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Edexcel GCE

Mathematics (8450/9374)

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Examiners' Report

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Core Mathematics Unit C1
Specification 6663

Introduction

Although average candidates often scored good marks in the first five or six questions of this paper, parts of Q7, Q8 and particularly Q9 proved more demanding. Candidates usually appeared to have time to attempt all ten questions, although time was often wasted on multiple attempts at Q7. Proficiency (without a calculator) in arithmetic was generally quite good. Standards of presentation were, as always, rather variable and while examiners try to give the benefit of the doubt where possible, some candidates certainly penalise themselves by not showing their methods clearly. In particular, in questions involving the use of a formula, candidates should be encouraged to quote the formula first before beginning to substitute values.

Report on Individual Questions

Question 1

The vast majority of candidates demonstrated very good understanding of factorisation, though many subsequently attempted to solve a non-existent equation. Most followed the most efficient route, taking *x* as a factor before factorising the quadratic expression, while other approaches (such as the factor theorem) were rarely seen.

Question 2

Many candidates understood the requirements of this question, scoring full marks. Some, however, failed to recognise the oscillatory nature of the sequence and used in part (b) the formula for the 20[th] term of an arithmetic sequence. Weaker candidates sometimes used methods such as taking $u_2 = 2$ and $u_3 = 3$ to find u_3 and u_4 respectively.

Question 3

In part (a), nearly all candidates were able to provide a convincing verification that the given point was on the given line. Answers to part (b) were generally good, with most candidates knowing the method for finding the gradient of a perpendicular line and for finding the equation of a straight line. Careless algebraic slips and the failure to give the equation in the required form (with integer coefficients) were not uncommon.

Question 4

This was a standard test of candidates' ability to differentiate and integrate, and many completely correct solutions were seen. Answers to part (a) were usually correct, although $18x^{-2}$ appeared occasionally as the derivative of $-6x^{-3}$. Mistakes in the integration in part (b) were more common, particularly with the negative power, and inevitably the integration constant was frequently omitted. Sometimes the answer to part (a) was integrated, rather than the original function.

Question 5

The surd simplification in part (a) was completed successfully by most candidates, although $9\sqrt{5}$ was sometimes seen instead of $3\sqrt{5}$. In part (b), candidates often showed competence in the process of rationalising the denominator, but sometimes made mistakes in multiplying out their brackets, with frequent mishandling of terms involving $\sqrt{5}$. It was disappointing to see a few candidates proceeding correctly to $\frac{28+12\sqrt{5}}{4}$ and then dividing only one of the terms, to give, for example, $7 + 12\sqrt{5}$. Not surprisingly, those who were unfamiliar with rationalising the denominator usually scored no marks in part (b).

Question 6

Many candidates were well prepared for this question, scoring high marks. Answers to part (a) were usually correct, with few translations going 'the wrong way'. In parts (b) and (c), method marks were given for attempted stretches parallel to the y-axis and x-axis respectively but it was common here to see stretches in the wrong direction and two-way stretches. The most popular mistake was to stretch, for $y = \mathrm{f}\left(\frac{1}{2}x\right)$, by a factor of $\frac{1}{2}$ instead of 2.

Question 7

Many candidates found this question, an arithmetic series in context, difficult. It was very common to see multiple attempts at parts (b), (c) and especially (d). While most candidates used the arithmetic series formulae efficiently, a significant minority produced long lists of numbers and calculations, which sometimes led to correct answers but which were often poorly presented and difficult for examiners to interpret.
Part (a) was intended to help candidates understand what was happening, and nearly all gave a correct explanation, although some made heavy weather of this, perhaps using the sum formula for 2 terms.
In parts (b) and (c), just a few candidates confused term and sum, and a few thought that the common difference was £700 rather than £200, but apart from this the most common mistake was to use a wrong value of n such as $n = 18$ (the girl's age).
Pleasingly, candidates often managed to set up a quadratic equation in part (d), although the resulting algebra defeated many. An over-reliance on the quadratic formula (rather than factorisation) gave a much more difficult task for this particular equation, $n^2 + 4n - 320 = 0$.
Those who successfully reached $n = 16$ sometimes lost the last mark by not giving the girl's age or by giving it as 27 rather than 26.

Question 8

Candidates often had difficulty with this question. The first step, before integration, should have been division to express $\frac{5x^2+2}{x^{\frac{1}{2}}}$ as two separate terms. Although $2x^{-\frac{1}{2}}$ was commonly seen, some candidates had trouble with the other term. Sometimes $\mathrm{f}'(x)$ was multiplied by $x^{\frac{1}{2}}$ before integration. Other mistakes included separate integration of numerator and denominator, and differentiation.
Integration techniques were, however, usually sound, but then for some candidates the lack of an integration constant prevented any further progress. Some attempts to find the value of the constant failed because candidates used only $x = 1$ and not $y = 6$ in their expression for $\mathrm{f}(x)$.

Question 9

In part (a), a surprising number of candidates were unable to find both values. Although $x = 2$ for Q was usually seen, $x = -2$ for P was sometimes not realised.
Part (b) required the expansion of $(x-1)(x^2-4)$ and then the verification of its derivative, and this was well done by the vast majority. In part (c), however, where candidates had to show that $y = x + 7$ is an equation of the tangent to the curve at the point $(-1, 6)$, many simply substituted the x and y values into the equation of the curve and/or the given equation of the tangent. Use of the derivative was needed here.
In part (d), weaker candidates often had no idea how to find the other point on the curve with a parallel tangent. A common wrong approach was to use the method for finding the point at which the tangent intersects the curve again. Those who did start correctly often proceeded well, but accuracy in the calculation of the y-coordinate was frequently lacking. Sometimes the value of x was substituted into the equation of the tangent, or into the derivative, rather than into the equation of the curve.

Question 10

Few candidates scored full marks on this question.
In part (a), most were familiar with the method of 'completing the square' and were able to produce correct values for a and b. Most candidates knew that a sketch of a parabola was required in part (b), but the vertex was usually in the wrong position, often in the first quadrant. Some candidates omitted part (c) and others clearly had little idea of the definition or significance of 'discriminant'. Some were able to find its value but were not able to relate this to the sketch.
Although in part (d) most candidates realised the need to use a condition involving $b^2 - 4ac$, the condition was sometimes thought to be $b^2 - 4ac = 0$. About half of all candidates did correctly reach $k^2 - 12 < 0$, but then very few proceeded to a correct set of values for k, the most popular suggestion being $k^2 < \pm\sqrt{12}$.

Core Mathematics Unit C2
Specification 6664

Introduction

There was a strong candidature for this paper again but probably not quite as strong as last January. The basic calculus questions, Q7 and Q9, were answered very well and the algebraic skills were generally good. Trigonometry was probably the weakest topic with Q5 and both parts of Q8 causing a number of problems. There was little in the way of logarithms on this paper and, judging from the poor attempts involving logs on Q4(d), this may have made the paper slightly less discriminating than usual.

Report on Individual Questions

Question 1

This proved to be a friendly starter question for most candidates and it was usually answered correctly. Part (a) caused few problems and most candidates used the factor theorem as intended. Most realized that $(x - 1)$ was a factor in part (b) and proceeded with some division. In the majority of cases this was completed correctly and the resulting quadratic factor was factorized successfully too. Some candidates do not appreciate the difference between "factorize" and "solve". Some used a quadratic formula to find the roots of their quadratic factor, occasionally they then tried to turn these roots into factors but invariably lost the 2 from $(2x - 1)$. Others went on from a correct factorization to solve $f(x)=0$, but there was no penalty for this on this occasion. In part (c) a number of students used division, rather than the remainder theorem. This wasted time and created more opportunities for errors but well over half of the candidates found the correct value for the remainder.

Question 2

This question was answered well by the majority of the candidates. The most common error was to fail to square the p in the third term giving $36px^2$ which led to a value of 144 for q. Most candidates were able to use their binomial expansion in part (a) to form two equations in part (b) for p and q. Occasionally problems were caused by candidates including an extra x term but in most cases success in part (a) was followed by a sensible attempt at part (b). A few candidates used Pascal's triangle to evaluate their coefficients in part (a) but there were often errors in the triangle, this is not an approach the examiners would recommend.

Question 3

Most candidates knew how to find the length of *AB* and they usually gave the exact surd form of the answer although a number went on to use a calculator approximation in part (c). Part (b) was very well done with over 90% of candidates giving the correct coordinates for *P*. The formula for the equation of the circle in part (c) though was not so well known. Most attempted to use $(x-x_p)^2+(y-y_p)^2=r^2$ but some had $(x+x_p)^2...$ or $(x-x_p)^2-(y-y_p)^2$ and there were a number of candidates who did not appreciate that the right-hand side of the formula required *r* not *AB* or they forgot the square. Some realized that they required $\left(\frac{\sqrt{26}}{2}\right)^2$ but they were unable to evaluate this correctly with 13 being a common error. There were a number of fully correct solutions but this was one of the few places on the paper where the success rate fell below 50%.

Question 4

Most students made very good progress with the first 3 parts of this question but part (d) caused dome problems. The proof in part (a) was usually carried out successfully with a minority of candidates choosing to verify rather than derive the result, they sometimes lost a mark for failing to provide a closing statement that $r = \frac{3}{4}$. Part (b) was answered well too with very few cases of students trying to use ar^n for the n^{th} term and only a handful failing to give the answer to the required accuracy. In part (c) a correct expression was usually given but some students struggled with the evaluation of $\left(\frac{3}{4}\right)^7$ and others ignored the bracket to get $120\times1-\left(\frac{3}{4}\right)^7$ but the vast majority of the candidates were successful here. In part (d) most were able to write down a correct inequality or equation but the simplification to a form with $r^n <$ (or =), and then a correct use of logarithms proved more challenging and under 40% of the candidates obtained the correct answer. A common error was to replace $120\times(\frac{3}{4})^n$ with $(90)^n$. Some avoided the challenges of inequalities, indices and logarithms by simply evaluating S_3 and S_4 and correctly deducing the answer. On this occasion that was a sensible strategy but it is not a tactic that is likely to work in the future!

