MATHEMATICS

Paper 0980/11
Paper 11 (Core)

Key messages

To succeed in this paper, candidates need to have completed the full Core syllabus. Candidates are reminded of the need to read the questions carefully, focussing on instructions and key words. Candidates also need to check that their answers are in the correct form, make sense in context and are accurate.

General comments

This paper proved accessible to many candidates. There were a number of questions that were standard processes and these questions proved to be well understood. Other questions were more challenging, for example finding when bus times coincide and the radius of a circle from the circumference. Most candidates showed some working with the most able candidates setting their working out clearly and neatly.

The questions that presented least difficulty were **Questions 3**, **7(a)**, **7(b)(i)**, **9** and **10**. Those that proved to be the most challenging were **Questions 1(c)** quadrilaterals, **12** rounding, **13(b)** lowest common multiple in context, **15** a volume conversion and **19** radius of a circle found from the circumference.

Comments on specific questions

Question 1

(a) The majority of candidates gave acute as their answer but there were some that gave obtuse. Other incorrect answers seen were right angle or reflex. A small number gave a numerical example of an angle less than 90°, for example, 40° rather than the name.

(b) The most common incorrect answer was hexagon or polygon or again a value, for example, 72°.

(c) This part of the question was found challenging. There was no diagram or list of names for the candidate to pick from. The majority of answers seen were names of quadrilaterals but other shapes such as triangle were also seen. Words such as perpendicular, isosceles or congruent were also given – these were from the list given in the following question.

Question 2

This question was not attempted by many candidates. Many other candidates identified two answers instead of one. The word ‘two’ did appear in the question, suggesting that some may not have read the question correctly.

Question 3

This was answered well by most candidates. Occasionally, candidates had not simplified far enough and so gave $\frac{12}{21}$ as their answer or gave a decimal, 0.571...

Question 4

The most common incorrect answers seen were –54 (implying an incorrect order of operations, i.e. $\sqrt{\frac{1}{0.01}}-8^2$) and 36 (from omitting the square root).

Question 5

(a) This part was not answered as well as the next part. Candidates drew in horizontal lines, vertical lines or lines parallel with the sides, either instead of, or as well as, the correct diagonals. Sometimes only one diagonal was drawn showing the candidate did not fully understand what was required.

(b) Most candidates shaded two squares only as required, with the right-hand square being the one most likely to be correct. Some appeared to be producing a diagram with reflective symmetry rather than rotational.

Question 6

There were some excellent responses to this problem solving question that were fully correct and well presented. However some candidates were unable to start correctly. A number of candidates recognised that the simplest way to solve this problem was to first calculate 19 × 7 = 133. Many candidates could not proceed past this. The most common errors seen included the adding of the sides or multiplication of three or more of the sides. Many just divided the shape into two rectangles or offered no response to the question.

Question 7

(a) Nearly all candidates gave the correct answer of 10 10. There were a few who gave 10 00, 10 15 or 11 10.

(b) (i) Most candidates answered this part correctly. A very small number gave the time when Hua stopped for a rest rather than the distance from home.

(ii) The most frequent incorrect answer was 30 minutes from a misunderstanding of the scale – each square represented 10 minutes not 15.

(c) The correct answer was a horizontal line at 12 km from 11 10 to 11 20 then a diagonal line down to the axis at 11 50. Many candidates drew the diagonal line correctly but drew nothing to indicate her stay in the library. Some candidates had Hua incorrectly arriving home at 12 00, the last time on the axis, without any calculations to show how they decided this. There were a few candidates who had the return home at 10 30 or 10 50 depending on in which direction they drew the stay in the library – candidates should understand that times always move to the right but lines showing distance can go up and down. If a candidate did not gain any marks from completing the travel graph, there was a mark for showing that the journey home would take Hua 30 minutes; not many candidates showed this working and so were unable to benefit from this mark.

Question 8

This question was answered well, with many accurate drawings with the construction arcs visible. Some candidates did not appear to be able to set their compasses accurately. Nearly all managed the conversion as indicated by lines the correct length drawn if not by calculation.

Question 9

This question was answered well with many correct answers seen. Candidates who realised the need to divide 1190 by 7 almost invariably went on to arrive at the correct answer. Common incorrect answers came from dividing by 5 or 2. A few candidates gave Beth's amount of money.

Question 10

Most candidates were successful in this question, with the majority of candidates showing good understanding. Most errors were either arithmetic slips or sign errors. A small number of candidates appeared to think this question involved fractions, evaluating $-\frac{2}{3}+-\frac{5}{1}$ in the first part usually leading to the answer $\left(-\frac{17}{3}\right)$, usually shown with a fraction line. Similar errors involving fraction calculations were made in the second part.

Question 11

This problem solving question required candidates to analyse what they are being asked, to recognise what information they have and to work out their method. There were some excellent answers seen using clear and efficient methods. Many candidates reached the stage of finding that the total cost for potatoes was \$6.30 but some did not know how to proceed from here – this gained a method mark for a partial method done correctly. Some candidates struggled to start the question with many working out only 2.8 × 2.65. Some picked the wrong figure to work with, for example 3.6 kg instead of 2.8 kg, when working out the cost of the leeks.

Question 12

This question proved challenging for the majority of candidates but a reasonable number of fully correct solutions were seen. A few candidates rounded 49.2 to 2 significant figures, (49), or to 5 or down to 40. Occasionally 4.085 became 5 instead of 4. Many candidates found the exact answer and attempted to round that, showing that they did not read the whole question before starting work. Some candidates had trailing zeros in their values corrected to 1 significant figure, which in this instance, was credited with a mark but using trailing zeros is not correct and must be discouraged.

Question 13

(a) This part was answered reasonably well by many candidates. There were others who listed the factors of 18 rather than 18 as a product of prime factors. Many candidates showed correct working to find the prime factors in a tree or ladder diagram which gained a mark when the answer was incorrect. Some candidates included a 1 in their product – this was not correct as 1 is not a prime number.

(b) The previous part was a lead-in to this question in context to encourage candidates to find the prime factorisation of 24 and so go on to find the LCM but this connection was often not seen. The LCM equated to the number of minutes after 10 47 when the two buses would next leave at the same time. There were other ways to approach this problem, such as listing the times of the two buses. Candidates made various errors, for example, arithmetic slips in listing the times or not noticing when 11 59 was in both lists and giving another time when the buses left together.

Question 14

There were some good answers to this fractions question seen. Many candidates showed clear working and all of the relevant steps required to evaluate the product. Most candidates who were able to convert the given values to vulgar fractions went on to multiply these correctly. A few candidates who got as far as $\frac{88}{12}$ and then cancelled down to $\frac{22}{3}$, stopped without giving the answer as a mixed number as asked for in the question – it is always important to check what form the answer should take. Some had difficulties with the multiplication by inverting a fraction or even adding the vulgar fractions. Candidates who attempted to evaluate the product by converting to decimals did not gain credit as did those candidates who gave the correct answer with no or incorrect working.

Question 15

This proved to be a challenging question for many candidates. Most answers included the figures 437, but not in the correct place values. Some candidates cubed 4.37 to give 83.45.

Question 16

The first step in this question was to successfully deal with the – 7 or the division by 5, giving $5x = 2y + 7$ or $x - \frac{7}{5} = \frac{2y}{5}$, with not many choosing this second approach. Candidates who completed the first step correctly usually went on to give a fully correct rearrangement. There were a considerable number who thought that $2y + 7$ was $9y$, spoiling otherwise good work. Many made sign errors in their first step so gave answers of $x = \frac{2y-7}{5}$.

Question 17

Many candidates knew the compound interest formula and often could write it correctly. Some incorrect versions of the formula were seen such as $16000 + \left(1 + \frac{5}{100}\right)^4$ or $\left(16000 + 1 \times \frac{5}{100}\right)^4$. Only a very small number attempted long methods, working out the value of the investment at the end of each year. The most common error was to round the answer. The full answer was exactly \$19 448.10 but there were many who gave \$19 448 or \$19 500. As the answer is an exact figure, then all the digits must be given. A few candidates gave the interest accrued. Some thought that the formula worked out the interest only so added on another \$16 000.

Question 18

(a) A large number of candidates did not plot any of the points. Many were not consistently accurate with their plotting or the use of the scale. Many candidates used a pencil that was too thick or a pen which could not erased if mistakes were made.

