MATHEMATICS (US)

Paper 0444/21
Paper 21 (Extended)

Key messages

To succeed in this paper, candidates need to have completed full syllabus coverage, remember necessary formulae, show all necessary working clearly and use a suitable level of accuracy.

General comments

This examination provided candidates with many opportunities to demonstrate their skills. There were many good scripts with candidates demonstrating an expertise with areas of the subject content and proficient mathematical skills. Very few candidates were unable to cope with the overall demand of this paper. Some candidates omitted questions or parts of questions, but this appeared to be a consequence of a lack of knowledge or familiarity with a topic rather than any timing issue.

Candidates showed particular success with the basic skills assessed in **Questions 1**, **2**, **3**, **5**, and **10**. The most challenging problems were **Questions 4**, **8b**, **11b**, **19**, **20c**, **21** and **22**, and to a lesser extent **8a, 14, 17** and **18**. All candidates need to take care to read the specific demand in each question. This particularly applies to the demands to 'describe the **single** transformation' in **Question 11a**.

In general, candidates were very good at showing their working, which made it easier to award method marks when answers were not correct or were inaccurate. However, a small number of candidates appeared to be crossing out all of their workings, even where correct. This is not advisable, as an inaccurate answer that does not score could then lead to correct but crossed-out workings gaining no credit. In addition, marks were sometimes missed by candidates not being careful with accuracy. For example, intermediate results were sometimes rounded prior to the final answer, which could distort the accuracy of the solution.

Comments on specific questions

Question 1

For many candidates this was a comfortable first question, with the correct answer being quite common. Some correctly found the fourth angle in the given quadrilateral, using angle sum, but neglected to find the required exterior angle. For those with incorrect answers it was common to see them incorrectly assuming that some lines were parallel, with incorrect answers of 56° and 71° being seen often. Errors in arithmetic were also seen on a number of occasions.

Question 2

Whilst there were many correct answers most errors came from poor addition of times, with the incorrect 05:15 being offered quite often, forgetting to 'carry' an hour when adding the 43 to 32 minutes. Some working ignored that there are 60 minutes in an hour rather than 100, or that there are 24 hours in a day, giving an answer of 30:15. Whilst alternative formats for the time (such as 6.16 a.m.) were acceptable a small number incorrectly gave their answer as a duration (e.g. 6 hours 15 min) and so did not score.

Question 3

The correct values for *a* and *b* were most usually found but the quality of reasoning varied greatly. Candidates must understand the demand to 'give a geometrical reason' meaning that correct vocabulary is expected, rather than descriptions in non-mathematical language. Reasoning for angle *a* was more commonly given credit than for *b*, with reference made to 'opposite angles being equal', although some candidates introduced doubt with additional reference to other geometrical properties or used non-geometric terms such as ‘mirrored angles’.

Vocabulary in the reasoning for *b* was less successful although those gaining credit usually did so by referring to the ‘interior angles’. There were candidates who attempted reasoning in stages, which is trickier as each part needs to have correct reasoning vocabulary. Many candidates gave or described calculations for *b*, which does not count as ‘geometrical reasoning’.

Question 4

There was a significant majority who did not address the demand to write each number in the given calculation correct to 1 significant figure. These candidates took much longer to answer the question and could not gain any marks. Had the rounding been done the calculation became straightforward, simplifying to $\frac{14}{14} = 1$. For those who did round, the most common error was to leave 18 unchanged instead of rounding to 20, or to truncate 6.7 to 6 rather than round to 7.

Question 5

The vast majority of candidates scored both marks on this probability question with very few arithmetic errors in evidence.

Question 6

The necessary formula was given on the formula page, but was not used by all candidates, and the answer was requested in terms of π to avoid any unnecessary calculations. Many candidates however included a value for π, making the question take longer and introducing inaccuracies. A common error seen was failing to halve the stated diameter to use radius in the formula. Other errors seen were using r^2 rather than r^3, doubling the diameter, or using $\frac{3}{4}$ rather than $\frac{4}{3}$.

