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Contents

MPC1 Pure Core 1

General

It was pleasing to see many candidates well prepared for this unit presenting their solutions clearly. Those who did not do quite so well might benefit from the following advice.

- The mid-point of AB where A is (a, c) and B is (b, d) has coordinates $\left(\frac{a+b}{2}, \frac{c+d}{2}\right)$
- The minimum point of $y = (x-p)^2 + q$ has coordinates (p, q)
- When asked to prove that a printed equation such as "$x^2 - 2x - 3 = 0$" is true, it is important to include " = 0 "
- A quadratic equation has equal roots when the discriminant is zero ($b^2 - 4ac = 0$)
- When asked to use the factor theorem, no marks can be earned for using long division only.
- The rate of change of volume is given by $\frac{dV}{dt}$
- The condition for y to be decreasing is $\frac{dy}{dx} < 0$
- When solving a quadratic inequality, it is wise to use a sketch or sign diagram

Question 1

Many candidates earned full marks on this introductory question.
(a) Most candidates multiplied out the two brackets to obtain four terms. The most common error occurred in the last term, which was sometimes seen as –2 instead of–4. Very few candidates recognised that it was the difference of two squares.
(b) This part was less well done. Some candidates had problems simplifying $\sqrt{8}$ and $\sqrt{18}$ and wrote $2\sqrt{4}$ and $2\sqrt{9}$, for example. Some, having correctly converted both surds, added them incorrectly and so $6\sqrt{6}$ was quite common. A few candidates thought $\sqrt{8} + \sqrt{18}$ were equal to $\sqrt{26}$.

Question 2

(a)(i) Candidates used various methods to prove that $k = -2$. Some used the most direct method of substituting $x = 5$ into the given line equation and solving for y; some chose to verify that $x = 5$ and $y = -2$ satisfied the equation of the straight line. Others took a longer route; they found the gradient using (1,1) and (5,–2) and then found the equation passing through one of the points and proved it to be the given one.

(a)(ii) Most candidates knew how to find the midpoint of a line. A few made a simplification error and wrote $\left(3, \frac{1}{2}\right)$ instead of $\left((3,- \frac{1}{2}).\right)$ The common error amongst the weaker candidates was to subtract the coordinates instead of adding them.
(b) Many candidates gave fully correct answers here. However, some, having obtained $\frac{-2-1}{5-1}$ wrote $\frac{3}{4}$ as a final answer. A few candidates used $\frac{x_1 - x_2}{y_1 - y_2}$.

(c)(i) Most knew the gradient rule for perpendicular lines. However, not all could implement it since it involved the reciprocal of a fraction.

(c)(ii) At least half of the candidates found the equation of the line passing through the midpoint of *AB* instead of through *C*. (iii) Most realised the need to substitute $y = 0$ into their *AC* equation and solve for *x*, so they at least earned the method mark. Even those with the correct equation did not always earn two marks. Some had difficulty in simplifying $\frac{1}{3} \div \frac{4}{3}$.

Question 3

(a)(i) Most candidates were familiar with the idea of "completing the square" and answered this part satisfactorily. There were occasional sign errors and $+ 9 – 4$ was not always evaluated correctly.

(a)(ii) There were several correct answers although some wrote (5,-2) instead of (5,2). Some did not recognise the link between parts (i) and (ii) and chose to differentiate instead. This was a satisfactory, though more time-consuming, alternative method. Some earned no marks here as they wrote comments such as "5 is the minimum", with no link to the *y*-coordinate being 5.

(b)(i) This simple proof was usually well done. Occasionally the mark was lost due to the omission of " = 0"..

(b)(ii) Many scored full marks here. Most factorised the equation and obtained the correct *x*-values. Some made no further progress, while a few substituted into the given quadratic equation and obtained $y = 0$, instead of using the equation of the line or curve to find the values of *y*. It was encouraging to see many factorising the quadratic correctly. Those who used the quadratic equation formula or completion of the square often made more errors than those who factorised.

Question 4

(a) There were several completely correct proofs here. Some lost the last mark by concentrating on the discriminant but failing to equate it to zero. There was a little fudging by some; for example, some who wrote $–4(4m+1) = –16m+4$ still managed to obtain the correct printed equation.

Some of the weaker candidates found $b^2 – 4ac$ using numerical values from the equation they were supposed to establish.

(b) Almost all candidates found both values of *m* successfully. A few spotted just one answer and some factorised correctly and then wrote $m = –2$, $m = –6$, but they were in the minority.

Question 5

(a) Completion of the squares in the circle equation was carried out well once more. The most common error was a sign slip usually in the second term. Another error lay in combining the constant terms, so answers such as –14 and 11 were seen for r^2.

(b) Most earned the mark for the coordinates of the centre of the circle as this was a follow through mark. The mark for the radius was not always earned as some failed to take the square root or had an inappropriate answer such as a negative value for r^2.

(c)(i) Most found *CO* to be 5. However, a few neglected to square –3 and 4 before adding and some subtracted 9 from 16.

(c)(ii) This part was answered well with most realising the need to explain, using both lengths, why O lay inside or outside the circle. Some accompanied their explanations with diagrams, although this was not necessary.

Question 6

(a)(i) It was good to see that almost all candidates started correctly by evaluating p(2), though a few thought they needed to find p(–2) and others wrongly assumed that long division was the "factor theorem". It was necessary to write a conclusion or statement after showing that p(2) = 0 , in order to earn the second mark.

(a)(ii) The most successful approach here was by using a quadratic factor (ax^2+bx+c), though long division also worked well for many. A surprising number who found the correct quadratic then factorised it wrongly. Those who tried the factor theorem again rarely spotted both factors. A few lost the final mark by failing to write p(x) as a product of factors.

(b) Although there were many correct sketches, many lost a mark by failing to mark the point (0,8) on the y-axis. Candidates were expected to draw a cubic through their intercepts, to use an approximately linear scale and to continue the graph beyond the intercepts on the x-axis. It was common to see the negative values in the factors wrongly taken to be the roots and hence the intercepts on the x-axis.

Question 7

(a)(i) The differentiation was generally well done, though some candidates found the fractional coefficient problematic. Those who wrote $\frac{6}{3}t^5$ were not penalised in this part but writing $6.\frac{1}{3}$ generally led to errors later in the question. Some tried to avoid the fraction by considering $3V$ throughout the question, making errors, and suffered a heavy penalty.

(a)(ii) Again, most applied the method correctly and here simplification of coefficients was necessary. A few failed to differentiate $6t$ or omitted it altogether.

(b) This part was poorly done with many not recognising that the rate of change was $\frac{\mathrm{d}V}{\mathrm{d}t}$ and substituted $t = 2$ into the expression for V or $\frac{\mathrm{d}^2V}{\mathrm{d}t^2}$. Quite a lot of candidates made arithmetic errors. A few found two values of the expression and averaged them.

(c)(i) Again, many failed to evaluate $\frac{\mathrm{d}V}{\mathrm{d}t}$ in order to verify that a stationary point occurred, but those who did generally obtained a value of zero. It was essential to include a relevant statement to earn both marks.

(c)(ii) This required evaluation of the second derivative at $t = 1$ or an appropriate test. Candidates who tried to test the gradient on either side of 1 almost invariably failed, as the values used were too far away from the stationary point. A surprising number evaluated 10 – 24 + 6 to be –20 thus losing the accuracy mark. Some appeared to be guessing and drew wrong conclusions about maxima or minima after evaluating the second derivative.

Question 8

(a) Not everyone recognised that the height of the rectangle was the value of y when $x = -1$ or $x = 4$. Some who did made numerical errors. Even having found the height 4, some obtained the wrong area by taking AB as 4 or 2 (sometimes using Pythagoras' Theorem) or by finding the perimeter instead.

(b)(i) The integral was generally correct, though sometimes incorrect simplification occurred subsequently. A few integrated x^3 to $\frac{1}{3}x^4$ and a surprising number misread the integrand as $3x^2 - x^2$. There were also candidates who confused integration with differentiation or whose process was a hybrid of the two.

(b)(ii) Almost everyone recognised that they should firstly evaluate the integral from -1 to 2 , but most stopped there, instead of going on to subtract the value of the integral from the area of the rectangle. There were a lot of sign errors in the work with some adding instead of subtracting or putting the two parts the wrong way round. A few wrongly substituted in the original function. Those who chose to work with the differences of two integrals seldom completed it correctly.

(c)(i) Differentiation was done well on the whole.

(c)(ii) Many substituted $x = 1$ into the derivative to find the gradient of the tangent and went no further. Most did not find the y coordinate of the point and so made no attempt at the equation of the tangent. A few non-linear equations were seen with a 'gradient' of $6x - 3x^2$.

(c)(iii) Very few candidates completed this part. Many made no attempt, and those who did tended to test a few values of x or to find the second derivative, which was of no value.
Only the strongest candidates realised that $\frac{dy}{dx} < 0$ was the condition for y to be decreasing and that, after a couple of lines of algebra, the given inequality could be obtained.

(d) Although most made an attempt at the quadratic inequality, few obtained both parts of the solution. It was imperative that candidates wrote $x > 2, x < 0$ and not $0 > x > 2$ as many incorrectly stated.

It was disappointing to see how many candidates at this level could not solve the equation $x^2 - 2x = 0$, obtaining values such as -2, $\sqrt{2}$, $1+\sqrt{2}$. Using the formula or completing the square sometimes led to $1 \pm \sqrt{1}$, which many candidates failed to simplify.

MPC2 Pure Core 2

General

Presentation of work was again generally very 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.

Generally candidates found the paper more straightforward than in summer 2005 and there was evidence of improvement in answering similar questions.

Once again, too many candidates had not been reminded to complete the boxes on the front cover to indicate the numbers of the questions they had answered.

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

- Show intermediate answers to a greater degree of accuracy before rounding the final answer to the degree of accuracy asked for.
- To show that $\theta = 0.430$ correct to three significant figures, a more accurate value of θ needs to be shown in the working.
- The word 'translation' should be used when describing the transformation in Question 6(a)(iii). Some candidates wrote 'tr' but this was not considered to be clear enough to distinguish between 'transformation' and 'translation'.
- 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. To go from $\log_a \frac{n^2}{5n-24} = \log_a 4$ direct to the printed answer $n^2 - 20n + 96 = 0$ is a step omitted.

Question 1

Many candidates were able to differentiate y correctly but weaker candidates then had difficulty dealing with the negative index. The common error was to lose the negative sign in the power and write $16 - x^{-2} = 0$ as $16 - x^2 = 0$ which lead to the wrong values ±4. Some candidates applied the difference of two squares as the initial step in solving $16 - x^{-2} = 0$ with varying final success.

Question 2

Many candidates had a clear understanding of how to apply the trapezium rule but careless non-use of sufficient brackets resulted in a significant number of incorrect solutions. Other common errors were (i) to use $h = \frac{b-a}{n} = \frac{4-0}{5} = 0.8$ which suggests that the meaning of n in the relevant section of the formulae booklet was not fully understood (ii) to assume y_0 equals 0.
A number of candidates lost the final accuracy mark because they gave their final answer as 1.3294 or 1.33 Part (b) was generally answered well although some failed to read the question carefully enough and gave the incorrect answer 'Use integration'.

Question 3

A majority of candidates indicated that the method for solving equations of the form $a^x = b$ was well known. The most common errors are illustrated by (i) $\log x^{0.8} = \log 0.05$ (ii) $x = \dfrac{\log 0.8}{\log 0.05}$ (iii) answers 13.4 or 13.43 Part (b), which tested geometric series, although answered much better than the corresponding question in summer 2005, still indicates a general weakness in this area of the specification and the associated algebraic manipulation. It was not uncommon to see candidates using a specific value of *a*, either 1 or 20 or even 100, to solve the equation $\dfrac{a}{1-r} = 5a$. In the final part a significant proportion of the candidature used the formula for the sum to *n* terms rather than the formula for the *n*th term. Some better candidates obtained *n* = 14.5… , but failed to realise that *n* was an integer.

Question 4

For many candidates this was their best answered question. In part (a) weaker candidates seemed to be unaware of the formula $\frac{1}{2}ab\sin C$ for the area of the triangle but the most common reason for the loss of a mark was not showing a value for θ other than the printed value and hence not showing that the result was correct to three significant figures. It was disappointing to see some candidates quoting the cosine rule with sin θ instead of cos θ (candidates should be aware that the cosine rule is given in the formulae booklet) but in general this part of the question was answered very well. Most candidates were able to quote the correct formulae for arc length and sector area but some recalculated the area of the triangle, quite often not getting the value 20 as given in the question. Some candidates quoted and used the incorrect formula $\frac{1}{2}r^2(\theta - \sin\theta)$ to answer part (c)(ii).