(b) The answer to questions asking what type of correlation is shown in a scatter diagram is only positive, negative or zero (or none). Some incorrectly gave positive but many other words or phrases were given, for example, decreasing, estimates, perpendicular, inverse, irregular, congested, good correlation or strong correlation.

(c) A ruled line of best fit was drawn reasonably well by many candidates. Occasionally, a line was too short (it should be long enough to cover the data points). Some candidates joined the top left of the grid to the bottom right – this was not an accurate enough line. Some drew a line with positive gradient or joined the points up with individual line segments.

(d) Many candidates gave an answer within the acceptable range.

Question 19

This was a challenging question for candidates. For those that attempted this question, the methods employed showed that it was not generally understood. Some guessed values and substituted them in the circumference formula to get as close to 56 mm as possible – mostly this meant that 8.9 cm was their answer for the radius. As this only has 2 figures, this did not gain the accuracy mark and the working was not acceptable for a method mark. Some started correctly, dividing 56 by 2π, but then went on to divide by 2 again or to square root. Some rounded after dividing by π before dividing that by 2 – this gave an inaccurate answer. Candidates must not round during a calculation. A few used the area formula or inaccurate values of π.

Question 20

This question was often left blank by candidates but conversely, there were some very good answers as well. Candidates who found the correct gradient often went on to give the correct equation. Those who recognised the need for a gradient generally used co-ordinates rather than triangles. Less able candidates often drew a triangle on the diagram (often not very accurately) or used values which were not co-ordinates on the line. Some candidates calculated the gradient by incorrectly using change in *x* over change in *y*. A frequent error was to give the answer, y = 1.5 + 3. Many were able to identify the constant as 3.

Question 21

(a) Most candidates realised the need to use trigonometry but not all were able to identify the correct trigonometric ratio to use. The errors that subsequently arose included being unable to rearrange $\tan\ x = \frac{10}{18}$ or using $\tan\ x = \frac{18}{10}$. Premature rounding was an issue, with a large number of candidates rounding their value of tan *x* to ether 0.5, 0.55, or 0.555, resulting in a significant degree of error in the final answer. Some candidates only gave their answer to the nearest degree and so did not gain full credit. There were a few long, indirect methods when candidates found the hypotenuse then used sin or cos or even stopped after finding the hypotenuse. These were rarely successful, as again, premature rounding did not give an accurate result for the angle. Candidates should analyse a problem to work out the most efficient method to use.

(b) This part was generally well attempted with many candidates correctly using Pythagoras' theorem and reaching the correct expression and answer. Incorrect responses included using tan again.

MATHEMATICS

Paper 0980/21
Paper 21 (Extended)

Key messages

To succeed in this paper candidates need to have covered the full syllabus, remember necessary formulae and definitions and show all working clearly. They should be encouraged to spend some time looking for the most efficient methods suitable in various situations. This was particularly important in **Questions 12** and **20**.

General comments

The level and variety of the paper was such that candidates were able to demonstrate their knowledge and ability. There was a high rate of no response on the final question but this seemed to be due to the vectors topic rather than a lack of time.

Working was well set out. Candidates should ensure that their numbers are distinguishable, particularly between 1 and 7 and between 4 and 9 and should always cross through errors and replace rather than try and write over answers.

Candidates still need to be reminded that prematurely rounded intermediate answers bring about a lack of accuracy when the final answer is reached. They should also be encouraged to check their work carefully as marks in more complex questions were often lost through basic errors such as manipulating algebra which had been done correctly in other questions or numerical and sign errors.

Comments on specific questions

Question 1

The vast majority of candidates made a good start to the paper, gaining both marks. Those who scored one mark usually made the error of giving a instead of $-a$. Some centres clearly encourage the grouping of the coefficients, however they must remind candidates of the need to evaluate, as the most common answer for those who did not score was $(3-4)a + (7+1)b$.

Question 2

This question proved to be straightforward for most candidates. The majority showed their construction arcs and lines drawn were usually with the tolerance allowed. Candidates who did not show construction arcs could score a maximum of 2 marks which many did manage to do, however this approach often led to one of the lines being inaccurate. The occasional blank answer space may have indicated that candidates did not have the correct equipment with them.

Question 3

This was a well attempted question, with the majority of candidates gaining full marks. There were a number of arithmetic errors and occasional miscopying of numbers, but working was clearly set out and so method marks could be awarded in these cases. Some candidates got to $13.72 - 2.8 \times 2.65$ but then did not go on to the division or did the division the wrong way round. Among those who did not score, a common incorrect first step was 3.6×2.8. A relatively common misconception was to assume some kind of direct relationship between the potatoes and leeks, as methods involving cross multiplying and ratios were often attempted.

Question 4

Most candidates plotted all four points correctly in **part (a)**. There were many who scored one mark which indicates that any mis-plotting was a careless mistake rather than not interpreting the scale on the axes correctly. There were a significant proportion of candidates who did not attempt to plot the points. The majority of candidates knew the correct terminology in **part (b)** and this was often accompanied by additional descriptors such as strong or weak. Those who did not score were often describing the relationship or simply wrote speed/distance. There were many good lines of best fit drawn in **part (c)** but candidates should be reminded that the line should cover the whole range of plotted points. Some did not draw a line and a very small number joined up all the points or the points they had plotted. In **part (d)** the overwhelming majority of candidates either gave a value which was in tolerance or followed through correctly from their line of best fit.

Question 5

There were many fully correct answers to this question but there still remains much confusion when being asked to estimate a calculation. Most of the errors arose from a lack of understanding surrounding significant figures. Some candidates rounded consistently to 1 decimal place, or to the nearest integer, which was a common way to score one mark, as three of the values were correctly rounded. Some decided to carry out the accurate calculation but rounded at the end whilst others worked out the numerator and denominator and then rounded those to 1 significant figure. A few candidates did not follow the instruction to estimate, suggesting that they had not read the question properly. Candidates should be reminded to maintain place value when rounding, as 5 rather than 50 was often seen in the numerator. They should also be reminded not to add in unnecessary zeros as it was quite common to see trailing zeros after the decimal point, often to maintain the number of decimal places as in the original number.

Question 6

Most candidates understood what was expected of them for this question, both in terms of showing their working and giving their answer as a mixed number in simplest form. The vast majority of candidates were able to turn the two mixed numbers into improper fractions as a first step. Most candidates multiplied through to an interim fraction of $\frac{88}{12}$ rather than cancelling before multiplying, but the numbers involved were such that few arithmetic mistakes were made. One common misconception was that denominators need to be the same in order to multiply and so $\frac{32}{12}\times\frac{33}{12}$ was often seen. This was often multiplied correctly and then cancelled down again, but it was also common to see a result of $\frac{1056}{12}$.

Question 7

Candidates demonstrated an excellent grasp of basic algebra in this rearrangement with the vast majority gaining both marks. By far the most common error was to subtract 7 from 2y rather than add it as a first step. Many candidates are keen to get the subject on to the left hand side of the formula but this often led to errors with the signs. Centres should encourage candidates to look for the most efficient ways of dealing with rearrangements and emphasise that they can reverse the sides of the equation without doing any processing.

Question 8

The problem solving element of **part (a)** proved to be challenging. The answer of 5 was common in recognition that multiples of 5 end in a 5 or 0, but the fact that it was an even number had been missed. It was common to see any of the numbers in the question as the answer, along with 10 or a multiple of 10. Many candidates multiplied all the numbers to give an answer of 210 and some gave two numbers as the answer, indicating that they had not recognised that a single digit was required. The more familiar **part (b)** was much better attempted and the majority gained both marks. Both factor trees and repeated division were used. Working was clearly shown and there was a good understanding that the factors should be shown with multiplication signs. Some lost the final mark because they gave the factors as a list or included the number 1. The vast majority of errors though were arithmetic errors when dividing, which could have been rectified had the factors been multiplied to check that they gave the correct value.

Question 9

Part (a) proved to be the worst attempted question on the paper, even among the strongest candidates, demonstrating a lack of understanding of how to increase an amount by a percentage greater than one hundred in one step. The majority of candidates gave the wrong answer of 40×3, the increase rather than the final value. The next most popular wrong answer was 40×300. **Part (b)** was much better understood with a significant majority selecting the correct calculation. The popular incorrect choices were $2^2 + (-3^2)$ and $\sqrt{2^2 - 3^2}$.