Question 7

Whilst most knew they should multiply by the map scale, a large number were unable to address the conversion between centimetres and kilometres. The more successful candidates often tackled this part in two stages, first changing to metres, but many stopped there. Few started by converting the scale to reach 1 cm: 2.5 km, which might have been more successful for some candidates.

Question 8

Many candidates spotted that each term in **part (a)** was 5 greater than the previous one but sadly few could correctly relate this to the *n*th term including $5n$, instead giving $n + 5$ as the most common incorrect answer. Some subsequent checks after finding their general term could have identified the error. Not understanding the demand of the question some merely offered the next term in the sequence (22), or the 9th term (42).

In **part (b)** it was extremely rare that candidates recognised that a power of 5 was needed to express the geometric sequence. Those recognising ‘×5’ as a term-to-term rule commonly tried $5n$ or simply found the next term.

Question 9

Using the straightforward scale factor of 1.5 between the similar triangles was only attempted by a minority of candidates. Many offered an answer without showing any method but these were rarely correct. The most common error made here was to add 2.5, the difference seen in the given corresponding sides, giving the wrong answer of 6.5. As the triangles were right-angled some incorrectly thought they needed to use Pythagoras Theorem or trigonometry.

Question 10

Many candidates were able to re-write $2\frac{1}{7}$ as an improper fraction, with most of the successful candidates on the question then taking a standard approach of multiplying by the reciprocal of $\frac{5}{9}$. A small number 'flipped' the wrong or both fractions before multiplying. The approach of re-writing the division of fractions with a common denominator was seen less often but was often successful. A number of candidates were able to gain the method marks but neglected to cancel to a mixed number as instructed.

Question 11

As in previous series many candidates in both parts of **(a)** failed to follow the instruction to 'describe using a **single** transformation', and hence did not gain marks. They should also note that correct vocabulary is required, rather than a description such as 'it doubles in size' for **part (i)**, which could not score for either 'enlargement/dilation' nor for 'scale factor of 2'. Some considered the transformation in the wrong direction, giving a scale factor of $\frac{1}{2}$. Whilst many recognised there was an enlargement, the most commonly omitted property for the transformation was the centre of enlargement. Again in **part (ii)** correct vocabulary ('rotation' rather than e.g. 'turn') was needed, with many recognizing the appropriate transformation. (The most common incorrect answer for a single transformation was reflection.) Pleasingly most candidates who gave the angle of rotation also stated 'clockwise', which was necessary. The centre of rotation was the most common error or omission.

The stretch in **part (b)** was not always attempted and was rarely correct. Whilst a small number performed a horizontal stretch on the triangle it was not always positioned correctly. Often it was stretched in both directions in error, possibly showing a lack of familiarity with '*y*-axis invariant'.

Question 12

The correct answer of 42° for angle *QSR* could most quickly be reached using the Alternate Segment Theorem. As *QS* was clearly a diameter many candidates instead subtracted 42° from the right angle at *Q*, but 48° was then often incorrectly given as the answer for angle *QSR*. The mark for angle *PQS* was often still earned (and was the most successful part of the question) as follow through for recognising it should be the same as their angle *QSR*. Candidates were least successful in finding angle *POS*, and this was sometimes left blank, although again the mark could still be earned as follow through for recognising it should be double their angle *PQS*.

Angles simply written on the diagram were insufficient to score marks as the question required candidates to demonstrate an understanding of the notation 'angle *QSR*' etc.

Question 13

This question on simple interest proved challenging for a significant number of candidates. There were a wide variety of incorrect approaches seen using a mix of division and subtraction to combine the values given in the question in a variety of different ways. It would benefit candidates to consider whether their answers are reasonable in the context of the question as this could identify that errors had been made. A small number seemed to be attempting the question as a compound interest problem indicating that greater care should be taken in reading the question.

Question 14

There were few fully correct solutions seen to this problem, with commonly errors being due to not reading the demand carefully enough by: **(i)** attempting linear proportion, **(ii)** attempting inverse proportion, or **(iii)** using square root rather than square. Some appeared to know what was required but failed to show their method clearly making method marks difficult to award when the answer was incorrect. It was common to see attempts without using a constant of proportionality and so failing to score.

