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General Certificate of Education

Mathematics 6360

Examiners' Report

2005 examination – June series

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MPC1 Pure Core 1

General

The general performance on this paper was very pleasing and suggested that most candidates had been well prepared for the examination. Basic coordinate geometry, solving quadratic equations, differentiation and integration seemed to be well understood. It was, however, disappointing to see such a plethora of elementary arithmetic and algebraic errors. Poor algebraic manipulation was a major reason for loss of marks. Some candidates clearly did not understand the meaning of the "Remainder Theorem" or the "Factor Theorem" and approached each of these by long division. They need to realise that when a particular method is stipulated in the question, any other approach is unacceptable. The conditions for "equal roots" and "no real roots" did not seem to be widely understood and candidates need to realise that the use of a discriminant is only appropriate for quadratic equations and not cubics.

Question 1

This was a straightforward question on coordinate geometry intended to get the candidates off to a confident start and many scored full marks. However many made very fundamental errors.

Part (a) Instead of finding the arithmetic mean of the pair of x-coordinates and the pair of y-coordinates, many candidates found the difference of the coordinates before dividing by 2 . A few were able to deduce the coordinates of the mid-point from a diagram and some used the half line vector approach successfully.

Part (b) There were many correct answers but a small number were incorrect and some candidates wrote $\sqrt{52} = 4\sqrt{13}$. Notational errors such as $36+16 = \sqrt{52}$ were seen and will not always be condoned. It was surprising how many candidates made no attempt at the distance formula.

Part (c)(i) Although the majority of answers were correct, an alarming number of candidates could not simplify $\frac{-6}{-4}$ correctly. It was also very disappointing to see many using $\frac{\text{difference in } x \text{ values}}{\text{difference in } y \text{ values}}$ in order to find the gradient of a line.

Part (c)(ii) Candidates were expected to use their gradient to determine the equation of the line and many had a complete proof. It was not expected that so many would use the equation $y = mx + c$ at this stage. Many fudged their work to get the printed answer. Some imagined that it was sufficient simply to show the required line had the same gradient as they had evaluated in part (c)(i) or to show that **one** of the points satisfied the given equation. Neither of these on their own scored any marks. Verifying two of the facts was given some credit.

Part (d) Although the majority of candidates found the point of intersection, there were many algebraic and sign errors in the attempts seen – adding equations after equalising coefficients being the most common. Many students did not recognise what was required and made no attempt at it.

Question 2

The variation between candidates was immense. Some did not appear to have covered this topic in any depth.

Part (a) About two thirds of the candidates found the correct values of p and q but it was alarming to see $(x-3)^2 - 9 + 16$ become $(x-3)^2 + 5$ or $(x-3)^2 + 25$ on so many occasions.

Part (b)(i) Only the confident candidates wrote down (3,7) for the vertex with no further working. Many used differentiation and found the correct coordinates, but others simply wrote either 3 or 7 as their answer. Quite a few felt that the minimum point was (–3,7). Common wrong answers from erroneous thinking were (3,0) , (7,0) , (0,16) or (7,16).

Part (b)(ii) Almost everyone drew a parabola though a few failed to sketch beyond the minimum point; a few graphs had a maximum point and a few cubic graphs were seen. However the positioning of the quadratic graph was crucial and often bore no connection to their vertex or the correct curve. To gain full marks the parabola had to be correct with the *y* intercept value of 16 clearly indicated.

Part (b)(iii) Correct curves were generally followed by correct equations for the line of symmetry, but a few gave their answer as $y = 3$. A significant number made no attempt at this part of the question.

Part (c) Full marks here could only be obtained by using the correct term **'translation'.** Using words such as 'shift' , 'move' or 'transformation' were not good enough for full marks. The best candidates used a vector, but correct descriptions of how many units the curve had been translated in appropriated directions were of course credited. However, many included a second transformation such as a stretch and this negated the first mark. Many candidates had incorrect vectors such as $\begin{bmatrix} -3 \\ -7 \end{bmatrix}$, or $\begin{bmatrix} 7 \\ 3 \end{bmatrix}$, or most commonly $\begin{bmatrix} 6 \\ 16 \end{bmatrix}$.

Question 3

Part (a) The equation of a circle seemed widely known, although some candidates wrote things such as $C = 2\pi r$. Sign errors were common and some forgot to square the radius or wrote $\sqrt{5}$ on the right hand side of the equation.

Part (b) Most candidates realised that the easiest way to verify that the point P lies on the circle was to substitute x = 6 and y = 2 into the left hand side of the equation and to show this was equal to 25, the same as the right hand side. Other ingenious methods were used in addition to verifying that PC was equal to 5.

Part (c) The same errors relating to part (c)(i) of question 1 were repeated here. Most candidates, however, were successful in finding the correct gradient of CP.

Part (d)(i) The relationship that the product of the gradients is –1 seems well known but a number of arithmetic slips occurred when finding the gradient of the perpendicular line.

Part (d)(ii) Several ignored the hint of part (d)(i) and many failed to realise that the tangent was a line passing through P(6,2). It was not necessary to simplify a correct form of the equation in order to score full marks. Those who used $y = mx + c$ usually fared badly here, because they rarely obtained a correct form of the equation.

Question 4

This question was answered very well by many candidates, and evidently the basic processes of differentiation and integration had been well rehearsed.

Part (a)(i) Most candidates substituted $x = 3$ into the given cubic equation and found p(x) to be zero. Some, however, lost a mark as they did not indicate that p (3) = 0 implied that x–3 was a factor.

Part (a)(ii) The coordinates (3,0) were often seen but some forgot to give the y coordinate.

Part (b)(i) Almost all candidates differentiated correctly, which was pleasing.

Part (b)(ii) Most candidates realised the need to equate $\frac{dy}{dx}$ to zero. However not all were able to solve the resulting equation. Some of those who did solve the quadratic offered both solutions, 1 **and** $\frac{7}{3}$. Many found the second derivative in order to ascertain which point was the minimum point M. This was unnecessary as the coordinates of A (1,0) were clear from the diagram.

Part (c) The second derivative was almost always found correctly followed by the substitution of $x = 1$.

Part (d)(i) The integration was carried out very well. Occasionally $\frac{3x^4}{4}$ was seen but this was rare.

Part (d)(ii) Most candidates used the correct limits of 0 and 1. However many arithmetic errors occurred when trying to combine the fractions so that the correct value of the integral $-\frac{11}{12}$ was not seen very often. Of those who did integrate correctly, many still lost the last mark for not stating that the area of the shaded region was $\frac{11}{12}$ and the negative value of the integral arose because the region was below the x-axis. It was not acceptable to simply write Area = $-\frac{11}{12} = \frac{11}{12}$.

Question 5

Part (a) The most common error was to multiply √3 by √3 to get 9 instead of 3.

Part (b) Of those candidates who multiplied both numerator and denominator by the correct expression, only about half simplified correctly and 2 + 2√3 was a common incorrect answer. Many of the rest multiplied by √3–1 instead, which led nowhere.

Question 6

Part (a) Practically everyone made a reasonable attempt to multiply out the brackets but the minus signs caused problems for the weaker candidates, particularly when trying to combine like terms.

Part (b) Many seemed unaware of the "Remainder Theorem" and tried to find the remainder by long division.

Part (c) Usually candidates were able to find the single real root 2. It was expected that candidates would have found the discriminant of the quadratic and, since this was negative, conclude that the quadratic equation had no real roots. All too often, candidates tried to find "$b^2 - 4ac$" for the cubic $x^3 - x^2 + x - 6$.

Question 7

Part (a) It was quite disappointing to see the type of errors being made in this question. In trying to simplify the right hand side, $3 - 5(x+6)$, many thought it was equal to $-2(x+6)$; others wrote it as $3 - 5x + 30$ or $3 - 5x + 6$. Even after obtaining $8x > -24$, it was not unusual to see the final answer as $x < -3$.

Part (b) The majority of candidates were able to factorise the quadratic or use the formula to find the two critical points. It was expected that some method such as a sketch graph or sign diagram would have been used in order to obtain the final solution. Many wrongly asserted that $x < 3$, $x < -2$ and this scored no method marks for the inequality. Clearly some candidates were able to write down the correct solution after simply factorising the quadratic and scored full marks.

Question 8

Part (a) Many candidates wrote the statement $mx - 1 = x^2 - 5x + 3$ followed by the printed answer. An intermediate step such as $x^2 - 5x - mx + 4 = 0$ was expected since the result was a printed answer

Part (b) Very few correct solutions were seen to this part of the question. The condition for equal roots was not clearly understood by many and all sorts of algebraic errors occurred when trying to square $-(5+m)$. A very common mistake after incorrect squaring was to write $25 + m^2 = 16$ and then final answers of ± 3 were given for m. An alternative approach was often successful. This involved a realisation that the quadratic must be $(x + 2)^2$ or $(x - 2)^2$ and hence the two possible values of m could be found.

Part (c) It was very rare to see a correct description of the line being a tangent to the curve. This might be a very useful question for future candidates to practice in order to understand the geometrical situations and algebraic relationships when a line intersects, does not intersect or is tangential to a given parabola.

MPC2 Pure Core 2

General

Presentation of work was generally good and most candidates completed their solution to a question at a first attempt with relatively few scripts containing attempts at parts of the same question at different stages in the answer booklet.

The vast majority of candidates appeared to have sufficient time to attempt all the questions although some seemed to be rushed at the end usually after using some 'long-winded' methods in earlier questions.

Once again, a large number of candidates had not been reminded to complete the boxes on the front cover to indicate the numbers of the questions they had answered. It is also worth reporting that some centres issued 16-page, instead of 8-page answer booklets to all their candidates for this 90 minute exam.

Teachers may wish to emphasise the following points to their students in preparation for future examinations in this unit:

- Write down formulae before substituting values. The cosine rule is in the formulae booklet.
- Ensure that your calculator is set in the correct mode. (eg degrees or radians)
- Check that final answers are sensible. Show intermediate answers to a greater degree of accuracy than required before rounding the final answer to the degree of accuracy requested .
- When asked to show a printed result sufficient working must be shown to convince the examiners that the printed answer is not just being quoted.
- The perimeter of a sector must involve the sum of the two radii.

- If the terms of an arithmetic sequence are decreasing, the common difference must be negative.
- The word 'translation' should be used when describing the transformation in Question 4(c).
- Understand the meaning of the letters used in the relevant formulae that appear in the formulae booklet.
- Show a printed value quoted to three significant figures it is necessary to write down a value to at least four significant figures.
- When asked to show an exact result involving surds, decimal approximations should not be used in any intermediate working.
- To show that f is an increasing function, show that the derivative, f ′(x), is positive for all values of x for which f is defined.
- In a later part of a question, when asked to **write down** an answer, look to see if any of the answers to the earlier parts of the question can be adapted.

Question 1

Many candidates were able to find the area of the triangle, although not all quoted and used the formula $\frac{1}{2}ab\sin C$. Some candidates had their calculators set in the wrong mode; both radians and grads were used. Such candidates, in this examination, were penalised by no more than one mark. In part (b) it was disappointing to see so many candidates failing to gain all three marks. It was not uncommon to see the cosine rule quoted with cos C replaced by sin C.

A very common error was to forget to take the square root and give the answer for AB as 6.47. It would have been advantageous for such candidates to realise that the side opposite the angle of 30° cannot be the largest side of the triangle.