Question 5

The cosine rule was the most common approach to part (a) and most candidates were successful. Some were unable to rearrange the formula given in the booklet to obtain the angle and a others split the isosceles triangle in half but they rarely were able to provide a full proof (using double angle formulae for cos2*x*) as they resorted to their calculators. Surprisingly a number of candidates failed to score the mark in part (b). Some used degrees, a few then tried to convert this to radians but accuracy was sometimes lost; they seemed reluctant to adjust their calculator and work in radian mode. There was much confusion in part (c) with a number of candidates giving the area of the triangle (or occasionally the segment) rather than the sector. Often they recovered in part (d) and had simply misread the instruction or confused "triangle" with "sector". Most knew how to find the area of the segment in part (d) and the formula for a segment was often quoted. Some struggled to find the area of the triangle, they did not attempt to use $\frac{1}{2}5^2\sin\theta$ but tried half base times height and sometimes used 5 cm as the height.

Question 6

Most candidates were able to complete the table correctly but a number truncated their answers, rather than rounding them, and 3.79 was often seen instead of 3.80. Most knew how to use the trapezium rule but there were still some candidates who divided 30 by 7, rather than 6, to find h and a number who failed to appreciate that the $\frac{h}{2}$ multiplies the all the y terms in the formula not just $\left(y_0 + y_6\right)$. Others ignored the zero in the y row and took their first y value as 1.22. Despite this there were a number of fully correct solutions.

Question 7

The differentiation in this question was answered very well in deed with over 95% scoring full marks in parts (a) and (d). In part (b) most candidates set their answer from part (a) equal to zero and proceeded to solve. Some tried to use the quadratic formula and occasionally ran into difficulties with the double minus signs but most found correct values for x. The y coordinates caused problems for some. There were a few problems with the arithmetic but others simply substituted back in their expression for $\frac{\mathrm{d}y}{\mathrm{d}x}$ and (usually), of course, obtained 0. Most knew how to use their second derivative to determine the nature of their turning points, there was some poor arithmetic but the method was usually demonstrated clearly. A common error in part (d) was to put their second derivative equal to zero and solve for x. A few candidates seemed not to know, or chose not to use, the conventional terms "maximum" and "minimum" and unsatisfactory phrases such as "turning up" or "it's got a hill" were seen instead.

Question 8

This was probably the least well answered question on the paper, with well under 50% achieving full marks in either part. Most candidates started part (a) quite well by dividing by 5 and finding 36.9 as their first solution to $\theta + 30$. It was disappointing though to see how many went on to say $\theta = 6.9$ or 173.1. There were still some who thought that $\sin(\theta + 30) = \sin\theta + \sin 30$ and they made no progress.

In part (b) under 40% remembered to include the $\pm$ when taking the square root. Most knew how to find a second solution when solving a tan equation but there were some candidates who simply kept adding 90 to their first solution and others who took their value away from 270. There were only a few candidates who had their calculators still in radian mode and gave answers that were a mixture of radians and degrees. Candidates should be encouraged to get a feel for the size of angles in both degrees and radians, an answer of 1.1 degrees for $\tan\theta = 2$ should raise suspicion.

Question 9

Part (a) was answered very well and most candidates scored full marks. In part (b) the majority knew they had to integrate and this was carried out accurately. The limits were usually used correctly too although arithmetic slips crept in here and those who used their calculators did not always obtain exact answers. Some forgot to subtract the rectangle and others attempted to find "line – curve" rather than "curve – line" but about 40% managed to obtain the correct answer of $\frac{1}{3}$.

Core Mathematics Unit C3
Specification 6665

Introduction

This was the second paper set on this specification and attracted a large entry of more than 15 000 candidates. The candidates, as expected, displayed a wide range in their knowledge of the topics in this specification. The majority had been well prepared and found the paper accessible. There were, however, a minority of candidates who had no knowledge of some topics in the specification and made no attempt to answer some questions. Calculator work was generally accurate and appropriate and most candidates gave their answers to the accuracy which was asked for. There were weaknesses in algebra, particularly where the simplification of fractions was required. This was particularly the case in Q3 and Q7 and not in the question which specifically concerned algebraic fractions, Q2. In Q2, if candidates started with the most efficient method, the great majority gained full marks. The paper contained a number of questions where candidates were ask to show or prove results and many candidates, who clearly had considerable manipulative skills, were not able to provide the logical sequences of steps needed to gain full marks on these questions. The majority of candidates gave complete, if not necessarily correct, solutions to the last two questions on the paper and time pressure does not seem to have been a problem for the majority of candidates.

Report on Individual Questions

Question 1

This question was well done and many scored full marks. In part (a), the great majority of candidates translated the graph in the correct direction. A substantial minority of candidates interchanged parts (b) and (c), giving the graph for part (b) as their answer to part (c) and the graph for part (c) as their answer to part (b). In part (c), it was not uncommon for candidates to have no branch of the curve for $x < 0$ and two branches of the curve with $x > 0$. The coordinates of the maximum points were usually correctly given.

Question 2

Those who realised that $\frac{2x^2+3x}{(2x+3)(x-2)}$ could be simplified to $\frac{x}{x-2}$ and then put the fractions over a common denominator usually completed the question quickly and full marks were very common. Those who put the fractions as they stood over a common denominator, if they work correctly, obtained the cubic term $2x^3+5x^2-9x-18$ in the numerator and factorising this proved beyond many candidates. Those who could factorise the cubic often wasted valuable time.

Question 3

The differentiation proved difficult and both $\frac{3}{x}$ and $\frac{1}{3x}$ were common. Even if a correct expression for $\frac{\mathrm{d}y}{\mathrm{d}x}$ was found, difficulties with simplifying fractions often led to incorrect work. For example, $\frac{\frac{1}{3}}{\frac{1}{3}x}$ was sometimes seen simplified to *x*. Failure to read the question carefully lead a number of candidates to give the tangent rather than the normal. There were also candidates who did not find a numerical gradient and gave a non-linear equation for the normal.

Question 4

Part (a)(i) was generally well done. In part (a)(ii), many had difficulty in differentiating $\cos\left(2x^3\right)$ and $-\sin\left(6x^2\right)$ was commonly seen. When the quotient rule was applied, it was often very unclear if candidates were using a correct version of the rule and candidates should be encouraged to quote formulae they are using. Notational carelessness often loses marks in questions of this kind. If $\cos\left(2x^3\right)$ is differentiated and the expression $6x^2 - \sin\left(2x^3\right)$ results, the examiner cannot interpret this as $6x^2 \times \left(-\sin\left(2x^3\right)\right)$ unless there is some evidence that the candidate interprets it this way. A substantial proportion of those who wrote down $6x^2 - \sin\left(2x^3\right)$ showed in their later work that it had been misinterpreted. Similarly in the denominator of the quotient rule $3x^2$, as opposed to $\left(3x\right)^2$ or $9x^2$, cannot be awarded the appropriate accuracy mark unless a correct expression appears at some point. The use of the product rule in such questions is a disadvantage to all but the ablest candidates. In this case, few who attempted the question this way could handle the 3 correctly and the negative indices defeated many.

Part (b) was clearly unexpected by many candidates and some very lengthy attempts began by expanding $\sin\left(2y+6\right)$ as $\sin 2y \cos 6 + \cos 2y \sin 6$. This led to attempts to use the product rule and errors like $\frac{\mathrm{d}}{\mathrm{d}x}\left(\sin 6\right) = \cos 6$ were frequent. Many could, however, get the first step $\frac{\mathrm{d}x}{\mathrm{d}y} = 8\cos(2y+6)$ but on inverting to get $\frac{\mathrm{d}y}{\mathrm{d}x}$ simply turned the *y* into an *x*. Those reaching the correct $\frac{\mathrm{d}y}{\mathrm{d}x} = \frac{1}{\cos\left(2y+6\right)}$ usually stopped there and the correct solution, in terms of *x*, was achieved by less than 10% of candidates. The answer $\frac{1}{8\cos\left(\arcsin\left(\frac{x}{4}\right)\right)}$ was accepted for full marks.

Question 5

This question was well answered and many candidates gained full marks. The great majority were able to provide the appropriate sequence of steps to demonstrate the result in part (a) and part (b) was nearly always completely correct with the answers given to the accuracy requested. The method tested in part(c) was clearly know to more candidates than had been the case in some previous examinations but there is still a minority of candidates who think that repeating the iteration gives a satisfactory proof. Here the question specified that an interval should be used and further iterations could gain no marks. The majority chose the appropriate interval $(1.3915, 1.3925)$ although incorrect intervals, such as $(1.391, 1.393)$ were seen. There were candidates who chose the interval $(1.3915, 1,3924)$. This probably reflects a misunderstanding of the nature of rounding but a change of sign over this interval does establish the result and this was accepted for full marks. To gain the last mark, candidates are expected to give a reason for their conclusion, e.g. there is a sign change, and give a suitable conclusion such as that the root is 1.392 to 3 decimal places, the traditional, QED or, the modern, W.

Question 6

Part (a) was well done. Such errors as were seen arose from $\tan\alpha = \pm 3$ or $\tan\alpha = -\frac{1}{3}$. In part (b), the majority could find the answer $38.0°$ although a substantial minority, with the correct method, failed to obtain this result through premature approximation. If an answer is required to one decimal place the candidate must work to at least 2 decimal places. The second answer proved more difficult. Many candidates produced their "secondary value" at the wrong place in their solution, giving the value of $360° - \left(\arccos\frac{7}{\sqrt{160}} - \alpha\right) \approx 322.0°$ instead of $360° - \arccos\frac{7}{\sqrt{160}} - \alpha \approx 285.2°$.

Part (c) was not well done. In (c)(i) 12 or 0 were often given as the minimum value and few realised that the answer to (c)(ii) was the solution of $\cos(x+\alpha) = -1$. Many produced solutions involving *R*. A few tried differentiation and this was rarely successful.