Question 15

Many candidates recognised the need to start off with $\frac{5}{13}$ for the probability of a first button being green, which earned a first method mark. Many fewer however were then able to use this correctly in a product with $\frac{8}{12}$ for a second button being non-green to score the next mark. Only the strongest candidates realised that they also needed to double the result of the product to account for the possibility of green being the second button, with only a few scoring full marks. A common error made by candidates who recognised the need to find a product was to miss that the question stated that the buttons were taken out 'without replacement'. It was also noted that there were a number of candidates who obtained answers greater than 1 which should have indicated to them that an error had been made.

Question 16

Only a minority of candidates understood what was required of them to find the magnitude of the vector in **part (a)**, with the elements instead combined in various different incorrect calculations. Of those realising that Pythagoras' Theorem was needed many used -6^2 rather than $(-6)^2$ and so did not score.

In **part (b)**, some candidates were able to correctly find the required vector $\overrightarrow{CB}$ in terms of **x** and **y**, but they were in the minority. There were a range of incorrect answers seen, some of which were incorrect combinations of the two vectors, but others were not actually vectors in that candidates had squared, square rooted, multiplied or in other ways tried to process the given vectors in an incorrect way.

Question 17

There were a small number of correct responses offered demonstrating that few candidates fully understood the principles of simplifying with indices. A common error seen was applying the power of $\frac{3}{4}$ to only the x^{12} or (less often) to only the 81 but not to both, often giving an answer of $81x^9$. Also seen was adding the indices in error, or treating the power of $\frac{3}{4}$ as a factor to work out $\frac{3}{4}\times 81$.

Question 18

A number of candidates were able to square the surd fully in **part (a)** and give the answer 18. However, working in stages, some candidates knew how to start, but could not simplify further once they reached e.g. $9\sqrt{4}$. Common errors seen were to square the $\sqrt{2}$ but not the 3, leading to an answer of 6, or to ignore the square root sign and obtain an answer of 36.

In **part (b)** some candidates were able to correctly square the bracket, or at least gain credit for showing their expansion, however these were in a minority. The most common incorrect answer was $5+3\sqrt{15}$ which appeared to be more of a guess using figures from the question. Another incorrect approach was squaring the $\sqrt{5}$ and the $\sqrt{3}$ but ignoring the products of the two surds in the proper expansion to give $5-3=2$.

Question 19

Very few candidates were able to attempt a sketch of a cosine graph in **part (a)**, and it was often left blank, showing that this is a skill much in need of practising. Some offered versions of a sine graph instead. Of the few with attempts at the correct graph, there was often a poor indication that there were turning points at 0° and 360° (sometimes appearing almost parabolic), or they were often very linear, or demonstrated no idea of symmetry. Also seen was starting correctly at (0, 1) but cutting the x-axis at 180° (and often then again at 360°).

In solving the trigonometric equation in **part (b)** very few seemed aware how to start, i.e. by rearranging the equation to $\cos x = -\frac{3}{5}$, which could have scored a method mark. To proceed further candidates need to learn the results for standard angles (here that $\cos 60° = \frac{1}{2}$) for this non-calculator paper.

Question 20

Whilst the correct *y*-value was often found in **part (a)** the most common errors were either a sign error when squaring –1 or in evaluating –2*x*, with a common incorrect answer being 0.

There were a fair number of fully correct graphs drawn for **part (b)**. Points were usually plotted accurately with only a few incorrectly reading the scale. Candidates will benefit from practice drawing smooth curves through plotted points – these need to be a single curve without breaks that do not miss the points plotted. It is not appropriate for polynomials to join points with straight lines as was seen a number of times. It appeared that some candidates did not make the connection between **parts (a)** and **(b)** with sometimes completely incorrect points plotted.

Many left **part (c)** blank, with very few attempting to rearrange the given equation to deduce the correct straight line needed to solve it using the graph from **part (b)**. For those with an attempt at this part, a line was not usually looked for, as required by the question, with instead an attempt made using the quadratic formula. This was condoned for 1 mark provided candidates gave only the root within the stated range of x, but attempts were not usually successful.