Question 2

Most candidates realised that the arc length was 1.5r but a significant minority could not form or solve the equation $r+r+1.5r=56$. The area of the sector required in part (b) was answered well, although some candidates used the incorrect formula $\frac{1}{2}r^2(\theta-\sin\theta)$.

Question 3

Part (a) was answered extremely well, but the wrong answer, 3, for the common difference was given more often than the correct answer. Part (c) was answered badly. The most common wrong method was to ignore the sigma sign and just solve $90-3n=0$. There were, however, some very elegant solutions seen based on the symmetry of the sequence. Other candidates started with a correct first step by using the formulae $S_n=\frac{n}{2}(a+l)$ from the formulae booklet to reach $\frac{1}{2}k(87+90-3k)=0$, but then multiplied out the brackets and abandoned the solution after a mass of algebra. Those using $S_n=\frac{n}{2}\left[2a+(n-1)d\right]$ often gained the equivalent method marks but ended up with a negative value for k after using the incorrect value d = 3.

Question 4

This question proved to be a good source of marks for many candidates. In part (a)(i) most candidates quoted the correct value for the power p. Although many candidates produced correct answers for the integration, all the usual errors, as illustrated by '$\frac{3}{2}x^{1.5}$, $x^{1.5}$, $\frac{x^{-0.5}}{-0.5}$, and $\frac{\sqrt{x}^2}{2}$', were seen. Most candidates stated and used the correct limits in part (a)(iii) but evaluation was sometimes poor. Many of the candidates found a correct equation for the tangent but it was surprising to find a significant minority of these candidates either making no attempt to find the area of triangle AOB or giving the area as a negative value. For full marks in part (c) the examiners were expecting to see the word 'translation'. Some candidates wrote 'tr' but this was not considered to be clear enough to distinguish between 'transformation' and 'translation'. Common wrong answers involved 'stretch' and vectors in the wrong direction. In part (d) there was a significant minority of candidates starting their solution with the incorrect statement '$\sqrt{x-1} = \sqrt{x} - \sqrt{1} = \sqrt{x} - 1$' but in general the trapezium rule was well understood and many candidates were able to give the final answer to the correct required degree of accuracy in this numerical integration question.

Question 5

This question on geometric series and logarithms proved to be very difficult for many candidates, with a significant number of the weaker candidates unable to quote correct relevant formulae from the booklet. Transforming the first sentence of the question into a correct equation was beyond many, but partial credit was usually gained by using the printed value for r. This part of the question seemed to show up a lack of understanding of algebraic manipulation. Rearranging '$4a(1-r) = a$' to '$r = \frac{3}{4}$' proved to be more difficult than anticipated.

In part (b) it was very evident that a significant number of candidates did not understand the meaning of the letter '*a*' in the formula for the sum to n terms of a geometric series. To their credit, some overcame this difficulty by working out S_1 as $\frac{a(1-r^1)}{(1-r)} = a$ and then stating 'so first term is *a*'. Those who used the correct formula from the booklet normally obtained the method mark but a significant proportion of these candidates could not evaluate the expression correctly on their calculators. Those candidates who resorted to listing the 10 terms and then adding them rarely obtained the correct four decimal place answer and clearly used up valuable time in the process.

Although some excellent solutions to all parts of (c) were seen, relatively a few candidates went beyond part (c)(i). Many were able to quote the correct expression for u_n from the formulae booklet. For u_{2n} a common incorrect answer was $2ar^{n-1}$. It was very common to find candidates using ar^{n-1} to mean $(ar)^{n-1}$ which, although not penalised in part (c)(i) lead to mistakes by candidates in reaching the printed answer in part part (c)(ii). Those candidates who recognised the left-hand side of part (c)(ii) as $\log_{10}\left(\frac{u_n}{u_{2n}}\right)$ and then cancelled the *a*'s were far more successful than those who did not use the law of logarithms before substituting. It was pleasing to see some candidates, having abandoned their solution to part (c)(ii), using the printed answer with n = 100 to gain credit in the final part of the question. For full credit, examiners expected to see some evaluation of $100\log_{10}\left(\frac{4}{3}\right)$ before writing the printed answer, for example '$\approx 12.49 \approx 12.5$' was acceptable.

Question 6

Many candidates were able to give the correct expansion in part (a), normally by applying Pascal's triangle. Many realised that *x* should be replaced by $\sqrt{5}$ but there was insufficient evidence in some cases to justify reaching the exact printed answer. Candidates should be aware that approximate decimal values for each of $4\sqrt{5}$ and $4(\sqrt{5})^3$ cannot then be added and the result used to equate to the exact surd part of the printed answer. The final part of the question proved difficult, although, again, some elegant solutions were presented. Those who wrote '$\log_2(1+\sqrt{5})^4 = \log_2(56+24\sqrt{5}) = \log_2[8(7+3\sqrt{5})]$' usually went on to score all three marks.

Question 7

Most candidates found one correct term but only a minority found both. The common incorrect answers are illustrated by '$x^8 - x^{-3}$' and '$x^5 - x^3$'. Most candidates were able to differentiate their expression for f(*x*), but the method required to show that f is an increasing function was not well known. Many did not attempt it and many others tried to justify it by considering the relative size of f ′ (*x*) for two particular values of *x*. Others incorrectly stated that 'f ′(2) > f (2) so f is increasing' or used the second derivative. Those who considered the sign of f ′(*x*) for the given domain, *x* > 0, usually gained both marks in a line of working. Those candidates who realised that the gradient of the tangent was given by f ′(1) usually obtained a correct follow through answer for the gradient of the normal. It is worth noting that many candidates went on to find the equation of the normal. Although, of course, this further work was not penalised, it may have used up valuable time for some of the candidates.

Question 8

Most candidates were able to state and use the identity '$\tan\theta = \frac{\sin\theta}{\cos\theta}$' to obtain the printed result in part (a)(i). The identity '$\cos^2\theta + \sin^2\theta = 1$', required in part (ii), was less well recalled, with sign errors and '$\cos\theta + \sin\theta = 1$' seen. Many candidates correctly solved the equation in part (b)(i) but the explanations given for part (b)(ii) were poor. The most common wrong answer was 'because $\cos\theta = -4$ is negative.' Those who realised the link between the parts normally gained the marks for (b)(iii) and part (c), but many tried to solve part (c) from scratch, despite the clear instruction to 'Write down' the values.

MPC3 Pure Core 3

General

The candidates were prepared for the demands of the paper but there were a number of weak scripts. The candidates presented their work well with clear diagrams shown. All questions were accessible to all candidates with the later parts of each question proving to be discriminating. Many candidates did not include a constant when integrating.

Question 1

Part (a) was reasonably well answered although there were some candidates who integrated using the product rule. In part (b)(i) candidates were expected to use the chain rule, but some candidates tried to expand the brackets. This method could score full marks but candidates who used this approach, in general, made mistakes on the expansion. Part (b)(ii) used the previous part; however a large number of candidates tried to use integration by parts and found this difficult. Candidates should be guided to look for relationships between parts of a question.

Question 2

Part (a) was reasonably well answered although some scripts showed evidence of poor algebraic skills when trying to tidy up the expression. Candidates could still score marks on this part even with an incorrect answer to the previous part. Scripts indicated that the basic method was understood although the algebraic skills left a lot to be desired; only a small number of candidates were able to correctly answer the final part.

Question 3

Part (a) was well answered, although some candidates integrated. There were many fully correct answers to part (b), but a lot of candidates chose the incorrect functions to equal u and $\frac{dv}{dx}$ with the obvious ensuing problem.

Part (c) was poorly answered. Candidates must realise that, in any substitution question, apart from replacing functions of x with functions of u, they must also find $\frac{du}{dx}$. A large number of candidates attempted to integrate an expression containing both x's and u's.

Question 4

Candidates should know the trigonometrical identities as outlined in the specification. Part (a) was well answered and there were many correct solutions to part (b), although some scripts did not give fully convincing arguments. Part (c) required answers correct to the nearest degree, but answers to a greater degree of accuracy were not penalised. There were a significant number of candidates who obtained an answer of 109.47 which was rounded to 109.5 which was then rounded to 110.

Question 5

Part (a) tested the relationship of e^x and $\ln x$. This part was well answered. Part (b) required algebraic manipulation using e^{-x} which discriminated between candidates. The final part was accessible to candidates who failed on the previous part. Candidates were required to give exact answers and not decimal equivalents.

Question 6

Part (a)(i) was well answered although some scripts used an approach of making a table of values and drawing a graph on graph paper. Part (a)(ii) tested the knowledge and use of the formula for volume of rotation. A number of candidates did not know the correct formula and a significant number of candidates could not expand $(4-x^2)^2$ correctly. Candidates could draw a modulus graph in part (b), but many had the wrong shape of the curve. Candidates attempted to solve the equation in part (b)(ii) with varying degrees of success. In the final part (b)(iii), successful candidates used the previous graph together with the solution of the intersection from part (b)(ii).

Question 7

This question was the least well answered question on the paper with very few correct solutions. Although the graphs of inverse trigonometrical functions is stated in the specification there were many incorrect graphs sketched. Many candidates had their calculators in degree mode and in part (b)(ii) found the values of 19 and 21 and then stated, 'change of sign, therefore root'. There were similar mistakes in part (c) with iterations jumping from 0.8 to 44 with candidates apparently not realising there was something amiss.

Question 8

This question discriminated well between candidates. Part (a) showed an alarming lack of the correct use of mathematical language. Candidates had to use the words translation and stretch. Centres must stress this to all their students. Part (b) was well answered although a number of candidates missed the +3 when calculating the values of y. There were many correct solutions to part (c) although some candidates missed the final mark by giving their answer as a decimal rather than the exact value that was required. Many candidates scored some marks on the final part but there were few fully correct solutions.

MPC4 Pure Core 4

There were some excellent performances by some candidates with a large number producing solutions of a high quality for all of the questions. Relatively few candidates performed badly and most candidates were able to attempt at least some of the questions.

Presentation was generally of a high standard with many candidates exhibiting confident use of their mathematics in responding to the questions. However there was also some untidy work, particularly where candidates had made deletions or repeated parts of questions and it was sometimes difficult to follow their working and/or to discern what their intended answer was. Questions were generally attempted in the order set on the paper, though sometimes they were left incomplete as candidates showed good examination technique in moving onto the next question, having run into difficulties.

Question 1

There was a very mixed response to this question with relatively few candidates gaining full marks. Some didn't know how to start it at all.

Part (a) Most candidates found R successfully but made errors in finding the value of α with some finding α to be 63.4°. Most candidates responded to the request for α to be to one decimal place, though this created problems for some in part (b).

Part (b) Many candidates gave answers close to, but not exactly, zero, not realising they were rounding off the same angle to different accuracies. Some candidates did not progress beyond $\sin(x+\alpha)=\sqrt{\frac{1}{5}}$ and, of those who did, many had problems in finding the second solution.

Question 2

Part (a) This was done very well with most candidates showing confidence and accuracy with the partial fractions. Both techniques of substituting suitable values of x or determining unknown coefficients using simultaneous equations were seen. Any errors made were usually arithmetical.

Part (b) Most candidates knew that they were to use the partial fractions in attempting the integral, and most knew these were 'ln' integrals, although some attempts at independently integrating numerator and denominator were seen. The common error in the ln integrals was the omission of the coefficient $\frac{1}{2}$.

