MATHEMATICS D

Paper 4024/11
Paper 11

Key messages

To do well in this paper, candidates need to demonstrate that they have a good understanding across the whole syllabus. As it is a non-calculator paper, candidates need to be competent in basic numeracy skills, particularly in multiplication and division of whole numbers as well as decimals, and be able to convert numbers from one form to another. Candidates need to learn necessary formulae and facts. All working should be shown and answers clearly written in the appropriate answer space.

General comments

Candidates generally displayed a good standard of presentation and the detail shown was usually appropriate to the question. It is important for candidates to check they have copied numbers correctly from the question and also when transferring their answer from the working to the answer line.

Generally, good skills were shown in basic numeracy. However, arithmetic slips were not uncommon and candidates are advised to check their working carefully. Candidates showed good skills in managing simple fractions and ordering numbers involving conversion to another form. Candidates dealt with basic algebra well when collecting like terms, working with indices and solving simultaneous equations. When solving or rearranging equations candidates are advised to work methodically, progressing one step at a time. In particular, some had difficulty in managing expressions when finding the inverse function and more generally in demonstrating their understanding of function notation.

The questions on constructing a triangle and the line bisector were handled well. Many would benefit from a greater understanding of some aspects of geometry, namely angles in polygons, transformation and similar triangles. Few candidates demonstrated a good understanding of working with regions defined by inequalities and of multiplying matrices.

Comments on specific questions

Question 1

(a) A very high proportion of candidates were able to subtract the fractions correctly.

A few arithmetic errors were seen when attempting to find a common denominator.

(b) A large majority of candidates gave the correct answer. Some lost the place value when multiplying leading to incorrect answers such as 0.16 and 0.0016.

Question 2

The majority were able to write the numbers in the correct order. Most others had only one number misplaced.

Question 3

This was answered correctly by a large majority. Candidates should be encouraged not to leave their answer as an improper fraction, this is particularly important if a question has a real-life context. Some were unable to set up the correct working of $\frac{45}{100}\times 30$, often with 45 and 30 written as a fraction. Candidates who

© 2021

cancelled the fractions before multiplying out were nearly always successful whereas a few made arithmetic errors when multiplying 45 × 30.

Question 4

(a) Many were able to shade the correct square to complete the rotation symmetry.

(b) Many correct answers were given by candidates. Common errors were shading the left and right squares or the middle two.

Question 5

A large majority were able to simplify $3a - a + 2a$ correctly. Errors seen were $3a - (a + 2a) = 0$ with or without brackets written, $a(3 - 1 + 2)$. Some candidates added the terms to $6a$ or included a^2 in their answer.

Question 6

Nearly all candidates attempted to use a ruler and a pair of compasses in their constructions.

(a) A large majority of candidates were able to construct the triangle accurately showing all construction arcs. A few constructed an isosceles triangle with sides 5 cm on the given base line.

(b) This was also very well answered with the majority of candidates able to construct the perpendicular bisector showing both pairs of construction arcs. Occasionally a perpendicular bisector was drawn with only one pair of arcs. In both parts almost all lines were ruled. Errors included dropping a vertical line down from point *C*, bisecting angle *C* or occasionally angle *A*, or drawing a line parallel to one of the sides of the triangle.

(c) Those who had scored in the previous parts nearly always shaded the correct region. A few partially shaded the region, some left it blank and a few did not follow the requirement of the question writing a *W* on the diagram rather than shading the region.

Question 7

(a) Most candidates gave the correct answer. Some gave 4 or 0.

(b) Most candidates gave the correct answer.

Question 8

(a) A large majority of candidates were able to convert the metres into kilometres. A common error was to divide by 100 to give 63 and occasionally a candidate multiplied by 1000 or 100.

(b) Many candidates answered this part correctly. A common incorrect answer of 10 was often seen.

Question 9

Some candidates found the correct answer efficiently. Candidates who calculated the exterior angle to be 24° usually proceeded to divide this into 360 successfully. While many of those who used the approach of equating 156 to $\frac{(n-2)180}{n}$ found the correct answer, this method commonly resulted in errors; these were omitting the denominator, n, or putting $(n - 1)$ in the bracket. Other errors seen regularly were 156 ÷ 24, 24 ÷ 2 and arithmetic mistakes when working out 360 ÷ 24.

Question 10

Many correct responses were seen. Candidates who determined that the two missing angles totalled 125° usually went on to share 125 in the ratio 3:2 correctly. Those who used an algebraic method such as $2x + 3x + 55° = 180°$ had a good understanding of the question and were nearly always successful. Most other candidates knew they needed to share a quantity using 5 ratio parts but this was often incorrectly applied to 55° or less commonly 180°.

© 2021

Question 11

Many correct responses were given for this question on rounding to one significant figure to find an estimated value. A few candidates incorrectly rounded 58.24 and 32.5 to 6 and 3 while others rounded to the nearest integer. Most used the correct value of 0.1 for 0.126. It was quite common for candidates not to estimate any of the numbers and try to calculate an exact answer.

Question 12

A large majority of candidates found the correct solutions for these simultaneous equations. Both the elimination method and the substitution method were used with equal success.

The most common errors seen were slips with signs, rearranging $2x - y = 12$ to $y = 12 - 2x$, slips with arithmetic or incorrectly choosing to add or subtract the equations.

Question 13

(a) A minority of candidates were able to describe the transformation completely. Many recognised it to be a translation but few could give the correct vector. Some wrote coordinates, got the digits or signs reversed while others thought it was a different transformation such as a reflection.

(b) A minority scored full marks for drawing a correct enlargement. Many were able to draw the triangle with scale factor 2 but misplaced it on the grid, sometimes upside down or reflected. A common error was to draw an enlargement with scale factor –2, centre (0, –1). There were a small but significant number who did not attempt this part.

Question 14

(a) A large majority were able to express 60 as the product of its prime factors. A few listed the prime factors or gave the factors of 60.

(b) Candidates found this part more challenging. While many correct answers were seen there were also many who did not know how to approach this question. Some cancelled the numbers for the pens and rulers in each pack given in the question to their simplest form or to a simpler form and wrote these values as their answer. Others added or subtracted the numbers and were unable to progress. Those who found the lowest common multiple as 420 usually gave the correct solution while others realised they could simply reverse the numbers in the cancelled ratio to get the correct answer; a succinct method.

Question 15

(a) A minority of candidates understood they needed to add the digits in the vectors to find the coordinates of point *B*. Most subtracted the given vectors, either way around, often making errors with negative signs in the process; a simple sketch showing a point *A* and the vector *AB* would have benefited here.