Question 7

Candidates who gained both the marks in part (a)(i) were in the minority. Most realised that the identity $\cos 2x \equiv \cos^2 x - \sin^2 x$ was the appropriate identity to use but the false working $\dfrac{\cos^{\cancel{2}} x - \sin^{\cancel{2}} x}{\cancel{\cos} x + \cancel{\sin} x} = \cos x - \sin x$ was as common as the correct working using the difference of two squares. Part (a)(ii) was better done and many gained full marks here. An unexpected aspect of many of the proofs seen here, and in part (b), was that the formula $\cos 2x \equiv \cos^2 x - \sin^2 x$ seemed to be much better known than $\cos 2x \equiv 2\cos^2 x - 1$. Many produced correct proofs using the former of these versions of the double angle formulae and $\cos^2 x + \sin^2 x = 1$. This was, of course, accepted for full marks but did waste a little time and these times can mount up in the course of a paper. There were many correct proofs to part (b). The majority started using part (a)(i) but then finished their demonstrations using double angle formulae rather than part (a)(ii). Part (d) was clearly unexpected in this context. The topic is in the C2 specification and may be tested on this paper. Among those who did realise they could divide by $\cos 2\theta$, the error $\tan 2\theta = 0$ was common. Some very complicated methods of solution were seen but these were rarely successful. An error of logic was frequently. On reaching an equation of the form $\mathrm{f}(\theta)\mathrm{g}(\theta) = A$, where A is a non-zero constant, candidates proceeded to deduce that either $\mathrm{f}(\theta) = A$ or $\mathrm{g}(\theta) = A$. A few candidates drew diagrams showing clearly the symmetrical nature of $\cos 2\theta$ and $\sin 2\theta$ and deduced the four solutions from this. Such an approach is sound and was awarded full marks.

Question 8

Part (a) asked for a proof of a straightforward result and, with four marks available, it was expected that each step of the proof was clearly demonstrated. The examiners wanted to see that the operations were performed in the correct order, that the index law was applied to the exponential function (a step such as $\mathrm{e}^{4x+2\ln x} = \mathrm{e}^{4x}\mathrm{e}^{2\ln x}$ is sufficient for this) and that a law of logarithms was used. This step could be shown by writing $2\ln 2 = \ln 4$ or $2\ln 2 = \ln 2^2$. The examiners did not require specific reference to a law of logarithms. Many gained only one or two of the marks available for part(a). The sketch was well done and more candidates seemed to be able to state the appropriate range than has been the case in some previous examinations. The differentiation at the in part (d) proved difficult for many and $\dfrac{\mathrm{d}}{\mathrm{d}x}\left(4\mathrm{e}^{4x}\right) = 4\mathrm{e}^{4x}, 8\mathrm{e}^{4x}$ and $16\mathrm{e}^{3x}$ were all seen from time to time. Apart from this, the method of solution of the equation was well understood.

Core Mathematics Unit C4
Specification 6666

Introduction

Although there were parts of several questions that posed problems for candidates the paper seemed to be accessible to the majority of candidates, and there were some excellent scripts seen. Good marks were generally scored in Q1, Q2, Q5 and Q7 with the first question proving a particularly good opening question, with much good work seen.
The attempts, particularly in part (b), at a seemingly standard vector question were generally very disappointing, and usually only the better candidates scored well here.
The quality of solution to integration problems too, particularly Q3, Q7(c) and Q8(c), was very variable.
Attempts at question 5 were generally quite good although a significant number of candidates, usually those who compared coefficients in part (a) and had difficulty with the resulting equations, needed more space than that allotted. It was a little frustrating, however, to see candidates using extra sheets for questions which still had one or two pages unused.
Examiners reported that some candidates were under the misconception that $\pi = 180$;
this was seen both in Q2(b), in calculating the value of "h", and in Q8(c) when substituting the limits of the integration.

Report on Individual Questions

Question 1

This question was generally well answered with most candidates showing good skills in differentiating explicitly. Candidates who found an expression for $\frac{\mathrm{d}y}{\mathrm{d}x}$ in terms of x and y, before substituting in values, were more prone to errors in manipulation. Some candidates found the equation of the normal and a number of candidates did not give the equation of the tangent in the requested form. It was quite common to see such statements as $\frac{\mathrm{d}y}{\mathrm{d}x} = 6x + 8y\frac{\mathrm{d}y}{\mathrm{d}x} - 2 + \left(6x\frac{\mathrm{d}y}{\mathrm{d}x} + 6y\right) = 0$, but often subsequent correct working indicated that this was just poor presentation.

Question 2

For a large number of candidates this proved to be a very good question, and there were many full marks awarded. However, some candidates had little appreciation of the degree of accuracy they should use, and in both parts (b) and (c) there were some common and serious errors seen. Although few candidates had trouble with the method of the trapezium rule itself, a common error in part (b) was in the miscalculation of "h". Many candidates divided the x interval $\left(\frac{\pi}{4}\right)$ by 5 instead of 4, even though the first two given x-values were 0 and $\frac{\pi}{16}$, but a more alarming error was in the use of 180 for π, so that "h" became 11.25 or 9.
In part (c) a very common error, resulting in the loss of both marks, was to use the answer to part (b), rather than the true value of $\ln(1 + \sqrt{2})$, as the denominator in calculating the percentage error.

Question 3

Most candidates chose to use the given substitution but the answers to this question were quite variable. There were many candidates who gave succinct, neat, totally correct solutions, and generally if the first two method marks in the scheme were gained good solutions usually followed.

The biggest problem, as usual, was in the treatment of "dx": those who differentiated $u^2 = 2x - 1$ implicitly were usually more successful, in their subsequent manipulation, than those who chose to write $u = \sqrt{(2x - 1)}$ and then find $\frac{du}{dx}$; many candidates ignored the dx altogether, or effectively treated it as du, and weaker candidates often "integrated" an expression involving both x and u terms. Some candidates spoilt otherwise good solutions by applying the wrong limits.

Question 4

There were many excellent solutions to this question but also too many who did not know the formula for finding the volume of the solid. Candidates who successfully evaluated $\int_1^3 x^2 e^{2x}\,dx$ were able to gain 6 of the 8 marks, even if the formula used was $k\int y^2 dx$ with $k \neq \pi$, but there were many candidates who made errors in the integration, ranging from the slips like sign errors and numerical errors to integrating by parts "in the wrong direction". An error with serious consequences for most who made it was to write $(xe^x)^2$ as $x^2\ e^{x^2}$; for some it was merely a notational problem and something could be salvaged but for most it presented a tricky problem !

Question 5

This was a high scoring question for many candidates, with even weaker candidates often picking up half marks.

A problem in part (a) was that some candidates used the fact that $B = 0$ to find A or C or both, especially by candidates who compared coefficients and found themselves getting "bogged down" with manipulating the equations. Candidates who substituted $x = -2$ and $x = \frac{1}{3}$ had an easier route and usually fared better.

The work on the binomial expansions in part (b) was generally well done, with the vast majority of candidates choosing to work with $3(1 - 3x)^{-1} + 4(2 + x)^{-2}$ rather than $(3x^2 + 16)(1 - 3x)^{-1}(2 + x)^{-2}$; those that did chose the latter route were rarely successful. Whilst dealing with $(2 + x)^{-2}$ did cause problems, the mark scheme did allow candidates to still score highly even if the 2^{-2} factor was not correct.

Question 6

Although this seemed a very fair test of vector work, and was well answered by good candidates, it was the poorest answered question, with a high proportion of candidates unable to gain more than the odd mark in parts (b) and (c). In part (a) many candidates found one correct value, usually $a = 18$, having found $\lambda = -4$, but then used the same parameter to find b, so that b = 8 + (–4) = 4 was common.
In part (b) the majority of candidates were clutching at straws and even some who knew that **a.b** = 0 could be used, had very little idea what **a** and **b** represented.
A generous method mark in part (c) was often as much as many candidates gained after part (a).

Question 7

The fact that this question had so many parts, with a good degree of independence, did enable the majority of candidates to do quite well. All but the weakest candidates scored the first mark and the first 3 were gained by most. The integration in part (c) did cause problems: examples of the more usual mistakes were to write

$\int \frac{1}{(2t+1)^2}\,\mathrm{d}t = -\frac{1}{2t+1}$ *or* $\frac{1}{2t+1}$ *or* $\frac{2}{2t+1}$ *or* $\frac{k}{(2t+1)^3}$, or to omit the constant of integration or assume it equal to zero; two of the mistakes which came more into the "howler" category were $\int \frac{1}{1000}\,\mathrm{d}V = \ln 1000V$ or $V\ln 1000$ and

$\int \frac{1}{(2t+1)^2}\,\mathrm{d}t = \int \frac{1}{4t^2+4t+1}\,\mathrm{d}t = \int \frac{1}{4t^2} + \frac{1}{4t} + \frac{1}{1}\,\mathrm{d}t = \ldots\ldots\ldots$.

Many candidates were able to gain the method marks in parts (d) and (e).

Question 8

The majority of candidates gained the marks in part (a) and a good proportion managed to produce the given result in part (b). Some candidates suggested that the area of R was $\int_{\frac{\pi}{3}}^{\frac{5\pi}{3}} y^2\,\mathrm{d}t$, which made the question rather trivial; although that happened to be true here as $y = \frac{\mathrm{d}x}{\mathrm{d}t}$, working was needed to produce that statement.
The integration in part (c), although well done by good candidates, proved a challenge for many; weaker candidates integrating $(1\text{-}2\cos t)^2$ as $\frac{(1-2\cos t)^3}{3}$ or something similar. It may have been that some candidates were pressed for time at this point but even those who knew that a cosine double-angle formula was needed often made a sign error, forgot to multiply their expression for $\cos^2 t$ by 4, or even forgot to integrate that expression. It has to be mentioned again that the limits were sometimes used as though $\pi = 180$,

so that $\left[3t - 4\sin t + \sin 2t\right]_{\frac{\pi}{3}}^{\frac{5\pi}{3}}$ became [900 - …….] – [180 - ….].

Pure Mathematics Unit P1
Specification 6671

Introduction

For this, the last paper set on this specification, there were fewer than 100 home candidates. The great majority of these were well prepared and experienced candidates. Nearly all produced complete attempts at all questions and there was little evidence of time pressure. The general standard of work in algebra, trigonometry and calculus was excellent and the only general weakness noticed was in the manipulation of surds. Calculator work was accurate and, usually, appropriate.

Report on Individual Questions

Question 1

This question was well answered although some candidates were not sure what was needed in part (a) and it was not unusual to see candidates gain the one mark with two or, even, three calculations were one would have done. Part (b) was almost invariably correct and only a few lost the final mark by not giving the equation of the line in the form requested.

