ADDITIONAL MATHEMATICS

Paper 0606/12
Paper 12 Non-calculator

Key messages

Candidates need to show full method so that marks can be awarded should an error be made in the accuracy of a solution.

The checking of answers as part of a solution, where possible, is advised as arithmetic errors are more likely to be corrected when checks are carried out.

It is important that candidates read each question carefully, interpreting any key statements and using all the information given.

Attention should be given to the instructions on the front page of the examination paper.

Candidates should also make sure that they refer to the list of formulas given on page 2 of the examination paper when needed.

General comments

Many candidates offered complete and correct solutions, with all necessary method shown. Most candidates attempted to answer all questions.

The majority of candidates demonstrated good arithmetic skills. A few candidates needed to improve their skills in this area, in particular when working with fractions. This was evident in **Question 8(a)** and **Question 10** in this examination.

When a value simplifies to an integer, it is generally expected that candidates will state the integer in their final answer. In **Question 3**, for example, a few candidates stated the value of r^2 as $\left(\frac{\sqrt{296}}{2}\right)^2$, which was not accepted.

When a question uses the key phrase 'Show that', candidates needed to show clear, correct and complete method, without error or contradiction. This was required in **Question 4(c)**.

Many candidates presented their work neatly in a logical sequence of steps. Some candidates used additional paper and indicated the number of each question on the additional pages. It was helpful when candidates who did this added a comment in the answer space in their main script to indicate that their answer was written, or continued, elsewhere. Many candidates used sheets of additional paper headed Rough Work. Candidates should be aware that rough jottings, written in various orientations on the page with no question number indicated, generally cannot be considered as part of a solution and potential credit may then not be given. If work is written on additional sheets of paper, even if it is considered by the candidate to be rough work, it should be numbered and written neatly so that it can be marked as part of the solution if needed. The use of rough notes can also lead to candidates making unnecessary miscopying errors.

Candidates seemed to have sufficient time to attempt all questions within their capability.

Comments on specific questions

Question 1

The majority of candidates found this question to be an accessible start to the examination.

(a) Most candidates were able to draw a correct pair of graphs. As each of these graphs was the modulus of a linear function, both graphs should have been ruled. Although most candidates used a straight edge to draw their graphs, a few did not. This was not condoned. Some candidates were able to draw one correct graph. More commonly this was $y = 4|x - 1|$. When drawing $y = |3x + 2|$, candidates sometimes positioned the vertex at $x = \frac{2}{3}$. A few other candidates reversed the *y*- and *x*-intercepts for this graph. A small number of candidates omitted to clearly indicate the positions of the intercepts. These may have improved if they had reread the question. A small number of candidates offered graphs that had vertices above the *x*-axis or that were curved.

(b) Again, candidates performed well in this part of the question with a good proportion giving fully correct solutions. Some candidates lost the final mark, often offering a final answer of $\frac{2}{7} < x < 6$ or $x \geqslant 6$ and $x \leqslant \frac{2}{7}$ or $x \leqslant 6$ and $x \leqslant \frac{2}{7}$.

Candidates who chose to work with a pair of linear equations or inequalities were commonly successful. However these candidates sometimes negated both sides and offered the solution $x \leqslant 6$ only. Others made sign errors and only negated one of the two terms in either $4x - 4$ or $3x + 2$. Candidates who attempted to square both sides were also commonly successful. In this case, some candidates omitted to include the 4 when squaring. This was usually avoided when candidates made an initial statement of $(4x-4)^2 \leqslant (3x+2)^2$ before expanding the brackets. A few candidates made expansion errors with the left-hand side and attempted to work with $4x - 1$. This error was made regardless of the method of solution chosen by candidates.

Question 2

This question was well answered and many candidates offered fully correct solutions. A few candidates were able to state two of the values, commonly *a* and *c*. Incorrect values offered more than once were $a = 10$ or 3, $c = -7$ or -4 and $b = 2$ or $\frac{1}{3}$. Candidates who relied on calculations to find the values often made slips whereas those who used the diagram to count cycles and find the midline directly, then simply stated the values, were more likely to be correct.