(b) This part was answered well by some candidates, who knew they needed to apply Pythagoras' theorem. Some tried to apply Pythagoras' theorem using the coordinates found in their answer to **part (a)**.

Question 16

(a) This question proved challenging with only some candidates finding the correct answer and demonstrating clear working. Some managed to secure the method mark for the correct expression $\sum(\textit{number} \times \textit{frequency})$ but could not gain further marks because they divided this by 4 (the number of intervals) or very occasionally by 10 (the sum of the numbers on the spinner) or by 24*p*. A few did set up a correct equation but made slips when trying to solve it. The most common error, seen very frequently, was to solve $\dfrac{6+5+13+p}{4} = 3$. This resulted in a negative value for *p*, which candidates accepted even though it was not possible in this context.

© 2021

(b) A minority of candidates gained credit for this part. Many did not appreciate the answer had to be a fractional value.

Question 17

(a) Many candidates recognised the factorisation involved the difference of two squares and factorised correctly. Some did not deal with the coefficient of 4 correctly and gave the answer $(4b + c)(4b - c)$. Those who did not recognise the method often tried to take a common factor of 4 from the two terms.

(b) This part was answered correctly by many candidates. Some factorised incorrectly but with values that produced the correct constant term.

Question 18

Although a minority of candidates scored full marks on this question most drew some correct lines, more commonly $y = 4$, $x = 1$ and $x = 5$. The slanting line $y = 3 - x$ caused most problems, with candidates frequently drawing horizontal and/or vertical lines through 3 on the axes. Those who had drawn the correct lines nearly always indicated the correct region.

Question 19

(a) (i) This part was answered very well with the majority listing the correct numbers.

(ii) Many gave the correct answer. Common wrong answers were $\frac{8}{12}$ or $\frac{2}{3}$.

(b) About half of the candidates were able to shade the correct region in the Venn diagram. Many varied incorrect answers were seen usually involving shading the overlapping regions.

Question 20

(a) Nearly all candidates were able to find the next term in the sequence.

(b) (i) Only some candidates found the correct expression. The more successful approaches compared the sequence of numbers with the expression for the *n*th term of a sequence given in the stem. Many approached this part and the next by finding the 1st, 2nd, 3rd sets of differences between consecutive terms and were unable to make progress.

(ii) Very few candidates found the correct expression.

Question 21

(a) A large majority were able to substitute correctly into the function. Errors made were usually arithmetic slips.

(b) Many candidates were able to find the correct inverse function and most had some understanding of how to approach the question. Some candidates worked backwards towards the original equation again. Others made algebraic errors in their rearrangement.

(c) Although some candidates often completed this question successfully many others found it challenging. Some of those who were successful used the most efficient approach $t = 5t + 2$ and nearly always solved this equation correctly. Others who set up fractions generally worked well with the algebra but a few slips were made. Some were able to write down the expression for $\mathrm{f}(5t + 2)$ but made no further progress. A common error was made in the expansion of $2 - (5t + 2)$, giving this as $5t$ rather than $-5t$. Some candidates treated *f* as a variable, using the incorrect method $\mathrm{f}t = 5\mathrm{f}t + 2\mathrm{f}$.

© 2021

Question 22

(a) Only a small minority of candidates were able to give a fully correct solution to show the triangles were similar. Few realised the answer should only refer to pairs of equal angles with reasons. Most incorrect answers referred to the lengths of sides and/or one triangle being an enlargement of the other. Many were awarded one mark for a partial solution. Candidates need to quote the mathematical reason for angles being equal such as 'alternate' and 'vertically opposite', rather than descriptions such as 'alternative' or 'Z angle'. Candidates need to be aware that angles must be described using three letters and notation such as 'angle A = angle D' is ambiguous.

(b) Although some candidates found the correct area of the smaller triangle many multiplied the area of the larger triangle by the scale factor $\frac{1}{3}$ from the ratio of the sides. Those who knew they needed to square this ratio nearly always calculated the correct area. Candidates who used the method of finding the height of the large triangle, the corresponding height of the smaller triangle and then using $\frac{1}{2}$ × base × height were equally successful.

Question 23

(a) The majority of candidates gave the correct answer. Following the correct four-term expansion of the brackets, a common incorrect answer was $x^2 - 3x - 10$ from incorrectly simplifying $-2x + 5x = -3x$.

(b) This part was answered well with the majority of candidates finding the correct expression. Most others set up the correct single fraction over a common denominator. Some slips in expanding the brackets were mostly responsible for the loss of accuracy in the final answer.

Question 24

(a) Although many correct answers were seen it was equally common for candidates to square each of the elements in the matrix rather than multiply the matrix by itself. Errors were common and involved arithmetic slips as well as the wrong combination of elements being multiplied together in the 2 by 2 matrices.

(b) A minority of candidates gave the correct answer. When forming the equation some did not include the negative sign in the term $-3x$. Those who did not know how to find the determinant of the matrix often multiplied the matrix by –2 or set it equal to –2 and made no progress.

© 2021

MATHEMATICS D

Paper 4024/12
Paper 12

Key messages

To do well in this paper, candidates need to be familiar with the content of the entire syllabus. As it is a non-calculator paper, candidates need to be competent with basic arithmetic. Candidates need to produce accurate graphs and diagrams and be able to interpret information presented in graphical form. They are expected to use correct mathematical terminology and set out their work in clear, logical steps.

General comments

In general, candidates were well prepared for most of the topics covered on this paper and most attempted all the questions. Work was generally presented well with the method clearly shown and the answers transferred correctly to the answer line. Most candidates used correct geometrical equipment to produce neat, accurate diagrams. Candidates should show their working clearly in the answer space for each question. If an answer or the working is corrected, this should be crossed out and replaced rather than overwritten because overwriting often makes the candidate's intention unclear.

Most candidates demonstrated good skills in basic arithmetic and algebraic manipulation. Many would benefit from a greater understanding of transformations and algebraic indices. Candidates still need more experience in answering questions where some problem solving is required, such as **Questions 9(b)** and **13**.

Some candidates were unfamiliar with some of the more straightforward content assessed. Few candidates were able to name simple solids from nets or to convert between metric units. Some candidates had difficulty working with negative numbers and cancelling fractions.

Comments on specific questions

Question 1

(a) Many candidates evaluated the square root correctly. The most common incorrect answers were 700 and 70^2.

(b) Most candidates evaluated 5^3 correctly.