Question 10

The majority of candidates understood that this was equivalent to compound interest and could quote and use the formula correctly. A significant proportion gained two out of the three marks available because they either rounded incorrectly or did not round at all. Some subtracted the initial value of 45 000, giving just the increase which was condoned for the method mark. Candidates should be encouraged to use their calculator efficiently and carry out the whole calculation in one go as some lost accuracy marks by prematurely rounding 1.016^5, writing it down and then calculating the answer. There were many answers of 48 600 seen from $45\,000 + 45\,000 \times 0.016 \times 5$, demonstrating a misinterpretation of the question.

Question 11

The problem solving aspect of this made, what was otherwise a fairly straightforward inequalities question, quite challenging. Successful candidates used the information given to write the missing coordinates on the diagram and often scored full marks. A mark of one was commonly awarded for two or three correct values where the most common incorrect value was for the reflected value of *b*, often given as 4 rather than 5. Many reversed the answers for *c* and *d*. Candidates should look carefully at the notation given in the question, as many gave answers as coordinates or included inequality signs which was incorrect. There were many weaker candidates who did not attempt the question.

Question 12

The most successful strategy in this question was to find the exterior angle and then divide this in to 360. Many candidates could get no further than finding the exterior angle of 24. The majority of candidates who got this question wrong used the interior angles formula incorrectly. The equation $180(n-2) = 156$ was seen many times, instead of $180(n-2) = 156n$. As a result, an inappropriate answer of 2.86 sides was extremely common. Many of those who did state the correct formula were unable to manipulate it to get to the correct answer.

Question 13

The majority of centres appear to have taught the method of multiplying the recurring decimal by powers of 10 and subtracting to find a fraction over 9, 90, 99 and so on. These were by far the most successful candidates as working was clear and well set out, demonstrating an understanding of the method employed. Other successful methods were seen and awarded full marks but it was far more common for candidates to make errors or not show full working on these alternative methods and it was clear that they did not always understand the method which they had been taught. Some candidates did not show any method and so could only gain 1 mark for a correct fraction, presumably gained from the calculator. Some candidates misinterpreted the recurring notation and wrote the number out as 0.1717…. Weaker candidates ignored the recurring symbol and simply wrote the fraction as $\frac{17}{100}$.

Question 14

Successful candidates rearranged the equation in to the form $y = mx + c$ in order to find the gradient. There were many who did this correctly to gain a mark but then gave an answer of $\pm\frac{1}{2}$. Many made a start to this first step but stopped at $8y = -4x + 5$, hence many answers of ±4 and $\pm\frac{1}{4}$ were seen. Following a correct rearrangement with the gradient as $\frac{-4}{8}$, some candidates left the final answer as $\frac{8}{4}$, which candidates should be aware will not score the answer mark as this is not processed. Again, candidates should check that they have answered the question, as an answer of $2x$ or $y = 2x + c$ does not give the gradient of a line and did not score the answer mark.

Question 15

Part (a) was well attempted but there was much confusion among many candidates. Some showed the division the wrong way round and there were many who gave the answer as the reduction of speed from 18 m/s to 6 m/s = 12 m/s. A small number of candidates also wrongly worked out the area under the line of deceleration, resulting in answers of 240 m/s and 480 m/s. A variety of answers were given for **part (b)**, as was expected due to the number of area calculations possible. Some candidates found efficient methods of trading off areas which were the same, but the most successful were those who found the whole area under the graph for the car and subtracted the 1200 for the motorbike. While the correct answer was seen frequently, the most common mark given here was one method mark for calculating one or more relevant areas, usually including 1200, but most could not give a fully correct area statement for the car. There was little working seen on the graph which may have helped candidates to identify the different areas which they were calculating. There were numerous errors in finding the different areas. One common starting point was to find the area of the rectangle 18 × 60 = 1080. Errors after this were to treat the remaining trapezium as a triangle and calculate $\frac{1}{2}(40 \times 18)$ or to split the remaining trapezium into a rectangle and triangle but to omit one of these. It was also common to see areas which were not a trapezium being treated as one, for example the whole area for the car was given as $\frac{1}{2}(60 + 100) \times 18 = 1440$ and the area under the motorbike and the car as $\frac{1}{2}(80 + 100) \times 12 = 1080$. Weaker candidates did not use the area under the graph and subtracted speeds, while others ignored the deceleration of the car and calculated 1800 – 1200.

Question 16

Strong candidates had no problem factorising the quadratic expression with little need to show any working although some did show splitting the $7x$ into $15x - 8x$. A minority of candidates gained 1 mark, usually for reversing the signs within the brackets. Many candidates used the quadratic formula or their calculator to solve the equation when equal to 0 but then could not make the final step of finding the factors and so $\left(x \pm \frac{4}{3}\right)\left(x \pm \frac{5}{2}\right)$ was a common answer. The other common answer was $x(6x + 7) - 20$. Many candidates had no strategy to attempt this question and so this is an area for centres to work on.

Question 17

It is clear that centres have worked hard on teaching functions as candidates demonstrated a very good understanding throughout the question. **Part (a)** was particularly well answered with the vast majority of candidates substituting correctly. By far the most common error was to omit the brackets for $(-2)^2$. Many candidates gained the method mark for a correct substitution but then calculated $(-2)^2$ as -4 and others added 12 to 19 rather than subtracting. Some confused the $x = -2$ and $f(-2)$ values while others did not know what the 19 represented. **Part (b)** caused more difficulty, particularly among weaker candidates, but was still well attempted. In **(b)(i)** it was a shame that many spoilt their answer by dividing through by 3 rather than factorising. The most common errors within the method were to calculate $hg(x)$, $g(x) \times h(x)$ and to solve $g(x) = h(x)$. There were a significant number who did not attempt **(b)(ii)** so finding the inverse function was slightly less familiar. The majority of candidates gained at least one mark for a correct first step of either reversing x and y or for a correct step in the rearrangement. A common error was to add 7 rather than subtract in the rearrangement and candidates often left their answer in terms of y, perhaps demonstrating a lack of understanding of what they were finding.

Question 18

Successful candidates were those who could correctly recall and substitute into the appropriate area formulae. The correct final answer was only achieved by the strongest candidates who worked methodically through each area. Most candidates gained a proportion of the marks by working out either the correct area of the sphere or hemisphere or the curved surface area of the cylinder. Most errors in recalling the correct formulae were in the curved surface area where 2 or 2π were often omitted. There were two very common misconceptions. The first was to use the surface area of a cylinder formula and include the area of two circles without thinking carefully about the given shape on the diagram. The other was to find the area of the circle but then turn it into a volume by multiplying by 12.

Question 19

This question caused some difficulty with a minority gaining the mark. There were two very common errors, the first being to omit the shading outside the sets. The second was to omit the shading of sections $M \cap P$ and $M \cap N$. This suggests a misunderstanding of the union symbol and is perhaps an area for centres to consolidate with candidates.

Question 20

This is the type of question where candidates need to take a minute to think about their approach and generate a sensible strategy. Many wrote out the addition of all the angles, putting them equal to 360 but then could progress no further than having an equation in terms of *x* and *y* or gave the answer of *y* in terms of *x*. Those who recognised that it was a cyclic quadrilateral and recalled the properties correctly usually gained full marks showing clear working. A few chose the rather inefficient method of using the 2 opposite angles which contained both *x* and *y*, along with the total angles adding to 360 and solved the pair of simultaneous equations. This usually led to more errors and was a far more time-consuming method. A large number of candidates mixed up which angles should add to 180 and so it was common to see $4x - 87 + 2x = 180$ leading to an answer of 44.5 and $4x - 87 + x + 60 = 180$ leading to 41.4.

Question 21

This question was well attempted by candidates across a whole range of abilities. A large proportion identified the correct triangle containing angle *PVT*. It would be advisable for candidates to draw and label the correct triangle as many angles marked on the diagram were ambiguous and could not score a method mark if they then continued incorrectly. Those who had identified the correct triangle usually went on to use the correct trigonometric function of sine 43, although some errors were made using cosine. There were some who used the inefficient method of finding *TV* and then used Pythagoras to find the required sign, adding an extra unnecessary step which often led to inaccuracy due to rounding. Premature rounding of sine 43 also led to inaccurate answers. Candidates who did not score were usually identifying an incorrect triangle, often *PVW*. The existence of a right-angled triangle also led to a number of candidates trying to use Pythagoras even though they only had one given side.