Question 3

A good proportion of fully correct solutions were seen. Most candidates used the standard form for the equation of a circle, $(x-a)^2 + (y-b)^2 = r^2$. Most candidates were able to deduce that the centre of the circle was the midpoint of the line *AB* and the majority of these candidates found the correct coordinates. A few arithmetic slips were made when calculating one of the coordinates, more commonly the *y*-coordinate which was sometimes given as 1. Many candidates found the length of the diameter, *AB*, and then halved it to find the length of the radius. Most of these were successful. A few candidates incorrectly identified the length they had found. In these cases, it was most common for the diameter to be labelled or used as the radius. This was not accepted. A few candidates did not state the value of r^2 as an integer and this was not accepted for full credit. A few candidates did not correctly recall the equation of the circle. These candidates may have improved if they had checked the List of formulas on page 2 of the examination paper as this formula is given. In weaker responses, candidates substituted the coordinates of *A* and *B* into $(x-a)^2 + (y-b)^2 = r^2$ and made no further progress. In other weak responses, candidates found the gradient of *AB* and then attempted to form a linear equation with either the coordinates of the centre or one of the given points. In a few other weak responses, candidates used an incorrect formula for the distance between two points, for example $\sqrt{(x-h)^2-(y-k)^2}$ or $\sqrt{(x-h)+(y-k)}$.

Question 4

(a) This part of the question, assessing the candidates' understanding of the factor theorem, was very well answered. Most candidates used $p\left(-\frac{1}{2}\right)=0$ successfully and almost all candidates correctly simplified the equation they had derived. A few candidates may have improved if they had reread the question as some gave final answers of ± 4 and a few gave answers of –4.

(b) When a question requires that candidates factorise a polynomial expression, it is expected that the polynomial be fully factorised. Some candidates did offer the fully factorised form, $2\left(4x^2+1\right)\left(2x+1\right)$. Many candidates offered the partially factorised form $\left(8x^2+2\right)\left(2x+1\right)$ which earned partial credit. A few candidates offered factors that when expanded did not give p(x). For example, candidates who use synthetic division often stated $\left(2x+1\right)\left(16x^2+4\right)$ or $4\left(4x^2+1\right)\left(2x+1\right)$ which were not accepted. Other candidates divided through by 2 first and offered $\left(4x^2+1\right)\left(2x+1\right)$ which was also not accepted. These candidates may have improved if they had checked their work by multiplying out to make sure that their factors were equivalent to the given expression for p(x).

(c) It was important that candidates made clear, complete and correct statements in this part of the question. In order to be successful, candidates needed to be working with a correct expression for p(x). Candidates could either show that, for example, $8x^2+2$ could not be 0 or they could find the discriminant and show that it was negative. In both cases, candidates needed to state a conclusion such as 'no solutions', 'no real roots' or 'the square root of a negative is not real' or similar, based on their correct work. Some candidates were successful. Other candidates made slips such as incorrectly evaluating the discriminant, stating that $2x + 1$ was a root or stating that a 'negative root' was not real.

Question 5

(a) This part of the question was generally well answered. Candidates who factored 2 from the first two terms and then worked with $2\left(x^2-x\right)+3$ were usually successful. Those who worked with $2\left(x^2-x+\frac{3}{2}\right)$ were more likely to make an error with the constant. Some candidates formed and solved equations, rather than completing the square. These candidates sometimes made sign errors. Also, not all of these candidates gave their answer in the required form at some point and, therefore, had not fully answered the question. This was not condoned. Weaker responses sometimes offered solutions which involved $\left(x-1\right)^2$. Candidates who made slips may have corrected these if they had expanded their final answer to make sure it agreed with the expression given.

(b) A reasonable number of candidates were able to correctly interpret their answer to part **(a)** or differentiated and found the correct value from equating the derivative to 0. Both methods were accepted as there was no requirement in the question that the previous part be used. Common incorrect responses, when seen, were $p \leqslant \frac{1}{2}$, $p = -\frac{1}{2}$, $p = 0$ or $p = \frac{5}{2}$.

(c) Again, a reasonable number of candidates were able to correctly interpret their answer to part **(a)** or used $2\left(\frac{1}{2}\right)^2-2\left(\frac{1}{2}\right)+3$ to find the correct value. Common incorrect responses were $f \leqslant \frac{5}{2}$, $y \in \mathbb{R}$, $f > \frac{5}{2}$, $x \geqslant \frac{5}{2}$, $f \leqslant 3$ or $f \geqslant 3$.

(d) Candidates found this part of the question to be more challenging. A small number of candidates gave fully correct expressions, deducing that, as $x \leqslant \frac{1}{2}$, the negative square root was needed in the expression for the inverse function. A few candidates offered a final answer that was almost correct, with the error in their answer being the inclusion of ± before the square root. Most candidates carried out a correct order of operations to change the subject, and also swopped the variable, but used only the positive square root. In weaker responses, candidates usually rearranged to an expression such as $y(y-1)=\frac{x-3}{2}$ and then were unable to make further progress.

