# MATHEMATICS (US)

**Paper 0444/21**
**Paper 2 (Extended)**

## General comments

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. It is also important that candidates read the question carefully to establish the form, units and accuracy of the answer required and to identify key points which need to be considered in their solutions (for example the requirement to draw a suitable line on the graph to solve the equation in **Question 18**).

This examination provided candidates with many opportunities to demonstrate their skills. It differentiated well between candidates with a full range of marks being seen. There was no evidence that the examination was too long with candidates attempting questions throughout. Some candidates omitted questions or parts of questions, but this was likely due to a lack of knowledge rather than time constraints. Some candidates' handwriting was not as legible as others, which may have contributed to the errors in their work. Candidates generally showed working, however there were instances where this could have been more systematically laid out which would have benefited the candidate in following their own processes.

## Comments on specific questions

### Question 1

In this question candidates were asked to find the coordinate that would complete the parallelogram. There were lots of correct answers seen, but there were also many responses seen with only one value in their coordinate correct. Some candidates could not identify the correct position for D on the diagram but were able to correctly give the coordinate for their point in the appropriate quadrant of the diagram. Common errors included drawing a triangle rather than a parallelogram or placing the coordinate in the $1^{st}$ quadrant rather than the $2^{nd}$ quadrant.

### Question 2

**(a)** In the first part of this question candidates needed to find the probability of an event not occurring. The majority of candidates were able to give a fully correct answer.

**(b)** Candidates were generally able to complete the table giving the number of wooden toys and using the equal probability of plastic and metal toys to find their probabilities. If errors occurred it tended to be with the number of wooded toys, but these candidates still normally achieved a mark for the probability of plastic and metal evaluated correctly.

### Question 3

**(a)** Candidates were required to use the nth term of sequences to find the $5^{th}$ term of sequence A and of sequence B. This was generally well answered with the majority of candidates able to find the required terms. Where candidates were not able to find both terms, they were often able to find the $5^{th}$ term of the linear sequence. A common error was to show a substitution into the nth term, but not to evaluate this to obtain the required terms.

**(b)** Candidates were told that the *k*th term of the quadratic sequence given by the nth term $n^2 – 300$ was –156 and were asked to find the value of $k$. Many candidates were able to make an attempt at this question, either by forming an equation or by use of trial and improvement. A common incorrect answer was $\sqrt{456}$ from adding 300 and 156 rather than subtracting, others correctly reached 144 but forgot to square root. There were a minority of candidates who did not know how to make a start with the question.

**Question 4**

Candidates were asked to find the greatest odd number that is a factor of 140 and a factor of 210. Whilst fully correct answers were seen regularly, so were the answers 7 (the greatest odd prime factor of 140 and 210) and 70 (the greatest factor of 140 and 210) gaining one mark only. Common approaches to the question were to find all factors of 140 and 210, often working with factor pairs, or to find the prime factorisation of 140 and of 210. On rare occasions candidates worked out the lowest common multiple instead and gave their answer as 840.

**Question 5**

Candidates were asked to work out $(6 \times 10^{17}) \times (2.1 \times 10^{17})$ giving their answer in scientific notation. The majority of candidates attempted this question, often knowing that they needed to work out $6 \times 2.1$ leading to an answer of $12.6 \times 10^{34}$ if they were also able to apply the rules of indices but did not recognise that this was not in correct scientific notation or sometimes further errors were made and answers such as $12.6 \times 10^{17}$.

**Question 6**

In this question candidates were presented with 6 congruent kites and asked to find the size of a missing angle. This involved application of the sum of angles on a straight line, sum of angles in a quadrilateral and properties of a kite. There were a reasonable proportion of fully correct answers. Where incorrect answers were seen a common error was working with 5 angles at C totalling 180 in total rather than 6. Some candidates drew in the diagonal DB and tried to calculate x from here using angles in a triangle, whilst some thought DCB = 40, the same as angle DAB. Another misconception was that angles in a kite added to 180 and having calculated 30 correctly, candidates then added 40, but subtracted from 180 instead of 360 before dividing by 2.