Question 2

Many candidates performed the calculation correctly, however in some cases the correct answer of –43 was seen in the working space but 43 written on the answer line without the negative sign. Some candidates interpreted the calculation incorrectly, for example $(-8+7)\times(-5)=(-1)\times(-5)=5$ or $(-8\times-5)+(7\times-5)=5$.

Question 3

Most candidates were able to shade the correct triangle to complete the pattern.

Question 4

Many candidates appeared to be unfamiliar with this topic. It was common to see names of two-dimensional shapes given rather than the name of the solid formed when the given net is folded. Rectangle was commonly used in place of cuboid, triangle in place of pyramid and trapezium in place of triangular prism. The correct names for the solids are cuboid, pyramid or square-based pyramid and prism or triangular prism.

© 2021

Question 5

(a) Some candidates were able to use angles on a straight line correctly to find angle *CXG*. Common errors were to make arithmetic slips in the subtraction 180 – 81 or to misinterpret which angle was required and give the answer 81°. Some candidates used a longer method and started by using angles in triangle *FGX* to find angle *FXG* and then used angles on a straight line to find angle *CXG*.

(b) Many candidates used alternate angles to find angle *BCX* correctly.

(c) Some candidates used interior angles between parallel lines to find angle *ABX* correctly. Some used two stages, first using alternate angles to find angle *CBX* = 46° and then using angles on a straight line. A common incorrect answer was to state that angle *ABX* = 46°. In some cases, arithmetic errors were seen in the subtraction 180 – 46 leading to incorrect answers such as 136 and 144.

Question 6

(a) The two common approaches in this part were to transform the calculation to $\frac{690}{3}$ or $69 \div \frac{3}{10} = 69 \times \frac{10}{3}$. Many candidates found the correct answer, although answers of 2.3 or 23 were common when candidates had adjusted powers of 10 incorrectly.

(b) Most candidates were able to convert $1\frac{4}{7}$ to $\frac{11}{7}$ and then use a correct method to divide the fractions. Many left their answer as an improper fraction, $\frac{55}{21}$, rather than converting to the mixed number $2\frac{13}{21}$. In some cases $1\frac{4}{7}$ was converted to an improper fraction incorrectly, for example $\frac{11}{4}$.

Question 7

Candidates who started by writing each number correctly to 1 significant figure usually reached the correct answer. Some candidates rounded their final answer to 200 and others included extra zeros, for example 240.0. It was common to see 0.64 rounded to 1 rather than 0.6 or 18.7 rounded to 19 rather than 20. Some candidates attempted to perform the calculation without rounding first which is not what the question required.

Question 8

(a) Most candidates knew the correct conversion 1 000 m = 1 km, but errors were seen in the multiplication of 0.06 by 1000. Some candidates used a long multiplication rather than simply making an adjustment to the place value. A small number of candidates divided rather than multiplied or used an incorrect conversion such as 100 m = 1 km.

(b) Few candidates were able to convert correctly between square metres and square centimetres with incorrect conversion factors of 1 m^2 = 100 cm^2 or 1 m^2 = 1000 cm^2 commonly seen. It was also common to see answers of 490 000, the result of converting 7 m into centimetres and then squaring the result.

Question 9

(a) Many candidates expressed 216 correctly as the product of its prime factors. The most common error was to evaluate 216 ÷ 2 as 18 rather than 108 when dividing using the ladder method which led to the answer $2^2 \times 3^2$ rather than $2^3 \times 3^3$.

(b) This part was found to be challenging with few correct answers seen. Many candidates did not know how to approach the problem, although many did show correct prime factorisation of 18,

© 2021

which was an appropriate first step in the solution. Few candidates showed a list of multiples of 18 which could be used to identify values that were also factors of 216. Some candidates attempted a trial-and-error approach by selecting numbers greater than 25 and attempting to find whether they fitted the criteria in the question and this approach was generally unsuccessful.

Question 10

(a) Some candidates correctly identified the transformation as a translation, but many of those were unable to state the correct vector. In some cases, the negative sign was missing or the *x*- and *y*-components were reversed. Some candidates mentioned a scale factor or a centre for the translation. The incorrect terminology was occasionally seen, such as translocation or transition. It was not uncommon for candidates to describe a reflection or rotation rather than a translation.

(b) Some candidates rotated the triangle correctly although rotations about the wrong centre or rotations by 90° clockwise were also seen. It was common to see a reflection of triangle *A* in either the *x*-axis or the *y*-axis or a translation of triangle *A*.

(c) Some candidates drew a correct enlargement of triangle *A* although a number of these used the wrong centre. Candidates who drew rays from the centre (5, –5) through the vertices of triangle *A* were more successful in positioning the image correctly than those who used the coordinates of the vertices and attempted to calculate the coordinates of the vertices of the image. In some cases (5, –5) was used as the bottom corner of the image rather than as the centre of enlargement. Many candidates drew an image that was not similar to triangle *A* so it could not be an enlargement of *A*.

Question 11

(a) Many candidates understood that the perpendicular bisector of *PQ* was required and constructed it accurately using correct arcs. Some bisectors did not reach across the whole quadrilateral so were too short to be able to define the region required in **part (b)**.

(b) Many candidates realised that an arc with centre *Q* was required to define the region satisfying the condition that the tree was more than 18 m from *Q*, and many identified that its radius would be 3 cm. Having drawn a correct arc some candidates did not identify both parts of the region required, and others shaded either inside the arc or the wrong side of the perpendicular bisector.

Question 12

Few candidates were able to give a complete proof to demonstrate that the triangles were similar. Some identified that angle *ADC* = angle *DEC* = 90°, but few stated the other two pairs of equal angles with the required reasons and a concluding statement. Many candidates referred to ratios of sides being equal even though there was no information given in the question to support this assertion. It was common for candidates to refer to angles using a single letter, for example angle *C*, which is unacceptable because it is not clear whether this means angle *BCE*, angle *ECD* or angle *DCB*. Many candidates gave pairs of angles that were not part of the required triangles, for example angle *AED* = angle *DEC* = 90° was commonly seen. Some candidates stated that sides were equal or tried to use the conditions for congruent triangles rather than similar triangles.

Question 13

This problem using basic statistics was found to be challenging by many. Candidates who understood that as the mean of the five numbers was 17 then the sum of the numbers would be 85 were often able to reach the correct answer. However, some found the total 85 and then did not know how to use the remaining information to progress further and used a trial-and-error approach. The most efficient method seen was to subtract the sum of the middle three numbers, 35, from 85 leaving the sum of the largest and smallest as 50 then use the fact that the largest was four times the smallest to reach 10 and 40 for these two. It was common to see a misunderstanding of the given information leading to the assumption that the sum of the five numbers was 17, and some candidates gave a list of five numbers with the three smallest being equal, or the sum of the middle three as 35 or the largest four times the smallest. Some candidates multiplied 17 by 3 rather than by 5. In some cases, the numbers were not listed in order as required by the question.

