frac{\pi}{4}$, the overwhelming majority of answers here was $t = 45°$ losing the accuracy mark. However, use of the value of $t = 45°$ subsequently condoned in the rest of the question.

(b) The majority of candidates gained the first two marks by being able to find $\frac{\mathrm{d}v}{\mathrm{d}t}$ correctly. There were a few students who attempted to use what appeared to be the chain rule, leading to an incorrect final answer. For those candidates who differentiated correctly, most kept their final answer as negative 10 and did not find the magnitude. A small number of candidates had the misconception that they should be equating the differentiated expression to 0 to solve for *t*. Some candidates then found the second derivative which they then set = 0 to find the value of *t* at maximum acceleration. This was not necessary, because knowledge that maximum value of sine is 1, would have found the value of *t* much quicker. We condoned the use of 45° here.

(c) Overall, part (c) was completed very well; candidates correctly integrated the necessary expression, substituted for *t*, and found the initial distance of 0.2 to add on, one way or another for full marks. Again, the use of 45° in integration was condoned.

However, full marks for the question as a whole were very rare, with the great majority seemingly unaware that trig differentiation is only valid in radians, and many not grasping the meaning of “magnitude”. The common marking pattern in this question for those candidates who largely knew how to tackle it was M1A0 M1A1A0 M1A1M1A1 (7/9)

Question 8

This was a routine question that produced a good number of straightforward and fluent solutions. There was very little evidence that any candidates were unable to access the question.

(a) In this part there were very few candidates who could not get to the correct quadratic and solve it for two values of *x*. However a small minority then failed to obtain the corresponding values for *y* and therefore lost both A marks. Although the question asked for coordinates, we allowed $x = 2, y = 1$ and $x = -3, y = 36$.

(b) The great majority of responses integrated a combined expression. Errors in integrating and substitution were only very rarely seen, although a few more lost the final A mark through producing a decimal rather than exact answer or by subtracting the line from the curve resulting in a negative answer. We were strict on this question, in that we awarded no marks for just the integration of the curve only without consideration of the line. Given that the question asked for the exact area of the region bounded by the curve and the line, and the curve is a positive quadratic, it follows that the line must be above the curve. Therefore the curve must be subtracted from the line. We condoned the area being derived from the curve − line and awarded full marks for a positive value of $\frac{125}{6}$.

Question 9

This was another routine question where candidates either accessed all or relatively few of the marks. The former was very common, with most gaining full marks.

(a) The overwhelming majority were able to find the values of *a* and *d*. A bout half of the candidates formed the correct equations which they solved, and the other candidates chose the route of the alternative scheme $\frac{80-108}{7}$ to find *d* and used first principles to find a . Occasionally a candidate tried to form these equations using the formula for the sum to *n* terms. In so doing they ended up with such unlikely looking equations that you would hope they would stop and try and see where they’d gone wrong.

(b) Candidates generally handled this part well, usually with clear and concise steps to show the given result. Occasionally, there was a candidate who took a longer route, expanding out the brackets and then re-factorising, but usually still attaining the given result. Some candidates used an incorrect formula, the most common erroneous formula being $S_n = \frac{n}{2}\left(a + [n-1]d\right)$ for which no marks were available.

(c) This part was very well done and the vast majority of candidates picked up all 4 marks.

Question 10

This was the most challenging question on the paper.

(a) Almost every candidate found $\overrightarrow{DC}$ correctly, using the correct path (although a small number started with an incorrect path and then generally did not recover in later parts). Most candidates realised what was required to show that *ABCD* is a parallelogram, but many did unnecessary work here finding the modulus of either or both pairs of vectors. All that was needed was $\overrightarrow{DC} = \overrightarrow{AB}$ (we accepted *DC* = *AB*) which could be seen by inspection. Indeed, some candidates who worked to find the modulus of DC and AB then only stated that $|DC| = |AB|$ which is not sufficient.

(b) This was again generally well answered, with most candidates finding $\overrightarrow{BD}$ correctly using a correct path. However, a large number of candidates either misread the question or did not realise what needed to be done to find the unit vector (sometimes stating that $-12\mathbf{i} + 5\mathbf{j}$ was the unit vector) and thus failed to go on to calculate the modulus of $-12\mathbf{i} + 5\mathbf{j}$ and find a parallel unit vector, as required.

(c) A good number of candidates realised that the '3' and '10' were key to success in this question, but a few did not use them correctly in a ratio using the fraction $\frac{3}{10}$ instead of the required $\frac{3}{13}$. . Those who did derive the correct fraction generally went on to succeed, writing a correct path and successfully applying the ratio to find $\overrightarrow{AE}$. This was also generally well answered.