Question 3

Part (a) It was anticipated that candidates would use the remainder theorem and many did, usually successfully. Others used the long division algorithm with varied success with some giving their remainder as an expression in x.

Part (b) Some candidates who did part (a) successfully by division realised they had also answered part (b) in doing so, and wrote down the values of a and b immediately. Other candidates just associated their remainder from part (a) with b, even if it was an expression in x. Some candidates started this part of the question afresh and there was a mix of approaches including division, manipulating the numerator and denominator or multiplying through by $(2x-1)$ and equating coefficients, and showed insightful understanding in using the remainder from part (a) to find the value of a.

Question 4

Part (a) Most candidates were successful here, using the formula book to help them with the expansion if necessary. There was some inaccuracy in the x^2 term.

Part (b) Most candidates knew they were requested to expand $(1+2x)^{-\frac{1}{2}}$ and attempted to use their result from part (a). The common error was to use $2x^2$ for $(2x)^2$, although some left the coefficient of the x^2 term as $\frac{12}{8}$ without further simplification.

Part (c) Most candidates substituted $x=-0.1$ into their expansion from part (b) and then many who had obtained 1.115 just doubled it to obtain the given answer, apparently believing they had answered the question. Few candidates convincingly linked $(0.8)^{-\frac{1}{2}}$ with $\sqrt{\frac{5}{4}}$ and so answered the question.

Question 5

Part (a) The vast majority of candidates calculated the coordinates correctly.

Part (b) There was a mixed response with some candidates confidently handling the algebra and others getting into difficulties in their attempt to eliminate t. Some verified the given equation by substituting the given expressions for x and y which gained partial credit, but no credit was given for verification using (3, 2) and claiming that the equation works.

Part (c) There were essentially three approaches as most candidates realised they had to do some form of differentiation. These were using parametric and implicit differentiation to find $\frac{\mathrm{d}y}{\mathrm{d}x}$ or solving for x and finding $\frac{\mathrm{d}x}{\mathrm{d}y}$; the latter was usually successful. The use of the two expected techniques was very mixed, some candidates confidently and clearly finding the derivatives and using $t=\frac{1}{2}$ or $(3,2)$ to obtain the answer given. Others were far less sure of what they were trying to do. There were errors in the chain rule such as $\frac{dy}{dx} = \frac{dy}{dt}\frac{dx}{dt}$ and in the derivatives with $\frac{d}{dt}\left(\frac{1}{t}\right) = \ln t$ being seen quite often. There were also errors in attempted simplifications of the algebraic fraction often resulting in a candidate just writing down gradient =2. Those who used implicit differentiation often had a loose $\frac{dy}{dx}$ at the front of their expression, which sometimes stayed in it. Errors were more common with the product xy than in the y^2 term. Some candidates who had the derivatives correct again just wrote down the given gradient, some just writing **calculator** beside their answer; they needed to show where 2 came from to gain full credit.

Question 6

Part (a) Most candidates successfully wrote down the expression for $\sin 2x$.

Part (b)(i) This caused difficulties for some candidates. Fairly common answers were $\cos 2x = 2\cos^2 x - 2\sin^2 x$ or $\cos 2x = \cos^2 x + \sin^2 x$.

Part (b)(ii) Most candidates made a reasonable start at proving the identity with many more able to handle the given $x + 2x$ than could consider $x + x$ for themselves. Candidates' responses varied considerably from clear concise derivations, to dead ends and restarts, to long meandering routes; some expanding cos2x and then bringing it back in. Most candidates knew they had to eliminate $\sin x$ at some point, but this was not always done convincingly.

Part (c) Those candidates who saw the connection to part (b) (ii) were usually successful in their integration, although there were some sign errors and also errors in handling the 4. Some candidates wrote $\cos^3 x$ as $\left(1-\sin^2 x\right)\cos x$ and went on to integrate correctly. Attempts by parts, and even by substitution, went awry. Many candidates opted for the somewhat hopeful $\sin^4 x$, or similar, as their integral but could get some credit for correct use of the given limits.

Question 7

Part (a) This was usually done well with most candidates obtaining the components 1, 5, 1 and showing the connection to $\sqrt{27}$.

Part (b) Here there was an unexpected lack of knowledge of the scalar product. Although $|a||b|\cos\theta = a \cdot b$ was often quoted, many candidates left their scalar product in a column and few could convincingly show where $\frac{7}{9}$ came from.

Part (c)(i) This was seen more so here, with scalar products written as columns and the given answer just written down. Candidates were expected to find $\overrightarrow{AP}$ using $\overrightarrow{OP} - \overrightarrow{OA}$ and relatively few did it convincingly.

Part (c)(ii) Most candidates understood that they needed to put $7 + 3p = 0$ and went on to solve for p and to find the coordinates correctly, although some made arithmetical errors.

Question 8

Many candidates gained full marks on Question 8 presenting clear, good quality answers.

Part (a) Most were successful dealing with the questions in parts (i) and (ii) involving the exponential function and gave their answers to sensible degrees of accuracy. Most showed knowledge of how to use logarithms to solve part (iii). The errors were mostly arithmetical.

Part (b)(i) Most candidates knew they were required to separate and integrate and attempted to do so, sometimes with poor notation and incorrect integrals but their intention was clear. Most candidates also included a constant of integration and attempted to find it using the given initial conditions. Some neglected to express t in terms of x with some going straight to the result given in part (b)(ii).

Part (b)(ii) This was often done well but the common error was in taking exponentials, with $e^{\frac{t}{40}} = e^{\ln 70} + e^{\ln(x-15)}$ being fairly common.

MFP1 Further Pure 1

General

There were many excellent performances, but at the same time there were many candidates who were not fully prepared. Nearly all the candidates showed a reasonable level of competence with elementary algebra, but many failed to cope efficiently with finding all the common factors in Question 3(a) or with expanding $(2 + h)^3$ in Question 4(a). The manipulation called for in Question 8(b) seemed to be beyond the ability of all but the strongest candidates.

Most candidates showed familiarity with matrices in Question 1, but few were able to describe the transformations precisely in Question 7. Questions 2 and 5 both required a knowledge of radians, and it was clear that many candidates were not sufficiently familiar with this part of the course. Question 6, dealing with the complex roots of a quadratic equation, was generally very well answered. Question 9 elicited some very good efficient solutions from some candidates, but those who had used time consuming methods earlier in the paper were at a disadvantage here.

Question 1

Most candidates made a good start to the paper by answering this question confidently, although in part (c) many candidates failed to show knowledge of the identity matrix.

Question 2

This question was reasonably well answered in general, but there were some common mistakes. One was to work in degrees throughout, despite the fact that the word 'radians' was printed in bold type. Another very common error was to continue the iterative process to the third iteration instead of stopping after the second. Some candidates failed to show enough working to make their method clear, while others attempted to solve the differential equation by integration rather than by the method required in the question.

Question 3

Most candidates realised that a subtraction of the two given expressions was required. The work in part (a) was disappointingly pedestrian, though the examiners had to admire the tenacity of many candidates who failed to extract the common factors from the two terms, yet persevered with some very heavy algebra to reach the conclusion legitimately. Candidates should expect to be penalised severely for claiming to have reached the answer when in fact they have done nothing of the sort. The response to part (b) was mixed.

Many candidates simply substituted $n = 11$, or sometimes $n = 7$, into the result from part (a). The most common mistake was to subtract the result with n equated to 4 instead of 3.

Question 4

As in the previous question, many candidates arrived at the correct answer after a considerable algebraic struggle. Errors often occurred in the course of the manipulation, but some candidates who coped successfully with the cubing of $2 + h$ then forgot to add a further $2 + h$ and to subtract 10, though in many cases they had previously declared their intention of doing these things. Unfortunately a high proportion of candidates who reached an answer of the required form in part (a) did not use it properly in part (b), resorting instead to a direct differentiation of the given function f or of their answer to part (a).

Question 5

Candidates who were confident with general solutions of trigonometrical equations answered both parts of this question with just a few lines of working. Others simply found one, or perhaps two, solutions for each of the given equations. A lack of familiarity with radians led to some inelegant work involving decimal approximations (which did not always yield the simple forms needed) or an ugly mixture of degrees and radians. Those who knew that they should insert $n\pi$ at some point often did so at the end of the calculation rather than at a much earlier stage.

Question 6

There were many high-scoring attempts at this question, most candidates showing the necessary familiarity with the roots and coefficients of quadratic equations as well as with complex numbers. The explanation called for in part (a) (iii) often showed an awareness that real numbers cannot have negative squares, but failed to indicate the fact that $\alpha^2 + \beta^2$ was not simply the square of α or of β. Some reference to the addition of the two squares was needed for full credit here.

In part (b) some candidates gave answers involving α and β rather than using the results they had obtained in part (a). In part (c) many candidates lost a mark by giving the wrong sign for the x term and/or omitting the 'equals zero' from their 'equation'.

Question 7

Many candidates scored precisely 6 marks out of 10 on this question, finding the coordinates of the image points correctly and drawing an accurate image triangle, but being unable to give either of the answers in part (b). There were even some who earned no marks at all, being apparently unfamiliar with transformations associated with matrices. Those who made a reasonable attempt at part (b) were sometimes working from their diagram and sometimes from the original matrix. The scale factor was very often given as 2 and the angle as 90°, despite the evidence of the diagram.

Question 8

Once again a lack of confidence with algebraic manipulation caused many candidates to spend an inordinate amount of time and effort on a question where success depended more on algebra than on specific knowledge. However, a good number of candidates were able to gain up to 5 marks by writing down, or calculating, the coordinates of P, finding the equation of PQ, and eliminating y from this equation and the equation of the given hyperbola.

Question 9

Some candidates were able to answer this question fully; others were able to pick up some marks, especially in part (a) where they showed some awareness of the properties of rational functions. In part (b) some candidates confused 'equal roots' with 'real roots', while others thought that the equation $9k^2 - 9k - 4 = 0$ was supposed to have equal roots. An approach adopted by quite a number of candidates was to solve this equation for k, obtaining two values, and then to show that the equation $f(x) = k$ had two equal roots for each of these two values of k. This was elongated but had the merit of leaving very little else to do in order to answer part (c) as well as part (b). The question was designed to test the candidates' knowledge of the method laid down in this unit for finding the stationary points of a rational function. No credit was given to candidates who used differentiation to find the stationary points.

MFP4 Further Pure 4

General

The overall performance was good but many candidates were not fully prepared for a paper at this level. Many candidates had difficulty in doing the simple things correctly, and quickly: evaluating a determinant, multiplying two matrices, evaluating scalar and vector products. Many candidates found questions 7 and 8 very difficult.

Question 1

This was a straightforward starter to the paper, and most candidates found it so, even if they made heavy weather of the algebra. Of course, one slip early on severely impairs the solver's chances of getting the correct solution, but very few candidates checked their answers. A direct algebraic elimination approach was generally the most commonly encountered, and the easiest, but several others were encountered. Generally, these were well successfully adopted, although it has to be said that the inverse-matrix approach is very much in "using a sledgehammer to crack a nut" territory and much more prone to errors.

Question 2

This was quite a straightforward test of some vector ideas. While most candidates were very happy to run through part (a) with little difficulty, quite a number seemed to have no idea what direction cosines are.

Question 3

Most candidates knew what to do.