Question 5

The candidates' solutions for this question would seem to suggest that they were either very familiar with the topic or had not met it before. Those who used the given values for the first three terms to form two equations in *p* and *q* almost always went on to solve the simultaneous equations correctly and to gain full marks to parts (a) and (b). Part (c) required the equation for *L* for any marks to be scored. In general, only the better candidates could answer the final part correctly. Partial credit was awarded in part (a) to those who used embedded values but many of these candidates only applied the process to one of the required equations and often assumed the value of *p* to find the value of *q* only, then to use *q* = 30 to 'show' that *p* = 0.6, the value they had already used. Candidates who had any knowledge of this topic generally obtained the correct value for u_4 in part (b).

Question 6

Most candidates were able to gain some marks in part (a). In (i) the common wrong answer was a stretch in the *x*-direction with scale factor $\frac{1}{2}$. In (ii) most gave a correct reflection and in (iii) many gave the correct vector or its equivalent but still some candidates are not using the correct word 'translation'. As previously stated, 'tr' was not accepted as a replacement for 'translation'.

Part (b) was not answered well. The usual common error, illustrated by '$\theta - 30 = 44.4$, $\theta = 74.4$ or $\theta = 180 - 74.4$' was seen too frequently. It was not uncommon to see candidates giving answers in all four quadrants. A more surprising error from the better candidates is illustrated by '$\theta - 30 = 44.4$, 135.6 so $\theta = 14.4$, 105.6'

Part (c) was answered well but the usual errors $(\cos x + \sin x)^2 = \cos^2 x + \sin^2 x$' and $(\cos x + \sin x)^2 = \cos^2 x + \sin^2 x + \cos x \sin x$' and the 'trig identity 'cos x + sin x = 1' were all seen.

Question 7

Although this question on logarithms was answered better than corresponding questions in summer 2005, the topic continues to be one which candidates find difficult. Many candidates gained credit for writing '2log n = log n^2' but then often made the error '$\log(5n - 24) = \log 5n - \log 24$'. In part (b) it was disappointing to find so many candidates unable to solve the quadratic equation. It was not uncommon to find solutions which involved the wrong factors of the form $(n \pm 24)(n \pm 4)$. In general, only the better candidates gave a fully correct solution for both parts of this question.

Question 8

This final question was a good source of marks for many candidates. Even the weaker candidates were able to give correct answers for parts (a) and (c) which tested standard C2 work on differentiation and integration. A significant minority of candidates started part (b)(i) by equating dy/dx to zero instead of substituting $x = 0$ to find the value of the derivative. Those who were able to answer the first two parts of part (b) correctly generally went on to find the correct coordinates of P. A significant number of candidates left their final answer as 24.3 without considering the area of the triangle *OAP* and carrying out the subtraction. For those candidates who attempted to find the area of the triangle some applied very lengthy methods which involved finding the length of each side of the triangle then using the cosine rule to find angle *OPA* then using the formula $\frac{1}{2}ab\sin C$ or involved the integration of the equations of the two lines. To their credit a number of such candidates did avoid premature approximation to reach the correct value for the area of the triangle which could have been obtained more directly by using $\frac{1}{2}OA \times |y_P|$.

MPC3 Pure Core 3

Candidates' performance:

The overall impression of the examination was that it was accessible to the majority of the candidates with few very low marks being seen.

Many candidates appeared to have been well prepared, being able to score very high marks. There was a very small number of scripts were candidates appeared to have run out of time but the majority of candidates seemed to have completed the paper.

General:

- candidates must ensure that their calculators are in the correct mode for trigonometrical functions.
- in questions on numerical methods, working should be to a greater degree of accuracy than the final answer
- if there is a given answer to a question then algebraic working should be precise e.g. no 'imaginary' brackets etc.
- parts of questions are often related and candidates should expect to use an answer from one part of a question in another part of the question

Question 1

(a) This was well answered although common incorrect answers were $3\sec^2 x$ and $\sec^2 3x$.

(b) Most candidates were able to apply the quotient rule but a large number of candidates were unable to correctly expand the numerator. A common response was $3(2x+1) – 2(3x+1) = 6x + 3 – 6x + 2$.

Question 2

This was reasonably well answered, although many candidates used 3 sf throughout their working and lost the final accuracy mark by giving an answer of 0.742. There were some candidates who used an even number of ordinates.

Question 3

(a)(i) This was reasonably well done, although some candidates integrated.

(a)(ii) Many candidates failed to appreciate the significance of part (a)(i) and obtained complicated incorrect expressions. Those candidates who did appreciate the relevance of part (i) either obtained the correct answer or $2\ln |x^4 + 2x|$.

(b)(i) This was fairly well answered. However, many candidates lost marks because they did not realise that in any substitution question, apart from replacing functions of x with functions of u, they have to find and use $\frac{du}{dx}$.

(b)(ii) The integration was very well answered by the majority of candidates with many accurately completing the question. Problems did arise through the use of incorrect limits. Many candidates converted their integration answers in u to terms in x and then used the original limits. This method was equally successful.

Question 4

(a) Candidates appeared to know the correct trigonometrical identity and this part was well answered.

(b) This was also well answered with candidates able to factorise the expression from part (a).

(c) This was reasonably well answered with most candidates obtaining two correct results and many fully correct answers seen. It was pleasing to see that there were very few candidates who used degrees. They were penalised.

Question 5

(a) The correct value of a was often seen, but $a = -9$ was a common incorrect answer. The majority of candidates gained the method mark in finding b, but a number of candidates then continued with incorrect manipulation of the exponential function.

(b) The majority of candidates answered this correctly.

(c) The majority of candidates knew the correct formula for the volume and went on to obtain either full marks or, in the case of a number of candidates who failed to substitute $x = 0$ correctly, the majority of the marks.

(d) The majority of candidates gained a method mark for trying to draw a modulus graph, but lost the accuracy mark due to failure to label the axes or due to an incorrect shape.

Question 6

This question was probably the best answered on the paper, with many fully correct solutions.
The only section where candidates lost marks was part (c)(i) due to incorrect calculations or rounding.

Question 7

(a) There were few completely correct attempts, with some candidates giving reversed coordinates, and several "coordinates" given without brackets

(b) Candidates frequently gained both method marks but lost the accuracy mark since their graphs tended to cross the y axis rather than touch it. Where candidates lost method marks it was usually for a translation in the y direction or for translating $\begin{pmatrix} -1 \\ 0 \end{pmatrix}$.

Question 8

(a)Well answered by the majority of candidates. The most common response by far was $x \geq 0$ which was not penalised on this occasion.

(b)(ii) Many candidates obtained full marks. However, a large number of candidates only found one solution because when they took the square root they neglected the negative answer.

(c)(i) This was reasonably well answered although some candidates failed to articulate their answer satisfactorily.
(c)(ii) This was very well answered by the majority of candidates although some lost the final accuracy mark as they ended up with $y = \frac{1}{x} + 2$.

Question 9

(a) Reasonable attempts were made by most candidates. The main mistake was finding the derivative of x^{-2} which was often seen as -2x^{-1}. This lost marks since candidates then 'found' the answer given by incorrect means.

(b) There were many fully correct answers but many candidates chose incorrect functions for u and $\frac{dv}{dx}$, with the obvious implications.

(c)(i) This was reasonably well answered, the main error seen being $1 - 2\ln x = x^3$.

(c)(ii) The majority of candidates obtained the method mark following through from their answer to part (b). Few candidates completed this question correctly.

MPC4 Pure Core 4

There many very good scripts with full, or near full, marks on most questions. Some candidates showed an impressive knowledge and understanding of the Specification, demonstrated in the high quality of their answers. There were relatively few poor scripts in which candidates showed little knowledge or understanding. Marks tended to be lost through algebraic and numerical inaccuracies rather than conceptual misunderstandings. Most candidates attempted all the questions in the order they had been set with only a few omitting questions or parts of questions. The presentation of the candidates' work was generally good although some who made deletions to their work would have benefited by doing so more tidily as it wasn't always clear what their intended answer was.

Question 1

Part (a) was done well with nearly all candidates getting the correct value of 0 for parts (i) and (ii), but in part (ii) some candidates were penalised for not explicitly evaluating power of -1 and so not obtaining the given answer convincingly. Most candidates attained the correct answer for part (iii) although some did considerably more work than others in gaining the marks. Some used the factors from parts (i) and (ii) to write down the values of *a* and *b* by inspection whilst others multiplied the three linear factors and then equated coefficients. Others used division either dividing by the quadratic factor or one or both of the linear factors.

Part (b) was generally done successfully with candidates opting for one of two methods. Of those who chose to use the remainder theorem, virtually all used $x = \frac{1}{3}$ correctly, but some made errors in the evaluation. Those who chose division were not so successful, some losing *d* completely, and some making simple errors having got to d-2 = 2 to d = 0 or d = 2. Sometimes a value for *d* was written down with no evidence, it appearing to be a guess.

Question 2

The great majority of candidates knew what was expected in part (a) but some made errors in attempting $\frac{d}{dt}\left(\frac{2}{t}\right)$; sign and coefficient errors being common and even $\ln t$ was seen. The chain rule was usually used correctly although a few multiplied the two derivatives or had the expression 'upside down'. Errors were sometimes made in simplifying the expression, with a sign error or 2 or 8 being seen instead of $\frac{1}{2}$, or the t^2 term moving to the top line.

Candidates generally showed they knew how to find the equation of a straight line in part (b) using their gradient from part (a) although a few found the normal rather than the tangent. Some candidates lost a mark through not giving their final answer in the requested form, or did not notice that their *a*, *b*, *c* were not integers, particularly those few who had a ln term in part (a). Part (c) was usually started well but not always finished convincingly, as the answer was given and sufficient working not shown.

The question did request a verification of the given answer rather than requiring it to be shown, but few candidates did it by the most efficient method of demonstrating $-4t \times \frac{2}{t} = -8$. There were many good answers using the elimination of t, although some candidates were too quick to write down the given answer without showing fully where it had come from.

Question 3

Parts (a) and (b) were done well and there were few errors, although some did make a sign error in finding angle α but didn't respond to the given answer, and just made a comment about it being an acute angle 'so is positive'.

Part (c) was found difficult by many candidates. Although most realised they were to use the results of part (a) rather than calculus, they confused the cosine having a maximum of 1 with the maximum value of the expression. Some candidates who had shown the maximum occurs at –33.7°, then subtracted from 90° or 180° to get a positive angle.

Question 4

This question was answered very well with most candidates gaining nearly full marks.

In part (a) many wrote £80 instead of just 80 but this was accepted.

Part (b) was mostly done accurately with many getting to $k = \sqrt[56]{62.5}$ which was accepted as *showing that*. Those who used logarithms lost a mark if they didn't show how $\log 62.5 = 56 \log k$ led to the given value of *k*.

Virtually all candidates got part (c) correct, with both the approximate answer 200707 and the more exact 200648 being seen, often with several decimal places attached, but this was of no matter as candidates had demonstrated a value greater than £200,000. In part (c)(ii) there were occasional errors although most candidates used logarithms to derive 124.7 correctly whilst a few used trial and improvement to deduce 125. However, many lost the last mark in incorrect interpretation of the year, or through not actually giving a year. The year 2025 was the common wrong answer.

Question 5

This question was usually done very well, with many candidates scoring highly. Binomial expansions and use of partial fractions were seen to be generally well known with most of the algebraic manipulation being done accurately. Most knew the result for part (a) (i) although some made errors with the sign of the *x* term and lost both marks. In part (ii) most made the expected start of $\frac{1}{3}\left(1 - \frac{2}{3}x\right)^{-1}$ and then gave a detailed expansion rather than use the result from part (i) with $\frac{2}{3}x$ replacing *x* in their expansion. Some candidates had 3 where $\frac{1}{3}$ should be, it just '*becoming*' $\frac{1}{3}$ to get the given answer. A few candidates manipulated powers of 2 and 3 for no good reason other than to achieve the given answer, most unconvincingly. Some used the expansion of $(a + bx)^n$ from the formula book, often successfully but the few who attempted to use $\binom{n}{r}$ with $n = -1$ gained no credit. The response to part (b) was similar to that in part (a) (i). Most candidates knew how to start part (c) although the accuracy of the algebraic expression written down often left something to be desired. Those who substituted $x = 1,\ x = \frac{3}{2}$ and $x = 0$ were usually more successful in getting A, B and C correctly than those who multiplied out and set up simultaneous equations by equating coefficients. Solutions to these equations were often just written down with no working seen. This gained full credit if they were correct, but usually none otherwise. Most attempted part (d) using the results from previous parts of the question. Many did this correctly although some made algebraic or numerical slips and some candidates used the reciprocals of *A*, *B* and *C*. A few did not use their partial fraction expression but multiplied out the product of the series directly often resulting in an algebraic error.