Question 21

Candidates needed to find an expression for the area of the sector and then subtract from that the area of the triangle. A few managed the first part appreciating that it was $\frac{1}{6}$ th of the area of the full circle, though a few calculation errors crept in (including using the formula for circumference). The second part proved more taxing. Finding the perpendicular distance from the vertex to the chord using Pythagoras Theorem, to then use for the area was rarely completed successfully. Alternatively use of the formula $\text{Area} = \frac{1}{2}ab\sin c$ (given in the formula list) could have been effective but requires the knowledge of standard angles (i.e. that $\sin 60° = \frac{\sqrt{3}}{2}$). A very common incorrect response was to merely insert the 12 and 60 from the diagram in place of *p* and *q* to give an answer of $12\pi - 60\sqrt{3}$.

Question 22

Few seemed to realise that factorisation was the key to answering this question (as it is common factors that can cancel), with many trying to perform incorrect 'cancellations' of terms seen in the numerator and denominator. Where some more appropriate progress was made the numerator was factorised, but occasionally with the incorrect signs on the constants. A few factorised the denominator but did not realise that the numerator also had a factor of $(2x+1)$ and that the bracket could then be cancelled as a common factor.

MATHEMATICS (US)

Paper 0444/41
Paper 41 (Extended)

Key messages

Candidates sitting this paper need to have a thorough understanding of all the topics on the extended syllabus. Some candidates did not respond to many parts of the questions, while others missed out whole questions entirely. This suggests that they may not have fully prepared for the exam.

Candidates were generally able to show their working well, but it is important to show the methods that were used. In some cases, incorrect answers were written on the answer line without any working. If these answers had included working, it may have been possible to award method marks. Other candidates crossed out all of their working, which should have been left to support their responses.

General comments

There were some excellent scores on this paper with a few candidates demonstrating that they had a clear understanding across the wide range of topics examined.

It is important for candidates to read the questions carefully and make sure they understand what is being asked. For example, in **Question 2(a)(iii** the question asks for the mean mass of pear trees, not all the trees. In **2(b)(ii)**, the amount needed is in dollars for one pear, not Euros for 12 pears. By carefully reading the questions, candidates can avoid making common mistakes and ensure that they are answering the questions correctly.

Questions that involve drawing within their solution should be clear and easy to follow with straight lines being drawn using a ruler when appropriate. On this paper, the histogram (**6(b)(ii)**) and the lines representing the inequalities (**11(b)**) should all be ruled as those drawn freehand were often inaccurate.

Many candidates show multiple attempts when answering questions. However, it would be helpful for candidates to indicate which of their attempts they would like to be marked when answering questions. This is because if none of the attempts leads to the correct answer, the attempt with the lowest mark will be used to calculate the candidate's score. This can sometimes have a negative impact on the candidate's score, as was the case with **Questions 2(b)(ii)**, **9(b)**, and **10(a)**.

Candidates should not make assumptions about diagrams. In **Question 3**, many candidates assumed that $EA = EB$ and that M was the midpoint of AB. In **Question 8**, it was a common assumption that angle ABC = angle ACB.

Comments on specific questions

Question 1

(a) (i) A good number of candidates were able to find the mode though a number of them gave it wrongly as 4 and 5, no doubt incorrectly choosing the numbers that occurred most often in the row of frequencies.

(ii) A similar number of candidates were able to find the median. The most efficient method was to see that 2 + 4 + 3 + 5 = 14 and that 2 + 4 + 3 + 5 + 5 = 19 and hence the 15th/16th values had a score of 8. A large proportion of candidates instead wrote the whole list of scores out, namely, as 4, 4, 5, 5, 5, 5, 6, 6, 6, 7, 7, 7, 7, 7…. which would have been a laborious method if the total frequency had been much larger. Common incorrect answers included 4, the median of the six frequency numbers, and 5, the median of the 14 numbers given in the table.

(iii) Some candidates scored full marks on this question. Others scored the method marks for either listing the sum of the seven products or evaluating the correct sum of 224. Many went on to divide by 30 but others divided by 7, the number of scores, 14, the total numbers in the table or 49 the sum of the 7 different scores. Other common errors included arithmetic slips and answers that were not seen to at least 3 significant figures. Candidates who answered this question with no working and gave inaccurate answers such as 7, 7.4, 7.5 and 7.46 did not score. Had they shown working they probably would have scored 2 out of 3 of the marks available.