**Question 7**

**(a)** In this part of the question candidates were asked to find the area of a compound shape made up of a right-angled, isosceles triangle and a semi-circle. Fully correct solutions were seen regularly, as well as responses that gained part marks. Most candidates were able to calculate the area of triangle JKL correctly. A considerable number were also able to work out the area of the semicircle correctly. Some candidates forgot to divide the area of the full circle by 2 to get the area of a semicircle. Some candidates used 12 (the diameter) rather than 6 (the radius).

**(b)** Candidates were asked to find the perimeter of the compound shape. In order to do so, they needed to find the arc length of the semi-circle and use either Pythagoras' theorem or, as was very rarely seen, trigonometry to find the hypotenuse of the triangle. Fully correct responses were seen, as well as responses that gained part marks. Common incorrect answers included $24 + 12\sqrt{2} + 6\pi$ where the candidate included an extra 12, and $12 + 12\sqrt{2} + 12\pi$ where candidates had difficulty in finding the arc length.

There were few fully correct responses and in a significant minority of cases candidates did not attempt the question. Many candidates who did not answer the question fully, did use Pythagoras Theorem to find KL correctly, although incorrect simplification of the surd was a common error. Some candidates did forget to divide their circumference by 2 but had often gained marks for using Pythagoras to get KL.

**Question 8**

Finding the nth term of the linear sequence in this question was well answered. Many candidates were able to give a fully correct nth term, often in the form $7n + 4$, but $11 + (n - 1)7$ was also a common correct response. Common incorrect responses included $7n + 11$ which scored 1 mark for $7n + j$. Other incorrect responses included n+7, 4n+7 from misunderstanding how to use the common difference in finding the nth term or +7 which was the term-to-term rule.

**Question 9**

This question on exponential decrease was answered correctly by only a minority of candidates. Where a correct answer was seen this was generally accompanied by clear working. Candidates generally worked in a stepwise manner, finding the value of the car after one year and then after the second year. A common incorrect answer came from working with simple depreciation rather than a compound process, this led to an answer of $6000 (2 years of depreciation at 20% of the original).

**Question 10**

In this question candidates needed to find the simple interest rate based on the initial amount in an account and the final amount in the account after 6 years. This was answered well by a minority of candidates who were able to find the interest rate of 2% often finding the total interest, then the interest per year and then working out the simple interest rate as separate steps. Around half of candidates were able to gain at least one mark, commonly from finding the amount of interest per year.

**Question 11**

Finding the inequalities that define the region was answered fully correctly by only a minority of candidates with many struggling with inequality notation or identifying the lines that made up the region. There were a range of errors seen in partially correct responses. Common errors included use of equals signs or the wrong inequality sign when attempting to express the inequalities, there were also others who included R in some manner in their attempted inequality statements. Some candidates had x and y reversed on the vertical and horizontal lines. Others were unable to find the equation of y = x correctly to use in their inequality for the diagonal line. In some cases, candidates seemed not to know how to express a region using inequalities, they either listed coordinates that they thought satisfied the region or were the vertices of the shape of R, whilst some tried to describe the region in words.

**Question 12**

This question on solving simultaneous equations was answered well by a minority of candidates. The most common correct approach taken was to multiply both of the equations to equate coefficients and then add or subtract. Where candidates took this approach, they generally chose to multiply $6x + 2y = 29$ by 2 and then add this to the second equation given in the question to eliminate the $x$ term. It was common to see errors in arithmetic which often meant that candidates could gain partial credit for a correct method with arithmetic errors. There were also a number of candidates who had incorrect processes such as not multiplying all terms when attempting to equate coefficients, adding the equations when they should subtract to eliminate (or vice versa), inconsistent addition/subtraction when attempting to eliminate or incorrect algebraic processes.

It was less common to see candidates attempting to use rearrangement and substitution in their attempt to solve the simultaneous equations. Where this was seen there were often errors made in the rearrangement. It was noted that few candidates using either method seemed to check their answers to ensure that they had a solution that worked for both equations, checking in this way would have highlighted when errors had been made in the approaches attempted.