(d) The majority of candidates did not attempt this question. Those candidates who did make a serious attempt this part of the question often made good progress and chose one of three methods to find the ratio *DC:CF*. The three paths to the solution of this question we saw were; vectors (using up to three different triangles) using similar triangles (which was the most efficient method) and using gradients coupled with straight line coordinate geometry. Many of those attempting this part knew how to go about finding the correct coefficients of λ and μ in $\overrightarrow{AF} = \lambda\overrightarrow{AE}$ and $\overrightarrow{DF} = \mu\overrightarrow{DF}$ but unfortunately failing to write down the final ratio and thus missing out on the last mark. Some candidates attempted to find a ratio by 'dividing' two vectors, but then made no further progress. Those who wrote down an initial statement involving an undetermined coefficient generally succeeded at least in writing a fully correct expression (for the first three marks). Many went onto make an attempt at equating coefficients but then got stuck in the algebra and did not reach a correct answer. Some candidates went astray with incorrect algebra and found completely inconceivable ratios which would suggest that going back and checking work was advisable.
However, a common marking pattern of those who made a credible attempt in this part was B1M1A1M1A0A0 (4/6).

Question 11

The first two parts of the question were attempted by most candidates and completed successfully but finding angles between planes in parts (c) and (d) was beyond many candidates. Failure to understand that the angle between two planes must be found in the plane perpendicular to both was widespread. Some of those not managing to find angles between planes did still manage to gain some credit on the last part giving working to find x given the area of one face.

Many candidates clearly struggled to visualise exactly what was required for some parts of the question notably parts (c) and (d). Many annotated the diagram given but more candidates might well have been successful had they taken the trouble to draw and label the individual triangles required for each part of the question.

(a) Most candidates used Pythagoras correctly to find *AX* with many spotting that this is the same as the height *EX*.
(b) Almost all candidates succeeding with part (a) also succeeded in finding *EA* by using either Pythagoras theorem or simple trigonometry.
(c) Many candidates would have been helped by a clear labelled diagram of the triangle in question identifying sides of the triangle as $10x$ and $6x$ (or $2\sqrt{34}x$) leading directly to solution by inverse tangent, sine or cosine.
(d) This part clearly calls for an acute angle so it is disappointing that the many candidates finding angle *DXC* did not realise their error and find the supplementary angle *AXD* required. Most candidates worked in the wrong plane to find angle *AED* which although was of no value in this part did help them to answer part (e).
(e) Candidates successfully approached this final part of the question in two different ways, some using some using the cosine rule with their *EA* to find angle *AED* followed by using $A = \frac{1}{2}ab\sin C$, and some used Pythagoras theorem to find the distance from *E* to the midpoint of *AD*, a lot simpler and less prone to error. Apart from inaccuracies associated with use of the cosine rule, the other weakness was losing x^2 from working and /or forgetting to square root to find the length x.

Paper 2

Question 1

The vast majority of candidates answered this question completely correctly. The handful of candidates lost marks either found the wrong angle, assumed a right-angle and used basic trigonometry or failed to give the angle to the correct accuracy.

Question 2

Overall, candidates performed well on this question, with the vast majority of candidates recognising it was a test of the product and quotient rule.

In part (a) most errors occurred due to the terms not being of the general form required, demonstrating either lack of knowledge or poor application of the product rule or less frequently, the chain rule.

Part (b) was again generally well done and a reasonable number of candidates managed to gain full marks in part (b) having lost marks in part (a). When using the quotient rule, the most common error was the incorrect order of the two terms in the numerator of the quotient differentiation, followed by using a plus sign instead of a minus sign and finally, failing to have the necessary squared term on the denominator. A further common error was failing to differentiate the e^x terms with the correct constant coefficient.

However, most errors on (b) came when candidates attempted to use the product rule rather than apply the quotient rule. In general, the application of the quotient rule appeared to be better than the application of the product rule.

Question 3

On the whole, compared with previous years, this was a surprisingly well answered question, especially the understanding of the chain rule and its application. Occasionally the notation here was suspect.

The majority of candidates achieved high marks. Those candidates who were comfortable working in index form appeared to make fewer errors than those working with decimals. Perhaps the most common mistake was the premature rounding of the height and its subsequent use in the final answer, leading to the final accuracy mark not being awarded.

Very few candidates made an error when differentiating and avoided the concept of a decrease being a negative term by ignoring it and surprisingly few left their answer as a negative even when they had quoted $\frac{dV}{dt}$ as such. Occasionally, a candidate tried to use a standard formula, such as that for the volume of a prism, rather than the given formula.

Question 4

In part (a) almost all candidates knew that they had to take natural logs for both sides of the equation but very few students reached the final answer in the form of ln 2. The most common mistake was leaving the answer as 1/3 (ln8). Some candidates attempted the cube root of both sides first, then took ln for both sides. By this approach, the correct final answer ln2 was often achieved.