Question 6

Part (a) was usually correct. Some candidates just wrote the result down whilst others derived it from $\cos^2 x - \sin^2 x$. The common error was to have $2\cos^2 x + 1$, or the 2 missing. There were many fully correct responses to part (b) and nearly all candidates made some attempt to make use of the double angle in their integration. Accuracy sometimes slipped with the $\frac{1}{2}$ attaching to the $\cos 2x$ term only. Virtually all candidates gave evidence of correct use of limits, but those who didn't obtain the requested form of $\frac{\pi}{a}$, showed no attempt to find their error.

Question 7

In part (a)(i) the vector $\overrightarrow{AB}$ was often just written down with no working shown, although sign errors were permitted for the method mark.

In part (a)(ii) many candidates just wrote $\begin{bmatrix}4\\4\\0\end{bmatrix} = 4\begin{bmatrix}1\\1\\0\end{bmatrix}$ with no explanation as to how this answered the question. A reference to having the same direction vector, or gradient, was expected.

There was a mix of responses to part (a) (iii). The most convincing were those in which candidates set up two equations and derived the value of λ from one of them and showed it satisfied the other. Some made a comment on the third equation, $-1 = -1$ although this wasn't required. Some candidates wrote $\begin{bmatrix}-4\\-4\\0\end{bmatrix} = -4\begin{bmatrix}1\\1\\0\end{bmatrix}$ without any convincing explanation of why it showed point *D* lies in the line, although some partial credit was often awarded, depending on the explanation.

For part (b) (i) most candidates showed they knew they had to find the direction vector $\overrightarrow{MD}$, although some made numerical errors in doing so. Many candidates omitted to write '**r** =' in writing down the equation of the line, with $l_2 =$, or *line is* or just the vectors, being common poor notations which were penalised. For part (b) (ii) virtually all candidates knew a scalar product was involved, although some chose incorrect vectors, using points rather than directions. Some who used the correct vectors and correctly evaluated the scalar product as 0, still calculated the moduli of the vectors, although all knew a zero value implied 90°. A correct angle often followed an arithmetic slip in the scalar products and this was given partial credit.

Question 8

Most knew in principle that they were to separate the variables and integrate, but there was a lot of mishandling of the $(x-6)^{\frac{1}{2}}$ term. Most candidates integrated $\mathrm{d}t$ correctly, and included a constant, and so were able to show they could use the initial conditions to find a value for the constant even if their *x* term was incorrect. Common errors in the integration of the *x* term were in the coefficient of $(x-6)^{\frac{1}{2}}$ or multiples of $(x-6)^{\frac{3}{2}}$ or $\ln(x-6)^{\frac{1}{2}}$.

Some candidates who had done all the integration correctly failed to give their final answer in the form requested.

For part (b) most candidates showed they understood the context through making a sensible comment in part (i), although a few thought it meant the tank was empty. Those who just stated $\frac{dx}{dt} = 0$ gained no credit.
In part (b) (ii) quite a few candidates lost the marks because they used $x = 48$ (70-22) rather than $x = 22$. However, there were many candidates who gave good full answers to this question even if a few lost sight of the correct units for the final answer. This was condoned.

MFP1 Further Pure 1

General

There was a high proportion of excellent performances, and only a relatively small number of candidates who seemed unprepared for the demands of the paper. The level of algebraic competence was high, as shown by a good number of faultless solutions to Question 8, but there were many careless slips in Questions 4(c) and 5, and more serious errors in Question 3, even by those who showed familiarity with general solutions of trigonometrical equations. Candidates for MFP1 should be aware of the following points:

If the question says that **a certain method** (eg linear interpolation) is to be used, then no marks can be expected for using other methods (eg Newton-Raphson). Candidates should know the **general solutions** for the equations $\sin\theta = \sin\alpha$, $\cos\theta = \cos\alpha$, and $\tan\theta = \tan\alpha$, and should be able to adapt these to find general solutions for x, when θ is of the form $(px + q)$.

If the question uses **degrees**, then **radians** should not be used in the answer, and vice versa.
If a **proof** is asked for, then the result should not appear until the end of the reasoning, and even then only if the reasoning genuinely leads to that result. If, on the other hand, the question asks for a statement to be **verified**, then the statement can be used in the answer. If there are only two marks for a part of a question (eg Question 5(a)(ii)), then candidates should be alerted to the fact that a whole page of working is **not** required. **Differentiation** should **not** be used in a question on MFP1 involving straight lines being tangents to curves. Candidates should use the **theory of quadratic equations** to find a condition for a quadratic equation to have equal roots as stated in the Specification.

Question 1

Most candidates obtained full marks in part (a) of this question, though some lost the second mark because of a failure to mention the change of sign between f(0.5) and f(1). In part (b) the success rate was not quite as high, though a good number of candidates confidently quoted a correct formula for linear interpolation, while others drew a diagram and formed appropriate equations from which to find the correct answer. Some attempts were only partially correct, while many candidates showed no knowledge whatever of linear interpolation and tried other methods, gaining no marks.

Question 2

There were many faults in the attempts at integration in this question, especially in part (a)(ii). Those who succeeded in the integration often failed to obtain full credit as they did not realise that $0^{-\frac{1}{2}}$ had no finite value. Part (b) was not well answered, even those who had succeeded in part (a)(ii) often failing to identify the feature that made the integrals 'improper'.

Question 3

This was the worst-answered question on the paper, with otherwise excellent candidates presenting error-strewn attempts. A very common error was to equate $\sin(4x + 10^\circ)$ to $\sin 4x + \sin 10^\circ$. A term such as $360n^\circ$ or $180n^\circ$ usually appeared in the working at some stage, but often at an inappropriate stage. Most candidates performed some algebraic manipulation to make x the subject of their equation(s) but even here some extraordinary errors were made. Some of the more successful attempts ended with the solution $(10 + 90n)^\circ$, omitting the other possibility $(30 + 90n)^\circ$. A good number of candidates quoted the solution for $\sin\theta = \sin 50^\circ$ correctly as $\theta = 180n^\circ + (-1)^n(50^\circ)$, but even then they were not always successful in deducing the general solution for x.

Question 4

Parts (a) and (b) of this question were generally well answered, though some otherwise good graphs did not pass through the origin as required. The inequality in part (c) was not tackled at all well. Few candidates seemed to realise that a good graph allowed them to read off the answer, the only further detail required being to ascertain the value of x for which $y = 3$. A distressingly large number of candidates simply multiplied both sides of the inequality by the denominator $(x - 1)$. Those who adopted sounder methods often arrived at the statement $x^2 < 1$, but then showed a lack of mathematical awareness by drawing a meaningless conclusion such as $x < \pm 1$.

Question 5

Part (a)(i) was answered well by the majority of candidates, though the fourth term in the expansion often appeared as $-\mathrm{i}^2$ instead of $-\mathrm{i}^2\sqrt{5}$, and $-\mathrm{i}^2$ was frequently simplified to -1 in the next line.

The next part, (a)(ii), tested the candidates' knowledge of technique to some extent. Those who understood what they were being asked to do invariably realised that the necessary hard work had already been done in part (a)(i), so that very little writing was needed to pick up two further marks. Those who thought they had to prove, rather than verify, the given statement were awarded one mark for showing a knowledge of the conjugate of z, but then spent much valuable time trying to solve the equation. There were three indications that this was not what the question required: the word 'Hence', the word 'verify', and the award of only two marks.

Part (b) of this question was generally well answered, though some candidates did not seem to be aware of the implications of the statement that the coefficients in the quadratic equation were real. The answers to part (b)(ii) were sometimes given in terms of p and q, and in part (b)(iii) many candidates equated p to the sum of the roots instead of to this number preceded by a minus sign.

Question 6

Very high marks were scored in this question. With few exceptions the values in the table and the points on the graph were accurately given, the work on logarithms was done well, and in part (d) the candidates showed an awareness that the gradient of the graph was needed. Sometimes an unfortunate choice of points was used as the basis for the calculation of this gradient.

Question 7

Many candidates were successful in part (a)(i) of this question. Wrong answers usually involved a 180º rotation or a reflection in $y = x$. Part (a)(ii) was nearly always done correctly, but the explanations offered in part (a)(iii) were often wrong or too vague to be worth a mark. The matrix calculations in part (b) were done well apart from occasional careless slips. Some candidates seemed to think that three marks were being offered in part (b)(ii) for merely quoting the same answer as in part (b)(i), while others attempted to use matrix algebra to express $(\mathbf{B} + \mathbf{A})(\mathbf{B} - \mathbf{A})$ in an alternative form before evaluating their expression. This usually led to a wrong answer.

Question 8

Marks were often lost in part (a) by a sketch which showed only the upper part of the parabola, or by the appearance of a cusp at the origin instead of a smooth curve touching the y-axis.

Part (b)(i) was also answered incorrectly by many candidates, who inserted + 2 or − 2 in inappropriate places. The transformation in part (b)(ii) was better known.

In part (c) many candidates sailed through all the parts in good style and picked up ten marks out of ten. Part (c)(i) was a particularly straightforward test for almost all the candidates. In part (c)(ii) a common mistake was to give the discriminant as $(2c - 12)^2 - 4$, ignoring the c^2 which was the constant term of the quadratic in part (c)(i). Some candidates omitted the y-coordinate in part (c)(iii), or gave it as ±6. Part (c)(iv) provided most candidates with the opportunity to end on a high note with a brief but correct response.

MFP2 Further Pure 2

General

The paper proved to be readily accessible to nearly all candidates and it was pleasing to note that a few candidates scored full marks. At the other end of the scale very few candidates produced work of little value. It needs to be stressed however, that full marks for a question or part of a question with a printed answer cannot be awarded without a suitably convincing argument.

The standard of presentation of work was good.

Question 1

There were many fully correct answers to this question. A few candidates did not spot the connection between the parts (a) and (b). Otherwise, the only errors in part (b) were errors of sign leading to the answer $1+\frac{1}{(n+1)^2}$ or the summation of n +1 terms rather than n terms of the given series.

Question 2

Candidates were also able to achieve good results on this question. In part (a), where errors occurred they were almost always errors of signs. For instance the value of p was given as 2 instead of –2 or the formula for $\left(\sum\alpha\right)^2$ was incorrectly quoted as $\sum\alpha^2 - 2\sum\alpha\beta$. There were fewer completely correct solutions to part (b) often due to inelegant methods of solution. The most successful candidates obtained the values of the other two roots and then worked out the product $\alpha\beta\gamma$. The main loss of marks using this method was to equate r to $\alpha\beta\gamma$ instead of $-\alpha\beta\gamma$. The other main method of approach to this part of the question was to substitute 3 + i into the cubic equation with the values of p and q already found in part (a). However any error in the values of p and q or in the substitution inevitably led to r having a complex value. Surprisingly this did not seem to worry the candidates in spite of the fact that the question stated that r was real.

Question 3

Part (a) was well done, as was part (b). In part (c) it was surprising to note how many candidates could not express the complex number in the form $re^{i\theta}$, although z_2 was almost invariably correctly written as $e^{i\frac{\pi}{3}}$ Errors in part (c) however did not deter candidates from drawing a correct Argand diagram as they usually used the form $\boldsymbol{a} + \mathrm{i}\boldsymbol{b}$ when plotting their points. Although the vast majority of scripts ended with $\tan\frac{5\pi}{12} = 2+\sqrt{3}$, very, very few candidates gave convincing proof that arg $\left(z_1+z_2\right)$ was $\frac{5\pi}{12}$, but rather seemed to take it for granted.

Question 4

Responses to this question were only fair. Although candidates had some idea of what was required for the inductive process, in part (a) they appeared to be easily confused. Common statements were for instance $\left(k+2\right)2^k = k2^k$ or $\left(k+1\right)2^{k-1} + \left(k+2\right)2^k$ or to even write down correctly $k2^k + \left(k+2\right)2^k$ but without any reference whatsoever as to what the expression represented. In part (b), unless candidates realised that the given series was the difference of two other series no progress was made and only a few realised the connection with part (a). A common approach was to try and prove this result by induction also.

Question 5

Most candidates realised that the locus in part (a) was a circle although it was frequently drawn in an incorrect quadrant, and occasionally with a radius of 2 rather than a radius of 4. The correct answer to part (b) was usually obtained although sometimes with a less than convincing argument. There were relatively fewer correct solutions to part (c). Those candidates who addressed the geometry of the figure were the most successful, but those who converted the equations of the circle and line into the Cartesian form and then attempted to solve a pair of simultaneous equations usually abandoned their solution after making algebraic errors.