Question 6

(a) A few candidates offered fully correct solutions. Many candidates earned partial credit for $\sqrt{\frac{5}{6}}$ or $\pm\sqrt{\frac{5}{6}}$ or the exact equivalent. These candidates had not taken into account that $180° < \theta < 360°$ and that, as the tangent of the angle was positive, the angle had to be in the third quadrant. In weaker responses, the most common error was to write $\tan\theta=\frac{\sin\theta}{\cos\theta}=\frac{\sqrt{5}}{5}$ and then state $\cos\theta=5$. More careful consideration of this answer should have indicated to candidates that this could not possibly be correct.

(b) Candidates who gave the correct answer to part **(a)** usually stated the correct answer in this part also. Those candidates who stated $\pm\sqrt{\frac{5}{6}}$ in part **(a)** also often stated the correct answer in this part. Candidates who stated $\sqrt{\frac{5}{6}}$ in part **(a)** tended to state $\sqrt{\frac{1}{6}}$ in this part. In weaker responses, the most common error was to write $\sin\theta=\sqrt{5}$. Again, more careful consideration of this answer should have indicated to candidates that this could not possibly be correct.

(c) Most candidates used their value of $\cos\theta$ from part **(a)** and $\tan\theta=\frac{\sqrt{5}}{5}$, taking the reciprocal of each and summing. Almost all candidates who were correct in part **(a)** offered fully correct solutions in this part. Many candidates were credited for stating or using $\frac{1}{\cos\theta}+\frac{1}{\tan\theta}$ or $\frac{1}{\cos\theta}+\frac{\cos\theta}{\sin\theta}$. A few candidates used $\sec^2\theta=1+\tan^2\theta$ but again, those who had incorrect signs in part **(a)** tended to repeat that error in this part.

Question 7

(a) Most candidates offered fully correct solutions to this part of the problem. The majority of candidates were able to earn the first mark for the elimination of one unknown and the correct clearing of the fraction. Candidates who combined the constants before multiplying by $x + 1$ were more successful at clearing the fraction. Those who attempted to simplify $\frac{5}{x+1}+2=2x+1$ sometimes omitted to multiply all terms by $x + 1$. Most candidates rearranged to form a correct three-term quadratic equation in x. Many candidates went on to solve their equation correctly, usually by factorising. A few candidates made sign slips which may have been corrected if they had expanded their brackets to check their answer or if they had checked that the point they had found satisfied the equation of the line and the curve.

(b) A good proportion of candidates offered fully correct solutions. Most candidates correctly integrated to find the relevant area under the curve and subtracted the area of the trapezium. Some candidates integrated $\frac{5}{x+1}-2x+1$ and were equally successful. A few candidates omitted to group the argument of the natural logarithm using either brackets or the modulus. Many of these were able to recover from this by using the expressions correctly in later work, but not all. A few other candidates incorrectly used a logarithm to base 10. Some candidates were confused by which values should be used as the limits of the integral as, even though they were integrating with respect to *x*, the limits they used were values of *y*. A few candidates made no attempt to answer.

Question 8

(a) Almost all candidates were able to form a correct pair of equations in *r* and *d*. Most of these candidates eliminated one of the unknowns correctly and solved. Many of these candidates offered a fully correct solution. A few candidates included one or both of $r = 1$ and $d = 0$, which was not condoned. Some candidates made sign slips when factorising. A few candidates used the equations $10r = 10 - 3d$ and $10r^2 = 10 - 5d$. These candidates sometimes confused themselves in doing this and stated a positive value of *d*. In weaker solutions, candidates were unable to form the equations needed. Some of these candidates did not appreciate that the value of *a* was 10 for both progressions and made errors when solving $ar^{1-1} = 10$ or $a + (1 - 1)d = 10$. Other candidates may have improved if they had referred to the List of formulas on page 2 of the examination paper in order to check the correct expressions for the *n*th term of each progression.