Question 4

Many Candidates would have benefited greatly from a keener awareness of what is given them in the **Formulae Booklet.** This was really a very direct test of those ideas.

Question 5

This vectors question was of a much more familiar kind and was handled very comfortably by the majority of candidates. At the very end of the question many overlooked the fact that the scalar product gives the complement of the angle required.

Question 6

This was a difficult question, and generally not handled very well. Candidates found a number of ways to answer the written arguments in parts (a)(i), (a)(ii) and (b)(iv). While many of these were excellent, there was a lot of incorrect reasoning.

Question 7

Candidates found this question difficult. The answer to part (a) is the determinant of the given matrix; it was not uncommon for candidates to find this and then take its square root and offer this as the scale factor required. Although there are at least three valid approaches to part (b), most candidates' uncertainty led to a mish-mash of algebra, with the correct answer often embedded in so much other working that the candidate producing it seemed to have no idea that they had just done the necessary work.

Question 8

This question was less well done than Question 7 for the most part. Many candidates knew how to expand a determinant, but were unable to manipulate one using row/column operations. With part (a) proving to be difficult, part (b) was usually even more difficult. Candidates often failed to use part (a) to answer part (b). Very few candidates produced a second quadratic factor for the determinant and only a minority of these justified that the required value of a was unique.

Question 9

Most candidates managed to score some marks here, Even those picking up 2 or 3 of the marks available here did so retrospectively. The most common error in part (b) was to fail to turn the equation $4x + 7y = 0$, gained from the second eigenvalue of – 2, into a correct eigenvector. Also, the factor of 1/det**U** was often overlooked. Part (e) was seldom attempted. It was, however, very pleasing to see some completely correct conclusions to the paper.

MS/SS1A/W Statistics 1

General

There was a wide range in the level of responses to this paper. Thus, whilst there were many excellent scripts seen that illustrated a thorough mastery of the statistical techniques involved, on the downside there was a significant proportion of candidates who were not prepared for the paper's demands. Such candidates scored few marks and it was disappointing to note that they were even unable to tackle any of the questions where skills should have been developed in undertaking the coursework associated with this unit.

Some candidates need more encouragement to use the statistical functions on their calculators. Those that used them in this examination, particularly in Questions 1, 4 and 6, saved time and were generally more successful than those who opted for using formulae from the supplied booklet or from memory. Centres are reminded that, whilst knowledge of the relevant formulae in the supplied booklet is expected, the number of marks allocated for calculating sample statistics from raw data will reflect the use of a calculator's statistical functions. Similarly, many candidates need to be made more aware of the instruction that **final** answers should be given to three significant figures. Too many candidates lost marks through excessively severe approximations at early stages in their answers or by simply writing down answers to fewer than three significant figures. Also some candidates did themselves no favours through atrocious handwriting and presentation and through not reading the question carefully and, as a result, not answering the question posed.

Question 1

This proved a good first question for the vast majority of candidates with most scoring at least 4 of the 6 marks. In part (a)(i), candidates from a majority of centres made appropriate use of the statistical functions on their calculators to usually obtain full marks. When marks were lost, it was invariably for quoting the answer to less than three significant figures. For a minority of centres, their entire entries spent valuable time calculating r using a formula approach, often without a sound understanding. Thus, although some numerical inaccuracies were not critical, confusion between $\sum xy$ and $\sum x \sum y$ was always catastrophic. In part (a)(ii), most candidates recognised that there was 'positive' correlation with 'strong' as the usual adjective accepted. The adjectives 'weak', 'some' or 'good' were not acceptable here. Most candidates also included the necessary statement in context by describing how time and value were related. Whilst the vast majority of candidates realised that the answer required in part (b) was that found in part (a)(i), a minority felt the need to perform a considerable amount of number-crunching for 1 mark.

Question 2

Most candidates made a confident start to this question. In part (a)(i), they usually standardised 60 using 56 and 2.5 though a very small minority used $\sqrt{2.5}$ or 2.5^2 in the denominator. However rather more candidates standardised 59 (0 marks) or 59.5 (1 mark). Part (a)(ii) was also answered well with many candidates scoring full marks. When marks were lost, the reason was usually for not dealing with $\Phi(-2.4)$ as $1 - \Phi(2.4)$; a difficulty that may not have arisen had such candidates indicated the required area on a sketch of a normal curve.

Very few candidates had correct answers to part (a)(iii). Apparently few candidates were aware that $P(X = x) = 0$ when X is continuous and so often attempted $P(54.5 < X < 55.5)$ despite there been only 1 mark available. A majority of candidates scored at least 3 of the 4 marks available in part (b); this lost mark was through using $z = +\ 2.0537$. A number of candidates lost at least 3 marks for equating $\frac{100 - \mu}{3.4}$ to the probability for $z = 0.98$ from Table 3 of the supplied booklet.

Question 3

This was probably the best answered question on the paper with many candidates, often through first constructing a tree diagram, scoring full marks. It was thus rare to see candidates not scoring the full 7 marks in part (a). When marks were lost, it tended to be in part (a)(ii). Part (b) proved a good discriminator for the more able candidates. Many candidates recognised the need for $p_1^2 \times p_2$, many fewer included the multiplier of 3 and/or had correct values for both p_1 and p_2. A small minority of candidates attempted to apply a binomial model.

Question 4

In part (a), candidates using their calculators' statistical functions appeared to have a significant advantage over those attempting the formulae path, although even the former often lost 1 mark for quoting the value 0.085 for b. In a few cases, candidates interchanged the values of a and b; an error that made nonsense of subsequent work. Too many candidates appeared unaware of the definition of a residual. Some candidates stated incorrect values without any working, others omitted the negative signs, whilst some substituted values of 3 and 7 into their equations. Candidates appeared totally unaware that $\sum r_i = 0$. Most candidates scored no marks in part (b)(ii), often through making no attempt. When attempted, all too often answers simply made reference to the numbers of points above and below the regression line and/or that their line was 'accurate', rather than comment on the sizes of the residuals and hence the appropriateness of the regression line.

Question 5

Answers to part (a)(i) revealed that some candidates apparently had no knowledge of the binomial distribution. Of those who did, a surprising number could not evaluate $\begin{pmatrix}17\\2\end{pmatrix}$ correctly. However, many candidates were more successful in part (a)(ii) when they opted to use cumulative binomial tables. Attempts using the formula were less successful due to numerical inaccuracies and/or the omission of $P(X = 0)$. Part (b) generally proved beyond all but the most able candidates. The most common approach was to state $P(Y \geq 30) = 1 - P(Y \leq 29)$ and then simply switch to $p = 0.45$ in order to use Table 2.

Question 6

Candidates were often able to score at least some of the first 4 marks using the statistical functions on their calculators, particularly as the mark scheme allowed for some 'errors' in finding the class mid-points that were not integers. Candidates using formulae were often much less successful usually through working only with either class mid-points or class frequencies. When attempted by the more able candidates, answers to part (b) often referred to skewness or non-symmetry, although statements referring to the discrete nature of the data or likely negative values were equally valid. However statements on the size of the standard deviation were deemed invalid. Most seen answers to part (c)(i) were correct through mention of the Central Limit Theorem, or large sample size, although in many scripts it appeared that this was perhaps as good a place as any to state it. Answers to part (c)(ii) were much less impressive with typical common mistakes equivalent to mean = μ = 25.2 and variance $= 17.2$ or 17.2^2. Despite this, many candidates recovered to make a valid attempt at part (d) by using a correct expression with a correct z-value. Here the final accuracy mark also required accurate answers to part (a). Finally, in part (e), some candidates failed to notice that the first claim referred to 'average' and so 30 required a comparison with their confidence interval. To score the marks, this comparison had to be clear. A number of other candidates simply compared 30 with their sample mean. However, a surprising number of candidates answered the second claim correctly by identifying that only 7% of the sample values exceeded 50; in some cases these were the only marks scored on the question.

MS/SS1B Statistics 1

General

Many candidates found this to be an accessible paper. On the other hand, there were too many candidates who could make little headway beyond some basic calculations and/or general statements. All but the weakest candidates were able to score well on the first 3 questions; the final 3 questions served well in identifying the more able candidates.

Candidates need more encouragement to use the statistical functions on their calculators. Those that used them in this examination, particularly in Questions 1, 4 and 6, saved time and were generally more successful than those who opted for using formulae from the supplied booklet or from memory. Centres are reminded that, whilst knowledge of the relevant formulae in the supplied booklet is expected, the number of marks allocated for calculating sample statistics from raw data will reflect the use of a calculator's statistical functions. Similarly, many candidates need to be made more aware of the instruction that **final** answers should be given to three significant figures. Many candidates lost marks through excessively severe approximations at early stages in their answers or by simply writing down answers to fewer than three significant figures. Also some candidates did themselves no favours through atrocious handwriting and presentation and through not reading the question carefully and, as a result, not answering the question posed.

Question 1

This proved a good first question for the vast majority of candidates with most scoring at least 4 of the 6 marks. In part (a)(i), many candidates made appropriate use of the statistical functions on their calculators to usually obtain full marks. When marks were lost, it was invariably for quoting the answer to less than three significant figures. For a minority of centres, their entire entries spent valuable time calculating r using a formula approach, though often with a good understanding. Hence, while there were some numerical inaccuracies, confusion between $\sum xy$ and $\sum x \sum y$ was rare. In part (a)(ii), most candidates recognised that there was 'positive' correlation with 'strong' as the usual adjective accepted. The adjectives 'weak', 'some' or 'good' were not acceptable here. Most candidates also included the necessary statement in context by describing how time and value were related. Whilst the vast majority of candidates realised that the answer required in part (b) was that found in part (a)(i), a minority felt the need to perform a considerable amount of number-crunching for 1 mark.

Question 2

Notation and presentation of method were in need of improvement on many scripts although many candidates scored high marks for correct answers. In part (a), almost all candidates knew how to standardise 250 using 200 and 25 and so obtained a correct answer. A minority of candidates used 249, 249.5 or 249.9, employed a divisor of 625 or 5, or, having found z = 1.8 correctly, chose to use 1.79 in Table 3. Fewer candidates were completely successful in part (a)(ii), usually through not making the area change, $\Phi(-0.2) = 1 - \Phi(0.2)$. In part (b)(i), many candidates made the mistake of using 0.5244 or 1 – 0.5244 rather than –0.5244, whilst a minority used 0.70 as a z-value in Table 3. More candidates answered part (b)(ii) correctly since the z-value needed was positive, but a minority read 'medium' as 'median' and so used z = 0. There was a surprisingly large proportion of correct answers to part (c) often from candidates who had answered part (b) incorrectly. One general point of note for the future: too many candidates lose valuable accuracy marks through finding approximate z-values from Table 3 rather then more exact values from Table 4.

Question 3

Many candidates scored full or almost full marks on this probability question, sometimes even those who scored very little elsewhere on the paper. Few candidates failed to score the first 2 marks but, in part (a)(ii), it was not uncommon to see 0.2×0.4. In part (b)(i), most candidates scored all 3 marks. However, in part (b)(ii), only 2 of the correct 3 permutations were often used.