Question 6

Parts (a) was quite well done and many candidates scored the available seven marks. There were however some serious algebraic errors, the commonest of which was to equate $z^2 + \frac{1}{z^2}$ to $\left(z + \frac{1}{z}\right)^2$ in part (a)(ii) with some consequent faking to arrive at the printed result in part (a)(iii). Part (b) however was very poorly attempted. Candidates did not seem to realise that z could be equal to zero and consequently multiplied $(\cos\theta + \mathrm{i}\sin\theta)^2$ by $4\cos^2\theta - 2\cos\theta$. Of those candidates who realised that $4\cos^2\theta - 2\cos\theta$ was equal to zero, the factorisation of this quadratic in $\cos\theta$ evaded most and, even when attempts were made to solve $4\cos^2\theta - 2\cos\theta = 0$, the factor $\cos\theta$ disappeared and the other solution $\cos\theta = \frac{1}{2}$ usually produced just one root from $\theta = \frac{\pi}{3}$. Candidates who were able to obtain both $\cos\theta = 0$ and $\cos\theta = \frac{1}{2}$ usually produced only two solutions and subsequently two roots. It did not seem to occur to candidates that a quartic equation would have four roots.

Question 7

Candidates were generally well drilled in proving the identities of parts (a)(i) and (a)(ii) although in (a)(ii) sometimes($\left(\mathrm{e}^{\theta} - \mathrm{e}^{-\theta}\right)^2$ was written as $\mathrm{e}^{2\theta} + \mathrm{e}^{-2\theta}$ with the same result from $\left(\mathrm{e}^{\theta} + \mathrm{e}^{-\theta}\right)^2$, thus obtaining the correct answer from incorrect algebra. Part (b)(i) was usually quite well done so long as candidates did not write $\cosh^3\theta$ as $\frac{1}{8}\left(\mathrm{e}^{\theta} + \mathrm{e}^{-\theta}\right)^3$. Those who worked in powers of e^{θ} and $\mathrm{e}^{-\theta}$ found it impossible to reconcile their formula with the printed result and so make little meaningful progress. Part (b)(ii) proved to be beyond all but the most able candidates. The required integral, $\int \frac{3}{2}\sinh 2\theta\sqrt{\cosh 2\theta}\,\mathrm{d}\theta$, was tackled successfully by these candidates by a variety of methods. Some spotted the integral, others used the substitution $u = \cosh 2\theta$ whilst others again integrated by parts.

MFP3 Further Pure 3

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.

There were many excellent scripts although there were signs that some candidates did not appear to understand the method of solving a first order differential equation by using a complementary function and a particular integral. There were only a few poor scripts seen for this examination.

Candidates usually answered the questions in numerical order and appeared to have sufficient time to attempt all the questions.

Too many candidates had not been reminded to complete the boxes on the front cover to indicate the numbers of the questions they had answered.

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

- Where a method is specified in a question and the phrase 'or otherwise' does not appear, candidates are expected to use the given method in their solution. For example, Question 3(b) required implicit differentiation and Question 4(b) required candidates to use Maclaurin's theorem rather than quote and use the series expansions for e^x and $\sin x$.

- 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 examiners expected to see a further step between $e^{-\ln x}$ and the printed result $\frac{1}{x}$ in Question 5(b)(i).

- Candidates are expected to show the limiting processes used in the evaluation of improper integrals.

Question 1

The majority of candidates gained at least ten of the twelve available marks for this opening question which tested the solution of a second order differential equation. Part (a) caused few problems although there were a few who had difficulty simplifying $\frac{\sqrt{4-8}}{2}$ correctly. The most common method error in the question occurred in part (b)(i). These candidates considered a particular integral of the form 'ax' instead of the correct form '$ax + b$'. In general, candidates were able to apply the given boundary conditions in a correct manner.

Question 2

Most candidates applied integration by parts correctly in part (a) but it was disappointing to see a significant minority not attempting to substitute the given limits. The standard result required in part (b) was well known. In the final part, although many showed the limiting process used, a significant number of candidates just replaced x by ∞ without comment.

Question 3

A significant number of candidates attempted to solve the differential equation by using an integrating factor. Some were clearly mixing up 'integrating factor' with 'particular integral' as their solutions stated 'particular integral = $e^{\int \frac{2x}{x^2-1} dx}$' whereas others seemed to almost go onto 'auto-pilot' as they just solved the differential equation without reference to a particular integral or implicit differentiation. For full marks the examiners expected candidates to justify that the solution given in part (b) was indeed the complementary function. A statement linking one arbitrary constant with the general solution of a first order differential equation was required.

Question 4

A common error in part (a) was to write the expansion of $\ln(1-x)$ as the expansion of $-\ln(1+x)$. It was disappointing to see so many candidates failing to use Maclaurin's theorem to answer part (b) especially as almost an identical question appears in the specimen paper for this unit. Those who did differentiate $f(x)$ generally obtained the first two derivatives correctly but then had difficulty when differentiating $\cos^2 x\ e^{\sin x}$. A significant minority of candidates failed to use the approximation for $\sin x$ in part (c).

Question 5

This question was a good source of marks for many candidates. The methods in part (a) were well understood and most candidates worked accurately to obtain the correct approximations. In part (b)(i) a high proportion of the candidates obtained the printed answer but some failed to show sufficient stages in their working. In part (b)(ii), weaker candidates could not integrate $\ln x$; such candidates frequently gave the answer as $\frac{1}{x}$. Those who inserted the constant of integration were generally able to apply the given boundary condition. Surprisingly, not all candidates who obtained the correct solution for part (b)(ii) were able to give the correct value for y in part (b)(iii).

Question 6

Those candidates who used $y = r\sin\theta$ and $x^2+y^2 = r^2$ had no problem reaching the printed answer in part (a). In part (b), although almost all candidates started with a correct integral for the area bounded by the curve, errors in the squaring of $2\sin\theta + 5$ were not uncommon. The method for integrating $\sin^2\theta$ was well understood but sign errors in the subsequent integration were seen. In the final part of the question, many candidates applied a correct method to find the points of intersection P and Q but a significant number could not present a valid method to find the area of the quadrilateral.

MFP4 Further Pure 4

General

Just over 200 candidates sat this paper. As far as it can be judged, all managed to attempt all the questions on the paper within their scope.

My overall impression of the candidature is that they were a reasonably capable group of mathematicians and that, with a little more practice on the appropriate standard of questions and a little more examination-maturity, would have been capable of gaining very high marks indeed. Sadly, despite showing excellent promise, few managed to attain marks above 60, due largely to a shortfall in one of two areas. In the first case, many candidates produced excellent work in response to most of the questions, but seemed to be uncertain as to what was required in one or two others. Thus, when they lost marks, they lost five or six at a time. In the other case, there were candidates with a good spread of knowledge and understanding, but who didn't quite grasp ideas in depth and so tended to lose two or three marks on each of four or five questions. Around half of the entry fell into one of these two categories.

Question 1

This was a straightforward starter to the paper, requiring the use of information supplied in the *Booklet of Formulae.* It was very rare to find a candidate who failed to score all three of the marks available here.

Question 2

This was another straightforward question, and almost all candidates scored highly on it. Apart from a very few who multiplied to get **PQ** first, most were happy to use the result det **PQ** = (det **P**)(det **Q**) to get the required quadratic and find the two values of *k*.

Question 3

This was one of the questions which candidates with a weak grasp of the underlying ideas behind topics found difficult. Part (a)(i) can be done either by a single vector product or by two scalar products. A large number of candidates then used one of the plane's two direction vectors, rather than the position vector of the point (2, 5, 1) which lies in the plane Π, to find the scalar constant *d* required. This is one of several fundamental errors made by candidates.

Part (b) was a straightforward test of the alternate form of a line equation, yet it was frequently answered in unconvincing ways. The instruction to "verify" – that is, to substitute the given expression for **r** into the given equation for *L* – was clearly not understood by many. The perfectly allowable alternative approach is to explain the role of the line's direction vector and show that the point (2, 2, 5) is a point on the line. Many candidates managed one or the other but there was often a confusing amount of vector algebra and arithmetic presented with no apparent purpose and absolutely no explanation. Such vague approaches usually gained one of the two marks, but not both.

Part (c) was generally done quite well, as there are at least three approaches, at least one of which does not require successful progress in any previous part of the question.

Question 4

This was a much more popular question, but even here the two parts of the question requiring explanation showed up candidates' inability to explain clearly what was going on. In part (a)(ii), candidates were given the choice of "dependent" or "independent" for one mark. It is naïve for candidates to put either answer down **without explanation**.

Question 5

In part (b), the determinant of the transformation matrix is the scale factor of area enlargement under T – very few candidates used the key word "area" here. In part (d), having found the image of $(x, -x + c)$ to be $(x', y') = (3x - c, 2c - 3x)$, which many successfully did, candidates were supposed simply to show that $y' = -x' + c$. Few candidates understood that this was what was required.

Traditionally, describing transformations is very poorly done, and this was no exception. There was a lack of understanding as to how the algebra, matrix algebra and coordinate geometry all tie together with the geometry of transformations, and some more practice was needed for most candidates on this score.

Question 6

This question was a good source of marks for most candidates, although few managed to achieve full marks on it. Only around 50% of candidates knew how to manipulate determinants using row and/or column operations, although many got by on a much simpler level by expanding the determinant out to begin with, multiplying out the three brackets $(a - b)(b - c)(c - a)$, and showing that they gave the same expression. This is a valid and acceptable approach, even though not the intended one. Even so, many thought they could get away with expanding the determinant and then just saying that this was equal to the given answer $(a - b)\ (b - c)\ (c - a)$. They got two of the five marks available here. For future reference, it should be noted that handling determinants of higher order than a cubic is very unlikely to be done successfully by candidates using alternate approaches such as those described here and that straightforward row and column operations will be required to extract factors.

Answers to parts (b)(i) and (ii) were often poorly explained, despite being relatively straightforward in principle.. A pleasing number of candidates realised that they could use the answer to part (a) in part (b)(i). Three of the five marks for part (b)(iii) were straightforward and most candidates got as far as $z = 2.5$ and $x + y = -1.5$.

Disappointingly, an overwhelming majority stopped here, failing to write the solutions in any obviously acceptable parameterised or vector line form, such as $(x, y, z) = (t, -1.5 - t, 2.5)$ or equivalent. Many, implicitly or explicitly, suggested that $x + y = -1.5$ is the equation of the line solution. Any candidates who *explained* why the answer $z = 2.5$ and $x + y = -1.5$ will suffice would, of course, have scored full marks, but satisfactory explanations were very few and far between.

Question 7

Candidates generally managed the first twelve marks on this question without much difficulty, even if they chose to ignore the question's structure and go about things in their own way. The final two parts of the paper were deliberately more demanding, requiring candidates to understand that the eigenvalues/eigenvectors of a matrix enable matrix multiplication of certain vectors to be replaced by a scalar multiplication, Amongst those who seemed to have a good idea of what was going on, the requirement to explain why the final answer was valid for "positive **odd** integers n" proved beyond them, largely due to a widespread inability to notice that $(-2)^n$ and -2^n are different.

MS/SS1A/W Statistics 1

General

The overall performance of candidates on this paper was very impressive with 20% scoring at least 50 (raw) marks and only 10% failing to achieve at least 20 (raw) marks. This improved performance suggested that most centres had noted, from previous papers, the effects of the change in specification on the paper's composition and, from published mark schemes and reports, the responses expected.

Most candidates attempted the questions in the order printed and completed their solutions to each question at the first attempt. Consequently, it was thankfully rare to find part answers to a question spread throughout an answer booklet. Presentation of numerical work was usually clear and to a sufficient level of accuracy. However, some candidates' atrocious spelling and grammar made an understanding of descriptive answers almost impossible, particularly when combined with almost illegible handwriting!

Many candidates made good use of the statistical functions on their calculators (particularly in Questions, 1 and 4) and correct and appropriate use of Tables 1, 3 and 4 in the supplied booklet. A significant number of candidates spent valuable time on unnecessarily lengthy calculations in finding regression and correlation coefficients. A comparison of responses to questions that were also on the MS1B paper suggested that skills, developed in undertaking the coursework associated with this unit, were not transferred to the written paper.

Finally, from responses to Question 3(a), some candidates from a minority of centres appeared unaware of the formula for (sample) variance; sometimes even for sample mean. This was inexcusable, particularly as a formula for variance is given on page 12 of the supplied booklet. Teachers should note that similar summarised information may be provided in questions involving correlation or regression. However in all cases the information will be provided in a form that matches directly a relevant formula in the supplied booklet.

Question 1

Many candidates found correct values for a and b using the statistical functions on their calculators although too many such candidates quoted b to only two decimal places. In a significant number of cases values for a and b were interchanged. Where candidates used the formulae supplied, answers were generally sound although, in particular, too many candidates were of the impression that $\sum xy = \left(\sum x\right)\left(\sum y\right)$. Answers to part (b) were often incorrect or even non-existent. Candidates often simply identified them as 'intercept and gradient' without any reference to the context. Where an attempt at context was made, answers were in fact often explanations of y rather than a or b. A minority of candidates, perhaps through their own part-time employment, attempted explanations based upon personal knowledge rather than on the information given in the question! Apart from a few weak candidates, who could not apply the correct order of arithmetic operations to their calculation [$y = (a + b)x$], part (c) was answered correctly. In part (d), many candidates commented on the reliability of estimates using the words "interpolation" and "extrapolation" but few candidates made correct use of the information given about the residuals.