(b) A reasonable proportion of candidates offered a correct response in this part. It was sufficient to state $|r| < 1$ therefore the sum to infinity exists, providing that this was correct for their value of *r*, and many candidates did so. A few candidates stated that $r < 1$ which was not accepted. The decision made needed to be correct for their value or values of *r*. Candidates who stated two values of *r* in their final answer to part **(a)**, needed to make a decision about the existence of the sum to infinity for both values. In these cases, some candidates made a single general statement that did not apply to both the values they had found or made a specific determination for one of their two values only. In weaker responses, candidates found a value for the sum to infinity and determined that, as they had found it, it existed.

Question 9

Many candidates offered fully correct solutions to this question. Most candidates changed the logarithms to a consistent base of 2 and were mostly successful. Other candidates changed the logarithms to a consistent base of $x + 1$ and were also mostly successful. A few candidates incorrectly rejected, for example, $\log_2(x+1) = -1$ or $\log_{(x+1)} 2 = -1$. It is likely that these candidates incorrectly recalled the fact that the argument of the logarithm cannot be negative. These candidates may have not fully understood the relationship between logarithms and exponentials. Candidates who changed to other consistent bases, such as base e or base 10, more commonly made slips when attempting to solve the equation that resulted. A few candidates made slips when rearranging to quadratic form. These candidates often misinterpreted the square as being the square of the argument of the logarithm instead of the square of the logarithm. A few candidates sensibly avoided this difficulty by stating and using a substitution such as $y = \log_2(x+1)$ or $u = \log_{(x+1)} 2$ before rearranging to quadratic form. A few other candidates made sign slips when factorising or solving. In weaker responses, candidates either were unable to deal with the 4 correctly when changing to base 2 or misapplied laws of logarithms and formed an equation that was not quadratic.

Question 10

This question was generally well-answered. A fair number of candidates offered fully correct solutions. These candidates used the simplest methods for finding *R*: displacement vectors or the midpoint formula. Some candidates were able to find the correct coordinates of *Q* but were unable to interpret the information given in the question to find the coordinates of *R*. Often these candidates offered a whole page of algebra, solving the equations of the tangent and the normal. Most candidates formed and used the correct derivative. Most candidates correctly recalled the relationship between the gradient of the tangent and the gradient of the normal. Most candidates were able to correctly evaluate $y = 27^{\frac{2}{3}}$. Many candidates found the equation of the tangent as well as the normal. This was not required. Candidates using $y - y_1 = m(x - x_1)$ were less likely to make a sign error when forming the equation of the normal than those who used $y = mx + c$ and then evaluated *c*. When other errors were seen, they were commonly:

- incorrectly finding $\frac{2}{3} - 1$ for the power of the derivative

- using $m_1 m_2 = 1$
- evaluating $\frac{10}{3} \times \frac{1}{3}$ as $\frac{10}{6}$ or evaluating $\frac{10}{3} \times 27^{-\frac{1}{3}}$ as 10.

Question 11

(a) This part of the question was well answered. Some candidates made good use of the diagram and gave careful attention to the direction of vectors using arrows in the conventional way. Candidates who did not annotate the diagram in any way, sometimes stated vectors with incorrect directions. A few candidates did not interpret $\overrightarrow{ON} = 3\overrightarrow{NA}$ correctly. Usually, these candidates stated that $\overrightarrow{ON} = \frac{2}{3}\mathbf{a}$. A few candidates incorrectly used $\frac{\lambda}{1+\lambda}$ or $\frac{1}{\lambda}$ for the scalar.

(b) This part of the question was also well answered. More candidates understood that $\overrightarrow{OM} = \frac{1}{2}\mathbf{b}$ and used this correctly to find $\overrightarrow{MA} = \mathbf{a} - \frac{1}{2}\mathbf{b}$ and then also $\overrightarrow{OX}$. Those candidates who made errors, again, usually had an incorrect direction or used an incorrect scalar such as $\frac{1}{1+\mu}$.

(c) A good proportion of candidates offered fully correct solutions. Some candidates formed a correct pair of equations in λ and μ but then made slips in the solution of these equations. In weaker responses, candidates did not realise that to find the values of λ and μ they needed to equate scalars only. These candidates usually formed equations involving the vectors as well as the scalars and then did not know how to proceed. Other candidates equated vector expressions for $\overrightarrow{OX}$, but made no real progress beyond this step.

Question 12

(a) Candidates found this to be a very straightforward part of the question. It was very well answered with almost all candidates offering the correct solution. Candidates who were not successful either did not interpret the expression as a product or were unable to differentiate the exponential correctly or both.