Question 2

The general standard of calculus displayed throughout the paper was excellent and full marks were common on this question. A few candidates took the negative index in the wrong direction, differentiating x^{-3} to obtain $-2x^{-2}$ and integrating x^{-3} to obtain $-\frac{x^{-4}}{4}$.

Question 3

The work on trigonometry was of a high quality. There are 6 answers to be found in this question and the majority of candidates did find all of them. In part (a), the error $\tan\theta = \frac{2}{3}$ was sometimes seen and a few missed the second solution. In part (b), one or both solutions associated with $\cos\theta = 0$ were sometimes lost. Almost all candidates gave the answers to the degree of accuracy specified.

Question 4

The first part of this question gave difficulty to many. There are a number of possible approaches but many just wrote down $3x^{\frac{1}{2}} - x^{\frac{3}{2}} = 3\sqrt{3} - 3^{\frac{3}{2}} = 0$ and this was thought inadequate unless they could show that $3^{\frac{3}{2}}$ or $\sqrt{27}$ was $3\sqrt{3}$. $3^{\frac{3}{2}} = 3\times 3^{\frac{1}{2}}$ would have been sufficient demonstration of this. In part (b), not all could solve $\frac{3}{2}x^{-\frac{1}{2}} - \frac{3}{2}x^{\frac{1}{2}} = 0$ and a few found the second derivative and equated that to zero. In part (c), most could gain the first four of the five marks available but cleaning up the final answer to the single surd, $\frac{12}{5}\sqrt{3}$ or its equivalent, proved difficult and many had recourse to their calculators, which did not fulfil the condition of the question that an exact answer is to be given.

Question 5

The first two parts of question 5 proved very easy but part (c) was very demanding and there many futile attempts to find the results using areas. All such attempts seen were circular and either should have given 0 = 0 or actually did give 0 = 0. b only needs simple trigonometry, $b = 6\sin 1.2 \approx 5.59$. Some very complicated attempts to find a were seen involving both the sine and cosine rules. The quickest method is to see that $a = 12 - 6\cos 1.2$.

Question 6

Parts (a) and (b) were generally well done although the error of having the minimum of the curve on the y-axis was sometimes seen. There were a few candidates who were not familiar with the term discriminant but the majority could calculate it correctly and make the connection, which is that the curve does not intersect the x-axis, with their diagram. Part (d) proved demanding and only a minority of candidates could give the complete range $-2\sqrt{3} < k < 2\sqrt{3}$.

Question 7

The first three parts of the question were well done although a few did not realise that the result of part (b) was needed to produce a satisfactory solution to part (c). Part (d) proved very difficult for the majority. Most could equate the curve to the line and reduce the problem to solving the cubic $x^3 - x^2 - 5x - 3 = 0$ but many left it there and others tried laborious methods of searching for roots using the factor theorem not recognising that the conditions of the question imply that $x = -1$ must be a root of the equation. If it is recognised that $x = -1$ must be a repeated root then $x^3 - x^2 - 5x - 3 = (x+1)^2(x-3)$ can just be written down but only 4 or 5 candidates saw this.

Question 8

The procedures needed for solving this question were well understood but candidates often got confused with the details of the description in the question. With the approach that most used for parts (b) and (c), the value of n needed for the standard formulae quoted was $n = 8$ but the values 7, 9, 17 and 18 were all used by a number of candidates. A few candidates confused parts (b) and (c) giving the answer to (c) in (b) and giving a further accumulation of numbers in part (c). Most knew how to set up an equation for solving part (d). The large numbers meant that errors were seen in "cancelling" zeros but many reached a correct solution $n = 16$. Here, however, difficulty was found in interpreting this answer and the incorrect "Alice is 27" was commoner than the correct age of 26. Some thought that she was 16, failing to see that this answer contradicted their correct answer to part (c). A few candidates gave a solution to this question involving no algebra and using only the procedures of arithmetic. As long as all the calculations were shown, this was accepted.

Pure Mathematics Unit P2
Specification 6672

Introduction

This was the final examination for specification 6672. The entry was small, and could reasonably be assumed to contain many candidates attempting to improve upon previous results. There was no clear evidence however of a larger than usual proportion of very poorly prepared or weak candidates.

Much of the work seen was of a high standard. Many candidates presented concise and accurate answers to all questions. The spaces allocated on the answer paper were about right - there were relatively few instances of candidates using additional sheets of paper. Most candidates offered solutions to all the questions, with only a small minority appearing to run short of time. Q8 and Q9 yielded the weakest responses.

There was some evidence of an increasing reliance on calculators: a disappointing majority of candidates gave an incorrect final answer in Q1, despite having the correct values to add up, presumably because the answer involved more digits than their calculators could display. Similarly, in Q3 several candidates found correct roots to quadratic or cubic expressions in their numerators, but the factor $(2x+3)$ often appeared as $(x+\frac{3}{2})$ with no evidence of the additional factor 2.

Report on Individual Questions

Question 1

Candidates started this question confidently. The overwhelming majority of them completed the binomial expansion correctly. A few only went as far as the term in x^3, and others suggested that the expansion might continue beyond the term in x^4 by giving a set of dots on the end of their answer. Only a handful ignored the fact that the expansion needed to involve powers of $6x$ and/or the coefficients 1, 4, 6, 4 and 1.

Many candidates were familiar with the method for (b) and correctly identified the need to substitute 100 in place of x in their expansion. It was disappointing that so many candidates then went on to add the numbers using their calculators and did not appreciate that they should have expected their answer to end with the digit 1. Some candidates simply offered a calculator value for 601^4 with no evidence of use of their expansion at all. Many answers were expressed in standard form, often with the value rounded to 3 or 4 significant figures.

Question 2

This question was similar in style to several that candidates will have seen in the past papers. Many well-rehearsed and totally correct solutions were seen. Where errors did occur, the problem was usually with $f(|x|)$. Some candidates clearly knew that they were looking for a reflection in the *y* axis, but they then produced a sketch with a large α shape in the first quadrant, having left the original section in place and reflected the section from the second quadrant in the *y* axis.
There are some candidates who seem to think that when drawing the modulus function you draw just the positive sections and ignore anything that lies below the *x* axis.
A small minority of candidates appeared to be drawing sketches more like y=x+3, $y = |x+3|$ or $y = |x| + 3$, and a third sketch that was a repeat of their second. This often involved creating an associated table of values. Their answer completely ignored the original function sketched for them.

Question 3

Those candidates who factorised the two unfactorised terms and simplified before attempting to add their fractions were at a clear advantage here. There were a lot who did follow this route, but the alternative resulting in a numerator of $2x^3 + 5x^2 - 9x - 18$ was very popular. Many of these candidates never actually reached this expression due to a sign error in multiplying out their brackets at the previous stage resulting in $2x^3 + 5x^2 - 9x + 18$. Some candidates did not attempt to simplify the expression any further than this. There was quite a lot of correct factorization, some of it appearing with very little evidence of any working. Those candidates who achieved a factor of $(x + \frac{3}{2})$ with no obvious working were presumably working backwards from roots found using their calculators.
Almost all candidates started by looking for a common denominator in the early stages of their working. However, there were a small number who started by trying to split the original fractions into partial fractions. All but one of these candidates failed to appreciate that the first of the two fractions is top heavy so they should have been expecting a purely numerical term in addition to their fractions. Although this approach can sometimes produce a quick and simple solution to the task this was not the case on this occasion.

Question 4

Those candidates who could differentiate the logarithmic function had no difficulty with the question. A gradient function of the form $\frac{k}{x}$ was expected. Many candidates ran into problems with the $\frac{1}{3}$, and some obtained the correct expression $\frac{\frac{1}{3}}{\frac{x}{3}}$ but did not simplify this correctly.
Most candidates obtained the correct value, *y*=0 when *x*=3, but some had problems with $ln1$.
Almost all candidates offered a sensible attempt at the equation of the normal rather than the tangent.

Question 5

A few candidates made no attempt to link the original function with the iteration formula. For those who did attempt this part, the most popular route was to start with f(x)=0 and attempt to rearrange it. There were a few algebraic slips, and some candidates who could not see how to achieve an x^2 term, but most were successful. The few candidates who worked in the reverse direction, working from the iteration formula towards f(x) were all successful.

Many candidates were successful in applying the iteration formula, and usually noticed the instruction to give x_1, x_2 and x_3 to 2 decimal places. A few candidates appeared to think that this instruction applied only to x_3. There were some candidates having difficulty in the correct use of their calculators; a common set of false answers resulted from the alternative formula $\sqrt{\frac{2}{x}}+\frac{1}{2}$, despite the original formula being quoted correctly.

The wording of the final part of this question clearly indicates the need for a method involving an interval, yet many candidates simply continued for several more applications of the iteration formula. This approach gained no credit. Some candidates continue to have difficulty in identifying the correct values to use for the endpoints of their interval. (1.391, 1.393) was quite a common error, as was candidates attempting to add and subtract 5 in the wrong decimal place. There were a good number of totally correct answers.

Question 6

Almost all candidates found the x-coordinates of A and B correctly. Any errors were usually algebraic slips, but a small number of candidates compared the gradients of the two functions rather than the functions themselves.

In attempting to find the shaded area, most candidates found areas relative to the x axis, but some preferred to work relative to the y axis. Most candidates made a valid attempt at the area, although some forgot to integrate, and a few used the volume formula. The area of the trapezium was usually found separately. The answer was often correct, but some candidates said they were treating it as a triangle and others used the incorrect formula $\frac{1}{2}\left(\frac{3}{2}-\frac{1}{2}\right)(3-1)$ despite calling it a trapezium. A *ln*(…..) term was expected from the integration of $\frac{3}{2x}$, but many candidates did not achieve this. It was common to see either an x^2 term in the denominator or the function rewritten as $\frac{3}{2}x$ before an attempt to integrate. Candidates who recognized the correct form were sometimes confused by the constants.

A lot of correct working was seen, but several candidates gave away the final mark because they went into decimals and never gave an exact form for the final answer (as requested in the question). Candidates were expected to tidy their final answer to given a single log. term.