**Question 13**

This question was based on knowledge of angle facts in cyclic quadrilaterals. Candidates needed to work with the fact that opposite angles in a cyclic quadrilateral add to 180° to form and solve equations. Candidates either knew the required angle fact and could work with this to find the required answer or made no meaningful progress towards the required angle. This was answered well by a minority of candidates, with errors being common.

Many candidates thought the correct method was to add all 4 angles together and equate to 360 (angle sum of a quadrilateral). This approach nearly always led to no progress being made towards the answer. However, candidates who did realise that the opposite angles of a cyclic quadrilateral added to 180 and added 4 m and 5 m first to get 9 m = 180 were able to solve the question. A few candidates just added 4 m + 38 and p to get 4 m + 30 + p = 180 and could not solve from here but did gain a mark.

**Question 14**

Here candidates were required to find the area of a shaded major sector. A reasonable proportion of candidates were able to find the required area successfully. However, some candidates just worked out the area of the whole circle and made no further progress. Others found the area of the circle and then realised they needed to take something off this answer but were not sure what to subtract. Some candidates worked out the area of the smaller sector using 45, gaining a mark, or had the angle of the major sector 315 seen.

**Question 15**

**(a)** Candidates were asked to simplify $\sqrt{20} \times \sqrt{5}$. There were a good proportion of fully correct responses of 10 as the answer. Some candidates reached $\sqrt{100}$ but did not simplify this to 10. Incorrect responses generally had errors in application of the rules of surds with, for example, $\sqrt{20}$ incorrectly simplified to $4\sqrt{5}$ or $5\sqrt{4}$.

**(b)** Candidates were told that $(3 + 2\sqrt{3})^2 = c + k\sqrt{3}$ and were asked to find the value of $c$ and the value of $k$. This was not answered well by the majority of candidates. Many did not attempt to expand $(3 + 2\sqrt{3})^2$ or if they did made errors leading to the common incorrect answer of $c = 9$ and $k = 4$.

**Question 16**

**(a)** Candidates were asked to simplify 177°. Around half of candidates gave the correct answer of 1. Common incorrect answers were 177 and 0.

**(b)** In this question candidates were asked to simplify $\left(\frac{1}{2}\right)^{-2}$. This proved to be challenging for candidates with only a small minority of correct answers seen. There were a range of incorrect answers seen, although $\frac{1}{4}$ from $\left(\frac{1}{2}\right)^{-2}$ was common as was $-\frac{1}{4}$ showing that the negative index had caused difficulties.

**Question 17**

This question asked candidates to find the area of a triangle which involved use of the formula area of triangle = $\frac{1}{2}ab \sin C$. This was answered correctly by only a small minority of candidates. Where progress was seen using the correct method it was common for an answer of 36 sin (150) to be given where candidates did not know how to find the exact value of sin (150) from sin (30) or perhaps did not know exact trigonometric ratio values. Common incorrect attempts included treating the triangle as right-angled and working out $\frac{1}{2} \times 9 \times 8$.

**Question 18**

Candidates were asked to draw a suitable line on the graph provided in order to solve an equation. There were very few fully correct answers seen and many candidates did not attempt to draw a line, but instead just gave two values for $x$. Where candidates did draw a straight line, this was often $y = 2$ rather than the necessary $y = 2x$. If a candidate did manage to draw the line y = 2x successfully they nearly always gained full marks.

**Question 19**

**(a)** In this part of the question candidates were asked to factorise $12m^2 - 75t^2$. This was only answered correctly by a minority of candidates; however, some were able to gain part marks for a correct partial factorisation. Many candidates were able to factorise out the 3 successfully, but from here failed to recognise the difference of two squares. Some tried to factorise into 2 brackets and had terms that gave 12 $m^2$ and/or $-75t^2$ but that also left *mt* terms if expanded.

**(b)** Only a minority of candidates were able to factorise $xy + 15 + 3y + 5x$ successfully. There were also a small number of candidates who were able to make a start and factorise to $x(y + 5) + 3(y + 5)$ or $y(x + 3) + 5(x + 3)$ but could not complete the process. Incorrect responses included a wide range of incorrect attempts at factorisation and incorrect simplification of the algebraic expression.