(b) Few candidates answered this correctly and there was a wide range of reasons for this. The most common incorrect answers were 13.3 per cent, the percentage scoring 5 or 20 per cent, the percentage scoring 5 or less or 80 per cent the percentage scoring more than 5 and 96.4 per cent, from $\frac{216}{224}$, the percentage of marks scored by those who scored 5 or more.

(c) A small proportion answered this question correctly. Again, there was a wide range of incorrect answers, which were produced with no method evident. It was rare for any candidate who did not score full marks to evidence finding 30 per cent of 30 or state 9. The most common incorrect answer was 6, the number of candidates who scored "*x* or less" rather than "less than *x*" as required.

(d) A good number of candidates scored one mark for either $\frac{6}{30}$ or $\frac{21}{30}$.but it was rare for candidates to score more. Few candidates recognised that this was effectively a probability question without replacement and $\frac{6}{29}$ or $\frac{21}{29}$. were hardly ever seen. Other errors included having 9 or 24 as the numerators, adding rather than multiplying the fractions and not multiplying by 2. Some candidates tried to work in ratios but were almost always unsuccessful; fractions are the required and more successful approach.

Question 2

(a) (i) Many candidates answered this question correctly. Some scored one mark for correctly finding one part as 50 but proceeding no further. The most common incorrect method seen was to divide 1250 by 12, without using the fact that there were 25 parts in total.

(ii) Many candidates answered this question correctly though some scored just one mark for finding the total mass as 80 000 kg but did not convert to tonnes. Others divided by 64 rather than multiplying.by 64 whilst a small number of candidates did not read the question carefully enough and tried to find the mass of just the apple trees.

(iii) A fair number of candidates answered this part correctly, recognising this as a reverse percentage question. The common errors were answers of either 59.4 or 48.6 from either increasing or decreasing 54 by 10 per cent. A small number of candidates first worked out the total mass of pears from the 450 trees as 24300 and worked with this number, some were successful but others made the same common errors as stated earlier.

(iv) Many candidates answered this part correctly. Some scored one mark for finding the number of trees lost as 250 but not going on to give the number remaining. The most common incorrect method was $1250 - \frac{1}{5} = 1249.8$ without appreciating the need to find one fifth of the trees.

(b) (i) It was rare for candidates not to answer this part correctly. The most common error was to find the cost but not go on to calculate the change.

(ii) Whist a small number of candidates answered this part correctly many did not score any marks at all. A wide range of different errors were seen, including multiplying by the conversion rate rather than dividing, subtracting values in different currencies, such as 0.54 –0.51, rounding prematurely or using 1 – 0.826, Many chose to work with 12 pears, and were able to earn one method mark or two special case marks if they correctly reached $0.93 for the extra cost in dollars of 12 pears.

Question 3

(a) Many candidates scored at least one mark on this question. However, few managed to use both of the correct unit conversions to find the correct number of grams. Whilst the majority used 1000 g = 1 kg only a minority used 1,000,000 cm^3 = 1 m^3. Candidates not scoring had usually divided rather than multiplied the two values.

(b) To be successful in this part, candidates needed to recognise they first needed the area of triangle *ABE* from $\frac{145}{15}$. Few candidates took this first step. The majority of candidates incorrectly assumed that *M* was the midpoint of *AB* and used 3.2 in various calculations, often involving trigonometry or Pythagoras, in their attempt to find *EM*

(c) Few candidates thought to use sin(*EBA)* = $\frac{\textit{their } EM}{5.7}$. Most candidates either used 3.2 again with the assumption that *M* was the midpoint of *AB* together with Pythagoras or trigonometry. Others incorrectly assumed that *AE* = *BE* = 5.7 and attempted to use the cosine rule to find the required angle.