Question 2

This was a very high scoring question with many candidates scoring full marks. Only parts (a)(iii) & (b)(ii) presented any noteworthy difficulties. In the former, candidates sometimes evaluated the probability for 'exactly two of the three arrive late' and, in the latter, attempted use of the addition law for two non-mutually exclusive events was the most common incorrect approach.

Question 3

As mentioned earlier, far too many candidates lost at least 1 mark in part (a). Those that did not, usually used s_n rather than s_{n-1} whereas those that did, used s_n^2, s_{n-1}^2, $\sqrt{\sum(x-\bar{x})^2}$ or even $\sum(x-\bar{x})^2$.

In part (b), the value of z was identified correctly but the divisor of $\sqrt{n}$ was omitted on too many occasions; perhaps candidates were wary after already dividing by n in part (a)? Those candidates who used 286.5 for their sample mean apparently saw nothing wrong with a clearly incorrect answer if the context was considered! The many candidates who attempted parts (a) and (b) correctly invariably provided correct answers to an appropriate level of accuracy. Those candidates who referenced their confidence interval in answering part (c) usually scored the 2 marks available. However, too many candidates merely compared the claims with their value for the sample mean or produced a qualitative argument based upon their perceived reasons as to why the fire and rescue service would underestimate whilst the parish councillor would overestimate.

Question 4

It was disappointing to see how many candidates could not plot the four points accurately; point D causing the greatest problem. Most candidates were able to identify 'positive correlation' in part (b)(i) but slightly fewer identified the two 'anomalous' results. The vast majority of candidates identified the correct value in part (b)(ii) and identified C and D in part (c). However, a noticeable number did not identify the style or identified the style incorrectly whilst a small minority identified H and I presumably through thoughtlessness rather than under the impression that champion swimmers take longer times. Answers to part (d)(i) were usually correct even by those candidates not using their calculator's statistical function for r. Those candidates who identified boys other than C and D often lost most of the marks here. In answering part (d)(ii), about half the candidates merely referred to the stronger correlation and not interpret in context.

Question 5

Most candidates scored well on this question with many scoring full marks. Somewhat surprisingly, some candidates appeared to have no requisite knowledge of the normal distribution. In part (a)(i), the standardisation was usually correct and so followed by a correct z-value and hence a correct answer from Table 3 of the supplied booklet. A few candidates standardised 59 (0 marks) or used $\sqrt{8}$ (1 mark). It was pleasing to see that a majority of candidates recognised immediately that the answer to part (a)(ii) could be obtained directly from their previous answer by subtracting 0.5. Those candidates who essentially started afresh, invariably also obtained the correct answer. Most candidates were aware of the technique required in part (b) with many scoring all 4 marks. However, a noticeable number either equated their correct standardised value to 0.95 rather than 1.6449 or used 8 from part (a) rather than 16. In each case only 1 mark was then available.

Question 6

Most candidates had a sound knowledge of calculating binomial probabilities. Many fewer candidates appeared to know how to calculate the mean and variance of a binomial distribution, whilst some appeared not to have studied the binomial distribution. A large majority of candidates scored full marks in parts (a)(i) & (ii). In part (a)(iii), confusion often arose as to whether the tabulated values required were for 7 or 8 and for 4 or 3. As a result many candidates lost some marks. A small minority of candidates opted for using the binomial formula sometimes with complete success. In part (b), those candidates with the necessary knowledge scored both marks. Others sometimes obtained the mean value by intuition but of course could make no headway with finding the variance. Yet again, far too many candidates appear unaware of the information provided in the first table on page 11 of the supplied booklet.

MS/SS1B Statistics 1B

General

The overall performance of candidates on this paper was most impressive with many scoring above 50 (raw) marks and few scoring below 30 (raw) marks. This improved performance suggested that most centres had noted, from previous papers, the effects of the change in specification on the paper's style and, from published mark schemes and reports, the responses expected.

Most candidates attempted the questions in the order printed and completed their solutions to each question at the first attempt. Consequently, it was thankfully rare to find part answers to a question spread throughout an answer booklet. Presentation of numerical work was generally clear and to a sufficient level of accuracy. However, some candidates' atrocious spelling and grammar made an understanding of descriptive answers almost impossible, particularly when combined with almost illegible handwriting!

The majority of candidates made good use of the statistical functions on their calculators (particularly in Questions 1, 4 and 5) and correct and appropriate use of Tables 1, 3 and 4 in the supplied booklet. A significant number of candidates spent valuable time on unnecessarily lengthy calculations and/or on 'long-winded' methods. A small, but noticeable, number of such candidates appeared to run out of time on the final part of Question 7.

Finally, from responses to Question 3(a), far too many candidates appeared unaware of the formula for (sample) variance; sometimes also for sample mean. This was inexcusable, particularly as a formula for variance is given on page 12 of the supplied booklet. Teachers should note that similar summarised information may be provided in questions involving correlation or regression. However in all cases the information will be provided in a form that matches directly a relevant formula in the supplied booklet.

Question 1

Almost all candidates found correct values for *a* and *b* using the statistical functions on their calculators although too many such candidates quoted *b* to only two decimal places. In a small number of cases values for *a* and *b* were interchanged. Where candidates used the formulae supplied, answers were generally sound although, in particular, too many candidates were of the impression that $\sum xy = \left(\sum x\right)\left(\sum y\right)$. Answers to part (b) were often incorrect or even non-existent. Candidates often simply identified them as 'intercept and gradient' without any reference to the context. Where an attempt at context was made, answers were in fact often explanations of *y* rather than *a* or *b*. Apart from a few weak candidates, who could not apply the correct order of arithmetic operations to their calculation [$y = (a + b)x$], part (c) was answered correctly. In part (d), many candidates commented on the reliability of estimates using the words "interpolation" and "extrapolation" but few candidates made correct use of the information given about the residuals.

Question 2

This was a very high scoring question with many candidates scoring full marks. Only part (b)(ii) presented any noteworthy difficulty where 0.2 + 0.25 – 0.18 was the most common incorrect approach.

Question 3

As mentioned earlier, far too many candidates lost at least 1 mark in part (a). Those that did not, usually used s_n rather than s_{n-1} whereas those that did, used s_n^2, s_{n-1}^2, $\sqrt{\sum\left(x-\overline{x}\right)^2}$ or even $\sum\left(x-\overline{x}\right)^2$.

In part (b), the value of z was identified correctly but the divisor of $\sqrt{n}$ was omitted on too many occasions; perhaps candidates were wary after already dividing by n in part (a)? Those candidates who used 286.5 for their sample mean apparently saw nothing wrong with a clearly incorrect answer if the context was considered! The many candidates who attempted parts (a) and (b) correctly invariably provided correct answers to an appropriate level of accuracy. The many candidates who referenced their confidence interval in answering part (c) usually scored the 2 marks available. However, too many merely compared the claims with their value for the sample mean.

Question 4

In part (a), some candidates did not identify the correct mid-points usually through being 0.5 too high. These usually led to an incorrect mean value but to a correct value for the standard deviation. A minority of very weak candidates simply took the frequencies as 8 values of x. Answers to part (b)(i) usually scored the mark but a minority of candidates felt that 'randomness' was the key. Part (b)(ii) was intended to assist candidates but in many cases it did not. Whilst most candidates were able to state their value for the mean from part (a) as the mean of $\overline{Y}$, very few appeared familiar with the term 'standard error' and so either omitted to give an answer or re-stated their value of the standard deviation from part (a). Some of these candidates were still able to answer part (b)(iii) correctly as were most of those who scored full marks in part (b)(ii). Weaker candidates often tried to standardise 1½ with of course no real progress.

Question 5

It was disappointing to see how many candidates could not plot the four points accurately; point D causing the greatest problem. Most candidates were able to identify 'positive correlation' in part (b)(i) but slightly fewer identified the two 'anomalous' results. The vast majority of candidates identified the correct value in part (b)(ii) and identified boys C and D in part (c). However, a noticeable number did not identify the style or identified the style incorrectly whilst a small minority identified H and I presumably through thoughtlessness rather than under the impression that champion swimmers take longer times. Answers to part (d)(i) were usually correct even by those candidates not using their calculator's statistical function for r. Those candidates who identified boys other than C and D often lost most of the marks here. In answering part (d)(ii), about half the candidates merely referred to the stronger correlation and did not interpret in context.

Question 6

Most candidates scored full marks in parts (a)(i) &(ii); the latter usually from the binomial formula. Answers to part (a)(iii) were less impressive. Whilst many candidates had basically the correct idea, attempts of the form $P(R \leq 15) - P(R > 5)$ or $P(R > 5) - P(R \leq 14)$ were not uncommon and a very few candidates attempted repeated use of the formula. Answers to part (b) were again disappointing. Many answers were based solely on Sly's calculated values. When the value for the binomial mean was stated, it was often as a result of intuition rather than the formula. On the somewhat rare occasions when the value for the binomial variance was found, comparisons of means and variances were done in isolation and an overall conclusion was lacking for the final mark.

Question 7

A pleasing number of candidates scored full marks on this last question. In part (a)(i), almost all candidates carried out a correct standardisation but a very small number then omitted the area change after referring to Table 3 in the supplied booklet. On the relatively rare occasions when marks were lost in part (a)(ii), it was often the result of subtracting 0.64058 from 0.79673. The small number of candidates who used their calculator's normal distribution function, rather than Table 3, perhaps needs to show some evidence of working so as not to automatically score zero for incorrect answers. In part (b)(i), explanations were often just sufficient to score marks. Attempts that involved mere re-arrangements of the given result scored at most 1 mark if they involved a worthwhile explanation for 1.96. Those who could do this, usually found 1.0803 from Table 4 as a start to part (b)(ii). Those candidates who were well-prepared often scored full or almost full marks. Other candidates appeared to have absolutely no idea as how to proceed beyond perhaps stating that $z = 1.0803$.

MS2A Statistics 2

General

It was very pleasing to see that the majority of candidates produced excellent solutions to each of the questions. However, there are still some weaknesses shown when interpretation in context is required.

Question 1

Answers to part (a)(i), were invariably correct with most candidates using the statistical tables provided. A minority of candidates calculated P(X = 0) + P(X = 1) using the correct probability function for Po(0.5) and were often successful. Part (a)(ii) was done well by all but the weaker candidates who usually attempted to use tables to find $\mathrm{P}(X = 2)$ for $\lambda = 2.4$ and $\lambda = 2.6$ and then find the mean of the two values obtained! In part (b)(i), most candidates considered $\mathrm{Po}(3.0)$ and then used the formula or tables to achieve correctly the given answer of 0.224. In part (b)(ii) most candidates correctly considered $(0.224)^4$ and so scored the 2 marks available. The majority of candidates, in part(c)(ii), correctly interpreted 'T at least 18' as meaning '1 – ($T \le 17$)'.

Question 2

This question produced many disappointing responses. In part (a), most candidates stated correct hypotheses and usually worked out the required values for the E_i. However, there were still some candidates who insisted on rounding these values to the nearest whole number; which is penalised. The calculations of the E_i were usually followed by an incorrect assumption that $\nu = 3$ and consequently the wrong χ^2 value was quoted from the tables. Although many candidates failed to realise that when $E_i < 5$, similar categories must be combined, the majority went on to use the correct method for evaluating χ^2. The conclusions drawn were usually correct and often in context. However, some candidates still think, incorrectly, that the rejection of the null hypothesis proves that the alternative hypothesis must be true. Part (b) proved to be beyond all but the very best candidates. The vast majority failed to interpret their results found in part (a). Most candidates simply referred to the original data, usually stating that 'more females than males played hockey' rather than making the required reference to the expected and observed values.

Question 3

Most candidates were able to first show that $\overline{x} = 301.0$ and $s^2 = 24.5$. In part (b), although there were some good solutions seen, too many candidates used a z-value rather than the required t-value. Responses to part (c) were rather disappointing with comments often not in context and usually with no reference to the confidence interval that they had just found in part (b).

Question 4

Part (a)(i) was usually done well, with most making sufficient reference to the area of a rectangle to gain the mark. Some candidates insisted on using calculus in this topic and, although they usually went on to show the given result, it did mean that more time was spent on this part of the question than was anticipated. In part (a)(ii), most candidates were able to show that

$\mathrm{E}(X) = \int_a^b kx\,\mathrm{d}x = \left[\frac{kx^2}{2}\right]_a^b = \frac{1}{2}k\left(b^2 - a^2\right)$. Unfortunately, many then simply wrote down the given answer without any further evidence of method. Others often seemed unfamiliar with the method of 'the difference of two squares' in the factorisation of $b^2 - a^2$ and so simply tried to fudge the given answer. In part (b)(i), the answer $\mu = 1$ was usually stated correctly. In part (b)(ii), although the majority of candidates used the formula $\sigma^2 = \frac{1}{12}(b-a)^2$, quoted from the formula booklet provided, to show that $\sigma = \sqrt{3}$, there were several who used integration to find $\mathrm{E}\left(X^2\right)$ before using $\mathrm{Var}(X) = \mathrm{E}\left(X^2\right) - \mu^2$, usually correctly. Unfortunately, some of the mainly weaker candidates thought that $\sigma = \frac{1}{12}(b-a)^2 = 3$. With follow-through marks being available in part (b)(iii), many candidates were able to show a good understanding of the rectangular distribution. However, some candidates again used calculus unnecessarily to work out the given probability, with $\int_{-2}^{1/\sqrt{3}} \frac{1}{6}\,\mathrm{d}x$ often seen and correctly evaluated.