Question 22

There were many completely correct simplifications given and the majority of candidates were able to score some marks. The most common marks to award were for showing $x(x - 5)$ in the numerator and for $2(x^2 - 25)$ in the denominator. Many candidates did not then spot the difference of 2 squares and did not continue any further. Weaker candidates were crossing out x^2 from the numerator and denominator and also dividing the 5 and 50 by 5.

Question 23

Vectors continue to be a challenge, with only the strongest candidates making good attempts, particularly in **part (a)**. Giving a correct route is a mark accessible to most candidates and so this should be encouraged as a first step. Centres should reinforce the importance of direction as it was very common to see for example, the error $AC = \frac{1}{3}CF$, $FC = \mathbf{n} - \mathbf{m}$ or $CF = \mathbf{m} - \mathbf{n}$, with all other work then following on from this correctly.

Missing brackets also cost many candidates marks, with $\frac{1}{3}\mathbf{m} - \mathbf{n} + \frac{1}{2}\mathbf{m}$ very commonly seen; resulting in candidates losing marks due to basic algebra, with the vectors concept itself being understood. Similarly, the answer mark was often lost due to mistakes with signs when multiplying out the bracket and adding the fractions to simplify. Many candidates did not attempt the question, particularly **part (b)**. Successful candidates understood that vectors are defined by their magnitude and direction and wrote a fact about each of these. There were many completely correct responses describing that the vectors were parallel and that $\overrightarrow{GH}$ had a greater magnitude than $\overrightarrow{JK}$, with or without the actual ratios. The most common misconception was that the vectors were collinear so candidates should understand the extra piece of information required in order to show this. Some wrote down the ratio in reverse, thinking that $\frac{5}{18}$ is 3 times bigger than $\frac{5}{6}$.

Candidates who could not interpret the question wrote down trivial facts comparing the fractions and said, for example, that they both contained **2**p **+** q**.**

MATHEMATICS

Paper 0980/31
Paper 31 (Core)

Key messages

To be successful in this paper, candidates had to demonstrate their knowledge and application of various areas of mathematics. Candidates who did well consistently showed their working out, formulas used and calculations performed to reach their answer.

General comments

This paper gave all candidates an opportunity to demonstrate their knowledge and application of mathematics. Most candidates were able to complete the paper in the allotted time. Few candidates omitted part or whole questions. Candidates generally showed their workings.

Areas which proved to be important in gaining good marks on this paper were; calculating with money, time and negative numbers, probability, calculating averages from a frequency table, calculating surface area and volume and constructing nets of 3-D shapes, understanding and finding missing angles in geometric problems involving parallel lines, triangles, circle theorems and polygons, finding factors, multiples and prime numbers, effective use of their calculator, using standard form, completing and shading a Venn diagram, simplifying and factorising expressions, solving linear and simultaneous equations, decimals and percentages, rounding, finding the HCF of two numbers, transformations, plotting and interpreting a reciprocal graph, and sequences. Although this does not cover all areas examined on this paper, these are the areas that successful candidates gained marks on.

Candidates find 'show that' questions challenging and often use the fact that they are trying to show in their calculations.

Candidates should be encouraged to process calculations fully and to read questions again once they have reached a solution so that they provide the answer in the format being asked for and answer the question set.

The standard of presentation was generally good. There was evidence that most candidates were using rulers to draw diagrams and straight line graphs and using a pencil to draw the reciprocal graph.

Comments on specific questions

Question 1

(a) The majority of candidates correctly converted the cost given in yuan to dollars. The most common error was \$7680, from multiplying by the exchange rate instead of dividing. Several candidates used the correct method and found the cost in dollars as \$187.50 but then rounded this exact value to \$188. Candidates should be reminded that exact answers should be written fully and not rounded to 3 significant figures.

(b) (i) Candidates showed good understanding of negative numbers and most candidates found the correct difference. The most common error seen was 11°C from 15 – 4, not considering that the minimum temperature was –4 not 4.

(ii) Candidates did equally well in this part with most finding the correct temperature. Common incorrect answers were 7°C and –7°C from –5 – 2 and 5 + 2.

(iii) This part proved to be one of the most challenging questions on the paper. Only the most able candidates found the minimum temperature on Sunday as –8°C. The most common incorrect answer was 18; candidates used –5 as the minimum temperature for the week and therefore –5 + 23 = 18. The question states the minimum temperature for Sunday and as 4 was the maximum temperature for Sunday then an answer of 18 is impossible. Other common errors were 23 – 15 = 8 instead of 15 – 23 = –8; 19 from 23 – 4 and –19 from 4 – 23. Many less able candidates did not attempt this question.

(c) Finding the smallest number of guards needed each week proved to be one of the most challenging questions on the paper and the correct answer of 7 guards from correct working was seen only from the most able candidates. Working out the number of hours the museum was open for in a week was challenging to many candidates, with 8 + 6 = 14 seen as a common incorrect answer, not realising that these hours applied to all five weekdays and each of Saturday and Sunday. Other errors included 9 hours for each of Monday to Friday, and 7 hours for each of Saturday and Sunday by including the start hour. Some candidates multiplied by 7 instead of 5 and 2 to find the total number of hours open. Some candidates worked out 8 weekday hours and 6 weekend hours but then multiplied these by the number of guards. Most candidates who found the correct number of hours as 52 usually could not convert this into man-hours and $(52 \times 4) \div 30$ was rarely seen. A few candidates used the fully correct method but truncated their answer of 6.93 to 6 guards instead of 7. The most common incorrect answer which followed the correct number of hours open was 2 guards which was found by dividing 52 by 30. A large proportion of candidates did not attempt this question.

(d) Calculating the increased entry price was well answered by most candidates. A variety of methods were used with the most common correct method being to find 28% of $18 and then adding to find the increased price of $23.04. Some candidates then went on to round this exact value to the nearest whole dollar. A common error was just finding the increase and giving the answer of $5.04. Many less able candidates divided 18 by 28 and multiplied by 100 giving the common incorrect answer of $64.29.

Question 2

(a) (i) This part was well answered. Some candidates converted to a decimal or percentage, often truncating (66.6% or 0.666) but were not penalised if they had shown the correct fraction first. $\frac{4}{20}$ or $\frac{12}{20}$ were common incorrect answers as the candidates added the values on the spinner.

(ii) Most candidates found the correct probability. 6 was the most common incorrect answer. Ratio answers of 6:6 or 6 out of 6 were seen but rarely. A small number of candidates gave the answer as $\frac{6}{20}$ or $\frac{20}{20}$, following the same error as in **part (i)**.

(iii) Most candidates gave the correct answer of 0 or $\frac{0}{6}$ or 0%.

(b) (i) Most candidates could complete the table correctly. Some candidates did not read the question fully and did not add the scores on the spinners. These candidates often looked for patterns in the table.

(ii)(a) Many candidates found interpreting the table and extracting information from it challenging. A common error had candidates misinterpreting the table and using 24 possibilities instead of 16. Many less able candidates counted the correct number of 5's in the table but did not express their answer as a fraction.

(ii)(b) A similar number of candidates were able to find this probability as in the previous part. The common error was to include 5 when counting the number of values 'more than 5', giving the common incorrect answer of $\frac{14}{16}$.

(c) (i) Most candidates found the mode correctly as 1. Other candidates understood that they were looking for the highest frequency but gave the answer of 15 (the highest frequency) instead of the number on the spinner. Another common incorrect answer was 2, possibly being confused with the median; the mean was seen rarely here. Most candidates who chose to list all 50 outcomes got this question correct.

(ii) The most common incorrect answers were 3.5 (the middle value of 1 to 6), 8 (the middle value of the ordered frequencies) or 7 (the middle value of the unordered frequencies).

(iii) Finding the mean was challenging to many candidates. Candidates should be encouraged to make a common-sense check after finding their answer; any answer greater than 6 should lead candidates to check their working. However, $\frac{50}{6}$ = 8.33.. was the most common incorrect answer. The correct answer of 2.76 was seen often following full and correct working out. Candidates who found the correct total of 138 often divided by 6 or 21 (= 1 + 2 + 3 + 4 + 5 + 6) and not 50.

Question 3

(a) (i) Nearly all candidates showed understanding of factors and correctly identified 18. A common incorrect value given was 8.