**Question 20**

Here candidates were asked to solve $4\cos x + 5 = 3$ for $0° \le x \le 360°$. This was poorly answered. The majority of candidates appeared unsure of how to solve a trigonometric equation. A minority of candidates reached $\cos x = -\frac{1}{2}$ but then could not find the required angles from this point. Common incorrect answers included guesses at angles that were multiples of 45° or 90° or values taken from some stage of the rearrangement of the equation such as –2 and 4.

**Question 21**

Part **(a)** of this question requiring use of angle facts including circle theorems to write expressions for **(a)(i)** angle *AXB* and **(a)(ii)** angle *CDX* in terms of the angles shown on the diagram.

**(a) (i)** Only a small minority of candidates were able to identify that angle *AXB* formed a triangle with the angles marked *x* and *y* on the diagram. Those that did identify this were generally able to correctly state that $AXB = 180 - x - y$. There were a range of incorrect answers, sometimes indicating that *AXB* was equal to *x* or *y* and sometimes attempting to find a numerical answer.

**(ii)** This part of the question required candidates to identify that angle *CDX* was $y°$ by using angles subtended by the same arc. Only a small minority of candidates gave the correct answer here. Incorrect answers were most commonly a range of numerical values.

**(b)** In this part of the question candidates needed to recognise that there were two similar triangles present in the diagram and use the given lengths in order to work out the length of *CX*. The majority of candidates attempted this question and a little under half of those who did were able to find that the missing length was 2.7 cm. Incorrect answers generally involved giving one of the lengths from the question, adding *AX* and *BX* to get 4.8 or adding or multiplying values from the lengths given.

**Question 22**

This question on probability required candidates to identify a method to find the probability that Jen picks red and then work with this to find the probability that both Stephan and Jen picked a blue counter. This was answered well by a small minority of candidates, but many incomplete or wrong answers were also seen. A common error was $0.6 \times 0.75 = 0.45$, whilst some candidates added where they should have multiplied.

# MATHEMATICS (US)

**Paper 0444/41**
**Paper 4 (Extended)**

## Key messages

Candidates sitting this paper need to ensure that they have a good understanding and knowledge of all the topics on the Extended syllabus. A number of candidates did not offer any responses to many of the parts and some candidates missed out whole sections.

Candidates generally showed a good level of working but the importance of showing methods that are being used cannot be underestimated. Often candidates would have similar incorrect final answers but only those whose working could be seen and followed could be awarded method marks.

## General comments

Candidates should be careful with accuracy. Many candidates are working to 2 significant figure accuracy, which is not sufficient. All calculations should be worked out to enough significant figures, so that final answers are accurate to at least 3 significant figures.

Many candidates show multiple attempts when answering questions, but it should be clear which of their attempts they require to be marked. If none of the methods lead to the answer line, all attempts will be marked and the attempt with the lowest mark will be the mark awarded. This can often have a detrimental effect on the candidate's score. Others routinely cross out their working throughout the paper and this sometimes leads to a possible correct solution being overlooked if several are offered. Candidates should also try to work down the page and from left to right. Some candidates write solutions which go all over the answer space, and this makes it difficult for examiners to follow their method.

The 'show that' questions on this paper are 5(a)(ii), 6(b)(i), 6(b)(ii) and 7(b)(i). Questions that ask candidates to 'show' results require rigour within the solutions and no errors can be made. Candidates are expected to start with the given information and arrive at the value or result that is asked to be shown, ensuring that every step is explicitly shown.

## Comments on specific questions

### Question 1

**(a) (i)** Most all candidates correctly reflected the triangle. The most common error was to reflect the triangle in the y-axis.

**(ii)** Most candidates translated the triangle correctly. The most common error was to translate the triangle by the wrong number of units in one or other of the x and y directions.

**(iii)** Fewer candidates answered this part correctly. Many recognised that the triangles dimensions should be halved but either drew the triangle in the wrong position or used a scale factor of $+\frac{1}{2}$ rather than $-\frac{1}{2}$.