Question 7

Most candidates applied the given formula correctly to obtain values for *y*, which were not always given to the required degree of accuracy.
The majority of candidates then went on to apply the trapezium rule correctly, although some had difficulties with the interval width (5/6 was quite a popular alternative), and in such a familiar question it is disappointing to see so many candidates misapplying the formula as $\frac{1}{2}\left(0+3.482\right)+2(0.062+0.271+0.716+1.612)$. In most of these cases it is not an error in the way in which they use their calculators, they simply express the formula incorrectly from the outset. Some candidates who set the working out like this do come up with the correct numerical result because they have used poor presentation and "invisible brackets".
Most candidates realised that to find the volume of the section they simply needed to multiply their area by 6, but several came up with complicated false alternatives, often involving formulae for cone, cylinder or sphere.
For the final two marks, some candidates gave answers relating to the complexity of forming this shape from concrete, and missed the point that the trapezium rule over-estimates this area. Others were more concerned about the rounding errors due to working to 3 decimal places.

Question 8

This proved to be the most difficult question on the paper, not necessarily because the candidates could not attempt it, but mainly due to the errors made.
A "given answer" is often an invitation to bluff that you have demonstrated more than you actually have, and that was certainly the case here. Most candidates started with the correct combination of the two functions, but few demonstrated the splitting of the index to give the product of two terms, and even fewer showed a full explanation for $e^{2\ln 2}=e^{\ln 4}=4$.
Candidates need to appreciate the importance of setting out all stages of their working in this situation.
There were several good sketches, but there were sketches of the incorrect shape, sketches that crossed the *x* axis, sketches passing through (0,1), and a number where the horizontal asymptote appeared to be noticeably above *y*=0.
Candidates' descriptions of the range of gf were often not consistent with their sketches. Incorrect answers often included 0, or the full set of real numbers. A maximum or minimum value of 4 was also a common alternative.
Most candidates demonstrated little or no understanding of how to differentiate $4e^{4x}$. In many instances the answer was $4e^{4x}$, but $4xe^{4x}$ and $4e^{3x}$ were also seen. Despite errors in the differentiation, many candidates reached an expression of the form $e^{p}=q$, but were not able to go on to use logarithms correctly to attempt to solve their equation.

Question 9

In (ai) most candidates identified the appropriate form of the double angle formula to substitute in the left hand side of this identity, but the following cancelling was frequently incorrect. The most popular (and incorrect) answer was:

$\dfrac{\cos 2x}{\cos x + \sin x} = \dfrac{\cos^2 x - \sin^2 x}{\cos x + \sin x} = \dfrac{\cos^2 x}{\cos x} - \dfrac{\sin^2 x}{\sin x} = \cos x - \sin x$. Some candidates started by multiplying both sides of the identity by $(\cos x + \sin x)$ and multiplying out the difference of two squares. This method was acceptable provided that the candidate clearly picked out this form of the double angle formula as a known result and completed their argument correctly.

The response to (aii) was usually much more successful, but many candidates clearly have problems over the distinctions between $\cos^2 x$, $\cos 2x$ and $2\cos x$.

In (b) most candidates started by applying (ai), but usually went on to pick out the double angle formulae in their working rather than apply (aii).

In the final part, some candidates expended considerable time and effort in trying to expand both sides of this equation to obtain an equation in a single trig.function. This invariably involved a false step of the form $\sin 2x = 2\sin x$. Some tried squaring both sides of the equation which allowed them an equation in $\sin 2x$ or $\cos 2x$, but also introduced false solutions that were not discarded. Those candidates who did realise that this equation is equivalent to an equation in tan2x often went on to obtain the correct answers, but common errors here involved answers in degrees, radians but not expressed as multiples of π, or an incomplete set of solutions. Some candidates had difficulty in rewriting the equation and arrived at the false equation $\tan 2x = 0$.

Pure Mathematics Unit P3
Specification 6673

Introduction

The standards of answers on this paper were wide-ranging. There were several accessible questions, notably Q1(a), Q2, Q3(a), Q5(a) and Q7, which were familiar to and done successfully by many candidates. Most candidates attempted all the questions and although some did not attempt Q8 this was most likely due to the depth of understanding needed for the question rather than a lack of time. Poor arithmetic and algebraic manipulation led to errors in several questions. Candidates also lost marks when they ignored the requirement for an exact value.

A few candidates using supplementary paper failed to identify their scripts in any way; centres would be wise to ensure candidates put their full details on all the paper they use.

Report on Individual Questions

Question 1

Many candidates were successful with part (a). The most frequent error involved the use of powers of $2x$ rather than $(-2x)$. The careless use of brackets led both to sign errors in part (a) and also a significant number of incorrect answers in (b), the most common being either 100, 10 or $\frac{1}{100}$ × [answer to part (a)].

Question 2

The vast majority of candidates scored full marks for this question. A few incorrectly stated that $f(1) = 6$ or $f(-1) = 0$ but were still able to gain some marks by using a valid method to solve simultaneous equations in a and b. The most common error was seen in evaluating $f(-1)$ when $-(-1)^2$ was given as $+1$.

Question 3

In part (a) most candidates were familiar with the equation of the circle in the form $(x - a)^2 + (y - b)^2 = r^2$ and showed sufficient steps in their working towards the given answer. Candidates using $x^2 + y^2 + 2gx + 2fy + c = 0$ were less successful, often giving muddled or incomplete solutions. Part (b) was also well done. Some candidates lost the final A mark when, having found $x = 2$, they substituted this into the equation of the circle (rather than into $y = 2x$). This gave them two values of y and they were required to pick out the correct value of y for the final mark. A few candidates used implicit differentiation to reach $\frac{dy}{dx} = \frac{8-2x}{2y-6}$ but then did not proceed to substitute $\frac{dy}{dx} = 2$ and $y = 2x$ to find the required value of x.

Question 4

The product rule was well understood and many candidates correctly differentiated f(x) in part (a). However, a significant number lost marks by failing to use ln e = 1 and fully simplify their answer.
Although candidates knew that integration by parts was required for part (b), the method was not well understood with common wrong answers involving candidates mistakenly suggesting that $\int \ln x \, \mathrm{d}x = \frac{1}{x}$ and attempting to use $u = x^2 + 1$ and $\frac{\mathrm{d}v}{\mathrm{d}x} = \ln x$ in the formula $\int u \frac{\mathrm{d}v}{\mathrm{d}x} \mathrm{d}x = uv - \int v \frac{\mathrm{d}u}{\mathrm{d}x} \mathrm{d}x$.

Candidates who correctly gave the intermediate result $\left[\left(\frac{x^3}{3} + x\right)\ln x\right]_1^e - \int_1^e \left(\frac{x^3}{3} + x\right)\frac{1}{x} \mathrm{d}x$ often failed to use a bracket for the second part of the expression when they integrated and went on to make a sign error by giving $-\frac{x^3}{9} + x$ rather than $-\frac{x^3}{9} - x$.

Question 5

Many correct answers were seen to part (a). Candidates who used long division were generally less successful often leading to the misuse of $1 + \frac{8x^2}{9 - 4x^2}$ to attempt partial fractions. The few candidates who ignored the 'hence' in part (b) made no progress in their integration, but would not have gained any marks anyway. Although candidates knew $\int \frac{1}{ax + b} \mathrm{d}x = k\ln(ax + b)$, they were less accurate with the value of k. This question provided another challenge for candidates who were careless in their use of brackets whose answers often led to giving –[–(–1)] as +1. A few candidates ignored the requirement for an exact value.

Question 6

Part (a) specifically asked the candidates to explain why k was a positive constant. Although candidates linked the negative sign with the rate of decrease, they often did not then explain how this related to k. When explanations were given they tended to be verbose.
Candidates who used C as a constant of integration in part (b) often confused themselves. It was not unusual to see no constant of integration or to see the correct statement $\ln C = -kt + A$ leading to the incorrect statement $C = \mathrm{e}^{-kt} + \mathrm{e}^{A}$. It seemed that candidates were familiar with an exponential decay result of the form $C = A\mathrm{e}^{-kt}$ but were not necessarily sure how to get to this result from a given differential equation.
Errors in method were seen in part (c) when candidates had omitted the constant of integration in part (b) and full marks were only given to a full and correct solution. Many candidates ignored the given starting value of $C = C_0$ at time $t = 0$ and instead used, for example, $C_0 = 1$ or $C_0 = 100$. This was allowed provided the candidates went on to use $C = 0.1\times$their value of C_0 at time $t = 4$. The most frequent error was the use of $0.9C_0$ or its equivalent. This was another question where some candidates ignored the requirement for an exact value.

Question 7

Most candidates found the correct values of p and q in part (a). However, inaccurate arithmetic was again seen in evaluating $q - (-1)$. Candidates who made errors were either unable to distinguish the position vector of a point on the line from a direction vector or falsely assumed that $\overrightarrow{AB} = 2\mathbf{i} + 2\mathbf{j} + \mathbf{k}$.

The method for part (b) was unfamiliar to many candidates.

Many correct solutions were seen for part (c), although a few candidates lost a mark by finding θ but never actually giving the value of $\cos\theta$ as requested in the question.

Part (d) proved a good source of marks but, although $5\mathbf{i} + 3\mathbf{j} + 3\mathbf{k}$ was accepted on this occasion, it should be noted that the question asked for coordinates not a position vector.

Question 8

This question proved a significant test for many candidates with fully correct solutions being rare. Many candidates were able to find $\frac{\mathrm{d}x}{\mathrm{d}t}$ and $\frac{\mathrm{d}y}{\mathrm{d}t}$, although confusing differentiation with integration often led to inaccuracies. Some candidates attempted to find the equation of the tangent but many were unsuccessful because they failed to use $t = \frac{\pi}{6}$ in order to find the gradient as $-\frac{\sqrt{3}}{6}$.

Those candidates who attempted part (b) rarely progressed beyond stating an expression for the area under the curve. Some attempts were made at integration by parts, although very few candidates went further than the first line. It was obvious that most candidates were not familiar with integrating expressions of the kind $\int \sin at \sin bt \, \mathrm{d}t$. Even those who were often spent time deriving results rather than using the relevant formula in the formulae book.

Those candidates who were successful in part (a) frequently went on to find the area of a triangle and so were able to gain at least two marks in part (b).