(ii) Nearly as many candidates showed understanding of multiples and correctly identified 57. The common incorrect answer was 39.

(iii) Fewer candidates showed understanding of prime numbers. Common incorrect answers were 39, 51, 57 or prime numbers not in the list (e.g. 2, 3).

(b) Finding the reciprocal of 64 was challenging for many candidates. The correct fraction was the most common answer although the correct decimal was seen from some candidates. The most common errors were to square root or halve 64. Other incorrect answers seen were $\frac{64}{1}$, –64 and $\frac{-1}{64}$.

(c) (i) Some candidates found using standard form challenging. Common incorrect answers were 4800 and 0.0481.

(ii) Most of the candidates were able to write 75 000 in standard form. The most common incorrect answer seen was 75×10^3.

(iii) Candidates were generally more successful in this calculation as most were able to gain partial credit for an answer which contained a 9, e.g. 9×10^5, 9×10^{-2}, 90×10^3, 0.9×10^3, 90 000, 0.09, –0.09. Fewer candidates were able to change the correct value 90 000 to standard form.

(d) (i) Completing the Venn diagram challenged many candidates. More able candidates could place all 6 values in the correct positions in the Venn diagram with the most common errors involving the 2 and 32 which were often placed inside the circles or not included in the diagram. Another common error involved the number 64, writing it in both circles instead of the intersection. Some candidates included all square numbers to 100 and cube numbers to 125.

(ii) Only a minority of candidates correctly shaded the Venn diagram. The most common error was shading the intersection.

Question 4

(a) This part was attempted by all candidates with the majority gaining full or partial credit. Sign errors leading to $4a$ and $\pm 1b$ were seen frequently. Candidates were more likely to gain partial credit for $8a$ than $-7b$. A few did not simplify $8a + -7b$ or attempted to simplify the correct answer to $1ab$.

(b) The vast majority of candidates gained full credit. Occasional errors were seen, usually with $5 \times (-3)$. A small number of candidates changed their expansion into an equation and solved it, reaching $x = 3$.

(c) (i) Most candidates correctly solved the equation. The most common error was 6 from $\frac{18}{3}$ or, less often, $\frac{1}{6}$ from $\frac{3}{18}$, or 15 from 18 – 3.

(ii) This part was equally well answered as **part (i)**. Common errors in rearranging resulted in answers of 2 from $\frac{(18-8)}{5}$. Most candidates attempted to rearrange the equation by moving terms across the = sign although some solved the equation by substituting values until they found the value that satisfied the equation. Few gave an answer without any working.

(iii) Solving the more complex linear equation was more challenging, although many candidates were able to rearrange and solve correctly. The most common error was to add $4x$ to $12x$ instead of subtracting and so $16x = 24$ was a common incorrect rearranged equation.

(d) Many candidates were able to give the correct value of x. 8 was a common incorrect answer. Some candidates saw 6^2 on the right hand side and gave 36 as their answer. $x = 6^{-8}$ could not gain credit. Less able candidates divided 10 and 2, or wrote $10x = 2$.

(e) Solving the worded problem was the most challenging part of this question. Candidates who were able to use simultaneous equations to model this problem were more successful in finding the price of the tickets. For the candidates who knew what to do after they had set up their equations, elimination was the favoured method. This was not always done in the most efficient way however, so this made the numbers on the right hand side large, which sometimes led to errors. Candidates tended to keep the equations in the order that they were given in the question, so that when they subtracted, they ended up with both sides of their equation with one variable having negative terms, which often led to errors. Substitution was seen less frequently after equations had been written down but was usually successfully. Most candidates who did not recognise this as a simultaneous equations question were unable to solve the problem. However, many who attempted a trial and error method often gained partial credit by finding solutions that fitted one equation or family criteria, commonly making adult and child tickets the same price. Other candidates treated the two families separately and tried to solve them individually. Trial and improvement were evident but rarely resulted in fully correct answers. Another common error was to treat both variables as a in the first equation giving $8a = 124$, $a = 15.5$ and both variables in the second as c giving $8c = 100$, $c = 12.5$.

Question 5

(a) Many candidates found writing the number in figures challenging, although a majority of candidates gave the correct answer. Several candidates made errors in the position and number of zeros, e.g 12 020, 1 002 020 or 120 000.

(b) Nearly all candidates demonstrated good use of their calculators to reach the correct answer. Occasional errors tended to be caused by misreading their calculator display.

(c) (i) Nearly all candidates were able to write the fraction of the rectangle that was shaded. Few incorrect answers were seen but these included $\frac{3}{8}$, $\frac{3}{5}$ or the correct fraction written as a percentage.

(ii) Not as many candidates found the percentage of the rectangle that is not shaded. Common errors were to find the percentage shaded or write the correct answer but as a fraction not a percentage.

(d) Candidates that converted all numbers into decimals were more successful. Most candidates gained at least partial credit by having 3 numbers in the correct order or converting 3 numbers to decimals. The most common error was in converting either $\frac{5}{17}$ or $\frac{7}{29}$ into decimals.

(e) Most candidates rounded correctly. Common incorrect answers included 0.3, 3.7, 372.8 or 3.728.

(f) Most candidates were able to use their calculator or knew that any number to the power of zero is equal to 1. The common incorrect answers given were 0 and 19.

(g) Most candidates were able to gain at least partial credit for one correct value (often 127.5) or correct values but reversed. Some candidates misunderstood the degree of accuracy required and wrote 127.95, 128.05 or 127,129. 128.4 was seen occasionally instead of 128.5.

(h) Successful solutions often included factor trees or tables to identify the prime factors. Candidates were able to gain partial credit for a correct pair of factor trees or tables although combining the correct prime factors to find the HCF was more challenging. Often candidates found the LCM. A significant number, following correct factor trees or tables, gave a common factor (2,3,6 or 9) but not the highest common factor.

(i) Finding an irrational number with a value between 6 and 7 proved to be challenging. Very few irrational numbers were seen and many of them were not between 6 and 7 (e.g. π). The only correct answers seen were the square root of a number between 36 and 49 or 2π. The vast majority of candidates who attempted this question gave a decimal value between 6 and 7.

Question 6

(a) Providing the candidates with one face of the net meant that very few candidates drew a 3-D drawing of the triangular prism. Most candidates showed they understood that the net needed two more rectangular faces and two triangular faces although getting the correct dimensions was challenging to many candidates. Many drew the remaining two rectangles as both 4 cm by 6 cm. Few worked out the length of the hypotenuse, but got it correct on the drawing of the triangular faces as they usually drew the other two sides as 3 cm and 4 cm. Several triangles were seen with a base and height of 4 cm. Several candidates did not attempt it at all, possibly not knowing what is meant by net.

(b) Working out the surface area of the prism was more challenging than the previous part with few fully correct solutions seen. The most successful solutions were organised with words or diagrams and calculations to clearly show the area of each face added together. Many calculations were clearly volume calculations whilst others found the surface area of a cuboid with similar dimensions to the given prism. Finding the width of the sloping edge was not obvious to many. Of the candidates who did not gain full credit, many managed to score at least partial credit by finding a correct rectangle area or a correct triangle.

(c) Working out the volume of the prism proved to be challenging also. The best solutions included the use of a formula. The most common error was to work out $3 \times 4 \times 6$ and not divide by 2. A significant number of less able candidates did not attempt this question.

Question 7

(a) Successful candidates used the angle properties of an isosceles triangle and angles on a straight line to correctly find the size of the angle. Good solutions showed each step of the calculations. Many candidates gave partial solutions by subtracting and giving an answer of 62 but did not then go on to complete the solution. Several candidates started correctly finding 62 but then divided this by 2 and marked the bottom two angles of the isosceles triangle as 31. Less able candidates often started with subtracting from 360° or using 360 as the total of the angles in a triangle.

(b) Many candidates gained partial credit for correctly finding the value of x as 31 using alternate angles. However, few candidates were then able to find the value of y to be 121. The most common incorrect answers were 149 (= 180 – 31) or 59 (= 90 – 31).

(c) Good solutions to this circle problems question recognised that the angle in a semi-circle is 90°. Candidates who knew this often went on to gain full credit. Most errors came from not knowing that the angle at *B* was 90°, e.g. treating the triangle as isosceles (180 – 53 – 53 = 74 or *a* = 53) or ignoring the angle at *B* (180 – 53 = 127).