In part (b) most candidates attempted to eliminate *y* between the two equations and obtained an equation in *x* which they proceeded to solve. Almost all were able to produce a 3 term quadratic in e^{3x} and attempted to solve this by factorisation. Using a substitution for e^{3x} was popular and mostly led to the correct answers. However, some candidates chose to use *x* or *y* as their substitution variable of e^{3x} which commonly led to confusion. Most candidates found the exact coordinates of *x* and *y* and paired them correctly. A few candidates gave decimal answers instead of exact values.

Candidates who obtained the coordinates of *P* and *Q* (correct or otherwise) were mostly successful in using the correct formula for the length of *PQ* in part (c). However, some candidates lost the A mark for not being able to provide the degree of accuracy required, despite having already obtained the correct exact answer.

Question 5

Most candidates answered this question well. A very small number used arithmetic series formulae instead or used notation without the '*a*' and '*r*' involved (u_1 u_2 etc.) Almost all were able to write the equations correctly and proceed to the correct quadratic. Of those that didn't it was generally poor algebra on the elimination of '*a*' that let them down, e.g. cancelling the r^2 terms from the numerator and denominator. In part (b) some candidates ignored the convergent information and used both their *r* values, but most obtained a single correct final answer.

Question 6

Part (a) was usually well attempted and successfully completed. Most considered a cuboid without a top and proceeded well with correct algebra in the substitution. The most common error was forgetting $S =$ in an otherwise fully correct solution.

The overwhelming majority of candidates differentiated correctly in part (b), arriving at a correct value for x^3 or x. A significant minority achieved a correct x or x^3, but did not go on to substitute and find S or carried out this substitution in part (c), implying a lack of understanding of what each derivative might show or the context of the question.

In part (c) practically all candidates followed the route of finding the second derivative usually attaining the M mark and many candidates achieved the full 2 marks. Answers to this question were occasionally seen in part (b), where marks could not be awarded.

A relatively small minority of candidates struggled to reduce the powers of the negative term correctly when differentiating in parts (b) and (c).

Question 7

Most candidates knew the binomial expansion with very few candidates not putting the $2x/5$ into the correct powers in part (a) although part (b) caused more problems in this respect due to the negative sign. Almost all candidates achieved full marks for part (a) but omission of the negative sign resulted in no marks for part (b). Many candidates gained the mark in part (c), with a few using 2/5 rather than 5/2.

Candidates did not always see the link between parts (a) and (b) and then part (d). These students gained very few marks and often gave up completely. Of those that saw the connection, a number failed to deal with the 5s correctly or put them into each expansion as either 5 or $\sqrt{5}$. But if they proceeded to multiply the brackets they could still gain one mark.

Part (e) seemed to have been clearly understood by all, so most achieved the first 3 marks even though they may have carried forward some incorrect expression from part (d). However, a significant number showed no substitution working, so couldn't be awarded this method mark. Of those that had correct solutions too many jumped to an incorrectly rounded answer of 0.2170 for example and then lost two marks.

Question 8

Question 8 was proved to be the most challenging question in the whole paper.

Part (a) was attempted well by many candidates. Generally most candidates were successful in replacing *A* and *B* with θ in the given identities and obtaining the required trigonometric identities. The common mistake was seen in (i), in which some candidates omitted the intermediate step by not showing $\cos^2\theta = 1 - \sin^2\theta$ explicitly and just went straight to the given answer.

A wide variety of methods to prove the identity in part (b) were seen. The better candidates were able to use the results in part (a) concisely and efficiently obtain the required result. Many candidates used more complicated approaches than expected (even repeating the work of part (a)) but nevertheless completed it successfully. The weakest candidates either applied incorrect trigonometric identities or were unable to correctly handle the trigonometric expressions.

Many candidates were able to see the connection between parts (a), (b) and (c), with the rest mostly attempting to form and solve a 3 term quadratic in $\sin^2\theta$. Generally both methods were completed successfully by the better candidates. It was disappointing at this stage to see candidates losing marks through not giving the answers to the required degree of accuracy. Some candidates only found one angle (13.3°) without realising there was more than one solution in the given range.

A substantial number of scripts showed no attempt at the integration in part (d). The better candidates saw the connection between parts (b) and (d). However many still made simple algebraic errors in obtaining the correct integrand. Common errors were then seen in the integration of $\cos4\theta$ and $\cos2\theta$ and the constant 3. Having obtained their integral, the majority of candidates were then able to gain marks with their correct substitutions of the limits. A number of correct answers were seen. Candidates who did not see the connection between the earlier part of the question resorted to attempting to integrate powers of $\sin\theta$ with foreseeable consequences. Some candidates tried to use the equation in part (c) instead of the identity in part (b).