Question 5

This was the best answered question on the paper. In part (a), candidates usually found $\mathrm{E}(X) = 50$, with most going on to show the correct value of the standard deviation to be 10.13. In part (b), many correct answers were seen, with most candidates using their knowledge of the mean and variance of ($aX + b$) to show that $\mathrm{E}(Y) = 750$ and that the required value of the standard deviation was 101.3. A minority of candidates constructed a new table for the distribution of *Y*, and then repeated methods used in part (a), often with considerable or complete success.

Question 6

There were many excellent solutions seen to this question. Most candidates stated the correct hypotheses and then attempted to use a 2-tailed *t*-test. The main errors occurred in either looking up the wrong *t*-value from the tables or not giving a conclusion in context.

MS2B Statistics 2

General

It was again very pleasing to see the large numbers of excellent solutions to each question. Candidates seemed to have been well prepared for this paper. The main area of concern was, yet again, the inability of many candidates to interpret their conclusions in context.

Question 1

Part (a)(i) was answered successfully by all but the weakest candidates, with most obtaining the correct value of 0.251. Unfortunately some failed to write their answer to 3 significant figures. In part (a)(ii), too many candidates considered $\text{Po}(4.5)$ instead of evaluating $(0.251)^3$ to obtain the correct answer of 0.0158. Most candidates realised that in order to achieve credit in part (b)(i), they had to state **both** the distribution (Poisson) **and** the value of its parameter ($\lambda = 9.0$). There were many excellent solutions seen to part (b)(ii) with most candidates realising that to find 'P(at least 12)' implies that $\text{P}(Y \geq 12) = 1 - \text{P}(Y \leq 11)$ has to be considered. As on previous papers, candidates found it very difficult to answer the type of question posed in part (c). Many attempts did not relate to the context used in the question but simply stated general conditions under which a Poisson distribution may be appropriate.

Question 2

This question produced many disappointing responses. In part (a), most candidates stated correct hypotheses and usually worked out the required values for the E_i. However, there were still some candidates who insisted on rounding these values to the nearest whole number; which is penalised. The calculations of the E_i were usually followed by an incorrect assumption that $\nu = 3$ and consequently the wrong χ^2 value was quoted from the tables. Although many candidates failed to realise that when $E_i < 5$, similar categories must be combined, the majority went on to use the correct method for evaluating χ^2. The conclusions drawn were usually correct and often in context. However, some candidates still think, incorrectly, that the rejection of the null hypothesis proves that the alternative hypothesis must be true. Part (b) proved to be beyond all but the very best candidates. The vast majority failed to interpret their results found in part (a). Most candidates simply referred to the original data, usually stating that 'more females than males played hockey' rather than making the required reference to the expected and observed values.

Question 3

There were many excellent solutions seen to part (a), with most candidates realising that they first had to find that $\bar{x} = 8.0$ and that $s = 2.121$. Although many candidates understood that the *t*-distribution had to be used with $\nu = 8$ and hence $t = 1.860$, since the data given formed a small sample from a normal distribution with unknown standard deviation, many others did not. These latter candidates usually used *z*-values from the normal distribution tables. Part (b) was not well answered as many candidates failed to make any reference to the context of the question or the confidence interval that they had just found.

Question 4

Part (a)(i) was usually done well, with most making sufficient reference to the area of a rectangle to gain the mark. Some candidates insisted on using calculus in this topic and, although they usually went on to show the given result, it did mean that more time was spent on this part of the question than was anticipated. In part (a)(ii), most candidates were able to show that

$\mathrm{E}(X)=\int_a^b kx\,\mathrm{d}x=\left[\frac{kx^2}{2}\right]_a^b=\frac{1}{2}k\left(b^2-a^2\right)$. Unfortunately, many then simply wrote down the given answer without any further evidence of method. Others often seemed unfamiliar with the method of 'the difference of two squares' in the factorisation of b^2-a^2 and so simply tried to fudge the given answer. In part (b)(i), the answer $\mu=1$ was usually stated correctly. In part (b)(ii), although the majority of candidates used the formula $\sigma^2=\frac{1}{12}(b-a)^2$, quoted from the formula booklet provided, to show that $\sigma=\sqrt{3}$, there were several who used integration to find $\mathrm{E}\left(X^2\right)$ before using $\mathrm{Var}(X)=\mathrm{E}\left(X^2\right)-\mu^2$, usually correctly. Unfortunately, some of the mainly weaker candidates thought that $\sigma=\frac{1}{12}(b-a)^2=3$. With follow-through marks being available in part (b)(iii), many candidates were able to show a good understanding of the rectangular distribution. However, some candidates again used calculus unnecessarily to work out the given probability, with $\int_{-2}^{1/\sqrt{3}}\frac{1}{6}\,\mathrm{d}x$ often seen and correctly evaluated.

Question 5

This was the best answered question on the paper. In part (a), candidates usually found $\mathrm{E}(X)=50$, with most going on to show the correct value of the standard deviation to be 10.13. In part (b), many correct answers were seen, with most candidates using their knowledge of the mean and variance of ($aX+b$) to show that $\mathrm{E}(Y)=750$ and that the required value of the standard deviation was 101.3. A minority of candidates constructed a new table for the distribution of *Y*, and then repeated methods used in part (a), often with considerable or complete success.

Question 6

Although there were many good solutions seen to part (a), there were still some candidates who either did not state hypotheses or stated them incorrectly. Also, conclusions were often too positive in nature and not in context. In part (b), although most candidates could state the definition of a Type I error, they either could not or did not state the meaning of a Type I error **in the context of the question**, where a reference to students' underachievement was required.

Question 7

Candidates seemed well able to attempt part (a) with the result that many successful outcomes were seen. Part (b)(i) was only done correctly by the most able students, with $\int_0^t 4t\left(1-t^2\right)\,\mathrm{d}t$ rarely seen otherwise. Many candidates either used 0 and 1 as their limits or simply ignored limits altogether. It was not sufficient to simply consider the indefinite integral $\int 4t\left(1-t^2\right)\,\mathrm{d}t$ without consideration of the boundary conditions.
In part (b)(ii), many candidates realised that $\mathrm{P}(\mu<T<m)=\mathrm{F}(m)-\mathrm{F}(\mu)$ but then went on to use the equation $2m^2-m^4=0.5$ to show that $m=0.541$ before attempting to evaluate $\int_{\frac{8}{15}}^{0.541}\mathrm{f}(t)\,\mathrm{d}t$, instead of simply evaluating $0.5-\mathrm{F}\left(\frac{8}{15}\right)$.

Question 8

There were many excellent solutions seen to this question. Most candidates stated the correct hypotheses and then attempted to use a 2-tailed t-test. The main errors occurred in either looking up the wrong t-value from the tables or not giving a conclusion in context.

MM1A/W – Mechanics 1A/W

General Comments:

The paper proved accessible to candidates who were adequately prepared, allowing them to show their knowledge of mechanics concepts and the relevant techniques for solving problems relating to mechanics situations. Algebraic standards were generally high as were levels of accuracy, with only rare instances of the use of inaccurate calculation or of inappropriate rounding. There was however a lack of understanding about the significance of the directions of various quantities, and sign errors were too frequent.

Question 1

Candidates were able to construct appropriate momentum equations in both parts of the question, but errors with signs in part (b) were frequent.

Question 2

There was considerable confusion here in all parts between the initial and final velocities and with the sign of the acceleration due to gravity. In part (b)(ii) it was not uncommon to see a new calculation instead of simply doubling the answer to part (b)(i) as intended.

Question 3

Both requests in part (a) were usually answered successfully using trigonometry with a correct right-angled triangle or the more general Sine Rule. The most frequent errors were to use the velocity of 12 ms^{-1} as the 'resultant' velocity, or to use the given result for u to find V in a circular calculation involving two applications of Pythagoras Theorem. Part (b) was less successful. Candidates sometimes drew incorrect triangles, failing to link the directions of the velocities correctly. Others were unable to solve correct triangles; often trying to use the Sine Rule where only the Cosine Rule would work. However, those using methods involving velocity components were generally very successful.

Question 4

This question proved difficult, and a number of candidates showed a lack of appreciation of the differences between the horizontal and vertical components of the motion. Solutions in part (a) sometimes lacked convincing reasoning. Algebra let some down in part (c), and part (d) proved very discriminating on the understanding of the motion.

Question 5

Again there were frequent sign errors in part (a)(i). However, the rest of the question was popular and mostly done well with many fully complete solutions.

Question 6

Part (a) was often answered well but candidates appeared to find the requests complex and supplemented their answers with several lines of unnecessary working. Part (b)(i) proved popular and successful, but part (b)(ii) was very discriminating.

Question 7

A surprising number of diagrams in part (a) failed to include all the forces. Part (b) was very successful, showing a good understanding of the friction law. Part (c) was done well by many, but others couldn't appreciate the significance of the constant speed, the necessary starting point of the explanation. Many were successful in part (d), although some confused the normal reaction with the vertical component of the tension. Part (e) was generally done well with candidates gaining credit for correct calculations using their components of the tension force.

MM1B – Mechanics 1B

General Comments:

The paper proved accessible to candidates who were adequately prepared, allowing them to show their knowledge of mechanical concepts and the relevant techniques for solving problems relating to mechanical situations. Algebraic standards were mostly high as were levels of accuracy, with only rare instances of the use of inaccurate calculation or of inappropriate rounding.

Question 1

Candidates were able to construct appropriate momentum equations in both parts of the question, but errors with signs in part (b) were frequent.

Question 2

Part (a) was done well, but in part (b) many stopped after finding the velocity at the given time, instead of continuing to find the speed by evaluating the magnitude of the velocity vector.

Question 3

Answers to part (a) were mostly good except for occasional sign errors. Part (b) revealed some mis-conceptions, with some candidates thinking the weights of the falling objects to be a significant factor in the motion. Many understood the effect of air resistance but were not always able to clearly express the link with the change to the motion.

Question 4

Both requests in part (a) were usually answered successfully using trigonometry with a correct right-angled triangle or the more general Sine Rule. The most frequent errors were to use the velocity of 12 ms^{-1} as the 'resultant' velocity, or to use the given result for u to find V in a circular calculation involving two applications of Pythagoras Theorem. Part (b) was less successful. Candidates sometimes drew incorrect triangles, failing to link the directions of the velocities correctly. Others were unable to solve correct triangles; often trying to use the Sine Rule where only the Cosine Rule would work. However, those using methods involving velocity components were generally very successful.

Question 5

This question proved difficult, and a number of candidates showed a lack of appreciation of the differences between the horizontal and vertical components of the motion. Solutions in part (a) sometimes lacked convincing reasoning. Algebra let some down in part (c), and part (d) proved very discriminating on the understanding of the motion.

Question 6

The sketch graph in part (a) proved a good source of marks although some graphs were drawn without the use of a ruler and intended straight lines were 'wobbly'. Part (a)(ii) was usually successful although some omitted some of the areas in trying to find the total distance. Parts (a)(iii) and (a)(iv) were popular and successful. Part (b)(i) was done well, but part (b)(ii) mostly lacked the required link between the curves of the graph and the more realistic changes in motion.

Question 7

Part (a) was often answered well but candidates appeared to find the requests complex and supplemented their answers with several lines of unnecessary working. Part (b)(i) proved popular and successful, but part (b)(ii) was very discriminating.

Question 8

Parts (a)(i), (ii), (v) and (b) proved routinely successful for well prepared and accurate candidates. Parts (a)(iii) and (iv) tested the understanding of the forces in the static situations and proved highly discriminating.

MM2A/W Mechanics 2 A/W

General Comments

The performance of the candidates who entered this examination was quite varied. Some were well prepared and took the whole paper in their stride. There were also some who did very well on some topics but not on others, suggesting that they may not have completely finished studying all of the content of the module prior to the examination.

The paper did require the use of calculus in some of the questions. Where this involved polynomials the candidates experienced very little difficulty, but the exponential functions caused more difficulty. It appeared that the candidates were less familiar with the calculus of these functions.

Question 1

Most candidates did very well on this question, although there were a few who did not seem to be able to attempt this type of problem.