**(iv)** It was rare for candidates to describe the transformation accurately. Although a few used the word 'stretch' many other words, such as reduce, shrink, compress, scaled down and dilated were seen, none of which scored. Others used more than one transformation such as 'translate and stretch' and as this is not a single transformation this again did not score. Some candidates correctly gave the factor $\frac{1}{2}$ but as many wrote $-\frac{1}{2}$. Candidates needed to include the words 'invariant line' as just writing $y = 1$ was insufficient.

**(b)** A minority of candidates answered this part correctly. The majority of candidates worked out $10 \times 3 \times \frac{2}{5} = 12$ taking no account that enlarging the area needed to use the square of the scale factor for each part of the enlargement.

**Question 2**

**(a)** Under half of all candidates answered this question correctly. Common errors included inaccuracies when copying the numbers, dividing the numbers the wrong way round, finding the answer as a fraction rather than a percentage and giving the answer inaccurately as 4.5 or 4.54.

**(b)** A good number of candidates were able to gain one mark for evidencing some simplification of the ratio. The simplest starting point was to divide the three numbers by 1000 and simplify from there. Common errors included miscopying of the original numbers, not simplifying far enough or simplifying beyond the simplest form so that decimals, rather than integers, were seen in the ratio. A common approach that did not score was to divide each of the three given numbers by their total.

**(c)** Whilst this question could be worked out by using the actual areas of the countries, and a significant number attempted this, it was much easier to work out the answer using only percentages. The starting point was to find 30% and then calculate 30% of $43\frac{1}{3}$%. Some candidates used the correct method but approximated $43\frac{1}{3}$% to 0.433 and lost the accuracy mark. Very common errors included merely adding together 60% + 10% + $43\frac{1}{3}$% or working out $43\frac{1}{3}$% as $43 \times \frac{1}{3} = 14\frac{1}{3}$%.

**(d)** A fair number of candidates answered this part correctly. Common errors included multiplying the area of the rain forest by $\frac{27}{50}$ or $\frac{23}{50}$ or $\frac{50}{23}$ and a large number of candidates lost the final mark because they did not attempt to round to the accuracy required. Other errors included answers which used percentages and were either 100 times too big or too small and calculator errors or slips when copying numbers.

**(e)** There were a good number of correct answers seen. The most common errors usually had the omission of one of 60 or 24 in the calculation and others used 360 or $52 \times 7$ for the number of days. Whilst many were credited for 31 903 920, this was not always converted into standard form or was written either with an incorrect power or with less than 3 significant figure accuracy or for example as $31.9 \times 10^6$. Candidates using an incorrect method often scored one mark for converting *their* answer correctly into standard form.

**Question 3**

**(a) (i)** Most candidates correctly evaluated C. The most common incorrect answer was 400 from $\frac{1}{4} \times (5 \times 8)^2$

**(ii)** This part was answered well by many candidates. However there were a significant number of candidates who made errors when isolating $y^2$. These errors almost always saw candidates subtracting the $\frac{1}{4}$ and /or 2.4 from 15, rather than dividing them into 15. Less common errors included misreading 2.4 as 24 and forgetting to square root 25.

**(b)** Most candidates used the correct common denominator of $(x - 1)(2x + 5)$ and set up the numerator correctly as $4(2x + 5) - 3(x - 1)$. The most common errors arose from the $-3(x - 1)$ term, when candidates either did not have brackets or did not remove the brackets correctly, with the 3 frequently becoming –3 or –1. Other errors included having the numerator round the wrong way as $3(x - 1) - 4(2x + 5)$, reaching $\frac{4(2x+5)-3(x-1)}{(2x+5)(x-1)}$ but cancelling the brackets to give 4 – 3 = 1, slips with arithmetic and slips when multiplying out the brackets in the denominator, which was not required. Candidates who did not score had often simply added the numerators and denominators.

**(c)** A few candidates simplified the expression correctly. A few gained marks for factorising the numerator or the denominator. However, most candidates were unable make any real progress and frequently candidates cancelled either the 2's or the x's where they appeared in both the top and the bottom, without realising that this is mathematically incorrect.