© 2021

Question 14

(a) Many candidates found the acceleration correctly although some simplified the fraction $\frac{15}{20}$ incorrectly or converted it incorrectly to a decimal. A small number of candidates divided time by speed or multiplied time by speed.

(b) Many candidates identified that the cyclist was moving with constant speed. Some gave descriptions that were too vague such as 'constant' or 'constant motion' that were unacceptable. A small number of candidates said that the acceleration was constant, which was not acceptable, or that the acceleration was zero, which was acceptable. Some candidates also said that the cyclist was at rest, a result of assuming that this was a distance–time graph rather than a speed–time graph.

(c) Many candidates understood that the total distance travelled is the area under the graph. They usually divided the shape into a triangle, a rectangle and a trapezium and many found the correct area for the triangle and rectangle. The final trapezium was more of a challenge with many treating it as a triangle, which led to the common incorrect final answer of 400, or using the trapezium formula with one or more of the values incorrect. Some candidates incorrectly assumed the shape to be a single trapezium and used $\frac{1}{2}(50+10)\times 15$. In some cases, base × height was used for the area of a triangle. A small number of candidates attempted distance = speed × time, using a time of 50 and a value of either 15 or 20 for the speed which is a method that only works for a journey with constant speed.

Question 15

Most candidates were able to calculate the percentage decrease correctly. The most common errors were to calculate 160 as a percentage of 200 rather than the percentage decrease or to find 40 as a percentage of 160 rather than of 200.

Question 16

Many candidates were able to show a correct first step in solving the inequality, usually reaching $8n > -18$. Some continued to give the correct answer of $n > -\frac{9}{4}$, however many omitted the negative sign in their answer, gave the value $-\frac{9}{4}$ as their answer rather than the inequality or reversed the inequality sign to give $n < -\frac{9}{4}$ as the answer.

Question 17

Most candidates were able to factorise the expression correctly. Those candidates whose final answer was incorrect had usually shown a correct partial factorisation in their working.

Question 18

Candidates found writing down the three inequalities very challenging. Some identified that the lines required for *AB* and *BC* were $x = -4$ and $y = 2$, but few were able to insert the correct sign in all three inequalities. Some candidates confused x and y, with $y \geqslant -4$ and $x \geqslant 2$ often seen. Although the equation of line *AC* was given in the question, some candidates unsuccessfully attempted to find the equation of this line from the diagram. Some candidates gave equations rather than inequalities in their answer and others gave the coordinates of points *A*, *B* and *C*.

Question 19

Some candidates used the property that the radius is perpendicular to the tangent to calculate angle *BOQ* and then used angle at the centre is twice the angle at the circumference to calculate angle *BAC* correctly. Some candidates annotated the diagram with the angles they had found which helped to indicate when they

© 2021

had used one of these properties correctly. Common errors were to work out angle *BOC* as 180 – 36 = 144, to treat *ABQ* as a right-angled triangle or to find *x* as double, rather than half, of angle *BOQ*. Arithmetic slips in subtracting and dividing by two were also common.

Question 20

Some candidates were well practised at finding an inverse matrix and found the correct result efficiently. Others, having reached the correct matrix, made errors when trying to simplify it. It should be noted that giving an answer in the form $\frac{1}{8}\begin{pmatrix} 2 & 2 \\ -1 & 3 \end{pmatrix}$ is acceptable and there is no need to simplify by taking the fraction inside the matrix. Some gave the answer $\begin{pmatrix} 2 & 2 \\ -1 & 3 \end{pmatrix}$ without considering the determinant and others calculated the determinant wrongly, often $3\times2-2\times1=4$ rather than $3\times2-(-2)\times1=8$. A small proportion of candidates misinterpreted the inverse notation and replaced each number in the matrix with its reciprocal.

Question 21

(a) (i) Many candidates found the median correctly. The most common errors were to give the answer 60, the middle value on cumulative frequency axis, or 50, the middle value on the mass axis.

(ii) Candidates who knew that the interquartile range is found by subtracting the lower quartile from the upper quartile usually read the values from the graph correctly and reached the correct answer. Some added the lower quartile to the upper quartile or gave the answer as either the lower quartile or the upper quartile and others found the range rather than the interquartile range. A common misconception was to identify the required cumulative frequencies as 90 and 30 and, rather than reading the graph at these points, subtracting first then either giving 60 as the answer or reading the graph at a cumulative frequency of 60 leading to the median value as the answer.

(b) Candidates had more success in finding the number of large eggs. Many read the graph correctly at *m* = 63 and subtracted this from 120 to give an answer in the required range. Others gave their reading as the answer, which is the number of eggs that are not large rather than the number that are large.

Question 22

(a) The first step in solving this problem was to write both sides of the equation as powers of 3. Those that did this correctly as $3^{3k}=3^2$ often reached the correct answer. Some candidates identified that 27 = 3^3 and 9 = 3^2 but were not able to use that information to set up a correct equation. It was common to see an answer of $\frac{1}{3}$, the result of solving the equation 27*k* = 9 without appreciating that *k* was a power in the given equation.

(b) Candidates who dealt with the index in two stages, first by rewriting the expression as $\left(\frac{x^8}{16}\right)^{\frac{1}{4}}$, were most successful in reaching the correct answer. Some candidates were unable to simplify $16^{\frac{1}{4}}$ correctly, with 4 being a common result. A common incorrect first step was to invert the power as well as the fraction leading to the incorrect expression $\left(\frac{x^8}{16}\right)^4$. Some candidates attempted to cancel the power outside the bracket with a power or a value inside the bracket without recognising that the power $-\frac{1}{4}$ is applied to both terms.

© 2021

Question 23

Many candidates set up a correct equation using the inverse proportional relationship correctly, used the given values to find the constant of proportionality and then used this to find the value of y when $x = 9$. The most common errors were arithmetic slips or setting up an equation for direct proportion rather than inverse proportion.

Question 24

(a) (i) Most candidates evaluated f(3) correctly.

(ii) Candidates who were familiar with the inverse function notation often gave the correct answer. Common errors were sign errors when rearranging, leading to $\frac{6-x}{2}$ for example, giving the answer in terms of y rather than x or writing the reciprocal of g(x).