(d) Candidates found this 'show that' question challenging. A large proportion of candidates used the fact that the three angles added up to 360° to calculate the interior angle of the octagon i.e. 360 – 90 = 270 and 270 ÷ 2 = 135 to then show that the 3 angles added up to 360°, therefore giving a circular argument. Calculating the size of an interior angle of a regular octagon proved to be the most challenging part of this question. Successful solutions showed each step of the calculations. A common error was not knowing how many sides an octagon has (6 and 10 the common incorrect number of sides used). Equally common was 360 ÷ 8 = 45 only. A significant number of candidates did not attempt this question

Question 8

(a) (i) Good answers contained all three parts to describe a rotation, including degrees and direction and centre of rotation. The most common error was to omit the centre of rotation. When the centre of rotation was attempted it was often correct although several candidates wrote it as a vector instead of a co-ordinate. Few candidates described two transformations; a rotation followed by a translation which could gain no credit.

(ii) The description of the translation was found the most challenging of all the transformations in this part. Common errors were writing the vector as a co-ordinate or reversing the signs.

(iii) Most candidates understood that it was an enlargement, but the centre of enlargement was often not given. However candidates who drew lines connecting vertices of the two shapes often were able to give the correct centre of enlargement. The scale factor was more often given than the centre of enlargement.

(b) Many candidates did not attempt this drawing of a reflection. However, of those that did attempt it, most were able to gain full or partial credit. The most common error was to reflect in the line $x = -1.5$. Other errors seen were reflections in the line $y = -2$ or $x = 2$. Candidates who drew a mirror line were more successful at drawing the reflected image.

Question 9

(a) Completing the table was the most successful part of this question and most candidates gained full credit. The few errors seen were generally for omitting minus signs for x = –5, –3 or –2.

(b) Candidates generally drew smooth reciprocal curves. Very few straight lines joining points were seen and even fewer thick or feathered curves drawn. Few candidates joined the points (–1, –15) and (1, 15). Plotting points proved challenging due to the scale on the *y*-axis.

(c) A large proportion of candidates did not attempt this question. The most common error was drawing a diagonal line through (0, 6).

(d) A significant proportion of candidates did not attempt this part. The most common incorrect answers were 90 (15 x 6) or incorrect reading from their graph. The follow through was only available if their line for $y = 6$ had been drawn horizontal.

Question 10

(a) (i) All candidates attempted this question and nearly all candidates were able to write down the next term of the sequence.

(ii) Candidates found writing the term to term rule more challenging. Correct answers had many formats, +7, add 7, increase by 7, etc. Common attempts which did not gain credit were $n + 7$ and 7 without a description of increasing.

(iii) Finding the *n*th term was the most challenging part of this sequences question. The correct answer was seen frequently but often candidates repeated their attempt for the term to term rule or did not attempt the question. Many candidates attempted to use the formula to find the *n*th term and when quoted correctly this often led to the correct answer.

(b) (i) Finding the next term of the quadratic sequence was more challenging than the linear sequence in **part (a)**. However, it was well answered with the majority of candidates finding the correct next term. Often candidates found it useful to write down the first difference and sometimes the second difference.

(ii) Finding the next term of this sequence was not as well answered as the previous part. Despite working out differences many did not find the correct term. The most common incorrect answers were 64 (by adding the latest first difference (16) to 48), 50 by starting the first differences back at 2, and 32 by continuing the sequence of first differences.

(c) A significant number of candidates did not attempt this question. Successful solutions showed clear working out, full substitution of $n = 1$, 2 and 3 in 3 separate sums. Common incorrect answers were 6, 9, 14 (using $n^2 + 5$); 6, 18, 42 (using $(n^2 + 5)n$) and 6, 11, 16 ($1 + 5n$).

MATHEMATICS

Paper 0980/41
Paper 41 (Extended)

Key messages

To achieve well in this paper, candidates need to be familiar with all aspects of the extended syllabus.

The recall and application of formulae and mathematical facts in varying situations is required as well as the ability to interpret situations mathematically and apply problem solving skills to unstructured questions.

Candidate's work should be clearly and concisely expressed with answers written to an appropriate degree of accuracy. Candidates should work with more than 3 significant figures in their intermediate working. Accuracy marks may be lost if answers are not given correct to at least three significant figures.

Candidates should show full working within their answers to ensure that method marks are considered where final answers are incorrect. Candidates should write down any intermediate step that they may have done with a calculator.

Candidates should avoid writing in pencil and then overwriting in pen as solutions can become illegible.

Candidates should take sufficient care to ensure that their digits from 0 to 9 can be distinguished.

Candidates should ensure that their calculator is set in degrees.

General comments

Many candidates demonstrated their understanding of a wide range of mathematical concepts.

The majority of candidates indicated their methods clearly but some candidates only gave their answers, with no working, and subsequently could not gain partial marks.

Candidates should continue to take care to correctly read numbers and algebraic expressions given in the question paper. Candidates should not reduce the number of significant figures at the start of a question.

If work is replaced it is better for candidates to make a fresh start rather than attempting to overwrite figures and expressions.

Candidates should not expect the Examiner to select the correct method if presented with a choice of methods by the candidate.

In the 'show' questions the best solutions had a step by step style with just one equals symbol per horizontal line. The algebraic question on this paper required careful squaring of a bracket.

Candidates seemed to have sufficient time to access all questions, although some did struggle with the difficulty of the last question.

Most candidates followed the rubric instructions with respect to the values for π although a few used $\frac{22}{7}$ or 3.14, which may give final answers outside the range required.

It is important that candidates show the fractions used in a probability product as a final simplified value may not indicate a correct partial method.

The topics that proved to be accessible were: drawing and describing transformations, simple ratio and proportion, percentage reduction, calculation of the mean from grouped data, reading from a cumulative frequency diagram, use of trigonometric formulae, gradient of a tangent, simplification of routine algebra, using the quadratic equation formula.

More challenging topics included: calculation of a time difference with a change of time zone, interpretation of a box-and-whisker plot, given a frequency calculate the height of a histogram, finding the interception points of a line and a quadratic curve algebraically, working with bearings, simplification of the product of three brackets, squaring a bracket with a fraction, factorising a quadratic equation where the coefficient of x^2 is not 1, finding probabilities of two events, finding the equation of a tangent at a point when given an expression for the gradient, working with and sketching the tangent function.

Comments on specific questions

Question 1

Overall, this was a very accessible first question, with most candidates scoring high marks.

(a) Most candidates drew a correct translation. Those who did not score full marks usually scored one mark for one component being correct.

(b) Most candidates scored full marks with a correct reflection. A few reflected in one of the lines, $x = -1$, $y = 1$ or $y = 0$. A small number of candidates reflected the image of part **(a).**

In **parts (c)** and **(d),** almost all candidates gave single transformations but when a combination of transformations was seen the extra transformation was a translation. When the candidate gives an extra transformation no marks can be awarded for the question part.

(c) Almost all candidates correctly stated that the transformation was an enlargement and many gave the correct factor of 3. A few gave a factor of $\frac{1}{3}$. It is also important for candidates to know that ratio forms of the factor are not accepted. The centre of this enlargement proved to be more challenging and many candidates gave incorrect coordinates or omitted this property of the enlargement.

(d) Almost all candidates correctly stated that the transformation was a rotation and most gave the correct angle. A few omitted the fact that it was clockwise. As in **part (c)** the centre proved to be more challenging, again with a number of omissions or the answer (0, 0). The vocabulary of the syllabus is expected so ‘turn’ is not allowed as an alternative to rotation.

Question 2

(a) Most candidates found this ratio question very accessible. The correct answer was usually stated without any interim working. It is expected that a simplified ratio should contain integer parts. Occasionally candidates did not fully simplify the ratio or gave fractions within their ratio.

(b) (i) The majority of candidates used $\frac{114}{6}$ to achieve the correct answers. The most common error seen was to divide 114 by the total number of parts, 25.

(ii) This percentage reduction question was usually answered correctly. Candidates who calculated 96.90 as a percentage of 114 first sometimes forgot to then subtract from 100 per cent. The majority of candidates used the correct denominator of 114 but some weaker candidates used 96.90.

(c) (i) Many candidates achieved only partial success in this question part. Incorrect answers of 1h 50 m, 3 h 50 m and just 50 m were common indicating that candidates misunderstood or disregarded the time difference.