Question 2

There were some good responses to this question. In part (a), a small number of candidates did not show sufficient working to justify the marks available, even though they were able to obtain the correct answer. It is important in questions of this type to demonstrate that any calculations result from resolving or considering a triangle of forces. Some of the poor responses looked as if the candidates had experimented with the numbers until they had obtained 22.6. The responses to part (b) were generally very good or completely unsuccessful. Interestingly, some candidates did part (a) but made no progress with part (b), while some others were unable to do part (a), but used the printed answer to enable them to do part (b).

Question 3

Quite a few candidates had problems dealing with the differentiation and integration of the exponential function in this question. They used techniques that were confused and were unable to obtain the correct results. This was probably due to the fact that this question demanded the use of techniques from the core mathematics modules, with which the candidates were not yet fully confident. In part (a)(ii), very few candidates gave fully correct answers for the range of values of the acceleration. Some obtained either the value 2 or the value 14. Of those that did obtain both values, very few used the correct inequalities.
In part (b), there were problems with the integration of the exponential function and also with candidates omitting or not find the constant of integration.

Question 4

Part (a) was done well by most of the candidates. Part (b) was found to be more difficult. Candidates either managed to produce the equation without difficulty or struggled to make any significant progress. Almost all of the candidates tried to solve the quadratic equation, but some were not able to do this correctly

Question 5

This question required the use of a differential equation, but some candidates tried to use constant acceleration equations. There were a number of good, complete solutions. Some candidates were on the right track with their solutions, but made algebraic or integration errors. A few candidates omitted the negative sign when they started the question and ended up with a final answer which simply had a missing negative sign.

Question 6

Many of the candidates were able to obtain the printed answer, but sometimes from very dubious working. There were a number of candidates who tried to use the constant acceleration equation $v^2 = u^2 + 2as$. They did obtain the correct result, but their method was not valid. The candidates that started with a clear statement or equation based on conservation of energy, were usually able to complete the solution correctly. In part (b), there were fewer correct responses than in part (a). Most of the candidates realised that they needed a zero reaction force, writing $R = 0$. The main cause of errors was either not resolving the weight at all or not resolving the weight correctly. A few candidates obtained correct values for $\cos\theta$ but gave incorrect angles.

Question 7

Parts (a) and (b) of this question were done very well, with many candidates gaining full marks on both parts. Part (c) (ii) was also done well, but some candidates did not show both solutions to the quadratic as part of their working. In questions like this candidates should be encouraged to show both solutions and then select the appropriate solution in the context under consideration. Part (c)(i) was very challenging and there were relatively few correct solutions. The three main problems were:

- Not including the elastic potential energy when released,
- Using an incorrect expression for the extension of the string when forming an expression for the elastic potential energy,
- Using an incorrect distance when forming an expression for the gravitational potential energy.

MM2B Mechanics 2 B

General Comments

The performance of the candidates who entered this examination was quite varied. Some were well prepared and took the whole paper in their stride. There were also some who did very well on some topics but not on others, suggesting that they may not have completely finished studying all of the content of the module prior to the examination.

The paper did require the use of calculus in some of the questions. Where this involved polynomials the candidates experienced very little difficulty, but the exponential and trigonometric functions caused more difficulty. It appeared that the candidates were less familiar with the calculus of these functions.

Question 1

Generally the candidates did very well on this question and a good number scored full marks. Some candidates used constant acceleration equations to find the speed of the stone when it hit the ground and then calculated the kinetic energy using the formula $\frac{1}{2}mv^2$. While this approach was acceptable in this context, it is a better strategy for candidates to use an energy method, as in some contexts constant acceleration equations cannot be applied.

Question 2

There were some good responses to this question. In part (a), a small number of candidates did not show sufficient working to justify the marks available, even though they were able to obtain the correct answer. It is important in questions of this type to demonstrate that any calculations result from resolving or considering a triangle of forces. Some of the poor responses looked as if the candidates had experimented with the numbers until they had obtained 22.6. The responses to part (b) were generally very good or completely unsuccessful. Interestingly, some candidates did part (a) but made no progress with part (b), while some others were unable to do (a), but used the printed answer to enable them to do part (b).

Question 3

Quite a few candidates had problems dealing with the differentiation and integration of the exponential function in this question. They used techniques that were confused and were unable to obtain the correct results. This was probably due to the fact that this question demanded the use of techniques, from the core mathematics modules, with which the candidates were not yet fully confident. In part (a) (ii), very few candidates gave fully correct answers for the range of values of the acceleration. Some obtained either the value 2 or the value 14. Of those that did obtain both values, very few used the correct inequalities. In part (b), there were problems with the integration of the exponential function and also with candidates omitting or not find the constant of integration.

Question 4

Part (a) of this was generally done quite well, although some candidates did use a moment equation as their explanation. Part (b), was either done very well or very badly. Almost all of the candidates who were able to make a good start completed this part without difficulty. In part (c), finding the angle correctly caused more difficulties. The main stumbling block was that candidates did not subtract the answer to part (b) from 10 before using trigonometry to find the angle. There were many good answers to part (d).

Question 5

In part (a), many of the candidates found the force correctly, but some did not go on to give the magnitude. A few candidates did not substitute $t = 0$. In part (b), the main problem was with the integration of the trigonometric terms. A particular problem was with the signs of the functions. Most candidates did attempt to find the constants of integration. A small number of candidates tried to use $\mathbf{v} = \mathbf{u} + \mathbf{a}t$.

Question 6

The responses to the modelling in parts (a) and (b) were very varied. Only a small number of candidates gained all three marks, but most gained at least one mark. Some candidates made statements that contradicted the information in the stem of the question, such as "the resistance force will be constant". Part (c) tended to be done very well or very badly. There was some use of constant acceleration equations, but this was not very common. The biggest issue was the omission of a negative sign in the formation of the differential equation, which then continued throughout the solution. This error was quite common. Other problems were caused by incorrect algebraic manipulation, particularly with logarithms, or integration.

Question 7

Many of the candidates were able to obtain the printed answer, but sometimes from very dubious working. There were a number of candidates who tried to use the constant acceleration equation $v^2 = u^2 + 2as$. They did obtain the correct result, but their method was not valid. The candidates who started with a clear statement or equation based on conservation of energy, were usually able to complete the solution correctly. In part (b), there were fewer correct responses than in part (a). Most of the candidates realised that they needed a zero reaction force, writing $R = 0$. The main cause of errors was either not resolving the weight at all or not resolving the weight correctly. A few candidates obtained correct values for $\cos\theta$ but gave incorrect angles.

Question 8

Parts (a) and (b) of this question were done very well, with many candidates gaining full marks on both parts. Part (c) (ii) was also done well, but some candidates did not show both solutions to the quadratic as part of their working. In questions like this candidates should be encouraged to show both solutions and then select the appropriate solution in the context under consideration. Part (c)(i) was very challenging and there were relatively few correct solutions. The three main problems were:

- Not including the elastic potential energy when released,
- Using an incorrect expression for the extension of the string when forming an expression for the elastic potential energy
- Using an incorrect distance when forming an expression for the gravitational potential energy.

MD01 Mathematics Decision 1

General:

In general the candidates were prepared for the demands of the paper with the vast majority of candidates being well prepared. The candidates presented their work well, with clear diagrams shown. It is of concern that an increasing number of candidates do not complete the administration on the inserts and fail to **attach** the insert to their script.

Question 1:

Part (a) was well answered and usually scored full marks. In part (b) some candidates are still not following the previous advice about writing down their alternating paths. Candidates who used numbers on a diagram quite often did not show their two paths distinctly and lost marks. A number of scripts had just one continuous path which was penalised. In any question where 2 pieces of data are missing from the initial match then the algorithm must be applied twice.

Question 2:

The majority of candidates used the correct sorting algorithm. Candidates who used the 'middle' number in a list as the pivot were often inconsistent in their later choice of pivots. Candidates who used the first number in each list as a pivot were generally successful – this should be encouraged when candidates use the quick sort algorithm.

Question 3:

This question was a good source of marks for virtually all candidates, with few scripts using the wrong algorithm. Candidates who listed all the edges in part (b) were successful, although a common mistake was including edge FH. Some diagrams of minimum spanning trees were not labelled at the vertices.

Question 4:

This question proved to be a good discriminator. In part (a) candidates realised that they had to consider extreme points on the feasible region, but many failed to find the correct vertices.
In part (a)(iii) only the best scripts correctly identified (75, 10) as the minimum point on the feasible region. It was pleasing to note the number of candidates who scored full marks in part (b), although the inequality $2x + y \leq 160$ was the most challenging for candidates who failed to score full marks.

Question 5:

The majority of candidates were able to make a reasonable attempt at the question. Dijkstra's algorithm appears to be well known; however a number of candidates used a complete enumeration and others failed to apply the algorithm for the whole network.

Question 6:

Part (a) of 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. It was pleasing to see the responses in part (b), in which candidates were able to follow the looping instructions in the question, although a number of scripts missed the stopping condition and had an extra pass.

Question 7:

The majority of candidates correctly answered part (a). In part (b) candidates realised that the method involved pairing odd vertices, however many candidates failed to find the minimum pairing connecting the odd vertices. Candidates must realise that they must consider the shortest distances connecting vertices when solving a Chinese postman problem. Many candidates who obtained the correct minimum pairing AI + BC failed to obtain the correct answer of 500.

Part (c) was poorly answered. Candidates should realise that the purpose of pairing odd vertices is to add extra edges to the network. This makes the network Eulerian and it is immediately apparent as to the number of times each vertex would appear in an optimum route.

Question 8:

This question discriminated between candidates. A significant number of candidates were unable to handle a directed network and many failed to score the marks in part (a). Part (b) was beyond the majority of candidates as they merely quoted a general definition of a Hamiltonian cycle.

Part (c)(i) was well answered, although some candidates failed to return to S. Part (c)(ii) was a standard piece of bookwork but it was still poorly answered. Definitions, and understanding, of upper and lower bounds are essential. Only the most able of students was able to achieve the correct answer in part (iii).

Question 9:

Again this question discriminated between candidates. The majority of candidates were able to find the five straightforward inequalities, but the other proved to be challenging. Candidates were either unable to handle percentages or unable to use the total production as $x + y + z$. Even candidates who started this inequality correctly then floundered on the algebraic simplification.

MD02 Mathematics Decision 2

General

The general performance on this paper was very good. Some topics such as Critical Path Analysis, Linear Programming using the Simplex Method and Game Theory seemed to be well understood and many candidates presented their solutions showing all the key steps in their working. Teachers might benefit from consulting the solutions in the mark scheme to see an exemplar of the recommended layout when answering questions on other topics.

- When using the Hungarian algorithm, separate matrices should be used at each stage rather than crossing numbers out and replacing their values in a single tableau. The lines required to cover the zeros should be drawn and the minimum value, m, of the uncovered numbers should be stated before the matrix is adjusted by adding m to the entries covered by two lines and subtracting m from the uncovered entries.

- It should be possible to trace the route through the network in a problem of this kind. Simply writing 69^{1} on a vertex, for example does not achieve this. Candidates may be required in future to use the conventional stage and state techniques for dynamic programming.

- When using flow augmentation, the labelling procedure requires that both the potential increase and decrease of flow be indicated on each edge. This is best done using forward and backward arrows or a repeated edge; one showing forward potential increase and the other showing backward decrease. The individual routes from S to T augmenting the flow should be indicated and the values of the extra flows recorded in the table provided.

Question 1

The main problem here was presentation rather than content. It was quite common for candidates to doctor one matrix by crossing out entries and replacing them. There were far fewer errors when a new matrix represented each stage of reduction. Some candidates handed in their actual **question papers** with all the numbers in the matrix altered several times; this scored few or no marks at all since it was impossible to see how the columns and rows had been reduced. A minority did not realise that the extra row needed to have equal entries.

Far too many performed the column and row reductions, but then made no attempt at adjustment because the positions of the zeros required only four lines to cover them. This is an essential part of the Hungarian algorithm. Problems are set with small matrices so that the steps of the algorithm can be clearly indicated. It was evident that far too many candidates were merely guessing at the matching without the essential stages of row adjustment, producing a matrix requiring 5 lines to cover the zeros.

Question 2

In part (a), too many candidates drew a diagram resembling a tree diagram and disregarded the three stages indicated in the question. The majority of candidates performed calculations on their network. Although for such a straightforward example this could be justified, it often left candidates unable to retrace their route satisfactorily. For this reason, and in order to be prepared for less standard examples, candidates should be strongly encouraged to use standard dynamic programming methods, working backwards through the process and tabulating their stage and state results. The mark scheme indicates how this question might have been best answered and future candidates would be wise to consult this.