Question 9

This was another well answered question on the paper with the majority of candidates making significant progress throughout. There were many fully correct responses, and parts (a) to (c) were often correctly attempted.

Part (a) was generally well understood, with most candidates showing the correct process required. The majority were able to gain at least two marks for finding the required gradients, and showed understanding that the product of the two gradients should equal -1. Mostly this was done by attempting the product, though some stated the condition without showing the calculation explicitly, and there were also many who simply stated “negative reciprocal” or similar. However, some stated “inverses” or just “reciprocals” losing the last two marks as they had not shown sufficient understanding. Attempts via use of the Pythagorean identity were very rarely seen. Errors in this part it were usually due to use of the wrong coordinates, or calculating change in x over change in y.

Part (b) was again well answered, with most candidates getting the line in the correct form and scoring full marks. The most common method was to first find the gradient of BC and then proceeding via $y = mx + \text{c}$ with either B or C to find the intercept. A few candidates were less efficient and first found the mid-point here, not realising that B or C could be used.

Most candidates did then rearrange to the correct form of the line required, usually correctly. Aside from errors in manipulation, there were some candidates who used the gradient of a perpendicular line here, or whose gradient formula was incorrect, who did not access any marks for this part.

Part (c), though again generally well attempted by most, proved more problematic than the first two parts. The two key aspects of perpendicularity and bisecting the points were not always put together, with a significant number of candidates not even attempting the midpoint, instead using one of the end points for the line to pass through. Among those that did realise the midpoint was needed, there were a number of candidates who did not proceed to use the perpendicular gradient. Finding the midpoint correctly was a challenge for some who knew the correct overall method.

Part (d) was where incorrect answers became more common, with many different variations of the coordinates of *E* seen. It was very rare to see responses that recognised that *E* was necessarily the midpoint of *BC*. The most common approach was for students to find the point of intersection using the answers from parts (b) and (c). With no method mark available here any earlier errors in part (b) or (c) meant such approaches were unsuccessful in obtaining the correct points. There was little recognition that some obvious incorrect answers (such as finding *E* to be the point *B* for those who used the incorrect gradient in (c)) were incorrect.

The most common method seen for part (e) was by the "determinant" approach. The set up for this was generally well done, with correct sets of coordinates with their answer to (d) used. Only very few neglected the factor 1/2, and the attempted expansion of the determinant was carried out in nearly all cases via this approach - those that did not get full marks using this method were the candidates that had an incorrect *E* found in part (d).

For those using other approaches there were some very clear and well set out correct attempts, but also some without supporting work; these candidates may have been fortunate to choose correct sides. Those who used the correct two sides gained at least the methods marks, and usually full marks if (d) were correct. Those who chose the wrong sides would often get at least one method mark for attempting an appropriate length. Other attempts saw candidates attempt a midpoint of one of the sides *AC* or *CE*.

Attempts at finding the difference between the areas of triangle *ABC* and *ABE* were also fairly common, as were attempts using either trapezia, or forming the surrounding rectangle and subtracting the appropriate triangle areas for each corner. These were usually successful. It was very rare to see candidates appreciate the relationship between triangles *ABC* and *AEC*.

Question 10

The first two parts of this question proved accessible to most candidates, but there were relatively few fully correct answers in part (c). Many candidates had learnt the basic algorithm for finding a volume of revolution but were not able to visualise this specific problem and therefore not able to apply their knowledge.

Parts (a) and (b) were mostly answered fully correctly. Missing brackets in the equation was the most common cause of errors, with $2a^2 = 16a$ being a common incorrect equation. There were also some who did not manage to set up a correct equation of any sort. In part (b) the preferred method seemed to be finding the equation of the line through point *A* and then find the *x* intercept, with about two thirds of candidates gaining both marks.

Fully correct attempts at part (c) were comparatively rare, with many candidates only gaining the mark for attempting the integral of $16x$ in some fashion, and fewer for the attempting the integration. This reflected the fact that most responses attempted to use a curve – line or line – curve approach, as would be the case in finding the area between a line and a curve, and the two expressions were combined before integrating. Candidates who drew a diagram and thus knew they were adding rather than subtracting volumes were generally more successful, though even here many attempted a difference of volumes rather than a sum.

The volume of the cone was often incorrect if attempted, with a radius of 4 instead of 8 often used by those using the formula, or incorrect limits being applied by those who did keep integrals separate. The incorrect limits would often come from first attempting to solve the equation of the line and curve simultaneously, resulting in answer of 4 and 16, with these limits being then used.

Overall a lack of visualisation of the situation and over reliance on use of a set formula was in evidence in this question. The successful candidates were those who showed a correct understanding of the shape formed, and kept their integral for the volume generated from the curve and the cone volume separate. The latter was equally attempted by integration (with correct limits) or formula, with mixed success, but usually put together correctly.