(d) A minority of candidates answered this correctly recognising that the cosine rule should be used. A few others were successful using longer alternative methods, such as using the perpendicular height of the triangle from **(b)** and Pythagoras' theorem twice. Some made errors with the cosine formula and others tried to use the sine rule but found they had not got enough information so could make no progress. Many candidates assumed the triangle was isosceles and gave the answer 5.7.

(e) Some candidates were able to score one mark for the area of one of the rectangular sides. Fewer candidates also scored a mark for one or both of the triangular sides. Again assumptions were made regarding *AE* = *BE* = 5.7. It was not uncommon for candidates to give an answer with no working and it was rarely possible to work out where these candidates' answers had come from.

Question 4

(a) Almost every candidate started their answer to this question by correctly plotting points *A* and *B* on the grid. A minority of candidates then completed the square on the diagram to score full marks. Of those who completed the expected square, many lost marks by inaccuracy in their plotting, costing them some or all of the other marks. Some tried to find the equation of the line joining *A* and *B*, and hence of *BC* or *AD* but this was an almost too complicated and too long a method for them to be successful. The majority of answers were incorrect and did not have squares drawn, usually a rectangle *ACBD* with coordinates (1, 1) and (–2, 5) or a rhombus with *ABCD* and coordinates (4, 1) and (1, –3).

(b) (i) Many candidates answered this question correctly with many candidates using the grid to draw *P* and *Q* to help them. For those not using the grid, the main errors arose from arithmetic errors, sign errors, or finding the mean of the difference, rather than of the sum, of the coordinates.

(ii) A reasonable number of candidates were able to obtain the length of *PQ* to the required accuracy by calculation. Common errors included adding the coordinates rather than subtracting them or not squaring the differences and arithmetic errors. Those who used the grid and counted the squares and found $\sqrt{14^2+2^2}$ did not score, nor did those who measured the length as they could not give the length to the required 3 significant figure accuracy.

(iii) A fair number of candidates gave the correct slope for the line either from calculation or from points *P* and *Q* on the grid. The most common errors came from arithmetic slips, errors with signs or using ''rise over run'' upside down.

(iv) Whilst some candidates found the correct line, there were a wide range of errors seen. These included not using their slope from **part (b)(iii)** or using the reciprocal of the slope from **part (b)(iii)**. Whilst some used (2, 0) to find the value of c, others used (0, 2) or *P* or *Q* or the midpoint of *PQ*, none of which were on the line. Again, there were arithmetic slips and sign errors. Candidates omitting the ''y='' or giving an inexact equation, with rounded decimals rather than exact fractions, could score a maximum of 2 out of 3 marks.

Question 5

(a) The majority of candidates used the correct formula, $\pi r l$, however most candidates thought that $l = 12$ and did not use Pythagoras to work out the sloping edge as $\sqrt{5^2 + 12^2}$. Some candidates found the volume of the cone whilst others simply found the area of the circular base of the cone.

(b) Some candidates found the volume accurately though some lost a mark for either premature approximation within their working or for using an inaccurate value of pi, such as 3.14. There were others who only got as far as finding the area of a semi-circle or who found the volume of the whole cylinder. Other errors included using an incorrect formula for the area of a circle or for answers which came from multiplying various multiples of 6, 11 and pi together.

(c) (i) Some candidates answered this part very well. Working was usually set out clearly and it was almost always easy to follow the methods being used with most answers accurate, with very few errors given to premature approximation. Other candidates found it hard to work out the exact area to take away from the rectangle but they, more often than not, were able to earn method marks, one for each of the area of the rectangle and the area of the circle. A minority of candidates did not use the correct formula for the area of a circle.

(ii) This part was answered reasonably well, with clear working and methods evidenced. Again, many candidates were able to earn a method mark for either the circular or straight part of the perimeter, even if they could not work out the total perimeter correctly. Common errors included working out the total perimeter of the rectangle without subtracting the two missing lengths of 4 units, subtracting rather than adding the arc length, finding either the whole or wrong fraction of the circle or using an incorrect formula for the perimeter of the circle.

Question 6

(a) (i) Many candidates gave the correct median. The most common incorrect answer was 35, this being the the middle of the age range. Some candidates gave answers over 100 years old, without thought that this might be too old.