(b) Many candidates started by attempting to set up the required equation, but there was often a sign error in their first step, with the incorrect equation $2x^2 + 7x + 4 - 2x + 6 = 1$ being seen more often than the correct $2x^2 + 7x + 4 - 2x - 6 = 1$. This led to an incorrect 3-term quadratic equation $2x^2 + 5x + 9 = 0$ which has no solutions, although candidates were able to gain some credit if they showed a correct attempt to solve this using the quadratic formula. Some candidates who reached the correct quadratic equation, $2x^2 + 5x - 3 = 0$ made an incorrect attempt to factorise, but many factorised correctly to reach the correct solutions.

Question 25

(a) Many candidates were able to complete the Venn diagram correctly. The most common errors were to omit 5 from the outer region or to write 4 in the sections labelled y and z and leave the other section blank.

(b) Many candidates did not correctly combine the given ratio with the information given in the Venn diagram to reach the answer. Some used the values from their Venn diagram with the total of 40 candidates to work out that $x + y + z = 18$, but then did not realise that they should divide 18 in the ratio 1 : 2 : 3 to find the three required values. A common error was to set up three separate equations involving x, y and z and attempt to solve these, for example $x + 12 + 1 + 0 + 5 = 40$, $z + 1 + 0 + 4 + 5 = 40$ and $x + y + 1 + 4 + 5 = 40$. Some candidates understood that they needed to divide some total in the ratio 1 : 2 : 3, but did not know how to find that total value. Some candidates incorrectly used $\frac{1}{6} \times 40$ or $\frac{1}{6} \times (40 - 5)$ to find x. In many cases, three numbers were written down with no working.

(c) Only a small proportion of candidates were able to use set notation correctly to describe this region. A common incorrect answer was $A \cap G$ rather than the correct $A \cap G \cap D'$. Some gave the answer { } or $\varnothing$ which describes a set with no elements but does not specifically describe the region in this Venn diagram.

(d) Very few candidates were able to interpret the notation correctly and give the correct answer of one more than their value of x from **part (b)**.

© 2021

MATHEMATICS D

Paper 4024/21
Paper 21

Key messages

Candidates should take care to use brackets around expressions, particularly in 'show that' questions. Candidates should ensure they are working in consistent units, whether the question deals with money or with time. Candidates are advised to use a suitable degree of accuracy in their working. Final answers should be rounded correct to 3 significant figures where appropriate or to the degree of accuracy specified in the question.

General comments

In general, candidates were well prepared for most topics covered on this paper and the majority of candidates attempted all the questions. Work was generally presented well with the method clearly shown and the answers transferred correctly to the answer line.

In some places, candidates gave an inaccurate final answer due to inappropriate rounding of intermediate results. Typically, intermediate values should be rounded to at least one more significant figure than that given in the question. It is important that candidates retain sufficient accuracy in their working and only round their final answer to three significant figures if their answer is not exact.

Comments on specific questions

Question 1

(a) Most candidates were able to find the total amount after the percentage increase. A small minority of candidates only found 8 per cent of $84.25 and did not add this amount on to find the total amount required. A very small proportion added 0.08 to 84.25 to get 84.33. As the answer was exact and relating to currency, it should not have been rounded to 91 and should instead have been left as 90.99.

(b) (i) This question was answered well by many candidates. Another exact answer, this time of 48.18, was sometimes given to 3 significant figures. Common errors in this question involved mismatched units. It should be noted that the information in the table is given in cents and the answer required is in dollars.

(ii) This question proved more challenging than the previous parts. Again mismatched units caused problems for some candidates. Note the amount Sara is charged is given in dollars whereas again the information in the table is in cents. Candidates should take care to ensure they are working in consistent units, in this case either all in cents or all in dollars.

(c) (i) This question was generally well answered by candidates although some did not give the answer in standard form. Some answers were rounded to 2 significant figures without showing the correct, exact answer to 3 significant figures.

(ii) Many candidates showed a more accurate answer than that required and went on to successfully round this to 3 significant figures. A small minority of candidates used the correct approach but gave an answer to 2 significant figures without showing a more accurate value. The most common error was in dividing by the figure from 2016 rather than that from 2010.

© 2021

(iii) Many candidates found this question challenging. One successful approach seen was to consider the 2016 figure as 96 per cent of the required 2013 figure, dividing the 2016 figure by 96 gave 1 per cent of the 2013 amount required, which was then scaled up to the full amount by multiplying by 100. A common error was increasing (or decreasing) the 2016 figure by 4 per cent.

Question 2

(a) (i) Roughly three quarters of candidates correctly found the mode of 1. A common error was an answer of 29, the frequency figure for the mode rather than the mode itself.

(ii) Approximately half of the candidates found the median correctly, through a variety of methods. The most efficient was using the given total frequency of 80, dividing by 2 and concluding the median lay between the 40th and 41st value, both of which are situated in the class of 2, and so finding the median as 2. Another valid method seen was writing a list of all the numbers of classes and counting from either end to find the middle value.

(iii) Many candidates were successful here. A common incorrect method used the figure of 5 classes in the calculation to find the angle, often finding (2 × 5 × 360) ÷ 80. The 5 should instead have only been used to find the frequency figure of 2, and to then calculate (2 × 360) ÷ 80.

(b) (i) Many candidates recognised the frequency of the members was given by the area of each block in the histogram, but then did not used the correct widths of the rectangles in their calculation. There was a sizeable proportion of answers which incorrectly used a width of 30 for every rectangle. Other common errors were in misreading the heights of the rectangles.

(ii) As this question asks candidates to justify their decision, it is important that mathematics is used within the justification. Some candidates did not complete **part (b)(i)** correctly but successfully went on to show comparable figures and arrived at a suitable conclusion. This could be finding the proportion of members who spent longer than 1.5 hours at the gym and comparing this with 1/10, or comparing the percentage with 10 per cent, or comparing the frequency of these members with 1/10 of their total figure from **part (b)(i)**.

Question 3

(a) (i) To explain why triangle *AOB* is isosceles candidates needed to note that two sides (*OA* and *OB*) are equal because they are both a radius of the circle. Many candidates did so successfully.

(ii) Many candidates clearly showed angles on the diagram to aid their calculation, and those who did were more likely to proceed successfully towards a solution. More successful solutions used clear notation for intermediate angles. A common error here was to assume triangle *BCE* was isosceles, or to confuse which two angles are equal in triangle *OBC*.

(b) Candidates should use exact values throughout a question, only rounding at the very end to avoid a lack of accuracy in the final answer. Some candidates attempted to use the sine formula for the area of a triangle. More successful responses found the area of the large sector with radius 7.4 + 1.2 and subtracted from this the area of the small sector with radius 7.4. More successful approaches typically worked with sectors and arcs as fractions of a circle.