**(d)** A minority of candidates solved this very efficiently using a variety of approaches. Some started by dealing with the negative power to get $\left(\frac{16x^{16}}{y^8}\right)^{\frac{3}{4}}$ and then dealt with the power of $\frac{3}{4}$ whilst others were able to successfully deal with the power of $-\frac{3}{4}$ on each of the 3 terms in one go. To score full marks candidates were required to simplify answers such as $\frac{y^{-6}}{\frac{1}{8}\times x^{-12}}$ to $\frac{8x^{12}}{y6}$ or $8x^{12}y^{-6}$.

Common misconceptions included changing the power of $-\frac{3}{4}$ to $\frac{4}{3}$ when dealing with the negative power, finding $16 \times \frac{3}{4} = 12$ rather than $16^{\frac{3}{4}} = 8$, cancelling $\frac{x^{12}}{y^6}$ to $\frac{x^2}{y^1}$ and not recognising that the power also operated on the 16. Those who started by cubing all the terms were usually not successful.

**Question 4**

**(a) (i)** Many candidates gave the correct value for the median. The most common incorrect answers were 9.25 from misreading the scale and 9.5 which was seen coming from calculations such as $\frac{6+13}{2}$.

**(ii)** Many candidates gave the correct interquartile range. The most common incorrect answer was to give the range 11.6–8.2 without evaluating it.

**(iii)** Some candidates answered this question correctly. Most were able to select the required times of 6 and 13 and many were able to go on and calculate the difference in speed, often first in m / s. However, candidates were not always able to then convert to km/h. Premature approximation and lack of a clear method was evident in many solutions. Those who converted from seconds to hours, before using speed, frequently gave statements such as 6 s =0.0017 h which was not sufficient without showing $\frac{6}{3600}$ or 0.00167 as a minimum level of rounding. A common misconception was to subtract the times before finding the speeds.

**(b) (i)** Many candidates gave the correct class interval for the median. The most common incorrect answer was $400 < d \leq 420$, which was the middle of the three classes.

**(ii)** This part was answered well, with the majority of candidates working out the mean correctly, supported by clear working. A minority of candidate used the lower or upper class bounds, rather than the mid interval value, but with a method shown, they were often able to score some marks.

**(iii)** A small minority of candidates answered this part correctly. Many candidates gave the answers 5.2, 7.6 and 8.4, which were found by multiplying the frequencies by $\frac{2.8}{7}$ without taking into consideration that the class intervals were different size widths.

**(iv)** A minority of candidates answered this correctly. Others scored only two marks because they did not take into account that the cars could be chosen in either order and did not multiply by 2. Other errors included calculating products using 'replacement' with denominators all being 80 and adding rather than multiplying the fractions. It was rare for a candidate not to score at least one mark for writing down $\frac{20}{80}$ or $\frac{7}{80}$.

**Question 5**

**(a) (i)** Many candidates gave the correct vector. Common errors included finding the vector in the opposite direction, namely $\overrightarrow{QP}$, adding the coordinates, slips with arithmetic and slips with signs. A few candidates including a fraction line within their vector which was not allowed.

**(ii)** Being a 'show' question, solutions needed to have no errors to score full marks and a fair number of candidates achieved this. The most common error was writing $\sqrt{5^2 + -5^2}$, without brackets around the –5. Others made no progress with this part and were unable to score.

**(iii)** Some candidates answered this correctly but not all of these recognised that the radius was found in the previous part, with many starting again. However, most candidates were able to state the formula for the area of a circle but had either no value or an incorrect value for the radius, so did not score. Common incorrect values used for the radius came from the length, or half the length, of the chord *PQ*.

**(iv)** This part was well attempted with some correct answers given and evidence of $\left(\frac{x_1 + x_2}{2}, \frac{y_1 + y_2}{2}\right)$ being used. Others scored one mark for one correct value. The most common incorrect answers were, for example, (2, –6) from $\left(\frac{x_1 - x_2}{2}, \frac{y_1 - y_2}{2}\right)$ and reversed answers, namely, (1,3).