(ii) Almost all candidates understood that the required calculation was 1802 divided by time. Some candidates made no attempt to convert their time to hours or lost accuracy by prematurely rounding their time to 2.8 or 2.83. Others used 2.5. Candidates that showed their working were able to achieve partial marks for correctly recalling, and substituting values into, the formula *speed = distance ÷ time*.

Question 3

(a) This proved to be a discriminating question as, in each part, a reason was required to support a decision.

The challenges were to state clearly which property of the box-and-whisker plots were being used and to also to make a comparison and not simply state values.

Median was required for the first statement and either range or inter-quartile range was needed for the second statement. The comparison required more than just statements of values and the use of 'greater than' or 'smaller than' were the most appropriate phrases to use. Phrases such as 'the boys median is 84 *while* the girls is 102' is not sufficient as no comparison of their relative sizes is given. Inclusion of an irrelevant statement even if accompanied by a correct statement is not acceptable. For example, for the first part, 'Disagree because the median for women is greater and the range is bigger' does not demonstrate an understanding that it is the median that allows for a comparison of the amount of time spent exercising, not the range.

(b) (i) This was a well answered question. Candidates seem to be very well prepared in this calculation of a mean, using mid-interval values.

There was the occasional slip, especially with mid-interval values but usually sufficient working was shown to allow for the award of part marks as appropriate. Some candidates used upper boundaries of the intervals. Some candidates used interval widths instead of mid values which scores no marks.

(ii)(a) Almost all candidates correctly found the 60th percentile from the cumulative frequency curve. Incorrect answers usually came from misreading the scale on the horizontal axis.

(b) Most candidates were also able to read from the time axis onto the cumulative frequency axis. A number of these candidates gave the value, 92, on the cumulative frequency axis instead of subtracting it from 100.

(iii) This was a very challenging question and only the stronger candidates were able to deal with the heights of bars on a histogram with unequal intervals. Few candidates were able to recall *frequency density = frequency ÷ group width* and that height is proportional to the frequency density. Many attempts did not involve frequency density leading to common wrong answers of 3.6 when the ratio of the frequencies and height were used but group widths ignored, and 16.2 when the ratio of group widths and height were used but frequencies ignored. A large number of candidates omitted the question.

Question 4

(a) There were mixed responses to this upper bound question.

The errors seen were adding 0.5 instead of 0.05 to the two given values, finding the area instead of the perimeter and calculating the perimeter using the given values then finding the upper bound of this answer.

(b) (i) This was a straightforward right angled triangle calculation and most candidates succeeded in finding the height of the trapezium. The sine rule and cosine rule were seen and usually correctly applied. Quite a large number of candidates gave this height to only two significant figures, writing 9 sin 80 = 8.9, losing the accuracy mark.

(ii) This explanation question proved to be challenging and many candidates appeared to be unsure of how to show that the triangle was isosceles.

The question required a clear calculation of one of the angles of the triangle or an explanation of how the particular value could be calculated. There was also the requirement to conclude that the triangle was isosceles because two angles were equal.

The more able candidates were able to do this articulately, for example:

Angle CDF = 100 because angles on a straight line add to 180. Angle DCF = 40 because angles in a triangle add to 180. Angle DCF = angle DFC so triangle CDF is isosceles.

The main errors seen were to assume the triangle to be isosceles and state this as the reason for the two angles being equal or to simply state that two angles were equal with no calculation or explanation as to why.

(iii) The area of the trapezium proved to be more challenging than anticipated with many candidates finding the area of trapezium ACDF instead of ABCF. Another quite common error was to use the length of a side of the trapezium instead of the height. The most successful method was to use the formula for the area of a trapezium and the other method seen was the subtraction of the area of a triangle from the area of a parallelogram. Premature rounding of the height 8.86 lead to inaccurate answers.

(c) This was a challenging multi-step question involving angle properties of a circle, right-angled triangle trigonometry and the area of a circle.

Most candidates correctly used angles in the same segment to find angle ACD. Many then recognised the angle in a semicircle to set up the correct trigonometry for a right-angled triangle. The candidates who reached this stage were usually able to divide the calculated diameter by two and then find the area of the circle. There were many final answers out of the accuracy range as a result of using only three significant figures in the working.

One error seen was placing the right angle at *A* instead of *D*. Another was to treat angle *BDC* as 21˚ and use an incorrect isosceles triangle.

Some candidates successfully used the isosceles triangle *COD* instead of the right-angled triangle.

(d) This was another problem solving question**.** Candidates had to equate the perimeter of a sector to the perimeter of a square and there were many good solutions.

A large number of candidates omitted the two radii from the perimeter of the sector and only earned one mark for the length of an arc.

The other error often seen was to equate areas instead of perimeters.

Question 5

(a) (i) Usually correct with values from 2.7 to 2.8 being given. The notation f(*x*) = 14 appeared to be unfamiliar to some candidates.

(ii) The majority of candidates drew a good tangent but some problems in the calculation for the gradient came from not using the correct scale on the y axis and not being able to read off the negative scale on the x axis. It is pleasing to note that the tangents drawn were invariably clear, in the right location and suitable for reading off values. Candidates are generally choosing convenient values for the purpose of reading values and subsequent calculation.

(iii) The drawing of the line was usually well done. Those who failed to get full marks either drew an inaccurate line, mis-read the scale at the intersection of the line and curve or gave a positive value such as 2.85. It is important that candidates check the accuracy of their line, particularly at the extremes. Using the line to solve the given equation proved to be more difficult with many blank responses.

(b) This question proved to be a challenge. Though many fully correct solutions were seen there were also many left blank. The best solutions began by equating $2x^2 - 2x - 7$ to $3x + 5$, rearranging and then showing a factorisation or application of the quadratic formula to find the values of *x*. Most candidates were then able to find the relevant values of y. Partial marks can only be awarded if clear working is shown and candidates should be warned against doing too much on their calculator without providing evidence of their method. Some candidates began by equating the expressions but then did not recognise how to proceed to solve the resulting quadratic equation in this unfamiliar context. The most common errors were either 'differentiating' the given quadratic and then going on to the find the minimum point or attempting to find the roots of the original quadratic. A minority of candidates did not immediately equate the two expressions but rearranged x in terms of y and then substituted this into the quadratic with little success. Some candidates calculated tables of values of x and y and were occasionally able to find the value at (4, 17) but the expected algebraic approach was the only approach that lead to finding both intersection points.

Question 6

(a) (i) The most successful solutions here began with the explicit form of the cosine rule. Many candidates showed correct substitutions into the formula but did not then appreciate that to *show* that angle CBD rounds to 106.0 it was essential to state the more accurate value of between 106.01 and 106.02. Candidates that jumped from the explicit cosine rule straight to the answer 106.0 were only able to gain the 2 method marks since the accurate value of the cosine was also omitted. Some candidates began with the implicit form of the cosine rule and while some successfully progressed to the correct explicit form others made sign errors when re-arranging or did not apply order of operations correctly and stated instead $287.9^2 = 576 \cos CBD$. Weaker candidates omitted this question part completely or used the value 106 in a calculation involving the sine rule or cosine rule and produced a circular argument. Using a given value that you should be 'showing' earns no credit.

(ii) There was a very mixed response to this bearings question. Common errors included 360 – 38 = 322, 360 – 106 = 254 and 106 – 38 = 068

(iii) This question again demonstrated that many candidates are not confident with bearings. Many good candidates used the sine rule correctly to find angle A = 40.0 and while some went on to find the bearing correctly. Others stopped here or continued to 90 – 40 = 50, 180 + 40 = 220 or 360 – 40 – 50 = 270, indicating a lack of understanding of the concept of bearings. Some candidates assumed that triangle BAD was right-angled at angle D and used SOHCAHTOA to calculate angle A. Weaker candidates made no attempt at trigonometry and instead showed additions and subtractions of various angles, or just gave an answer with no working. Others left this question part blank.

(b) (i) Many correct answers were seen here from candidates using 0.5 × 192 × 168 × sin106. Occasionally candidates made incorrect pairings of sides and angles, for example, 0.5 × 192 × 287.9 × sin 106. Candidates that used Hero's formula sometimes lost accuracy due to premature rounding as did candidates who chose to calculate and use angle DCB or angle CDB instead of 106. Weaker candidates used the area of a right – angled triangle and calculated 0.5 × b × h.