Pure Mathematics Unit P4/FP1
Specification 6674

Introduction

Although some of the questions on this paper were easily accessible to the majority of candidates, there were others that proved demanding and consequently the mean mark was comparatively low. Generally, candidates appeared to know what to do but were not able to complete solutions accurately or fluently, but weaker candidates were often ill prepared in some topic areas. Although there were only seven questions on the paper, rushed attempts at Q7 suggested shortage of time. Spending too long on Q5 (doing further iterations when not required) or on Q6 (long algebraic procedures, usually following errors) could have caused this. Also candidates sometimes spent too long trying to obtain given answers, often attempting to change wrong working and becoming more muddled.
In general, candidates showed their methods clearly, but crossing out of work and second attempts sometimes spoilt standards of presentation.

Report on Individual Questions

Question 1

Most candidates managed to complete this question successfully using standard sum formulae, although perhaps making heavy weather of the expansion or factorisation. Where mistakes were made, these were usually algebraic slips. Other approaches, which included the method of differences and proof by induction, were rarely seen.

Question 2

Various methods of solution were seen for this inequality. Some of these were based on sketches and others were completely algebraic, but the basis of all methods was to find the 'critical values'. Candidates who failed to realise that $x = 2$ was a critical value were able to score at most 3 marks out of 6. Standards of algebra were sometimes poor, but those who correctly identified all three critical values were usually able to obtain full marks.

Question 3

There were many excellent solutions to this question, but where candidates did find difficulty it was usually in part (a). Attempts that started with $\frac{z+2\mathrm{i}}{z-\lambda\mathrm{i}} \times \frac{z+\lambda\mathrm{i}}{z+\lambda\mathrm{i}}$, effectively treating z as a real number, were doomed to failure and often led to much confusion and wasted time. Fortunately, however, candidates could complete parts (b) and (c) independently of (a), and usually did so successfully.

Occasional mistakes in (b) included $\frac{\lambda/2+1}{\lambda/2-1} = \frac{1}{2}$ and $\frac{\lambda/2-1}{\lambda/2+1} = \arctan\frac{1}{2}$.

Also in part (b), there were a few candidates who equated the imaginary part to 1 and the real part to 2, giving two different values for λ.

Question 4

Most candidates knew how to find a general solution in part (a) and were able to use the initial conditions correctly in part (b) to find the particular solution. Minor slips in part (a) did not prevent candidates from scoring well in the rest of the question, but the omission of one (or even both) of the arbitrary constants was a major mistake. Some confused themselves by looking for a particular integral in part (a).
Few good sketches were seen in part (c). Some candidates omitted this part completely, while others failed to show the features of the graph clearly. Despite the given initial condition, very few graphs started with a positive gradient at $t = 0$. Sketches should have shown, for $0 \le t \le \pi$, decreasing amplitude of the oscillations, turning points and intersections with the axes.

Question 5

Some candidates had difficulty in interpreting the context of this question and worked with θ rather than α in part (a) and/or part (b). In part (a), a few were unfamiliar with linear interpolation or confused it with interval bisection, but most were able to use a correct formula to find an approximation to α. Some candidates persisted with further iterations, wasting time but still reaching the required answer 1.87. Numerical slips were not uncommon.
The Newton-Raphson procedure was well known in part (b) and many excellent solutions were seen. The required differentiation was usually correct, but a few candidates showed insufficient detail in their numerical working, penalising themselves if their final answer was wrong.
Occasionally part (c) was omitted, but most candidates were able to refer back to the context and calculate the required time.

Question 6

While good candidates sometimes coped very well with this question, producing clear, concise solutions, many found it difficult and wasted time in parts (b) and (c) with attempts that were leading nowhere.
In part (a), those who realised $\frac{\mathrm{d}y}{\mathrm{d}x} = v + \frac{\mathrm{d}v}{\mathrm{d}x}$ were usually successful, but $\frac{\mathrm{d}y}{\mathrm{d}x} = v$ and similar alternatives were unlikely to yield any marks.
Most candidates attempted to separate the variables of the differential equation in part (b), but not always correctly, and most also integrated with respect to x to obtain $\ln x$. Those who were able to see 'by inspection' that $\int \frac{3v+4}{3v^2+8v-3}\,\mathrm{d}v = \frac{1}{2}\ln(3v^2+8v-3)$ made life easy for themselves, but too many resorted to partial fractions, wasting valuable time and often making mistakes. The lack of an integration constant meant that a few candidates could progress no further. Removing logarithms correctly, especially dealing with the constant, was a problem for many candidates, so progress towards the given answer in part (c) was often rather limited, with many dubious attempts to obtain the 200.

Question 7

There were some very poor and rushed solutions to this question. In part (a)(i), surprisingly many candidates were unable to link the required expression with the given polar equation, even though they knew that $\cos 2\theta = 1 - 2\sin^2\theta$.

Most knew in part (a)(ii) that they had to deal with $r\sin\theta$, but made it more difficult for themselves by trying to differentiate $a\sqrt{\cos 2\theta}\sin\theta$ rather than $a^2(1-2\sin^2\theta)\sin^2\theta$ (as suggested by part (a)(i)). Consequentially many mistakes, often due to the fractional power, were seen in differentiation, and few candidates proceeded legitimately to the given polar coordinates of *P*. Particularly disappointing at this level was the (not uncommon) mistake of square rooting separate terms of a sum, e.g. $\sqrt{\sin^2\theta - 2\sin^4\theta} = \sin\theta - \sqrt{2}\sin^2\theta$.

Completely correct solutions to part (b) were rare. While better candidates did realise that they had to use the area of the triangle $\frac{1}{2}\left(\frac{a}{\sqrt{2}}\cos\frac{\pi}{6}\right)\left(\frac{a}{\sqrt{2}}\sin\frac{\pi}{6}\right)$, there was much confusion over which limits to use for the integral $\frac{1}{2}\int a^2\cos 2\theta\,\mathrm{d}\theta$, and which area this represented. A common mistake was to use $\frac{\pi}{2}$ instead of $\frac{\pi}{4}$ as the upper limit, even though the curve was defined only for $0 \le \theta \le \frac{\pi}{4}$.

Pure Mathematics Unit P5
Specification 6675

Introduction

The paper seemed to be a very fair test with the majority of candidates able to show good knowledge across most of the specification tested. Although this paper had a small candidature the standard was generally high with some excellent scripts; most candidates gained marks in all questions and there were very few marks below 20 .

There were parts of all questions that posed problems for some candidates, but even so the modal score on most questions was full marks; question 9 being a notable exception where the last part proved too great a challenge for the vast majority of candidates. The quality of solution was perhaps most variable in Q5 and Q7
and some candidates were greatly helped by the given answer in part (a) of Q6, judged by the amount of "back-tracking" that was seen.

Report on Individual Questions

Question 1

Generally a good starter with many full marks gained. There were some errors in completing the square, some of which made the solution impossible, but usually errors were in the translation to log form; ln [3 + $\sqrt{3^2+4^2}$] for arsinh (¾) being a good example.

Question 2

For most candidates this was a good short question, although using $b^2 = a^2(1 - \mathrm{e}^2)$ and giving both positive and negative values for e, in part (a), occurred relatively frequently. In the curve sketching the mark for the hyperbola
was not always gained and it was quite common to see the curves intersecting rather than touching.

Question 3

A very well answered question. The vast majority of candidates knew what to do and errors were usually more of a careless nature rather than through lack of understanding. Most candidates who gained the first 3 marks were usually able to carry out the integration correctly. A "slip" that proved costly was to write $1 + 2\cos t$ instead of $2 + 2\cos t$ after successfully expanding $(1+\cos t)^2 + (\sin t)^2$.

Question 4

Some candidates did not use the definition of cosh x in terms of exponentials in part (a) and so gained no marks and wasted time. The majority of candidates were able to prove the identity, although some had difficulty with finding a correct expression for $\cosh^3 x$.
There were a variety of successful approaches to part (b) but it was very common to see only one correct result, especially by those candidates who used
arcosh $x = \ln\{x + \sqrt{(x^2 - 1)}\}$. Some candidates who reached $\cosh^2 x = 2$ went on to solve both cosh $x = \sqrt{2}$ and cosh $x = -\sqrt{2}$; in the latter case it was quite common to see $x = \ln\{-\sqrt{2} + 1\}$ and then the "mod" inserted to give $\ln\{\sqrt{2} - 1\}$.
Many candidates chose to solve quadratic equations in e^x or e^{2x}, depending on whether they were solving cosh $x = \sqrt{2}$ or $\cosh^2 x = 2$; in the latter case arithmetic errors such as $(e^x + e^{-x})^2 = 4$ spoilt otherwise good solutions.

Question 5

There were many impressive, well presented solutions.
The majority of candidates who applied $s = \int \sqrt{\left\{1 + \left(\frac{dy}{dx}\right)^2\right\}}dx$ successfully often went on to gain most, if not all, of the marks, although omission of the constant of integration was seen.
Some candidates chose to find the radius of curvature (sec x) and went on to use $\frac{ds}{d\psi} = \sec x$.
In both approaches, however, some candidates did not show that $x = \psi$ in a clear manner. Some weaker candidates started with $\frac{ds}{dx} = \sec\psi$ and integrated with no regard to the variables involved.

Question 6

The vast majority of candidates found correct expressions for $\frac{dy}{dx}$ and $\frac{d^2y}{dx^2}$. From the number of sign changes seen in the work of some candidates, even when an incorrect identity had been used, it was clear that the given answer had been of considerable influence !
Even candidates who had not been particularly successful in part (a) often gained the marks in part (b), although the calculator operations did prove too challenging at times.

Question 7

There were some problems in applying the "by parts" technique correctly but the first 2 or 3 marks were often gained. A completely correct solution to part (a) was, however, only seen by the better candidates.
Part (b) was well done, even by candidates who were unable to make much headway in part (a).
A significant number of candidates, however, did waste time in showing the given result $\int_0^4 \sqrt{(4 - x)}\,dx = \frac{16}{3}$; sadly some showed it was equal to some other value, and used that value !

Question 8

Some candidates made heavy weather of part (a) and it was a little disappointing at this level to see some poor surd work. Candidates who reached the stage
½ $\ln(3 + 2\sqrt{2})$ were expected to show some working before writing down the given answer $\ln(\sqrt{2} + 1)$.
For many candidates part (b) was an easy two marks but equally there were many poor attempts such as $\frac{dy}{dx} = \frac{1}{1 - \sin^2 x}$. Although some candidates who started with $\tanh y = \sin x$ were successful, many were not able to give $\frac{dy}{dx}$ as a function of x.
The last part proved a good source of marks for good candidates. Although the question may have looked daunting many candidates integrated "by parts" well and realised the links with the other parts of the question.