Question 4

In part (a), those candidates using their calculator's statistical functions appeared to have a significant advantage over those attempting the formulae path, although even the former often lost 1 mark for quoting the value 0.085 for b. Most candidates made an attempt, often valid, at calculating the two residual values. Some candidates showed no working whatsoever, others omitted the negative signs whilst a minority substituted values of 3 and 7 into their equations. Candidates appeared unaware that $\sum r_i = 0$. Most candidates scored no marks in part (b)(ii), often through making no attempt. When attempted, all too often answers simply made reference to the numbers of points above and below the regression line and/or that their line was 'accurate', rather than comment on the sizes of the residuals and hence the appropriateness of the regression line. It was most disappointing to see the large proportion of candidates who, in answering part (c), lost 3 of the 5 marks available through simply ignoring the scan time, this despite the phrase '**total** time to scan and transmit'. However, references to 'interpolation' and 'extrapolation' were common in the many acceptable statements of reliability.

Question 5

Answers to parts (a)(i) & (ii), using the binomial formula and cumulative tables respectively, were in the main of a good standard although in some scripts it was surprising to see poor attempts at part (i) followed by correct attempts at part (ii). Part (b) generally proved beyond all but the most able candidates. The most common approach was to state $P(Y \geq 30) = 1 - P(Y \leq 29)$ and then simply switch to $p = 0.45$ in order to use Table 2. Some better candidates who reached $P(Y' \leq 20 \mid p = 0.45)$ then changed the correct answer of 0.2862 to 0.7138. Weaker candidates also often made no attempt at part (c), this despite the fact that it offered relatively easy marks. Those candidates who answered part (i) correctly, sometimes stated the variance as their answer to part (ii) or used $n = 10$. Many candidates, even with full marks for parts (i) & (ii), simply accepted the model in part (ii) because of 'two outcomes' and 'fixed trials'. Rarely did candidates comment on the discrepancy between the two values for the standard deviation.

Question 6

Candidates were often able to score the first 4 marks using the statistical functions on their calculators, particularly as the mark scheme allowed for some 'errors' in finding the class mid-points that were not integers. Candidates using formulae were often much less successful, usually through working only with either class mid-points or class frequencies. When attempted by the more able candidates, answers to part (b) often referred to skewness or non symmetry, although statements referring to the discrete nature of the data or likely negative values were equally valid. However statements on the size of the standard deviation were invalid. Most answers seen to part (c)(i) were correct through mention of the Central Limit Theorem or large sample size. Answers to part (c)(ii) were much less impressive with typical common mistakes equivalent to mean = $\mu = 25.2$ and variance = 17.2 or 17.2^2. Despite this, many candidates recovered to make a valid attempt at part (d) by using a correct expression with a correct z-value. Here the final accuracy mark also required accurate answers to part (a). Finally, in part (e), some candidates failed to notice that the first claim referred to 'average' and so 30 required a comparison with their confidence interval. A number of other candidates simply compared 30 with their sample mean. However, a pleasantly surprising number of candidates answered the second claim correctly by identifying that only 7% of the sample values exceeded 50. A minority of candidates compared 50 with their confidence interval.

MS2A Statistics 2

General

It was very pleasing to see an excellent standard of work from the majority of the small number of candidates sitting this paper in this series.

Question 1

Part (a) was usually answered well. In part (b), it was evident that most candidates realised that a description of the distribution and the value of the parameter were **both** required for full credit. The interpretation of 'at least 10' as '≥ 10' was usually correctly seen in part (b)(ii), with $P(X \geq 10) = 1 - P(X \leq 9)$ usually seen and Table 2 in the supplied booklet used correctly to achieve the required answer of 0.478. Part (b)(iii) was found difficult and beyond the capabilities of most candidates.

Question 2

This was the best answered question with full marks gained by about half of the candidates. It should be noted that a statement of at least the null hypothesis is expected in questions of this type, with conclusions in context.

Question 3

This question also proved to be a valuable source of marks for many candidates. The vast majority of them performed well on part (a) with only a few losing credit for not giving an **exact** answer as asked for in the question. In part (b)(i), the table of the probability distribution of *X*, although asked for in the question, was conspicuous by its absence. Candidates should realise that failure to answer the question as set will inevitably result in a loss of marks. A good number made excellent attempts at part (b)(ii) with the majority able to find an expression for the area followed by the correct answer of 33 for $\mathrm{E}(A)$.

Question 4

In part (a), almost all candidates were able to calculate the value of $\bar{x}$, usually by inputting the given data into their calculators, and then using this as an unbiased estimate of the mean of the population. Unfortunately, many candidates lost credit by quoting $s = 0.1028$ instead of $s^2 = 0.0106$, the value asked for in the question. In part (b), it was pleasing to see that the majority of candidates understood that a small sample from a population with unknown variance suggested a *t*-distribution. Unfortunately, $t(90\%)$ tended to be read from tables rather than $t(95\%)$. It was only weak candidates who used z-values instead of the required *t*-values.

Question 5

In general, candidates seemed to have less success with this question. In part (a), the correct graph was only seen very infrequently, with the majority of candidates drawing straight lines to represent both parts of the graph. Where a curve was drawn from $t = 3$ to $t = 6$, it was often concave rather than convex. The vast majority of candidates correctly gave the answer of 'zero' to part (b). However, a minority treated this as a discrete distribution and used $\mathrm{P}(X = 3) = \mathrm{P}(X \le 3) - \mathrm{P}(X \le 2) = \frac{1}{5}$. Part (c) was usually done well. However, many candidates used the more difficult integration route and, the correct answer of 0.4 was often seen. Part (d) was usually attempted quite well with most candidates aware that the median value, *m*, had to satisfy $\int_0^m \frac{1}{5}\,\mathrm{d}t = 0.5$. Part (e) was found difficult by all but the more able candidates. Calculating the mean to be 2.55 using the integration of two functions for the two different ranges was beyond most candidates, with several attempting to integrate one or other of the functions between 0 and 6. The final part, calculating $\mathrm{P}(\text{median} < T < \text{mean})$ was beyond almost all but the best candidates.

Question 6

This proved to be a good source of marks with many fully correct solutions seen. Most candidates knew that a large sample and known population variance meant that they had to use a *z*-test in part (a). Hypotheses were usually stated correctly, although a few candidates treated the test as one-tailed. Comments in context were usually attempted although in many cases, they were too positive in nature. Part (b) was usually attempted well with most comments given in context.

MS2B Statistics 2

General

It was very pleasing to see the high standard of answers submitted by many candidates. As a result, many fully correct solutions were seen to each question. It was evident that candidates had been very well prepared for this examination. In particular, hypotheses were usually quoted correctly and most candidates were able to apply the appropriate associated tests.

Question 1

There were many fully correct solutions to part (a) with the vast majority of these being found by the use of Table 2 in the supplied booklet. In part (b)(i), candidates realised that both a description of the distribution (Poisson) and the value of the parameter ($\lambda = 13$) were required. The first step of part (b)(ii) was answered well by most candidates, with the correct interpretation of 'at least 15' being used to give $\mathrm{P}(X \geq 15) = 1 - \mathrm{P}(X \leq 14) = 0.325$. Unfortunately, some candidates interpreted the phrase 'at least 15' as meaning the same as 'less than 15'. A surprising number of scripts from good candidates were seen where the solution to the second step (four successive) was missing altogether. This was the main source of error on this question.

Question 2

This was the best answered question on the paper, with very many fully correct solutions seen. However, some candidates did not state their hypotheses but still felt justified in making statements such as 'do not reject H_0' as a conclusion. Although most candidates realised that Yates' correction was required, a few failed to apply it correctly. Some of the candidates, $|O_i - E_i - 0.5|$ was used in the evaluation of χ^2 instead of $|O_i - E_i| - 0.5$. A minority of candidates looked values up incorrectly from Table 6 or even used the wrong tables. A conclusion in context, which is always required in questions of this type, was not always evident.

Question 3

In part (a), most candidates were able to calculate the value of $\bar{x}$, usually by inputting the given data into their calculators, and then using this as an unbiased estimate of the mean of the population. Unfortunately, many candidates lost credit by quoting $s = 0.1028$ instead of $s^2 = 0.0106$, the value asked for in the question. In part (b), it was pleasing to see that most candidates understood that a small sample from a population with unknown variance suggested a *t*-distribution. Unfortunately, $t(90\%)$ tended to be read from tables rather than $t(95\%)$. Only a few candidates used z-values instead of the required t-values.

Question 4

Candidates should be given more information regarding the terminology that is used in questions. Where **'state'** or **'write down'** are used it is to indicate to candidates that the answer can reasonably be simply written down and that working does not need to be shown. There were a great number of scripts seen where integration was used in order to find the answers to parts (a) and (b). Although the correct answer to each of these parts was eventually arrived at, it was certainly not the most efficient way of doing so. The value of $\mathrm{P}(X > 0)$ was usually found correctly to be 0.6 but again, far too many candidates wasted time by using integration. Part (d) was only usually done correctly by the most able candidates. The vast majority of candidates usually perceived incorrectly that $\mathrm{P}(X > 3.5)$ was required and so did not attempt to find $\mathrm{P}(X < -3.5) + \mathrm{P}(X > 3.5)$.

Question 5

This question again proved to be a valuable source of marks for many candidates. The vast majority of them performed well on part (a) with only a few losing credit for not giving an exact answer as asked for in the question. In part (b)(i), the table of the probability distribution of *X*, although asked for in the question, was conspicuous by its absence. Candidates should realise that failure to answer the question as set will inevitably result in a loss of marks. A good number of candidates made excellent attempts at part (b)(ii) with the majority able to find an expression for the area followed by the correct answer of 33 for $\mathrm{E}(A)$.

Question 6

The null and alternative hypotheses were usually correctly stated and values for $\bar{x}$ and s (or s^2) found correctly to be 563.75 and 2.816 (or 7.929) respectively. Again, as in Question 3(b), the majority of candidates realised that a small sample from a population with unknown variance suggested a *t*-distribution. Only a few candidates, used *z*-values here. However, there are still some candidates who seem to have very little idea as to which of the tables to use from the supplied booklet. Although candidates , on the whole, attempted to give a conclusion in context, they were often far too positive in nature and/or did not make any reference to the **'average contents'** of cartons.

Question 7

In general, candidates seemed to have less success with this question than others on the paper. In part (a), the correct graph was seen very infrequently, with the majority of candidates drawing straight lines to represent both parts of the graph. Where a curve was drawn from $t = 3$ to $t = 6$, it was often concave rather than convex in nature. The great majority of candidates correctly gave the answer of 'zero' to part (b). However, a minority treated this as a discrete distribution and used $\mathrm{P}(X = 3) = \mathrm{P}(X \le 3) - \mathrm{P}(X \le 2) = \frac{1}{5}$. Part (c) was usually done well. However, many candidates used the more difficult integration route and, although the correct answer of 0.4 was often seen, this was not always the case. Part (d) was usually attempted quite well with most candidates aware that the median value, *m*, had to satisfy $\int_0^m \frac{1}{5}\,dt = 0.5$. Part (e) was found difficult by all but the more able candidates. Calculating the mean to be 2.55 using the integration of two functions for the two different ranges seemed to be beyond most candidates, with several attempting to integrate one or other of the functions between 0 and 6. The final part, calculating $\mathrm{P}(\text{median} < T < \text{mean})$ was beyond almost all but the best candidates.

Question 8

This proved to be a good source of marks with many fully correct solutions seen. Most candidates knew that a large sample and known population variance meant that they had to use a *z*-test in part (a). Hypotheses were usually stated correctly, although some candidates treated the test as one-tailed. Comments in context were usually attempted although again, in many cases, they were too positive in nature. Part (b) was usually attempted well with most comments given in context.