**(v)** A small proportion of candidates gave the correct equation of the line. Most candidates were able to find the gradient of *PQ* but not all went on to find the gradient of the perpendicular. Others reached $y = \frac{1}{3}x + c$ but did not recognise that the previous part gave them a coordinate on this perpendicular. A minority of candidates used previous parts and recognised that the perpendicular bisector passed though the origin and were able to give the line directly, but this method was not expected.

**(b)** A small minority answered this correctly and those that did, had usually drawn a clear diagram, used vector notation correctly and showed clear routes and methodology to find the position vector of *M*. Other made little or no progress with few being able to complete a full diagram, write down a route for $\overrightarrow{OM}$ or state $\overrightarrow{AB} = b - a$. A common incorrect answer was $\frac{2}{5}a + \frac{3}{5}b$ which came from the ratio of *AM:MB.*

**Question 6**

**(a)** Less than half of the candidates answered this correctly. Common incorrect answers included 235 which was found using the reverse bearing from *H* as 180+55, wrongly assuming that *HB* was north.

**(b) (i)** Most candidates showed angle *CBH*=100 by clearly evidencing 180 – 25 – 55. To score the mark both of 25 and 55 needed to be seen together with a subtraction from 180.

**(ii)** The majority of candidates used the sine rule to set up an implicit equation to find *BH*. Many then successfully rearranged this to find an explicit calculation for *BH*. Some substituted the values for sin100 and sin25 before rearranging and these candidates were often at risk of premature approximation. The most efficient method was to use the calculator once to evaluate $\frac{32\times\sin 25}{\sin 100}$, to at least 2 decimal places in order to show that *BH*=13.7 to 1 decimal place as required.

**(c)** Many candidates recognised that the cosine rule was needed to find an angle within triangle *ABH* although it was not always clear that candidates knew which angle they were finding. Some used unnecessarily longer methods such as the cosine rule for angle *BAH* and then the sine rule to find angle *ABH*. Having found angle *ABH*, not all candidates added 190 to it to find the bearing. Common errors included errors in stating the cosine formula, errors in substituting into the formula and errors in evaluation, with $a^2 + b^2 - 2abcosB$ being evaluated as $(a^2 + b^2 - 2ab)cosB$. Some candidates wrongly tried to use right angle trigonometry.

**(d) (i)** There were some good answers to this question. Marks were mainly lost due to lack of accuracy when calculating $\frac{32}{10\times 1.852} = 1.727$ with candidates often using 1.7 or 1.72. Other errors included not multiplying by 10, using an incorrect formula for time, such as distance x speed or $\frac{\text{speed}}{\text{distance}}$ or finding the correct time interval but not giving the arrival time. Others gave the time incorrectly, such as 2.44 when 2.44pm was required.

**(ii)** A small minority of candidates answered this correctly. Others recognised the position of the boat but found its closest distance to *B* rather than its distance from *H* at that point of time. Incorrect answers included those that assumed the boat was at the midpoint of *CH* and others who found the distance *BC*.

**Question 7**

**(a) (i)** Most candidates were able to show the area of one side of the box but not all found the total surface area correctly as there were often errors with the numbers of each side. Some found the surface area of a closed box and others had more than 2 of some of the sides. Others had correct methods but made calculation errors with statements such as 40 × 30 = 120 frequently seen. A minority found the volume of the box.

**(ii)** Only a very small proportion of candidates attempted to answer this question using the correct method of fitting whole cylinders into the box. Whilst some of these scored full marks, others scored one mark for answers such as 18 from $\frac{30}{15}\times\frac{40}{20}\times\frac{70}{15} = 18.6$ . The majority of candidates used calculations involving $\pi$, whether it be for surface areas or volumes. An extremely common incorrect answer was 23 which came from dividing the volume of the box by the volume of a cylinder.

**(b) (i)** This was a more challenging 'show that' question. Only a small minority of candidates scored full marks by showing rigorously that the radius was 2.993 and thus 2.99 correct to 3 significant figures. Most candidates scored one mark for showing volume = $\frac{750}{8.9}$ but few could get much further. Candidates needed to use the given ratio to replace *h* by 3*r* in the formula for the volume of a cone, that is $V = \frac{1}{3}\pi r^2(3r)$. Many simply replaced *h* with 3 × 2.99 and went onto find *r* thus using the 2.99 to find 2.99.