Question 9

Parts (a) and (b) proved a good source of marks for many candidates; part (a) was particularly well done but 3 out of 5 marks was more the norm for part (b), where answers were left in a very unmanageable, or wrongly simplified, form.
Complete solutions to part (c) were usually only seen from grade A candidates, but many candidates had made the problem more complicated by having such unsimplified expressions for the coordinates of R.

Pure Mathematics Unit P6
Specification 6676

Introduction

This was a well balanced paper. All candidates had the opportunity to show their skills and knowledge. Early questions were accessible to most candidates whilst there were sufficient challenges throughout the paper for the most able. The paper was of a comparable standard to previous years and there was little evidence that candidates did not have sufficient time to attempt all questions.

The standard of algebra and calculus together with accuracy in working were excellent. Q7 and Q8 were good discriminators for the highest grades.

Report on Individual Questions

Question 1

For most candidates this was a good starter question in which they managed to score full marks; others also made some progress either by spotting one or two answers or recognising but not completing the general solution. A few candidates wrote

$$(\cos\theta + i\sin\theta)^5 = i$$

and used the binomial expansion to evaluate the bracket, managing to form two correct equations, and possibly identifying $\theta = \pi/2$ as one solution.

Question 2

This was a popular question with the majority of candidates scoring full marks. Some candidates misinterpreted the given value for $y_0 = 1$ as $y_1 = 1$. Others after making a correct start went on to evaluate y at $x = 0.6$. Candidates who used the given values and formed two simultaneous equations fared better than those who eliminated y_1 before substituting in values. It was pleasing to see that numerical and algebraic skills were easily sufficient to meet the demands of this question.

Question 3

Part (a) was a good discriminator. Many candidates did not realise that the image of the line was a point. Many confused their x's and y's, writing incorrectly

$$\begin{pmatrix} -4 & 2 \\ 2 & -1 \end{pmatrix}\begin{pmatrix} x \\ y \end{pmatrix} = \begin{pmatrix} x \\ y \end{pmatrix}$$

In part (b) the majority of candidates managed to obtain the correct eigenvalues; a small minority made numerical errors or mistakes in their algebraic manipulation when working towards the quadratic equation, although they clearly understood the method required.

In part (c) some candidates were unable to identify the required method, often neglecting to substitute their eigenvalues on the right hand side of the matrix equation **AX** = λ**X** , thus using **AX = X**

Question 4

Most candidates successfully completed part (a) finding the correct values of *k* when the determinant was zero; others did not understand that "singular" implied finding values of *k* for which det A = 0, and only tackled part (b).

Candidates scored well here but often made minor numerical and sign errors throughout or changed the sign in their determinant. Frequently confusion occurred between the matrix of cofactors and the adjoint matrix. Centres need to ensure that their candidates do understand these definitions and how they are related.

Question 5

Many candidates scored well on this question, showing that they fully understood the concept of inductive proof. Part (a) was answered better than part (b) where the differentiation needed proved too complex for many candidates.

In part (a), most candidates did understand the method required and managed to work towards the required inductive stage by adding on the extra term and showing that the result was of the correct form; most candidates completed the argument. In part (b), candidates had difficulty in setting up the (k+1) th. term, and/or completed the calculation incorrectly by using

$$\frac{\mathrm{d}^{n+1}y}{\mathrm{d}x^{n+1}} = \frac{\mathrm{d}y}{\mathrm{d}x} \times \frac{\mathrm{d}^n y}{\mathrm{d}x^n}.$$

Other candidates did not fully complete the deductive process in either part, but did complete the main argument.

Question 6

Candidates showed a clear understanding of the use of the product rule and implicit differentiation.

Part (a) was well done by candidates who differentiated using the given form to achieve the stated equation. In part (b) most candidates differentiated at least one side of their equation correctly. Those who chose to rearrange their equation before evaluating for part (c) often introduced algebraic errors.

Although previous errors in differentiation followed through into part (c) for some candidates, the use of Maclaurin's Series was accurate and well understood. Only a small minority formed an incorrect series by ignoring the factorials. A few candidates did not attempt part (c)

Question 7

All candidates managed to achieve some success on this question. Part (a) was answered well by most. Candidates were familiar with the vector product and few had any difficulty evaluating correctly, providing their vectors $\overrightarrow{RP}$ and $\overrightarrow{RQ}$ were accurate. Errors from part (a) prevented full marks in part (b).

In part (c), the majority of candidates successfully identified the normal from part (b) and substituted a point on the plane to evaluate the value of p.

Part (d) was a real discriminator, with some candidates recognising a concise method and putting it into practice, identifying the "correct" position of the image with a clear diagram. Others made a good start by using a known formula to find the perpendicular distance of the point S from the plane, but did not know how to then proceed. Others seemed to think that the origin was in the plane and made no significant progress at all. A clear diagram would be beneficial, and is critical in fully understanding the situation described in vector questions of this type.

Question 8

This question did cause many problems for most of the candidates; they seemed ill prepared for the demands of the question, and few achieved more than a few marks.

In part (a), some candidates understood that the locus was a circle but they had great difficulty in showing the correct circle or even recognising that the two points, $(-2, 0)$ and $(0, 2)$ formed a diameter. A sound knowledge of the circle theorems was crucial for an understanding of the concept underpinning this part of the question. Many did not identify the correct right angle between the two lines and even those who did, did not necessarily sketch the correct semi-circle. Only those who recognised the circle in part (a) were able to interpret this into part (b).

Part (c) was poorly attempted by all but the most able candidates. Many candidates were only able to score one mark for rearranging the given equation to get z as a function of w. They then continued to produce a page or more of incorrect or inappropriate working. Some wrote $w = u + iv$ but were unable to return to the original constraint on z. This section of the question was a good discriminator for the highest achieving candidates.

Mechanics Unit M1
Specification 6677

Introduction

The paper proved to be demanding for many candidates and the overall mean mark was lower than in some previous sessions. Candidates clearly found the vector triangle Q4 very unfamiliar, and they also struggled with the first question. Nevertheless, despite what appeared to be unfamiliar questions in some instances, it was disappointing to see candidates struggling with relatively elementary features such as distinguishing mass and weight (e.g. in Q7 taking the weight as m rather than mg). The standard of presentation was also at times disappointing with several solutions not clearly presented and working often a rather unclear jumble on the page.

Report on Individual Questions

Question 1

For candidates who realised the most efficient method (using a single constant acceleration equation in both parts), this was a relatively easy first question, though several failed to take account of the appropriate signs in the equations. However, probably more than 50% of the candidates chose to make the question considerably more complex by dividing the motion up into two or three parts, considering the motion to the highest point, and then down to the ground (or in even more stages). Some succeeded in getting to the correct answers, but often there were accuracy errors en route. Many also made unjustified assumptions about the motion (e.g. that the highest point was reached after precisely 2 seconds or that initial speed was zero). Some candidates fared slightly better in part (b), but again were evidently sometimes confused about which distance was which, and whether the ball had a non-zero or zero initial velocity.

Question 2

Candidates fared much better on this question that on Q1. Almost all could write down appropriate equations involving conservation of linear momentum in (a) and (b), and an appropriate expression for an impulse in (c). If errors occurred, they tended to be in the signs in parts (b) and (c), candidates failing to take note of the different directions of motion. However, many fully correct answers were seen here.

Question 3

Again most candidates scored highly on this question, clearly understanding the principles of moments and applying them correctly. There were some arithmetical slips, but most could make good progress in the question. The statement required about the uniformity of the rod was generally answered in such as way as to gain the mark, though ‘explanations’ were at times a little unclear (e.g. that the weight was ‘at’ the middle of the rod, rather than acting through the middle of the rod).

Question 4

This question proved to be the most demanding on the paper. The majority attempted it by trying to draw a vector triangle, but the triangles drawn were often unclear and rarely correct (with quite a few right-angled triangles drawn or assumed). Others attempted to use coordinates, though often made mistakes in using the implied equation $\mathbf{P} + \mathbf{Q} = \mathbf{R}$ (instead simply adding the two given vectors, i.e. assuming $\mathbf{P} + \mathbf{R} = \mathbf{Q}$). The presentation of work here was also very poor, with calculations or numbers often splayed all over the page with no clear justification for what was being attempted. Fully correct solutions were seen, but only occasionally!

Question 5

In parts (a) and (b) candidates managed to recover and most could make good attempts here. Most could resolve perpendicular to the plane and parallel to the plane, with a correct use of the frictional force. Some lost marks by omitting forces, but several gained at least all the method marks here. Part (c) proved to be more discriminating, at least for gaining all 5 marks. Some could make little progress since they did not realise that the normal reaction had now changed. Others did realise this and could get to the stage of setting up the value of the component of the weight down the plane and the value of μR. However it proved to be very difficult for candidates to understand clearly that 'μR' was not necessarily the actual frictional force acting (except in limiting equilibrium): hence there were many final answers to part (c) stating that the box remained in equilibrium 'because the frictional force was greater than the component of the weight'.

Question 6

Part (a) was generally well answered, most knowing how to calculate a 'speed' from a 'velocity'. In part (b), most calculated an angle, but as often as not failed to give any indication which angle it was in relation to the data; they then often failed to deal with the angle correctly to find the correct bearing. Candidates should be encouraged to show clearly their working and, if they are calculating an angle, which angle in a figure it is. In part (c), most correctly equated the two general position vectors to find a value of t, but some failed to make the full check to ensure that the value of t obtained produced equality for both coordinates (hence implying a collision). Part (d) proved to be more discriminating. Several could not find the new velocity of B correctly (given its magnitude and direction though with the direction not given in the form of a unit vector); however, a number of candidates did manage to pick up the method marks here by proceeding correctly with what they thought the velocity was.