(ii) Many candidates gave the correct lower quartile. A few candidates gave the answer 40, probably arising from $160 \div 4$.

(iii) This part was also answered well though some candidates, having scored one mark for 148, as the number of people aged 50 or less, then omitted to subtract this from 160. Another common error usually involved an incorrect reading of the scale as 144.

(iv) This part was answered well with many correct answers given. Others often scored one mark for 104 seen.

(b) (i) A small proportion of candidates answered this part correctly. Other than slips with arithmetic, the common incorrect responses included using the class widths rather than the mid-interval values, finding the mean or the median of the 4 frequency numbers and dividing by the sum of the mid-interval values rather than the sum of the frequencies. Again, many candidates gave an answer with no working so were unable to score whether it was totally incorrect or merely of insufficient accuracy.

(ii) Only a few candidates scored full marks on this and the histograms were expected to be accurate and ideally ruled and with no gaps between the bars. Many candidates drew bars with heights 1.85, 1.2 and 3 from dividing all of the frequencies by 20, taking no account of the different interval widths and these candidates often just scored one mark for the correct bar with height 1.2. Other candidates seemed to draw bars of various heights, which came from various sums, differences, products and divisions of the numbers given in the question.

Question 7

(a) Many candidates understood the function notation and gave the correct answer.

(b) A number of candidates were able to correctly find the inverse function. Most candidates started by swapping the *x* and *y* in the function to $x = 2y + 5$ and then rearranging. Common errors were not dividing every term by 2 or moving the $+5$ to the other side with the wrong sign. Other errors included just reversing the signs in $g(x)$ giving $g^{-1}(x) = -2x - 5$ or confusing the inverse function with reciprocal resulting in $g^{-1}(x) = \frac{1}{2x+5}$, or by writing $x - \frac{5}{2}$ rather than $\frac{x-5}{2}$ or leaving *y* in the answer rather than changing to *x*.

(c) Candidates who understood the term range were usually able to score full marks on this question. A common incorrect response was to place the domain values of –3 and 5 in the inequality.

(d) Some candidates were able to set up the combined expression correctly and scored full marks. However there were many incorrect attempts with the most common error first writing the combined expression without brackets as $x - 4 \times 2x + 5 - 2x + 5 - 4$. This invariably led to subsequent sign errors in the following work. In addition, some candidates gave the algebraic expression for g(f(*x*)) rather than f(g(*x*)) and others made errors in sign when expanding $(x-4)\times(2x+5)$. Basic slips in arithmetic or when combining like terms was also not uncommon.

(e) A fair number of candidates answered this part correctly. Many others were able to score one mark for just appreciating it involved g(–2), evaluating g(–2), finding an algebraic expression for g(f(*x*)) or writing $3^x = 1$. Common errors included finding f(g(*x*)) or g(*x*)f(*x*),

(f) For those that understood that $h^{-1}(x) = -2$ can be rewritten as $x = h(-2)$, this question was straight forward. Many candidates did not understand that this meant the inverse function and fewer answered this correctly than the number who correctly found the inverse function, $g^{-1}(x)$ in **part (b)**. The most common incorrect method included trying to solve an incorrect impossible equation such as $3^x = -2$.

Question 8

(a) (i) A minority of candidates showed understanding of how bearings are measured and these either calculated $270 + 29$ or $360 - (90 - 29)$. Common incorrect answers included 061 and 331 but there were also answers linked to the points of the compass and some candidates gave the bearing as a length.

(ii) The few that answered the previous part correctly were usually able to score full marks in this part. However, many candidates gave the same answer here as the previous part evidencing they did not understand the relevance of the reverse bearing. Few candidates used the diagram and drawing north lines at both *B* and *C* may have helped with working out the angles in both parts.

(b) There were a few excellent answers to this question, with candidates taking care with accuracy throughout. However, many candidates were unable to start this part because they could not work out how they could use the cosine or the sine rule to find angle *BAC* directly. Had they realised that finding a second angle would lead them to the third they may have been able to proceed. As a result, many candidates tried various more complicated approaches, such as adding a north line at *A*, but did not make much progress.