**(ii)** This was a complex part but some candidates showed excellent solutions, with clearly set out calculations and retention of accuracy, to score full marks. Other candidates found the curved surface area but omitted to include the circular base and others were only able to find the area of the circular base. Candidates often attempted to use the given formula but with inaccurate figures for the slant length. Where no workings were shown these candidates could not score. However if these candidates had shown use of Pythagoras, their method may have been rewarded despite the lack of accuracy. Others incorrectly used the height of the cone as the slant height.

**Question 8**

**(a)** A good number of candidates completed the table correctly. Others made slips in arithmetic. Some candidates tried to complete the table by looking for patterns between the numbers, without using the given function, and were always unsuccessful.

**(b)** There was a high correlation between the success of candidates in this part and the previous part, with candidates making similar slips and looking for patterns, rather than using the function.

**(c) (i)** There were some very well-drawn graphs that scored full marks. The most common errors included graphs that were ruled, rather than smooth, and points that were mis-plotted due to a misreading of the scales. Some candidates seemed to only plot a couple of points and attempted to draw a graph with just these, which never scored.

**(ii)** Again, there was a high correlation between the success of candidates in this part and the previous part. Again, there were some well-drawn graphs but again some graphs were ruled, some points were mis-plotted and some graphs had no resemblance to the function.

**(d)** Only those candidates who had plotted and drawn a correct graph were able to score this mark because, most other graphs did not have a point with zero gradient at (0, –2).

**(e) (i)** Again this part depended on having drawn two graphs that intersected, and marks were awarded for the x value of their intersection. Whilst some candidates were successful, there were again a number who did not read the scale carefully.

**(ii)** A minority of candidates scored in this part. It was evident, from the answers given, that most candidates did not understand that they were looking for the x value where the height difference between the graphs, with g(x) above f(x), was 2.

**(f)** A few candidates shaded the correct region. Without intersecting graphs and a good understanding of the notation candidates did not score.

**(g)** Only a small minority of candidates knew how to approach this question and they usually scored full marks. Most other candidates did not realise the starting point was to equate the functions and so could make no progress. Many candidates did not make any response or guessed 3 random values.

**Question 9**

**(a) (i)** It was extremely rare for a candidate not to find f(3) correctly.

**(ii)** Many candidates found gf(3) correctly.

**(iii)** Many candidates were able to correctly find the inverse function. Most candidates started by swapping the $x$ and $y$ in the function to $x = 6 - 2y$ and then rearranging. Common errors were not dividing every term by 2 or sign errors when moving terms across the equal sign or forgetting to switch x and y. Other errors included just reversing the signs in $g(x)$ giving $g^{-1}(x) = -6 + 2x$ or confusing the inverse function with reciprocal resulting in $G^{-1}(x) = \dfrac{1}{6-2x}$.

**(iv)** A good number of candidates answered this part correctly**.** Errors that were seen included sign errors in the simplification of $6 - 2(2x - 7)$, and slips with signs and arithmetic when solving $4x + 1 = 6 - 4x + 14$. Some candidates were unable to set up the correct equation, some simply writing $4x$

+ 1 = 2*x* – 7 and others trying to rearrange $f(x) = g(2x - 7)$ to find *x* in terms of f and g. Also seen were $g(x) = 6 - 2x(2x - 7)$ and $g(x) = (6 - 2)(2x - 7)$.

**(b) (i)** This question was answered well by many. Some candidates showed excellent algebraic work in being able to write hh(x)= $3^{3^{x-2}-2}$, although this was not required as an easier approach was to first evaluate h(2) and then find hh(2). Errors included writing $3^{-1} = 0.3$ and the misconception that hh(2)=h(2)h(2).

**(ii)** Unless candidates understood that $H^{-1}(x) = 10$ can be rewritten as $x = h(10)$ this part was almost impossible for candidates to solve. However, a number of candidates were successful and reached $x = 6561$.

**(c)** It was evident that most candidates did not recognise the terminology used in the question and it was extremely rare for any candidate to score.