Question 4

(a) (i) Most candidates found the angle *RPQ* = 130°. Not all candidates then went on to use the sum of angles in a triangle to find angle *PRQ*.

(ii) Various methods could be used to approach this problem, with the most successful one being to find the anticlockwise angle from North at *Q* to the line *QR* and subtracting this from 360. This anticlockwise angle is then made up of angle PQR from **part (a)(i)** + 40° as this is the co-interior angle to 140.

(b) Few candidates gained full marks in this part. Although the majority knew their speed formulas, with the time being given in clock times rather than hours and minutes some found this conversion difficult. Common errors were to assume the time taken in each direction was equal, to not include the time taken to travel from *P* to *T* when finding the time remaining, or to ignore the 15 minute stop in village *T*. The most efficient method seen was to find the time taken to travel from *P* to *T* (22

© 2021

minutes), then use this with the 15 minute stop and the start and finish times to find the time taken to travel from *T* to *P* (28 minutes). The average speed using the distance of 16.5 km and a time of 28/60 hours was then found.

Question 5

(a) (i) Most candidates found the correct probability. A common error seen was in miscounting the number of even numbers.

(ii) Many candidates had the correct probabilities stated for the first card drawn. However, some candidates treated this question as a 'without replacement' scenario. Candidates needed to carefully note that this question is 'with replacement', and therefore the probabilities for the second card remain the same as for the first.

(iii) Some candidates correctly found the combined probabilities of taking an odd number and an even number. Most knew to multiply their probabilities from their tree diagram, but many did not appreciate 'one odd number and one even number' means the cards could be taken in either order so that there are two routes to consider from their tree diagram.

(b) Some candidates correctly recognised that 'one yellow counter and one pink counter' means these can be taken in either order. Some candidates opted to draw out a tree diagram, others did not, and each approach was roughly equally successful. A common error was not having a total of 12 counters to begin with, and then not having 11 counters for the second counter.

Question 6

(a) (i) Many candidates made reasonable attempts to show that the equation stated was true for this problem. For those candidates who recognised the need to use Pythagoras' theorem, the main error made was in missing brackets around (2*x*) before squaring, and so a number of candidates incorrectly set up the equation as $8^2 + 2x^2 = (3x + 5)^2$. Candidates were usually adept at expanding the double brackets and rearranging to the given equation. Some candidates saw the quadratic equation and automatically attempted to solve it in this part.

(ii) Solving the quadratic equation was usually done well, although candidates should take care when there is a negative coefficient. Many candidates recognised the need for the use of the formula rather than factorisation.

(iii) Those candidates who had a positive solution from **part (ii)** could usually find the area of the triangle using their value found. However, some solutions did not use the value found for *x* and instead found the area as 8*x*, not recognising the interconnected nature of **parts (ii)** and **(iii).**

(b) Few candidates could correctly identify the hypotenuse in the triangle. Many wrote 12 for side *AC* rather than side *BC*. Another common error was finding side *AB* and stating that this was the shortest distance from *A* to *BC*. Many did not consider the perpendicular from *A* to *BC* as the shortest distance, and some who did split the 12 in half and used Pythagoras' theorem with a value of 6 to find this perpendicular distance.

Question 7

(a) A considerable proportion of candidates made a good attempt at this question. Despite there being no table given, candidates correctly found coordinates, plotted them accurately and joined them with a smooth curve. The most common error was misreading the *y*-axis. Occasionally candidates found coordinates for the curve $y = x^2$ rather than $y = 2^x$.

(b) (i) Most candidates who could accurately draw the tangent and appreciated the gradient was negative successfully found the value of the gradient. Many candidates correctly drew a tangent to the curve at *x* = 0.5 which touched the curve at a suitable angle. Occasionally the tangent was drawn at another point. The challenge for many was in finding the gradient of the tangent drawn. Many candidates gave the gradient of their tangent as positive.

(ii) Better responses stated that left side of the given equation is the same as the right side of the graph's equation, so that the right side of the given equation (2) is equal to the left side of the

© 2021

graph's equation (y), with some then going on to successfully find the value of x when $y = 2$. Relating the given equation to the graph proved very difficult for many.

(iii) This question was challenging for many candidates. Few were able to develop a solution which firstly rearranged the given equation in the form of the graph's equation. Done correctly, the graph's equation is equal to $7 - x$ meaning these candidates could then draw the line $y = 7 - x$ and find the x values of the three points where the two graphs crossed.

Question 8

(a) Approximately half of candidates correctly found the midpoint. Various methods were seen, including considering the midpoint as the average of the x and the y coordinates, or to think of the coordinates on a number line and to find the middle of the x and the y coordinates. Some candidates stated a formula for the mid-point but not all recalled this correctly.

(b) The best responses found the gradient of *AB* by using two of the points *A*, *B* and their midpoint, using this gradient in the equation of a straight line along with one of the points again, and then going on to obtain the given equation. Some attempted to show that the given equation was true by using the equation itself, which is a circuitous argument.

(c) Some candidates successfully used –1 divided by their gradient from **part (b)** to find the perpendicular gradient to *AB*. Having done this, a number of candidates then incorrectly used the coordinates of either *A* or *B* in their equation, rather than using the coordinates of the midpoint to find the equation of the perpendicular bisector.

Question 9

(a) This part was answered well by most candidates.

(b) Many candidates were able to correctly solve the inequality, but there were a minority who, having found $x < 0.6$ correctly in their working, then wrote the final answer as 1.5. It should be noted that the full answer of $x < 0.6$ should be written on the answer line. There were also a small minority of candidates who swapped around the inequality sign in their working and finished with $x > 0.6$.

(c) There were many candidates who managed to eliminate the fractions and solve the equation correctly. A small proportion of candidates were not able to add two fractions and did not recognise that both the left and right sides of the equation needed multiplying by the denominators in order to remove these.

(d) Candidates were generally successful in the partial factorisation of the numerator but struggled with the full factorisation of this. Factorising the denominator proved more challenging for many. Some factorised both correctly, then left this uncancelled on the answer line. There was a small number of candidates who did not attempt any factorisation.

Question 10

(a) A minority of candidates recognised this as a bounds question. Few correctly found the upper bounds of each of the three dimensions (6.25, 4.85 and 2.55) and then used these figures to find the surface area. Some candidates found the volume of the cuboid rather than the surface area.