MM1A Mechanics 1

General

The candidates seemed able to complete the paper in the time available. There were a number of very good scripts. Almost all candidates found parts of the paper accessible and were able to produce solutions to some of the questions.

A few candidates did not give full solutions when attempting some of the 'show that' questions and as a consequence lost some of the marks. It is important that candidates show all the steps that are needed in the solution. A small number of candidates used $9.81\ \text{ms}^{-2}$. This did cause problems in some cases, particularly for the ‘show that’ type questions.

Question 1

Generally this question was done very well. An error that was observed several times in part (a) was to find the area above the graph, rather than the area below the graph. Part (b) was done very well. Part (c) was also done well, but some candidates rounded their final answer to two significant figures.

Question 2

This question was generally done very well and there were many complete correct solutions. The main source of errors was due to mixing up velocities and masses.

Question 3

Part (a) of this question was done very well and there were many correct responses. Part (b) was more difficult. Most of the candidates found the angle of 8.5° first and then many of these went on to subtract it from 90° to find the bearing. A few candidates worked with velocity triangles where the 200 was the hypotenuse.

Question 4

Generally the candidates did well on his question. In part (a) there were a relatively small number of candidates who ignored the instruction to form an equation of motion for each particle. Some candidates used a method that produced $-2.8\ \text{ms}^{-2}$. This approach was acceptable for part (a), but these candidates then used 2.8 in their equation to find the tension and obtained an incorrect value. In part (c), there were many very good responses. Some candidates failed to double their answer and lost the final mark. A few candidates worked with the acceleration due to gravity, rather than the acceleration that they had calculated in part (a).

Question 5

The candidates seemed to find the fact that the arrow was fired horizontally difficult to handle. Many appeared to try to give the arrow a vertical component of velocity. In part (a) many candidates seemed to have been helped by the printed answer. In some cases they included an unnecessary negative sign, which led to a negative time. There were some good answers to part (b), but some candidates included an acceleration g. There were very varied answers to part (c). Some candidates gave very good responses, but there were very many confused ones too, which revealed a lack of understanding of the principles of this topic.

Question 6

There were many good responses to this question. Generally part (a) was done very well. Part (b) was most demanding, but many candidates still did well on this part. One error was to work with a position vector instead of a velocity vector. In part (c), a few candidates gave the velocity as their final answer instead of the speed.

Question 7

A variety of force diagrams were seen on the candidates’ scripts. Some were very good, but errors included the omission of forces and showing the friction force acting up the slope. In part (b) the candidates were clearly helped by the printed answer and there were many correct responses. In some cases the candidates did not show enough working to gain full marks. Part (c) proved to be very challenging, with only a very small number of candidates getting the correct coefficient of friction. The main problem was that the candidates did not include all of the terms that were needed in their equations of motion.

MM1B Mechanics 1

General

The candidates seemed able to complete the paper in the time available. There were a number of very good scripts. Almost all candidates found parts of the paper accessible and were able to produce solutions to some of the questions.

A few candidates did not give full solutions when attempting some of the 'show that' questions and as a consequence lost some of the marks. It is important that candidates show all the steps that are needed in the solution. A small number of candidates used $9.81\ \text{ms}^{-2}$. This did cause problems in some cases, particularly for the 'show that' type questions.

Question 1

Many candidates were able to make a reasonable attempt to produce a vector equation using conservation of momentum. A common error was to take the combined mass after the collision as $3m$ rather than $3+m$. Given a vector equation some candidates were not able to find the mass, but there were also many good solutions. Surprisingly, the candidates seemed to find it easier to find *V*, than to find *m*.

Question 2

Generally this question was done very well. An error that was observed several times in part (a) was to find the area above the graph, rather than the area below the graph. Part (b) was done very well. Part (c) was also done well, but some candidates rounded their final answer to two significant figures.

Question 3

In part (a) of this question many candidates seemed to have been helped by the printed answer. There were a number of solutions where '$90-23.6=66.4°$' had been introduced to make things right. Some candidates did this but had also drawn a diagram which contradicted their final answer. In part (b) most candidates took the correct approach, but a number used $\sqrt{2^2+0.8^2}$ instead of $\sqrt{2^2-0.8^2}$. There were some good attempts at finding the time to cross the river, but a few candidates did use a velocity of 2 rather than the velocity that they had just calculated.

Question 4

Generally the candidates did well on his question. In part (a) there were a relatively small number of candidates who ignored the instruction to form an equation of motion for each particle. Some candidates used a method that produced $-2.8\ \text{ms}^{-2}$. This approach was acceptable for part (a), but these candidates then used 2.8 in their equation to find the tension and obtained an incorrect value. In part (c) there were many very good responses. Some candidates failed to double their answer and lost the final mark. A few candidates worked with the acceleration due to gravity, rather than the acceleration that they had calculated in part (a).

Question 5

Good candidates tended to score well on this question while weaker candidates would only gain a few marks. Part (a) was often answered well, but candidates often missed the key assumption that was being made and stated assumptions that were not appropriate. In part (b) the most common error was to take the mass as 200 kg rather than 200 grams. When answering part (c), some candidates stated that the initial acceleration would be 8 ms^{-2} and some said that it would be zero. In the explanation, the quality of the expression was often poor and lacked clarity. Also some candidates did not explicitly state what would happen to the acceleration, but described what would happen to the velocity instead.

Question 6

Part (a) was often done well, but a number of candidates effectively repeated the same assumption twice. The candidates were often helped by the printed answer in part (b). Many of the candidates made life difficult for themselves by finding the initial speed and angle of projection and then working with these values. One consequence of this was that the final answers were inaccurate. Part (c) proved more challenging for candidates. The most common incorrect approach was to assume that the ball hit the wall when it was at its maximum height. In part (d) there were some good answers and many of the candidates were on the right track. However quite of few of the candidates produced answers which lacked clarity of explanation.

Question 7

There were many good responses to this question. Generally part (a) was done very well. Part (b) was most demanding, but many candidates still did well on this part. One error was to work with a position vector instead of a velocity vector. In part (c), a few candidates gave the velocity as their final answer instead of the speed.

Question 8

A variety of force diagrams were seen on the candidates' scripts. Some were very good, but errors included the omission of forces and showing the friction force acting up the slope. In part (b) the candidates were clearly helped by the printed answer and there were many correct responses. In some cases the candidates did not show enough working to gain full marks. Part (c) proved to be very challenging, with only a very small number of candidates getting the correct coefficient of friction. The main problem was that the candidates did not include all of the terms that were needed in their equations of motion.

MM2A Mechanics 2

General

There were very few candidates for the first entry of this paper. The scripts varied in standard, with the best showing a sound knowledge of the topics within the Specification and the necessary techniques for solving them. These most discriminating questions proved to be questions 5 and 7. Diagrams, algebraic and arithmetic work were of a high standard and work was well presented.

MM2B Mechanics 2B

General

The standard of work on the first sitting of this paper was good, showing that candidates were well prepared. Knowledge of the topics being tested and of the required techniques was sound, algebraic and arithmetic skills were good and the presentation of the solutions within the scripts was pleasing, making the assessment of candidates' work straightforward. Diagrams were mostly clear and verbal responses, while not always correct, were generally expressed well.

Question 1

Part (a) was done well, with candidates able to obtain the printed result convincingly. In part (b) there were many successful solutions. However, some candidates assumed the force on the particle to be constant and applied Newton's Second Law followed by the equations of constant acceleration.

Question 2

This proved to be popular and many candidates obtained full marks. Part (a) was often done well, but some omitted one of the forces at the foot of the ladder while others showed reaction forces perpendicular to the ladder. Part (b) was mostly successful, and there were many highly competent attempts at the moments equation in part (c), with the most common errors being trigonometrical or slips in subsequent working.

Question 3

This question also proved popular, with parts (a) and (b)(ii) showing a sound understanding of the principles of energy and work. There were many interesting solutions to part (b)(i), with the majority realising that the velocity of the particle increased at stages throughout the motion. Often candidates produced the correct shape in their sketch, but labelling of the axes was incomplete.

Question 4

Again a popular question. Part (a) was done well by most, with the most frequent error being the assumption that the masses of the pass and its wallet depended on their areas. Part (b) was often answered correctly, with only occasional errors in trigonometry and accuracy. Diagrams proved helpful to many candidates in selecting the appropriate ratio for their solution.

Question 5

Many candidates produced fully correct and succinct solutions here. Others barely scored any marks, as they seemed unaware of the variable nature of the acceleration and applied the equations of constant acceleration. A few started correctly, but made errors in separating variables prior to integration.

Question 6

Part (a) was frequently done well, with the most common error in part (a)(ii) being the introduction into the equation of motion of an additional force, usually the weight of the motorcycle and rider. Part (b) seldom produced assumptions backed by sound reasons. The majority of responses referred to information given in the question. In part (c), the most convincing solutions were based on the algebraic link between the force and the radius. There was a tendency in part (c) to assume that the magnitude of the frictional force could be altered by changing the radius of the circle, rather than the necessity to adjust the radius to compensate for the force.

Question 7

Many candidates proved competent in handling vector expressions, but a significant number lacked appreciation of vector and scalar quantities and the necessary notation. Errors in differentiation of trigonometrical functions, particularly in signs, also spoiled otherwise excellent solutions. Otherwise part (a) was done well, with the most frequent error being in the failure to present an answer in radians in part (a)(iii). Responses in part (b)(i) were variable, with scalar answers frequently presented, while in part (b)(ii), few appreciated the variable nature of the direction of the force, and many seeming unaware of both upper and lower bounds of the magnitude of the force.

Question 8

This proved, as expected, to be the most demanding question on the paper. Part (a) was generally successfully completed. To score marks in part (b) it was necessary to consider a general position when applying the energy principle and when constructing an equation of motion. Linking these equations and also linking angles and vertical distances proved beyond many in this unstructured request. Able and well prepared candidates produced excellent solutions which were both concise and accurate in algebraic manipulation.

MM03 Mechanics 3

General

There were many excellent responses to this paper. A large number of candidates attempted all questions and demonstrated a sound grasp of the relevant knowledge and skills. Some parts of the 0paper proved to be too demanding for a number of the candidates. Lack of understanding of the conservation of momentum and impulse/momentum principle and their use for solving problems based on collisions in one and two dimensions were particular areas of candidate weakness. Many candidates showed a high level of competency with the methods of calculus and with the algebraic manipulation required for this paper.

There was no evidence of lack of time for candidates to complete the questions.

Question 1

This question was answered well by the great majority of the candidates. A small minority of the candidates seemed to be unfamiliar with the concept of dimensional analysis. Some candidates benefited from follow-through marks in part (b).

Question 2

Many candidates answered part (a) of this question well. Most candidates collected **i** and **j** terms in each of the position vectors.

For part (b), about half of the candidates showed that *A* and *B* would collide by substituting $t = 1$ in the position vectors of the ships at time *t*. Alternatively, the position vectors of the ships at time *t* were set equal and then the corresponding **i** and **j** coefficients were equated to show that $t = 1$. However a minority of candidates lost a mark because they equated only **i** or j components, but not both.

Part (c) proved too difficult for some candidates. Almost all candidates who answered this part found the position vector of B relative to A by considering $r_B - r_A$. Even though the answer to part (c)(i) was given, some candidates used their own wrong result to answer part c(ii).