(b) A reasonable proportion of candidates offered fully correct solutions. A few candidates offered a correct expression but omitted the constant of integration. This was not condoned for full credit. A few candidates made slips when dividing an otherwise correct expression by 3. In these cases, it was usual for candidates to either omit brackets or to divide the first term in the difference but not the second. Other candidates made sign slips when rearranging. A few candidates made a correct initial statement but were unable to make any further progress. In weaker responses, candidates integrated the product 'term-by-term' as if it were a sum and offered an answer of $\frac{x^2}{2} \times \frac{e^{3x+2}}{3}$, for example.

ADDITIONAL MATHEMATICS

Paper 0606/22
Paper 22 Calculator

Key messages

Candidates should be aware that work done in previous parts of the question is sometimes intended to help with subsequent question parts, even if not explicitly stated.

The correct level of accuracy is essential, so candidates must be familiar with the rules associated with significant figures.

General comments

This paper did not have any questions on material new to the syllabus. Candidates were allowed the use of their calculators so the paper content would have been familiar to past papers. There were many excellent scripts seen, with candidates showing that they had prepared well and been prepared well for the examination. There appeared to be no timing issues. Candidates made full use of additional sheets when they needed extra room to complete or redo a solution.

Comments on specific questions

Question 1

Many candidates obtained full marks, showing a good understanding of circular measure.

(a) Most candidates found the correct angle, sometimes leaving their answer as 1.176 radians, which was acceptable rather than the expected 1.18 radians. A few candidates chose to find the angle in degrees and then convert to radians.

(b) Some candidates chose to use trigonometry rather than Pythagoras' theorem to find the length of the line *OB*, thus obtaining an inaccurate value. However, when correct methods were applied the resulting rounded answer was usually correct.

(c) As in the previous part, if an inaccurate length was used to find the area of the triangle *OAB*, a correct method, followed by appropriate rounding usually led to a correct answer.

Question 2

(a) A variety of approaches produced coordinates that were usually correct. Some candidates chose to integrate the given function as a product, but when equating to zero, chose the expand their result to obtain a 3-term quadratic equation. A few candidates, choosing to differentiate the function as a product, realised that (x + 2) was a common factor and were able to obtain the required x-coordinates without resorting to any expansion. Other candidates chose to expand the function out and then differentiate, usually obtaining a correct 3-term quadratic equation which was then solved.

(b) Whilst most candidates sketched a correct cubic shape, too many assumed that the maximum point was on the *y*-axis, not relating the work done in part **(a)** to the sketching process. This was often confirmed by an incorrect inequality in part **(c)**. Most candidates were able to obtain the correct intercepts on each axis.

(c) It was intended that candidates again make use of the work done in part **(a)** and part **(b)** to find the value of the *y*-coordinate at the maximum point. Too many candidates stated the incorrect result of

$0 < x < 6$ and were unable to gain any marks as a correct method had not been used. Some candidates did not relate the question to the previous parts and attempted a solution of the original cubic equation equated to k. Many correct solutions were seen with a fractional or correctly rounded upper limit being equally acceptable. It was also essential that the correct signs were used in the final answer.

Question 3

There were many completely correct responses, with candidates recognising a 'disguised' quadratic. Some candidates however, mistakenly discounted the root obtained from $\left(x\right)^{\frac{3}{5}} = -\frac{3}{2}$. Some candidates, having obtained the correct results $\left(x\right)^{\frac{3}{5}} = \frac{4}{3}$ and $\left(x\right)^{\frac{3}{5}} = -\frac{3}{2}$, were unable to find the correct values for x.

Question 4

(a) (i) Nearly all answers were correct.

(ii) Most candidates realised that there were two cases to consider and stated the two cases together with the number of different teams that could be formed in each case. A few candidates mistakenly chose to multiply these two answers rather than add them.

(b) There were two common approaches. The first involved considering the number of digits which had a zero in the final place and also the number of digits which did not end in a zero, multiplying the results. The second, very similar, approach involved considering the number of digits which started with an odd number and also the number of digits which started with an even number, multiplying the results. Although many correct solutions were seen, some candidates 'mixed' up the two methods. Others chose to consider individual cases and often did not consider all the possible cases. It was useful and good practice when candidates stated the cases they were considering.

Question 5

(a) Most candidates realised that the equation needing to be considered was $e^y = mx^2 + c$. Very few candidates did not gain a mark for this, which may have been implied by their solutions rather than stated explicitly. Provided the gradient and the given coordinates were used correctly, most candidates obtained the equation $e^y = -3x^2 + 18.75$. Candidates who did not use the given coordinates correctly were unable to gain any further marks. Although there were occasional errors in the application of logarithms, most candidates were able to obtain the correct final equation.