(b) (i) Many candidates realised the need to use Pythagoras' theorem in triangle *EXC* to find *XC* but did not then always realise the need to go on to use this figure in triangles *BXC* or *ABC*. A common error in this case was premature approximation, or not using an exact value for *XC*. These candidates often found length of the base to be 12.01 and then rounded this to 12.

(ii) Many candidates were successful here, the main error being the use of 12 rather than 12^2 for the base area, although occasionally 19 rather than 17 was used as the height of the pyramid.

(iii) A new diagram proved beneficial for many candidates here, helping them to identify the isosceles triangle for which right-angled trigonometry could then be used.

© 2021

MATHEMATICS D

Paper 4024/22
Paper 2

Key messages

Overall, the candidates understanding of vectors was good, however it is important for candidates to realise that when they choose to label vectors on a diagram a directional arrow is needed to indicate whether the vector is for example $\overrightarrow{BC}$ or $\overrightarrow{CB}$. Candidates need to appreciate the importance of the class width when plotting the height of each bar in a histogram.

It is important that candidates appreciate the need, when trying to show a value to 2 decimal places, that a value given to at least 3 decimal places will be required in the working.

General comments

In general, candidates were well prepared for the majority of topics covered on this paper and most attempted all the questions. Work was generally presented well. Most candidates gave detail in their method to support their final answer, with the answers transferred correctly to the answer line.

Most candidates demonstrated good skills in basic arithmetic and algebraic manipulation. Candidates found **Question 10** the most challenging, mainly due to the three-dimensional aspect in **part (b)**. A number of candidates did not understand that when asked to give a probability the answer will be between 0 and 1 inclusive.

Comments on specific questions

Question 1

(a) (i) Most candidates were able to correctly calculate the amount paid in December. Common mistakes were to either calculate the deposit or to determine the total cost as the sum of the three values given in the table.

(ii) Many correct simplified ratios were seen, however some who started with a correct ratio made errors when simplifying.

(b) An understanding of the mathematical calculations needed to find the money Jasmine received was seen on the majority of scripts with most using the method of converting \$350 into rupees and then subtracting 19500 rupees before converting back into dollars. Some candidates appreciated that 19500 rupees could be converted into dollars and then subtracted from \$350. Answers to 3 significant figures or to the nearest dollar were common rather than to the nearest cent.

(c) (i) Some candidates were able to give a correct answer in standard form. Others correctly found the difference of 13330 000 but were unable to write this in standard form. Some chose to approximate this answer to 1.3×10^7. Having correctly read the two values from the table, addition of these two values was sometimes seen.

(ii) The majority of candidates appreciated that a division was required to calculate the average, however not all the candidates divided in the correct order. Those who were able to correctly calculate the average were not always able to write their answer to the nearest dollar.

(iii) The correct answer was seen on about a quarter of the scripts. There were several candidates who appreciated that this was a reverse percentage problem and were able to set it up correctly

© 2021

although not all worked confidently with numbers in standard form. Several candidates calculated 23.5 per cent or increased or decreased the value in the table by 23.5 per cent.

Question 2

(a) (i) The majority of candidates were able to identify the correct modal class. Occasionally the angle of the modal class was stated rather than the ages of the people. A common wrong answer was 'Over 30' where candidates were looking at the largest ages rather than the largest sector.

(ii) Many candidates were able to use the information given for one sector to find the number of people in another sector. Common wrong methods were $\frac{90}{54}\times 30$ and $\frac{90}{54}\times 360$.

(b) (i) Many candidates drew rectangles with the correct base widths, however several of them were not able to calculate the heights for the frequency densities, with many using the heights as the frequency divided by 10. From those candidates who knew how to draw a histogram, there were sometimes errors in the vertical scale with the bar of height 0.9 plotted usually at 0.8 or the bar of height 2.1 plotted at 2.2.

(ii) The correct percentage was seen on some of the scripts. Common errors were to add the last two frequencies together to obtain a total of 102 and then find this as a percentage of 250 or to calculate the last frequency as a percentage of 250. A common misunderstanding was to think that the 75 given in the question had to be found as a percentage of 250. Some candidates did not know the correct method for finding a percentage and they divided the frequency by 100 and then multiplied by 250.

Question 3

(a) The majority of candidates correctly completed the table. Common wrong answers were 3.5, –3.5 and 2.

(b) The graphs were often well drawn with the points accurately plotted and joined with curves rather than line segments. Inaccurate graphs were usually as a result of a wrong value in **part (a)** or plotting (0, 0) rather than (0, –1).

(c) Few candidates were able to give a satisfactory explanation as to why the equation had only one solution. Several knew that the curve would only be cut once, but did not clearly state that it was the line $y = 3$ that would do this.

(d) (i) Some candidates were able to plot these two points accurately and join them with a straight line. A common mistake was to plot the point (–1, –2) rather than (–2, –1).

(ii) The majority of the candidates knew the method to work out the gradient of the line however not all candidates chose to use the two points they had been given but chose to use two points on their line. This often resulted in inaccurate gradients or a gradient from an incorrect line they had drawn. Some candidates wrote the gradient as $\frac{-2}{-3}$ rather than cancelling this to $\frac{2}{3}$.

(iii) Some candidates were able to accurately give three x-values where their curve cut their line. Some candidates gave coordinates, while others gave two positive values and one negative value, with the middle value usually the incorrect one. Despite the answer line indicating that three values were required, some candidates had not drawn the line long enough for there to be three intersections.

Question 4

(a) (i) Most candidates were able to complete the table correctly.

(ii) Candidates demonstrated some appreciation of the difference between the number of counters in consecutive patterns was 4. This resulted in some expressions being of the form $4n + k$, however the majority of these candidates wrote $n + 4$.

© 2021

(iii) Those candidates who had a correct expression in **part (a)(ii)** and equated to 150 usually found a value of 36.5. Many did not write this as a whole number, as the largest pattern requires an integer. Of those that did write their answer as a whole number, some incorrectly wrote 37. A common error was to substitute n = 150 into their expression.

(b) (i) Some candidates gave a correct answer of 44. Some who appreciated that the common difference was –6 chose to write down the terms in the sequence, however it was not uncommon to see these candidates arrive at either 38 or 50 as the first term of the sequence.

(ii) Correct expressions for the nth term were rare. Many candidates found an expression for an increasing sequence e.g. $44 + 6(n - 1)$.

Question 5

(a) Most candidates were able to form the correct two simultaneous equations, with many of these going on to find the correct solution. The method chosen to solve these equations was split between the substitution method and the elimination method, although not all were able to find the solution correctly with arithmetic errors seen. Some candidates correctly solved the simultaneous equations but then gave the mass of the card and envelope on the answer line (e.g. 4 × 16 = 64 and 3 × 7 = 21).