Question 3

Part (a) of the question was answered correctly by many candidates. Some candidates made sign errors when they applied Newton's experimental law.

For part (b), most candidates applied the Impulse/Momentum principle efficiently to the sphere B rather than to the sphere A to show the result.

In part (c), a significant number of candidates went through long algebraic manipulations to find the result, and in doing so, they made mistakes.

Candidates could not gain any marks for part (d) without first substituting $e = \frac{4}{5}$ to find the velocity of A in terms of $\boldsymbol{u}$.

Question 4

Very few candidates answered part (a) of this question correctly. The main difficulty was a lack of understanding and appreciation of the effect of the smoothness of the ball and the plane on the mutual reaction force between them.

Part (b) of the question was answered correctly by almost all candidates.

A large number of candidates did not answer part (c) of the question, failing to utilise the given statement in part (a) viz. the component of the velocity of the ball parallel to the plane is not changed by the collision.

Some candidates could not answer part (d) of the question through not being able to eliminate v in their Impulse/Momentum equation by using the given statement in part (a).

Question 5

The responses to part (a) were generally good, indicating a high level of knowledge and skills on the part of candidates to solve problems based on projectiles on inclined planes.

Many candidates answered part (b) of the question correctly. However, some candidates used $-g\cos 30^\circ$ instead of $-g\sin 30^\circ$ for the acceleration.

To find the maximum perpendicular distance requested in part (c), some candidates divided the time of the flight (from part (a)) by 2 and used it to find the maximum perpendicular distance. By using this "special result" these candidates could only gain 3 of the 4 available marks.

Question 6

The vast majority of the candidates answered part (a) of the question correctly.

For part (b), almost all candidates substituted 100 for x and 4 for y. However, some candidates had difficulty simplifying the resulting equation.

For part (c), most candidates stated that they assumed the ball was a particle, there was no air resistance or that the only force acting on the ball was the Earth's gravitational force. However, there were some candidates who stated the assumption of the ball being a particle without mass !

MD01 Decision 1

General

In general the candidates were prepared for the demands of the paper but there were a number of weak scripts. The candidates presented their work well with clear diagrams shown. Some candidates appeared to 'run out of steam' towards the end of the paper. Some candidates used coloured pens to help in demonstrating their alternating path. This did help markers to follow an answer but centres must stress that candidates must not use red or green.

Question 1

The majority of candidates knew the shuttle sort and were able to score full marks. Some weaker candidates did not use the correct sort and failed to score on the question. Some candidates wasted a substantial amount of time as they listed the order of numbers after each comparison rather than each pass.

Question 2

Part (a) was well answered with virtually everyone gaining full marks. Part (b) was usually well answered although some candidates did not show their path clearly or did multiple paths on the same diagram. A common mistake was to number the vertices (1 to 8) through their path; however two **distinct** paths were required. Candidates are strongly advised to write down their alternating path in addition to showing the path on their bipartite graph.

Question 3

Many candidates failed to indicate that Prim's algorithm had been used. Candidates must list the order in which edges are added to their spanning tree. Also a significant number of candidates started using the correct algorithm but failed to persevere to the end of the question with a loss of marks ensuing.

Question 4

This question discriminated between candidates. Although candidates must be able to apply their knowledge in questions, graph theory as a topic is important. The majority of candidates were able to attempt all parts but parts (a)(i) and (b) (ii) proved to be the most challenging.

Question 5

This question was reasonably well answered by the majority of candidates. Some candidates were able to correctly produce the trace table but made computational errors; others failed to write answers to 3 decimal places.

Question 6

Candidates scored well on both the first part and the nearest neighbour algorithm. Part (b) was reasonably well answered. It is clear that candidates can find lower bounds, however candidates must realise that the method involves adding the 2 shortest edges to a minimum spanning tree, and **not** twice the shortest edge. Part (c) showed a lack of understanding of lower bounds.

Question 7

All candidates were able to score on this question. Dijkstra's algorithm was correctly used in part (a) by the majority of students, but candidates **must** clearly show their working at each vertex. There were errors as candidates failed to apply the algorithm consistently throughout the network. Only the better candidates were able to correctly answer part (b) with many candidates simply writing down a route with no justification..

Question 8

All candidates were able to score on this question. Only the best candidates were able to produce convincing arguments in part (a). Parts (b) and (c) were well answered with diagrams being clearly drawn although a significant number failed to draw the objective line.

MD02 Decision 2

General

This was the first examination for the new specification and it was evident that many centres had not paid attention to the changes from the old Specification MAD2. In particular the application of dynamic programming to a minimax situation seemed unfamiliar to most candidates. Topics such as critical path analysis, the Hungarian algorithm, game theory and the Simplex method for linear programming seemed well practised. Candidates need to realise that obtaining a correct numerical answer will not necessarily score full marks if the steps of the algorithm are not clear in their working.

Question 1

Part (a) The explanations were very poor. Very few scored both marks for explaining that the transformation $20 - x$ produces a measure of wrong answers each person scores on the practice questions, thus allowing the Hungarian algorithm to be used since it now becomes a minimising problem.

Part (b) The row and column reductions were usually done well. Most candidates then attempted to cover the zeros with lines, but it was at this stage that many started to make mistakes in adjusting values. Quite a few aborted from the algorithm and tried to guess a suitable matching. Examiners cannot be expected to decipher an algorithm when candidates start crossing out figures in a matrix and replacing them with other figures; candidates need to show a sequence of matrices indicating the values produced by row and column reduction and further adjustment.

Question 2

Part (a) The explanation was intended to focus candidates' minds on the minimax situation but most candidates missed this strong hint. It was necessary to indicate that *SAET* has a maximum day journey of 9 whereas for *SADT* the maximum day journey is 10.
Part (b) Almost everyone was on autopilot to find the minimum time through the network instead of checking to see what was meant by optimal in this question. Those candidates who did not use stage and state were not able to score any marks at all in this part of the question. Candidates would do well to consider the solution in the mark scheme so as to have a good format for answering this type of question in the future. Some candidates do not seem to know the difference between dynamic programming and complete enumeration.

Question 3

This was a high scoring question for practically everyone. The activity network in part (a) was usually done correctly and candidates seemed well drilled in critical path analysis. Similarly, parts (b), (c) and (d) were answered correctly by even the weakest candidates. The explanation in part (d)(ii) was not always clear. Part (e) was meant to be a little more challenging, but only the weakest candidates failed to find the new earliest start time for activity *I* and the revised shortest completion time for the project.

Question 4

Part (a) The inequalities were often given as **"**equations**"** usually involving the slack variables. Quite a few wrote $<$, $>$ or $\geq$ instead of $\leq$.

Part (b) The Simplex method seemed to be well understood and, apart from a few arithmetic slips, the iterations were done correctly in part (i). The most successful were those who used fractions and elementary row operations. Some evidently have no idea of how the pivot can be identified, but these are clearly in the minority. Since the tableau in the question is the form which is likely to be given in future questions, it would be good for candidates to practise working with a grid in this form. Full credit was given for finding values of the variables in parts (ii) and (iii) provided that no negative values appeared in the top row of the final tableau.

Question 5

Part (a) It was necessary to work out the row minima and column maxima and then to **show** that the largest entry in the row minima was not equal to the least entry of the column maxima in order to demonstrate that the game had no stable solution. Candidates need to realise that all these steps in the working need to be shown in order to earn full marks.

Part (b) It was expected that candidates would have shown that elements of P_1 dominated corresponding elements of P_3 and so Pat should never play strategy P_3 .

Part (c) Most candidates attempted to find expected gains corresponding to Quigley playing the different strategies. These were usually calculated with Pat choosing P_1 with probability p and P_2 with probability 1–p, although some worked effectively by reversing these probabilities. It is advisable to state what p represents if this variable is introduced. Many of the graphs of expected gains were not drawn accurately enough so as to identify the critical point of intersection. Very few graphs had axes labelled showing the expected gain or payoff for Pat on the vertical axis and p ranging from 0 to 1 on the horizontal axis. It would seem that several candidates were selecting two of the three lines quite arbitrarily in order to find the value of p and hence the optimal mixed strategy for Pat.

Some candidates had been taught a method which produced the mirror image of the expected graph, but there was often a reluctance on the part of these to indicate whether p ranged from 1 to 0 or Pat was choosing P_1 with probability $1-p$. Consequently, it was difficult to know whether these candidates really understood what they were doing or whether they were simply drawing graphs using the numbers from the table.

Question 6

Part (a) A very common wrong answer for the value of the cut in part (i) was 44. This arose from assuming that the edge VY contributed 6 rather than zero to the value of the cut. A number of candidates wrote in part (ii) that the maximum flow was equal to the value of their cut and this response scored no marks.

Part (b) It was pleasing to see almost all the candidates finding the correct maximum possible flows along the two routes.

Part (c) The labelling procedure involves showing the flow already in the network, usually as a backward flow, together with the surplus potential flow as two distinct figures on the diagram. Candidates would benefit from seeing how the mark scheme indicates this with a suggested layout. A table was provided to indicate any flow augmentation and it is hoped that candidates will use such a table wisely in any future question of this type. When using the labelling procedure, the numbers on the network should be lightly crossed through so both the original and adjusted values can be clearly seen by the examiner. The setting out of the solution in part (i) needs much greater attention if candidates are to score full marks for using the labelling procedure in future examinations.

The value of the maximum flow in part (ii) was usually stated correctly but not always shown correctly on the diagram in the insert. Although a few made no attempt at the minimum cut, most were able to find this correctly. Some indicated this cut on a diagram; others indicated that the cut passed through the edges *UV, UY, XV, XY* ; still others listed the two sets of vertices { *S, U, X* } and {*V, Y, W, Z, T*} separated by the cut; each of these methods scored full marks.

Coursework

General

This was the first summer session for the 'new' specification and it was unclear whether this set of candidates will be typical of the population of candidates that will be seen in the future. The standard of the AS coursework seen was generally good with most candidates able to illustrate their understanding of the theory applied to a real life task. Not surprisingly, candidates continue to find the interpretation strand the most difficult of the four strands to score highly on. Many candidates still fail to express their results in a realistic context and many do not even state what their results actually mean in simple terms; they also fail to discuss why their results are not sensible, if that is the case.

There were a number of cases where errors on scripts were missed. The majority of these were numerical errors from calculations which had not been checked, but there were some cases of incorrect fundamental statements of theory which were ticked as correct. Centres are reminded that if errors are not highlighted on scripts (or even worse ticked) then this will very definitely affect the moderator's view of the marks awarded.

There were a number of centres where an adjustment to the marks was required. Primarily this was due to valuing scripts, usually where a significant piece of analysis had been done, as almost faultless; where in fact a number of the strands of the marking grid had not been properly addressed. It is understood that centres want their candidates to do as well as possible legitimately, but the distribution of marks from some centres with virtually every candidate getting a Grade A, although possible, was unrealistic and not justified by the quality of the scripts seen. It was pleasing to note that there were only a few centres where a serious misjudgement of AQA standards occurred.

There are still cases where the internal moderation procedures fail, leading to different standards being applied within a centre. If this was the case, it will be highlighted on the feedback form. Centres are advised to read their feedback forms carefully and act on the advice offered, particularly if a continuation form is completed. The forms highlight issues raised by moderators and must be seen in a positive, constructive way rather than a criticism of the centre.