(b) This question part proved to be more demanding of candidates. Many realised that the expression they were taking the logarithm of needed to be greater than zero and gained credit for this either stated or implied. However, for those candidates with correct inequalities, many did not realise that there were two critical values involved, ± 2.5, with many candidates using 2.5 only.

Question 6

(a) The great majority of candidates obtained a fully correct unsimplified answer, with most attempting differentiation of a quotient rather than a product. Either method was acceptable. Subsequent errors in attempted simplification were condoned as these errors led to a loss of marks in the subsequent parts of the question.

(b) Most candidates used a correct method using small changes. Too many candidates gave an answer of $0.085h$ rather than $0.0849h$, not taking into account that for significant figures, counting starts at the first non-zero figure for small numbers.

(c) The most common error made by candidates was not appreciating that y was decreasing in value. A correct rate of change approach was made by most candidates, but too many gave an answer of 4.71 rather than -4.71.

Question 7

(a) Candidates needed to read the demand of the question carefully. Here they were being asked for the least value of *a*. There were too many answers of $a \geqslant -1$, rather than the correct $a = -1$. The question depended on candidates realising that the range of f, $a + 2$, was fully included in the domain of g. It was clear that many candidates were not fully familiar with this condition.

(b) There were very few incorrect solutions seen. Most candidates applied the correct order when finding the composite function and solved correctly to find *x*.

Question 8

(a) Most candidates showed sufficient detail, in a variety of ways, to obtain the given result. It was necessary to deal with $\tan^2\theta$ correctly, either in an identity involving $\sec^2\theta$ or by writing it as $\frac{\sin^2\theta}{\cos^2\theta}$. It was then essential that candidates show either the use of the identity $\sin^2\theta + \cos^2\theta = 1$ or the use of $\sec^2\theta = \frac{1}{\cos^2\theta}$ together with correct manipulation and simplification in order to gain both marks.

(b) Most candidates used the result from part **(a)**, appreciating the use of the word 'Hence' in the demand of the question. Most candidates obtained and made a correct attempt to solve the equation $\sin 3x = \frac{1}{2}$. There were many fully correct solutions, but some candidates did not obtain all the solutions in the given range, often not considering the negative possibilities.

Question 9

(a) Most candidates differentiated the given displacement, with respect to time, in order to obtain an equation for the velocity. Equating this result to zero gave many correct solutions with the occasional arithmetic slip from some candidates.

(b) This question part was probably one of the most demanding parts of the paper, with many candidates finding the value of *s* when $t = 0$ and the value of *s* when $t = 2$. Again, candidates were expected to consider the work done in part **(a)** which was meant to inform them that the particle was at rest in the time interval stated. Consideration of the value of *s* when $t = 0.5$ was also essential. Candidates that did realise this, usually used a correct method to find the total distance travelled. Candidates had to realise that when $t = 2$, the displacement was negative and account for that correctly in their method. Solutions of the distance being equal to 1.9528 or exact equivalent usually did not gain any credit.

(c) Most candidates realised that they needed to differentiate again to obtain an expression for the acceleration of the particle. It was intended that candidates make use of the chain rule, with many doing so. Some chose to differentiate using the quotient rule, often with errors in the numerator either through incorrect simplification or incorrect differentiation.

(d) A correct answer to part **(c)** was needed to obtain the one mark available in this question. An answer of -0.2 or $-\frac{1}{5}$ were the only acceptable answers.

Question 10

Most candidates made use of their problem-solving skills and produced a fully correct solution. Candidates had more success when they expanded $(ax-2)^4$ and $\left(1+\frac{b}{x}\right)^3$ fully. This made it easier to pick out the relevant terms to obtain equations to find *a*, *b* and then *c*. Problems arose when candidates did not deal with the term in *a* in the expansion of $(ax-2)^4$ correctly, usually obtaining an incorrect answer of $a = 81$. Similar errors involving *b* sometimes occurred in the expansion of $\left(1+\frac{b}{x}\right)^3$. Arithmetic slips occurred occasionally and sometimes candidates did not consider all the terms required to obtain an equation in *b* and an equation in *c*.

Question 11

Many candidates obtained the statement $\tan(y+1.5)=\frac{1}{3}$. This was needed in order to continue. A correct order of operations was used by most with many obtaining both solutions in the given range.