(b) Few candidates recognised this as a difference of two squares expression. A common error seen was to factorise the expression as $(x - 5)^2$.

(c) Around half of the candidates were able to rearrange the formula correctly, resulting in either $\frac{5r}{r-2}$ or $\frac{-5r}{2-r}$, depending on the route they chose. Few candidates dealt with the fraction correctly and some did not isolate t, giving an answer with t on both sides of the equation.

(d) Many candidates gave a correct unsimplified single fraction as their answer. Errors, usually sign errors, were sometimes seen when the brackets were expanded in the numerator. Method errors were occasionally seen, for example adding the numbers in the numerator and/or adding expressions in the denominator.

Question 6

(a) (i)(a) The correct answers seen were usually in fraction form with a common wrong answer being $\frac{6}{8}$. Many candidates gave integer answers greater than 1.

(b) Many candidates gave the correct answer in this part. Again, there were a large number of integer answers seen that were greater than 1.

(ii) Few candidates were able to find the correct probability by multiplying the correct two fractions. Common wrong methods seen were $\frac{3}{8}+\frac{3}{8}$ and $\frac{3}{8}\times\frac{2}{7}$. Some candidates gave integer answers.

(b) Successful responses showed a clear method to calculate the correct probability, considering two counters of all three colours and combining these probabilities by addition. Mistakes included only considering two of the colours or finding the probability if the first counter was replaced. It was not unusual to see mistakes in the denominator of the second counter, usually e.g. P(2 red) = $\frac{7}{16}\times\frac{6}{14}$.

Other errors included $\frac{7}{16}\times\frac{6}{15}\times\frac{3}{14}$.

© 2021

Question 7

(a) (i) Many candidates were able to find the correct coordinates for the midpoint. Instead of finding the average of the two *x*-coordinates and the same for the *y*-coordinates, some found the difference and halved that. Some showed little or no working and their methods were difficult to follow. Another error seen involved finding square roots of their working.

(ii) Many candidates found this question challenging. A wide range of incorrect methods were seen.

(iii) Some candidates were able to find the correct length. Others knew the correct method but made errors by not giving the answer to at least 3 significant figures or incorrectly squaring the negative number. Some candidates did not demonstrate knowledge of the correct method as they did not use brackets around the negative value, resulting in an answer coming from –16 + 36.

(b) (i) Sound knowledge of basic vector work was seen on a considerable number of scripts.

(ii) Candidates found this part of the question more challenging, with few able to give a correct simplified vector. Many candidates demonstrated a correct vector route. Common errors included stating that $\overrightarrow{NB} = \frac{1}{3}\overrightarrow{AB}$ or that $\overrightarrow{BC} = 2\text{a}$.

Question 8

(a) Many candidates showed a correct substitution into the volume of a cone formula and rearranged this correctly to make *h* the subject. These candidates showed *h* as 8.57, but many did not give a more accurate value to show that it rounded to 8.57, correct to 2 decimal places. Some candidates chose to write the more accurate value as 8.575 which was not sufficient to show that it rounded to 8.57, correct to 2 decimal places. A minority used the radius as 7 and a few used a height of 8.57 and tried to show that the volume was 110.

(b) Pythagoras' theorem was used by many candidates. Some lost the accuracy in their answer, either by incorrect rounding or in the value they used for the height. Some candidates attempted to use the formula for the curved surface area in order to obtain the value of *l* but incorrectly equated this to the volume.

(c) Some candidates were able to answer this part fully and find the correct value of the angle of the sector. Some chose to equate the sector length to the circumference of the top of the cup, while slightly more opted to equate the area of the sector to the curved surface area of the cone. The most common error was to use the radius of the sector as 3.5 rather than the slant height calculated in the previous part.

(d) Few candidates were able to calculate the diameter of the top of the second cup. Some made the link between the ratio of the volumes and the ratio of the lengths and remembered the relationship is that the volume is proportional to the length cubed. Many candidates made either a linear link, with answers of 10.5 being common, or an area link, resulting in answers of 8.57. Many attempted to use the volume of a cone formula and frequently used some or all of the original dimensions e.g. $165 = \frac{1}{3} \times \pi \times r^2 \times 8.57$.

Question 9

(a) Many candidates were able to give correct expressions for both the length and width of the box.

(b) Some candidates were able to set up a correct algebraic equation and then correctly manipulate it and simplify to the given quadratic. Common errors seen when candidates did attempt to set up an equation were to use a closed box or to either omit brackets or expand them incorrectly. Candidates who had expanded the brackets for the length in **part (a)** to 2*x* + 10 were normally more successful than those who attempted to work with the length 2(*x* + 5) in this part. Some confused the formula for the volume with that for the surface area. Another common approach was to start with the given quadratic rather than work towards it, usually resulting in the solution of the quadratic in this part.

© 2021

(c) The most common method used to solve the given equation was the quadratic formula which many candidates knew and used well. There were very few who attempted to use the completing the square method although some did attempt to factorise, despite being asked to give their answer correct to 2 decimal places. The positive coefficient of x resulted in fewer errors in the formula than is sometimes seen, however some candidates still had errors in the substitution. A small number of candidates demonstrated they were able to use the formula correctly but made mistakes when evaluating this on the calculator.

(d) Many candidates wrote the correct formula for the volume but then did not work with their three correct values from their positive value in **part (c)**. Some attempted to work out algebraic answers rather than finding numerical values for the length, width and height.

(e) The correct answer for the lower bound of the mass of the box was obtained by few candidates. Many started by finding the mass of the box without dealing with the limits first; some chose to give this as the answer while others then attempted to deal with the limits. Of those who attempted to find the maximum and minimum masses of the individual parts first, the most common error was to subtract their minimum value for the mass of the chocolates rather than the maximum value.

Question 10

(a) The unstructured form of this question required candidates to carry out all the necessary steps in a systematic manner and this was successfully achieved by few. Some candidates realised that angle *BAD* was required and successfully found this angle to be 55°. The most common error was to write that this angle was 125°. Those who found an angle for *BAD* were not always able to apply a correct sine rule, many obtaining angle *ABD* as 42.7°. Having obtained an angle for *ABD* not all were able to progress to find the required bearing.

(b) Few candidates were able to use the information given in this part of the question, along with the original diagram, to interpret the problem and then calculate the angle of elevation. Many struggled to use triangle *BCD* correctly with wrong angles being used inside the triangle. Few candidates were able to correctly calculate the height of the mast.

© 2021