Question 9

(a) (i) Some candidates factored the expression completely. Some scored two marks for factoring the expression into two brackets, without taking out the 3. Most candidates were able to score just 1 mark by simply taking out a factor of 3 but not able to factor further as they did not recognise that $9y^2 - 1$ was the difference of two squares. Others were unable to make any progress with this question and candidates should be advised to look for any common factor, whether numerical or algebraic as a first step.

(ii) Some candidates factored the expression correctly and demonstrated a clear technique to do so. Some scored one mark for getting as far as $m(2-p)+k(2-p)$ or any equivalent useful step but then could not complete the solution. Other candidates gave two brackets with different signs such as $k(2-p)-m(p-2)$ but could make no further progress. Some candidates were not sure how to factor this type of expression.

(b) Very few candidates scored full marks on this question. There were a number of steps necessary and careful mathematical presentation with brackets and signs was required. Candidates first needed to recognise that they should express each of the 3 terms as a fraction with the common denominator $(x-1)(x+1)$. Of those that realised this, some then went on to have a correct numerator but there were frequently slips with signs or errors when multiplying out the brackets. It was also quite common for candidates to then wrongly cancel a bracket in the whole denominator with a bracket in only one part of the numerator whilst some even cross cancelled both the $(x-1)$ terms in the original expression as though the fractions were being multiplied rather than added. A number also just considered the two algebraic fractions and then simply took the minus one term off the numerator at the end.

(c) Most candidates recognised that the quadratic formula needed to be used for this question and many showed precise substitution into the formula evaluating the two solutions carefully to the required degree of accuracy. Common errors included stating the formula incorrectly, dealing with the $-b$ as -3 rather than $-(-3)$ or writing b^2 as -3^2 rather than $(-3)^2$, having short fraction lines or short square root signs which did not cover the relevant parts of the sum as well as arithmetic errors and answers rounded to the wrong number of decimal places.

Question 10

(a) There were some excellent answers to this question with candidates showing excellent algebraic manipulation. However, there were many conceptual errors seen. Common examples included, not using brackets or multiplying both sides by m incorrectly as $k = 4 + kp \times m$ rather than $k = (4 + kp)m$, error signs when collecting terms in k on one side, and factoring $k - kmp$ to $k(mp)$. Some candidates did not understand that they needed to manipulate the equation so that k was on only one side of the equation with a common incorrect final answer being $k = 4m + kpm$. It was not uncommon for candidates to try and solve the equation and try to give numerical value for k.

(b) A good number of candidates scored two marks on this question, but it was rare for any candidate to score full marks by recognising that $x = -6$ as well as $x = +6$. A very common error was for candidates to simplify $\sqrt{x^2+64} = 10$ to $x + 8 = 10$. Other errors seen included simplifying $\sqrt{x^2+64} = 10$ to $8x = 10$ or $\sqrt{x^2} = 10 - 64$.

(c) (i) Few candidates were able to write the given expression in the required form. Some overlooked the fact that the a^2 would impact the b,with $(x+5)^2 - 3$ being a common incorrect response, as was $(x+10)^2 - 3$ However many responses included $ax + x$, x^2 and $\sqrt{x}$ within the bracket and others tried to solve the expression as though it was an equation using the quadratic formula.

(ii) It was extremely rare to award the mark in this part. Most candidates did not have an expression of the correct form and those that did rarely gave their value of b.

Question 11

(a) Some candidates wrote down the three inequalities correctly. Most other candidates offered a response but there were frequently errors with both the direction and the type of inequality sign chosen. Other candidates had little knowledge of what was intended and wrote expressions which did not make any mathematical sense.

(b) A minority of candidates completed this correctly and they often used ruled, carefully drawn dashed or solid lines with clear shading and a defined region. Other candidates demonstrated a fair understanding of the approach needed but lost marks because they either used dashed or solid lines incorrectly, drew inaccurate lines, or shaded the wrong side of one or more of the lines. A significant number of candidates only scored 1 or 2 marks usually for drawing either $x = 4$ or $y = 7$. In addition, there were a number of candidates who did not offer a response or whose lines had no relevance to the problem.