Question 3

Parts (a),(b),(c),(d) and (e) were very well done by practically all the candidates. The topic of critical path analysis seems to be well understood by most candidates. Problems started to creep in when answering part (f) where sometimes the resource histogram was not a histogram at all; being more like a random collection of rectangles piled on top of each other, rather like Stonehenge. Candidates had been expected to indicate which activities were being represented on the histogram so as to make resource levelling easier to identify. Many candidates were successful in finding the minimum extra time, although the explanations as to why three extra days are sufficient were often incomplete.

Question 4

The insert seemed to help candidates to set out their solution in a logical manner. Most candidates completed the first network indicating the feasible flow. When doing the flow augmentation in part (b)(i), candidates rarely showed their working properly. It is in cases like this, with minimum and maximum capacities, that the formal method (i.e. two arrows and numbers for each edge showing potential increases and decreases of capacity) can be very helpful for candidates and they should be encouraged to always use it. Teachers might again find it valuable to consult the solution in the mark scheme and to encourage their students to take this approach. Also, in trying to find a cut of 14, only a minority of candidates used the original capacities in the network printed in the question paper.

Question 5

Practically everyone seemed familiar with the Simplex method. Apart from a few numerical slips, most candidates scored high marks on this question. A few weaker candidates did not seem to realise how a pivot is selected from a given column and all candidates need to be encouraged to state the value of the pivot at each stage.

Question 6

The idea of dominance seems to be well understood. Marks were lost in part (b) for not identifying the actual play safe strategies. It is not sufficient to draw circles around a couple of numbers and to simply state there is no saddle point. Unfortunately, this is precisely what many candidates offered as their solution. This question was a simple example of game theory, reducing to a 2 by 2 game, and most candidates wrote down and solved correctly an equation in p and hence the expected points gain for Sam. Consequently, it was pleasing to see many high marks in this question.

Report on Coursework Moderation for January 2006.

General

There was a significant reduction in the number of candidates submitting coursework at this session. The standard of the AS coursework seen was generally good with most candidates able to produce a sound piece of analysis of the set tasks. As usual, the interpretation strand continues to be the most difficult of the four strands to score highly on. Many candidates still fail to express their results in any realistic context and many do not even state what their results actually mean in simple terms; they should be always considering and attempting to answer the question; 'why?' when addressing this strand.

As mentioned in the summer 2005 report, there were a number of cases where errors on scripts were missed. The majority of these were simple numerical or arithmetic errors from calculations which had not been checked, but there were some cases of incorrect fundamental statements of theory which were ticked as correct. (The main issue here was the discussion of the Central Limit Theorem in Statistics). Centres are reminded that if errors are not highlighted on scripts (or even worse ticked) then moderators will assume that these errors have not been accounted for in the marks awarded unless this is clearly indicated in written statements in the body of the script or on any accompanying paperwork.

There were still a number of Centres where an adjustment to the marks was required, but the problems this session were far less severe than in the summer 2005 session. The main problem occurs when a piece of work lacks balance. There are cases seen where there is a short introduction, then a huge chunk of analysis followed by half a page of interpretation of the results. It does not matter how eloquently a candidate writes, this will not lead to a balanced script worthy of full marks across all strands; the strands have simply not all been addressed fully. It is understood that Centres want their candidates to do as well as possible, but the distribution of marks from some Centres with all candidates getting a Grade A, although not impossible, was unrealistic and not justified by the quality of the scripts seen. The Centres usually had the rank order correct, but had not used the appropriate range of marks to differentiate between the scripts. It was pleasing to note that there were only a few Centres where a serious misjudgement of AQA standards occurred.

Generally the Internal Moderation procedures were successful in this session. It is a requirement that Centres undertake some form of Internal Moderation to ensure consistent standards are being applied within Centres. There were one or two cases of candidates using methods which were not appropriate to the content of the unit being assessed. This should not be penalised as such, but it must also not receive positive credit either. If this is an issue then this will be mentioned on the Centre feedback form. Any advice or comments made, particularly if a continuation form is completed should be viewed in a positive, constructive way rather than a criticism of the Centre.

A great deal of discussion has taken place about plagiarism in coursework. It is pleasing to note that although candidates often collect data together, the write-ups are clearly different. However Centres need to be constantly vigilant, particularly when candidates have discussed the tasks in groups prior to their write-ups. The other issue that candidates need to be careful about here is the use of 'book-work' proofs or development of results from texts.

Administration:

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 Board – 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 mechanics principles together with details of experiments and tables of results, especially for 'Arctic Research' and 'Designing a Child's Slide', which were by far the two most popular tasks seen. 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 Child's Slide by referring either to real slides or data on slides from appropriate web sites to aid discussion. Occasionally, reports over-relied on extensive numerical work, done on a "trial and improvement" basis, which was less successful in the main.

There were a number of attempts at the new kinematics task seen in this session and examples will be made available at future autumn training sessions.

In M2 there were some really excellent scripts seen illustrating a thorough mastery of the mechanics principles in this unit. By far the most popular task seen was the 'Roller Coaster' task. It is pleasing to see that more candidates are trying to relate their results to a real roller coaster rather than trying to do all of their interpretation based on an experiment of rolling a car round a piece of plastic track which is invariably less successful and often blurs the interpretation of the candidates. A few candidates focussed discussion on the assumptions/modifications needed for their experimental model of the task and didn't 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.

At A2 a clear and appropriate force diagram is expected of any situation being considered.

Statistics

The work seen was generally of a good standard with a range of interesting individual responses to the tasks set. Many candidates generally showed sound understanding of the content of the unit (with perhaps the exception of the Central Limit Theorem) 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. In the task involving Confidence Intervals, diagrams were usefully used to consider 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 interpret and where guidance and explanation by the centres is needed. Candidates need to discuss how their samples were collected and should also be encouraged to explain in careful detail how it is random and likely to be representative. Just because the data is collected from a shop does not mean that a few quick lines will do. This section is worth 6 marks and some clear discussion is expected for full marks, related to any particular difficulties in any method chosen. Good use, for sampling purposes, can be made of secondary data found on the internet, but sampling needs discussion here as well. Candidates should take care that they are actually sampling; there were a number of cases where the whole population was used.

The new task on correlation and regression continues to be a popular and successful task for candidates. It is important that candidates think carefully about which is the 'dependent' and 'independent' variable for their data. It may be advisable for Centres who have found difficulty with the Confidence Interval task to consider this option.

There were more MS2A scripts seen in this session and the standard of work seen was generally good. The main issue noted was the inappropriate design used in some cases. Now that hypothesis tests are available which lead to a 'z' statistic or a 't' statistic, candidates should be looking carefully at their design to ensure that it will actually deliver their aims. Candidates attempting the contingency tables task usually produced a sound piece of work if a little laboured at times. The division into categories is an important issue and should be discussed clearly in the write-up. The very best pieces of work seen in S2 were cleverly designed so that not only was a hypothesis test done, but then an appropriate contingency table followed.

Centres are reminded that they must use one of the new tasks approved by the Board for MS2A.

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	52.5	16.2
MPC2: Pure Core 2	75	75	47.7	16.6
MPC3: Pure Core 3	75	75	50.7	16.3
MPC4: Pure Core 4	75	75	55.2	16.7
MFP1: Further Pure 1	75	75	56.8	14.6
MFP2: Further Pure 2	75	75	46.0	15.2
MFP3: Further Pure 3	75	75	49.9	16.6
MFP4: Further Pure 4	75	75	45.4	14.6
MS1A: Statistics 1A	-	100	68.2	15.3
MS1A/W: Statistics 1A Written	60	75	50.2	13.9
MS1A/C: Statistics 1A Coursework	80	25	17.9	3.3
MS1B: Statistics 1B	75	75	48.3	14.0
MS2A: Statistics 2A		100	69.8	13.1
MS2A/W: Statistics 2A Written	60	75	52.6	11.3
MS2A/C: Statistics 2A Coursework	80	25	17.1	3.0
MS2B: Statistics 2B	75	75	49.9	14.8

Mark Range and Award of Grades

Unit/Component	Maximum Mark (Raw)	Maximum Mark (Scaled)	Mean Mark (Scaled)	Standard Deviation (Scaled)
MM1A: Mechanics 1A	-	100	66.2	17.4
MM1A/W: Mechanics 1A Written	60	75	48.7	15.9
MM1A/C: Mechanics 1A Coursework	80	25	17.4	3.7
MM1B: Mechanics 1B	75	75	49.5	14.4
MM2A: Mechanics 2A	-	100	62.2	20.9
MM2A/W: Mechanics 2A Written	60	75	44.7	18.5
MM2A/C: Mechanics 2A Coursework	80	25	17.4	3.9
MM2B: Mechanics 2B	75	75	44.8	18.2
MD01: Decision 1	75	75	51.4	13.3
MD02: Decision 2	75	75	56.0	13.0

Unit MPC1: Pure Core 1 (11207 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 (3247 candidates)

Grade	Max. mark	A	B	C	D	E
Scaled Boundary Mark	75	58	51	44	37	30
Uniform Boundary Mark	100	80	70	60	50	40

Unit MPC3: Pure Core 3 (4802 candidates)

Grade	Max. mark	A	B	C	D	E
Scaled Boundary Mark	75	61	54	47	40	33
Uniform Boundary Mark	100	80	70	60	50	40

Unit MPC4: Pure Core 4 (439 candidates)

Grade	Max. mark	A	B	C	D	E
Scaled Boundary Mark	75	62	54	46	38	31
Uniform Boundary Mark	100	80	70	60	50	40

Unit MFP1: Further Pure 1 (1126 candidates)

Grade	Max. mark	A	B	C	D	E
Scaled Boundary Mark	75	62	54	46	39	32
Uniform Boundary Mark	100	80	70	60	50	40

Unit MFP2: Further Pure 2 (319 candidates)

Grade	Max. mark	A	B	C	D	E
Scaled Boundary Mark	75	58	51	44	38	32
Uniform Boundary Mark	100	80	70	60	50	40

Unit MFP3: Further Pure 3 (69 candidates)

Grade	Max. mark	A	B	C	D	E
Scaled Boundary Mark	75	60	52	45	38	31
Uniform Boundary Mark	100	80	70	60	50	40

Unit MFP4: Further Pure 4 (205 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 MS1A: Statistics 1A (255 candidates)

		Max. mark	A	B	C	D	E
Written Boundary Mark	raw	60	48	42	36	30	25
	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	80	70	60	50	41
Uniform Boundary Mark		100	80	70	60	50	40

MS1B: Statistics 1B (3380 candidates)

Grade	Max. mark	A	B	C	D	E
Scaled Boundary Mark	75	58	50	43	36	29
Uniform Boundary Mark	100	80	70	60	50	40

MS2A: Statistics 2A (27 candidates)

		Max. mark	A	B	C	D	E
Written Boundary Mark	raw	60	48	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	80	70	60	50	40
Uniform Boundary Mark		100	80	70	60	50	40

MS2B: Statistics 2B (640 candidates)

Grade	Max. mark	A	B	C	D	E
Scaled Boundary Mark	75	59	51	43	35	27
Uniform Boundary Mark	100	80	70	60	50	40

Unit MM1A: Mechanics 1A (140 candidates)

		Max. mark	A	B	C	D	E
Written Boundary Mark	raw	60	46	40	34	29	24
	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	78	68	58	49	40
Uniform Boundary Mark		100	80	70	60	50	40

Unit MM1B: Mechanics 1B (2572 candidates)

Grade	Max. mark	A	B	C	D	E
Scaled Boundary Mark	75	59	52	45	38	31
Uniform Boundary Mark	100	80	70	60	50	40

Unit MM2A: Mechanics 2A (118 candidates)

		Max. mark	A	B	C	D	E
Written Boundary Mark	raw	60	46	40	34	28	23
	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	78	68	58	48	39
Uniform Boundary Mark		100	80	70	60	50	40

Unit MM2B: Mechanics 2B (381 candidates)

Grade	Max. mark	A	B	C	D	E
Scaled Boundary Mark	75	58	50	42	34	27
Uniform Boundary Mark	100	80	70	60	50	40

Unit MD01: Decision 1 (2730 candidates)

Grade	Max. mark	A	B	C	D	E
Scaled Boundary Mark	75	59	52	45	38	32
Uniform Boundary Mark	100	80	70	60	50	40

Unit MD02: Decision 2 (407 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 (542 candidates)

	A	B	C	D	E
Cumulative %	23.6	43.2	60.9	81.5	92.8

Pure Mathematics

Provisional statistics for the award (3 candidates)

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

Further Mathematics

Provisional statistics for the award (17 candidates)

	A	B	C	D	E
Cumulative %	58.8	76.5	94.1	100.0	100.0

Advanced Awards

Mathematics

Provisional statistics for the award (26 candidates)

	A	B	C	D	E
Cumulative %	15.4	34.6	61.5	76.9	92.3

Pure Mathematics

Provisional statistics for the award (1 candidates)

	A	B	C	D	E
Cumulative %	100.0	100.0	100.0	100.0	100.0

Further Mathematics (0 candidates)

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*.