(ii) Many candidates correctly calculated 3.575 × their **bi)** and rounded to the nearest $100 as required. Some candidates did not round their answer at all or rounded incorrectly. Others began by dividing their area by 10,000 but then prematurely rounded this value before multiplying by 35750.

Question 7

(a) The completion of terms in the table for three sequences was almost always correctly carried out. There were a few mistakes with the triangular number sequence and some candidates did not see the last row as the sum of the previous two and instead attempted to use the difference between the terms.

(b) Most candidates recognised the square numbers but a significant number used the method of differences, not always with success. Candidates need to realise that the number of marks awarded for each question is an indication of the amount of work required.

(c) (i) The substitution into a quadratic expression was usually successfully answered.

(ii) This part involved finding the *n*th term, which was a quadratic expression.

The most efficient method was to subtract the answer to **part (b)** from the given formula in **part (c)(i).** This method was rarely seen as most candidates did not see this connection. Instead candidates seemed to be experienced in finding *n*th terms of this type of sequence, with approaches such as looking at n^2, $\frac{n^2}{2}$, $n(n-1)$ or using the method of differences.

(d) This was a very challenging final part to this question with many candidates omitting the whole question and many others not fully understanding the given information. Candidates did not take on board the significance of 'all' in the question being in bold. The very common misunderstanding was to use the total number of dots in the *n*th diagram and not the total number of dots in all of the first *n* diagrams.

The candidates who used the given formula correctly showed good algebra in solving their correct simultaneous equations and gained the full five marks. There were a few more attempts at the method of differences but often with the wrong sequence of values. A large number of candidates attempted to compare the quadratic formula in **part (c)(i)** with the cubic expression in this part. There were also some candidates who found one equation in terms of *a* and *b* and then attempted to rearrange in some way to find the values of *a* and *b* without a second equation. There were also some attempts at rearranging the given formula.

Question 8

(a) A very well answered part with most candidates able to write down the correct factorisation.

(b) Many fully correct inequalities were seen here but it was also common for candidates to just write the numerical answer or to use an equality. Many candidates kept both sides positive by collecting the constants on the left hand side and the *x* terms on the right but candidates who allowed the terms to become negative often ended up with the wrong inequality.

(c) Many candidates coped well with simplifying this expression involving indices. The most common error was in the numerical term with some candidates doing nothing with the 3 or writing 9 for 3^3 instead of 27. When errors were seen in the powers of *x* and *y* it was as a result of candidates adding 3 to the powers instead of multiplying, or occasionally cubing the powers to get x^8y^{64}.

(d) Many correct solutions were seen from candidates who began by cross multiplying. A significant number also correctly reached $4 = 8x$ but then concluded that $x = 2$. Some errors were seen in the expansion of $2(2-x)$ either to $4-x$ or to $4-4x$. Having reached $4-2x = 6x$ some candidates were unable to deal with the negative x term correctly and instead progressed to $4 = 4x$.

(e) This expansion of three linear brackets proved to be a challenge for many candidates. Good candidates understood the process of expanding the brackets, clearly multiplying a pair first and then multiplying by the third, but one or more sign errors or numerical slips in their expansions or in collecting like terms was common. A common error made by weaker candidates was to multiply the first two brackets and then add to the product of the second and third brackets to get a string of terms none of which were cubic.

(f) (i) Many candidates were familiar with compound interest and were able to convert the information in the question to the equation $206.46 = 200(1+\frac{r}{100})^2$ but the common error was then to solve this equation. Of those that recognised the need to expand the bracket only a minority were able to complete this process correctly. The result was often only two squared terms or failing to square the fraction term correctly. Some candidates began by putting the 200 inside the bracket and then attempting to square.

(ii) Candidates who approached this by using the quadratic formula usually showed their working, had good recall of the formula and gained the first two marks. It was however common to overlook the requirement for an answer to 2 decimal places and r = 1.6 was a common answer that did not gain the final mark. Some candidates chose instead to begin with the equation $206.46 = 200(1+\frac{r}{100})^2$. It was necessary to show all steps clearly to gain full marks. Candidates that progressed from $\sqrt{\frac{206.46}{200}}$ straight to r = 1.6 without showing intermediate steps were only able to gain one of the three marks available. A significant number of candidates left this question part blank even if they had solved the equation in **part (i).**

Question 9

(a) (i) This was answered well with many candidates scoring 2 marks. Some candidates could not find the value for the intersection but knew that the totals must be 15 and 18 respectively, for example 12, 3, 15 was often seen with 5 also correctly placed. Weaker candidates wrote 15 and 18 with the intersection left blank.

(ii) The majority of candidates correctly used the value of Spanish only out of the total number of candidates. A common error seen was when candidates did not take into account the 5 candidates who studied neither language resulting in a denominator of 27.

(iii) This proved to be more difficult for candidates with the main error of using 32 candidates rather than just the 15 who study German.

(b) This question part was very well answered with the majority of candidates using the concise calculation of $\left(\frac{54}{36}\right)$ x 64 , recognising that 54 represented 36 per cent of the total and that 64 per cent of the total was required. A small proportion of candidates correctly found the total number of marbles as 150 and gave this as their final answer. A common error was to find 36 per cent of 54 which resulted in a non-integer value.

(c) (i) In general with **parts (c)** and **(d)** candidates had some difficulty with combined probability and deciding if the probabilities are replaced or not. It is important that candidates show the fractions used in a probability product as a final simplified value may not indicate a correct partial method. The most common incorrect answers were from $\frac{15}{25}\times\frac{14}{24}$ where candidates ignored the replacement and $\frac{15}{25}+\frac{15}{25}$.

(ii) Most candidates realised they had to subtract the previous answer away from 1 and as such were nearly always successful. Some candidates failed to make the link with **part (i)** and tried working out all the required combinations with much less success.

(d) The majority of correct solutions worked through all the possible options. Some did see the ease of evaluating the probability of 1 – 'no red pencils '. Many candidates following the evaluating outcomes approach missed at least one outcome. The most common incorrect responses were $\frac{3}{5}$ which came as a result of only calculating RR, RY, RG (three of the five combinations forgetting YR and GR); and $\frac{1}{2}$ which was the result of RY,YR,RG,GR – forgetting RR. This question part emphasises the need to show working as simply stating a probability such as $\frac{1}{2}$ is not sufficient evidence for a correct multiplication of two probabilities involving denominators of 25 and 24 with different numerators. Most candidates understood the concept of 'no replacement' but instances of denominators not reducing were seen.

Some weaker candidates did not understand the importance of only picking two pencils and instead worked with triple products. There was minimal evidence of candidates using tree diagrams to help solve this question part.

Question 10

(a) (i) Many good candidates were able to find all three co-ordinates but occasionally muddled the order when writing in the answer space. Candidates must remember to refer to the diagram and also to show working out so that credit for correct method can be given. Weaker candidates often left this question part blank and others attempted to find the minimum point using differentiation.

(ii) Many candidates successfully differentiated the expression. Some spoilt their answer by equating to 0. Some candidates did not understand the word 'differentiate' and instead factorised the expression or left this part blank. This was evidenced by some very good candidates omitting this part but then completing **part (iii)** correctly using the notation $\frac{dy}{dx}$.

(iii) This part was challenging for most candidates as they were not able to link this part to the previous part. Many of those who had successfully differentiated in **part (ii)** were unaware that it would help here. Only the most able candidates were able to find the gradient and then the equation of the tangent successfully. The most common wrong approach was to try to find the gradient by using (2, 6) with another point on the curve or simply using (2, 6) directly to give a gradient of 3. This was typically followed by an attempt to substitute (2, 6) into their incorrect equation. Another error seen was to solve $2x + 3 = 0$ showing some confusion over the applications of differentiation.

(b) (i) There were a small minority of excellent sketches showing clear asymptotes and curvature. It is evident that many candidates were familiar with the shape of the sine function but less so the tangent. In some cases otherwise correct diagrams stopped at clearly fixed points, or had large gaps near 180 and 360.

(ii) This was a demanding question part but some candidates clearly had a very detailed understanding of how to solve trigonometric equations between 0 and 360. These candidates understood in which quadrants their solutions must lie and then correctly interpreted their calculator answer. Others managed to get –54.5 as a solution but could not then use it to get two solutions in the required range. This question provided a clear example of candidates who could have gained partial marks by working with values of greater than 3 significant figures in their intermediate working. Truncating –54.46 to –54.4 was common.