Administration

The old adage about Mathematics teachers and making simple arithmetical errors seems to have held true for this series! There were a large number of incorrect additions noted by moderators. Centres are advised to double check their totals before submitting them to AQA. It is a requirement to send a Centre Declaration sheet for **all** units in a session signed **clearly** by the staff responsible for the assessment. A number of centres missed the AQA-set deadline for the submission of their scripts, although fewer than in previous years. Centres should mark scripts in **red pen** and candidates should only use pencil for diagrams.

Mechanics

At AS level there were many correct and appropriate calculations based on a good understanding of mechanical principles together with details of experiments and tables of results especially for 'Arctic Research' and 'Designing a Child's Slide'. Graphs should always be drawn to aid generalisation, interpretation and prediction. Please note that attempts using scale diagrams alone are not appropriate for the new specification and solutions using vectors and/or sine/cosine rule are expected. Candidates should be encouraged to check their mathematical model for realism by comparison with 'real-life' data; for example, check the reality of possible solutions in 'Basketball' to see if the ball is on its downward path as it passes through the hoop and check whether some speeds and heights are realistically possible. Occasionally, reports relied on extensive numerical work, done on a 'trial and improvement' basis, which was less successful in the main. A few candidates focussed discussion on the assumptions/modifications needed for their **experimental** model of the task and did not distinguish explicitly between that and their **mathematical** model, leading to inappropriate work. They should be encouraged to consider the effects of all their assumptions on the outcomes and suggest modifications for their mathematical model.

There were no attempts at the new kinematics task seen.

At A2 there were very few scripts seen.

Statistics

The work seen was generally of a good standard with a range of interesting individual responses to the tasks set. Many candidates showed sound understanding of the content of the unit. In particular statistical theory was threaded through at appropriate points by the best candidates. Ample data was collected and there were many correct and appropriate calculations. Diagrams helped with the interpretation of the overlap (or not) of confidence intervals and most candidates appropriately used more than one level of confidence. This is still an area, though, that most candidates find hard to analyse and where guidance and explanation by the centres is needed. Candidates should also be encouraged to explain in careful detail how their sample was collected and how it is random and representative. Good use, for sampling purposes, can be made of secondary data found on the internet.

The new task on correlation and regression proved to be very successful and was a good task for many candidates. It may be advisable for centres who have found difficulty with the Confidence Interval task to consider this option.

There were very few scripts seen at S2, so no meaningful comments can be made.

Centres are reminded that they must use one of the new tasks approved by the Board for S2. The specification has changed and some of the legacy tasks are no longer appropriate.

Mark Range and Award of Grades

Unit/Component	Maximum Mark (Raw)	Maximum Mark (Scaled)	Mean Mark (Scaled)	Standard Deviation (Scaled)
MPC1: Pure Core 1	75	75	47.0	19.2
MPC2: Pure Core 2	75	75	37.7	19.4
MPC3: Pure Core 3	75	75	47.2	17.4
MPC4: Pure Core 4	75	75	43.4	19.0
MFP1: Further Pure 1	75	75	49.7	17.8
MFP4: Further Pure 4	75	75	41.1	16.2
MS1A: Statistics 1A	-	100	52.4	18.6
MS1A/W: Statistics 1A Written	60	75	35.4	16.5
MS1A/C: Statistics 1A Coursework	80	25	16.9	4.0
MS1B: Statistics 1B	75	75	36.0	18.0
MS2A: Statistics 2A		100	74.5	13.1
MS2A/W: Statistics 2A Written	60	75	53.1	11.0
MS2A/C: Statistics 2A Coursework	80	25	21.1	2.7
MS2B: Statistics 2B	75	75	52.3	17.1

Mark Range and Award of Grades

Unit/Component	Maximum Mark (Raw)	Maximum Mark (Scaled)	Mean Mark (Scaled)	Standard Deviation (Scaled)
MM1A: Mechanics 1A	-	100	67.5	20.7
MM1A/W: Mechanics 1A Written	60	75	50.4	18.3
MM1A/C: Mechanics 1A Coursework	80	25	17.0	4.2
MM1B: Mechanics 1B	75	75	47.0	20.6
MM2A: Mechanics 2A	-	100	49.0	25.0
MM2A/W: Mechanics 2A Written	60	75	31.9	21.9
MM2A/C: Mechanics 2A Coursework	80	25	17.2	2.8
MM2B: Mechanics 2B	75	75	45.3	16.2
MM03: Mechanics 3	75	75	51.1	19.0
MD01: Decision 1	75	75	47.7	16.0
MD02: Decision 2	75	75	51.3	15.8

Unit MPC1: Pure Core 1 (9723 candidates)

Grade	Max. mark	A	B	C	D	E
Scaled Boundary Mark	75	61	53	45	38	31
Uniform Boundary Mark	100	80	70	60	50	40

Unit MPC2: Pure Core 2 (14205 candidates)

Grade	Max. mark	A	B	C	D	E
Scaled Boundary Mark	75	55	48	41	34	27
Uniform Boundary Mark	100	80	70	60	50	40

Unit MPC3: Pure Core 3 (2075 candidates)

Grade	Max. mark	A	B	C	D	E
Scaled Boundary Mark	75	60	53	46	39	33
Uniform Boundary Mark	100	80	70	60	50	40

Unit MPC4: Pure Core 4 (2009 candidates)

Grade	Max. mark	A	B	C	D	E
Scaled Boundary Mark	75	60	53	49	39	32
Uniform Boundary Mark	100	80	70	60	50	40

Unit MFP1: Further Pure 1 (1182 candidates)

Grade	Max. mark	A	B	C	D	E
Scaled Boundary Mark	75	59	51	43	35	28
Uniform Boundary Mark	100	80	70	60	50	40

Unit MFP4: Further Pure 4 (333 candidates)

Grade	Max. mark	A	B	C	D	E
Scaled Boundary Mark	75	56	48	41	34	27
Uniform Boundary Mark	100	80	70	60	50	40

Unit MS1A: Statistics 1A (651 candidates)

		Max. mark	A	B	C	D	E
Written Boundary Mark	raw	60	44	38	32	26	21
	scaled	75	55	48	40	33	26
Coursework Boundary Mark	raw	80	64	56	48	40	32
	scaled	25	20	18	15	13	10
Unit Scaled Boundary Mark		100	75	65	55	45	36
Uniform Boundary Mark		100	80	70	60	50	40

MS1B: Statistics 1B (6909 candidates)

Grade	Max. mark	A	B	C	D	E
Scaled Boundary Mark	75	56	48	41	34	27
Uniform Boundary Mark	100	80	70	60	50	40

MS2A: Statistics 2A (10 candidates)

		Max. mark	A	B	C	D	E
Written Boundary Mark	raw	60	49	42	36	30	24
	scaled	75	61	53	45	38	30
Coursework Boundary Mark	raw	80	64	56	48	40	32
	scaled	25	20	18	15	13	10
Unit Scaled Boundary Mark		100	81	70	60	50	40
Uniform Boundary Mark		100	80	70	60	50	40

MS2B: Statistics 2B (472 candidates)

Grade	Max. mark	A	B	C	D	E
Scaled Boundary Mark	75	63	54	46	38	30
Uniform Boundary Mark	100	80	70	60	50	40

Unit MM1A: Mechanics 1A (507 candidates)

		Max. mark	A	B	C	D	E
Written Boundary Mark	raw	60	50	43	37	31	25
	scaled	75	63	54	46	39	31
Coursework Boundary Mark	raw	80	64	56	48	40	32
	scaled	25	20	18	15	13	10
Unit Scaled Boundary Mark		100	83	72	61	51	41
Uniform Boundary Mark		100	80	70	60	50	40

Unit MM1B: Mechanics 1B (4386 candidates)

Grade	Max. mark	A	B	C	D	E
Scaled Boundary Mark	75	62	53	45	37	29
Uniform Boundary Mark	100	80	70	60	50	40

Unit MM2A Mechanics 2A (2 candidates)

		Max. mark	A	B	C	D	E
Written Boundary Mark	raw	60	47	41	35	29	24
	scaled	75	59	51	44	36	30
Coursework Boundary Mark	raw	80	64	56	48	40	32
	scaled	25	20	18	15	13	10
Unit Scaled Boundary Mark		100	79	69	59	49	40
Uniform Boundary Mark		100	80	70	60	50	40

Unit MM2B: Mechanics 2B (337 candidates)

Grade	Max. mark	A	B	C	D	E
Scaled Boundary Mark	75	59	51	44	37	30
Uniform Boundary Mark	100	80	70	60	50	40

Unit MM03: Mechanics 3 (81 candidates)

Grade	Max. mark	A	B	C	D	E
Scaled Boundary Mark	75	60	52	44	37	30
Uniform Boundary Mark	100	80	70	60	50	40

Unit MD01: Decision 1 (2935 candidates)

Grade	Max. mark	A	B	C	D	E
Scaled Boundary Mark	75	61	53	45	38	31
Uniform Boundary Mark	100	80	70	60	50	40

Unit MD02: Decision 2 (340 candidates)

Grade	Max. mark	A	B	C	D	E
Scaled Boundary Mark	75	61	53	45	38	31
Uniform Boundary Mark	100	80	70	60	50	40

Advanced Subsidiary Awards

Mathematics

Provisional statistics for the award (9842 candidates)

	A	B	C	D	E
Cumulative %	22.7	37.5	52.4	66.8	78.7

Pure Mathematics

Provisional Mathematics for the award (118 candidates)

	A	B	C	D	E
Cumulative %	39.8	58.5	72.0	81.4	84.7

Further Mathematics

Provisional Mathematics for the award (632 candidates)

	A	B	C	D	E
Cumulative %	43.7	65.5	78.2	86.9	91.3

Advanced Awards

Mathematics

Provisional Statistics for the award (1713 candidates)

	A	B	C	D	E
Cumulative %	28.8	49.9	67.7	84.2	94.7

Pure Mathematics

Provisional Mathematics for the award (3 candidates)

	A	B	C	D	E
Cumulative %	33.3	66.7	66.7	66.7	66.7

Further Mathematics (65 candidates)

Provisional Mathematics for the award

	A	B	C	D	E
Cumulative %	40.0	60.0	84.6	95.4	96.9

Definitions

Boundary Mark: the minimum mark required by a candidate to qualify for a given grade.

Mean Mark: is the sum of all candidates' marks divided by the number of candidates. In order to compare mean marks for different components, the mean mark (scaled) should be expressed as a percentage of the maximum mark (scaled).

Standard Deviation: a measure of the spread of candidates' marks. In most components, approximately two-thirds of all candidates lie in a range of plus or minus one standard deviation from the mean, and approximately 95% of all candidates lie in a range of plus or minus two standard deviations from the mean. In order to compare the standard deviations for different components, the standard deviation (scaled) should be expressed as a percentage of the maximum mark (scaled).

Uniform Mark: a score on a standard scale which indicates a candidate's performance. The lowest uniform mark for grade A is always 80% of the maximum uniform mark for the unit, similarly grade B is 70%, grade C is 60%, grade D is 50% and grade E is 40%. A candidate's total scaled mark for each unit is converted to a uniform mark and the uniform marks for the units which count towards the AS or A-level qualification are added in order to determine the candidate's overall grade.

Further information on how a candidate's raw marks are converted to uniform marks can be found in the AQA booklet *Uniform Marks in GCE, VCE, GNVQ and GCSE Examinations*.