Question 7

Equations in part (a) often clearly started on the right lines with the correct number of terms; but equally often they produced a variety of errors, with missing m's, g's, some using cos instead of sin etc, and a number of students were unable to reduce their answer to a single multiple of mg. In part (b), most who attempted this could find the normal reaction, and also write down an equation of motion for B with the correct number of terms; again the same kind of errors were seen as in part (a) for the details. Correct answers to part (c) were rarely seen, many assuming that the force on the pulley was made up of the components of the two weights, and very few indeed realising that the resultant force acted vertically downwards,

Mechanics Unit M2
Specification 6678

Introduction

The paper proved to be very accessible and there were many high quality scripts. There was little evidence of candidates being short of time and most candidates were able to attempt all of the questions. The best source of marks came from Q2(a), Q3(a), Q4(a) and Q5(a). The questions which seemed to cause the most difficulty were Q4(b), Q5(b) and (c) and Q6. Candidates should again be advised that if they use g = 9.8 in a calculation they should give their final answer to 2 significant figures and, in these circumstances, answers given to more than 3 significant figures will be penalised. Candidates should also be warned against premature approximation and incorrect answers which result will be penalised.

Report on Individual Questions

Question1

This was generally well answered – almost every candidate identified Joules as the units of energy in the first part and most found the correct numerical value. The force-acceleration method was the most popular approach in part (b). There were some problems with accuracy and signs.

Question 2

Most candidates realised that they needed to differentiate, although there was the odd integration. Having found a velocity vector some then failed to find the modulus to obtain the speed. In part (b), a few used $\mathbf{I} = m(\mathbf{u} - \mathbf{v})$ and a very small number worked with scalars, but generally candidates reached the correct vector solution. Some candidates thought they then had to find the magnitude of their vector – they were not penalised for this.

Question 3

The most common error here was a sign error in the $F=ma$ equation required in part (a) but most knew the Power equation and were able to get to the printed answer. In the second part there were some sign errors and some used Power = Nett force x speed but many candidates produced correct solutions. Sometimes answers were given to a greater degree of accuracy than could be accepted.

Question 4

The first part was very well answered with the odd error of incorrect signs. It was pleasing to note that only a few gave the restitution equation the wrong way round. Most of the errors here occurred in parts (b) and (c). There appeared to be some confusion over the fact that the KE of every particle before and after the impact was required and that these needed to be added and subtracted correctly in order to get a positive loss of KE. Some candidates missed out the KE of one of the particles and many subtracted to get a negative KE. In part (c) the impulse equation was often incorrect, with an incorrect sign in the velocity term. This led to a value of $e > 1$. Some candidates realised that this was wrong and corrected their equation but others changed the final equation but failed to change the signs in their original impulse equation and were unable to score full marks.

Question 5

In part (a) many saw intuitively that $\bar{x}$ = 4.5 because of the distribution of the masses. Some made life more difficult by taking moments about different axes – especially to find the y-coordinate. Many completed the second part easily, but weaker candidates tried to find the area of the triangle and somehow got the required answer by devious means thereafter. A worrying number thought that 6 x 9 was 36. A small minority failed to complete this part through not knowing the position of the centre of mass of a triangular lamina . Part (c) was usually completely correct or else they had absolutely no idea. In the final part there were the usual problems of identifying the angle correctly with some attempting to find sine or cosine, using Pythagoras or the cosine rule.

Question 6

This was the most challenging question on the paper and very few scored full marks. Part (a) was generally well attempted with the printed answer undoubtedly helping. Many completely correct moments equations were seen and it was pleasing to note that few of the common errors such as missing terms, incorrect trig ratios or missing distances were made. The second part was more difficult algebraically, but nevertheless many candidates successfully found the value of *k*. However, it was surprising to see so many candidates, who produced a correct solution to part (a), make a complete hash of part (b). Full marks in the second part were very rare as the vast majority chose to work with $F = \mu R$ instead of $F \leq \mu R$ and produced the inequality "out of a hat" at the end. Some candidates included g in their equations despite being given that *W* was a weight.

Question 7

Parts (a) and (b) were usually correct although some candidates made things more difficult for themselves by splitting the motion into "up and down" etc but they still usually got there in the end. The third part was more challenging but most candidates were able to pick up some marks although the algebraic manipulation required to solve their equations for *V* defeated some of the weaker candidates. Part (d) proved to be a good discriminator, with most candidates simply trotting out the "usual" air resistance without really thinking about the situation.

Mechanics Unit M3
Specification 6679

Introduction

The paper proved to be accessible and there was little evidence of candidates being short of time. There were a great many very good scripts from well-prepared students and only a few really poor attempts. Overall the quality of the work was high but poor presentation was a feature of many of the weaker scripts, some of which were barely legible with cramped, partially scribbled out and over-written working, and no attempt to explain methods. Candidates should be encouraged to space out their solutions and not to write continuously on every line of the paper as they would an essay. Candidates should also be advised not to write in pencil.
One feature of the paper was that there were a number of questions where the candidates were asked to "Show that….". For such questions, where there is a given printed answer, candidates should realise that is essential that they fully explain their methods if they hope to gain full credit for their answers. "Methods" means the use of *accurate equations derived from the application of one or more mechanical principles*, not wordy or waffly arguments.
Most candidates were able to attempt all of the questions and Q4(a) and Q5(a) proved to be the best source of marks with Q3, particularly the first part, causing the most difficulty. Q6(c) proved to be a very good discriminator at the top end of the ability range.

Report on Individual Questions

Question 1

This provided a fairly straightforward start and most scored well but there were fewer full marks than expected. The answer to (a) was often given as 13.58, losing a mark, the value of F was frequently used mistakenly for T in (b) and accuracy errors were fairly common in (c) when a 2 sig fig answer to (b) was used to calculate a 3 sig fig value for the energy.

Question 2

This too was a straightforward question and full marks were common. Most errors arose from difficulties with the constants during integration, principally wrong signs in integrating $\sin$ and $\cos$ and multiplications instead of divisions by ½. Unfortunately, candidates who made mistakes in the first integration invariably repeated them in the second, ending up with only half marks. A small but significant minority integrated dv/dt as v^2 in (a) and were then faced with an integral they couldn't do in (b). A very few of the most able candidates were aware that they were calculating a displacement which might not equal the distance and investigated whether the particle stopped during the given time period. This showed insight but earned no extra credit.

Question 3

Part (a) proved difficult for very many candidates and there were a number of frequently repeated low scoring efforts. Instead of using integration, many tried to fit $Gm_1m_2/r^2 = F$ into the problem or quoted $a = c/x^2$ and then tried to use $v^2 = u^2 + 2as$ with some elaborate fiddling where $s = (R - x)$ cancelled with x^2 to give the correct answer. Another common error was to quote conservation of energy with PE rather than finding Work Done using integration. Part (b) was attempted more successfully but the positioning of the extra ½ in the KE equation was as often wrong as right. Candidates also had more trouble than they should have had in simplifying $\frac{1}{2R} - \frac{1}{R}$ accurately.

Question 4

This provided a very easy nine marks for many and almost all knew what they were trying to do. The most frequent mistake in (a) was to assume that volumes needed to be used for the cylinder and hemisphere and in (b) the fraction was often upside down. Where solutions did go wrong, there was again widespread fiddling. Even the volume versions sometimes ended up being rearranged, factorised or cancelled into the required expression.

Question 5

Apart from (a), which was almost always correct, this was not well done. With the definition of x clearly defined in the question, the proof in (b) should have been straightforward. For many it was, but there were again a huge number of fiddled attempts. Often, candidates started out correctly with $mg - T = \pm ma$, only to cross out the mg subsequently, when they realised that $T = \lambda x / l = ma$ led to the required expression, and therefore lose the mark for this equation. Part (c) was not well done either. Most chose to use the formula $v^2 = \omega^2(a^2 - x^2)$ but values for a and x were not often correct. Use of energy was popular as well but many omitted either the EPE or the GPE. Part (d) was a great discriminator and only the best candidates were able to describe the transition from SHM to free motion under gravity to SHM clearly and accurately.

Question 6

Part (a) was done either very well or very badly. Many candidates were completely comfortable with the theory and produced clear and concise derivations of *T*. Nearly everyone else managed to arrive at the same formula using some kind of fudged argument.. A favourite approach was $T = \frac{mv^2}{l} + mg$ and $v^2 = 3gl$ at *B*, so the tension in new position is $mg(1+3\cos\theta)$. There were many variations on this. Again, there were versions that may have been correctly reasoned but weren't expressed clearly enough for the examiners. For instance, one proof was perfect up to the point where it stated ma for circular motion $= \frac{mv^2}{l} = mg(1+2\cos\theta)$ and then said "Must add $mg\cos\theta$ to account for the weight". Candidates should be under no illusion that this type of argument will receive no credit whatsoever.

Part (b) followed on nicely from (a) for the majority who used a result obtained for v^2 in (a) with $\cos\theta = -⅓$.
Part (c) did discriminate between the top few candidates and the rest. Very few recognized the need to use v_y, either as the initial velocity in $v^2 = u^2 + 2as$, or = 0 (with v_x still present) when using energy. Too many thought that finding the height when the string went slack or to when $v = 0$ was sufficient to answer this part.

Question 7

For a significant number of relatively weak candidates this question ensured a respectable mark. If conical pendulum methods were well known, it proved very straightforward and large numbers of candidates gained full marks. However, the "show that" in part (a) threw many, who were not entirely happy with this topic, completely off track. It was very clear to many that $m\omega^2$ x $2a$ gave the right numerical answer, so they decided that this must be the right way to do the question. It was very common to see a solution which had started with $T\cos 30 = m\omega^2$ x $2a$ continue with the $\cos 30$ scribbled out. This then had further implications in part (c) where the candidates used the method which had "worked" in part (a) and failed to resolve here also. This betrayed a complete lack of understanding and justifiably led to the loss of a significant number of marks. There was further evidence in this question of inadequate "showing" by able students when answers are printed. Calculation of length *OA* as a was almost trivial but needed to be shown not assumed. Perfect solutions which ended up saying $OX = a/2$, so *X* is the mid-point of *OA* were not uncommon.

Mechanics Unit M4
Specification 6680

Introduction

The paper was accessible to the majority of candidates and seemed to be of an appropriate length. The most challenging questions were Q2 and Q6 with all the others proving to be good sources of marks. Many candidates had a good grasp of the basic principles of mechanics and the standard of integration and trigonometry required for the paper was generally very good. The standard of presentation was good but it would be helpful if candidates were encouraged to begin each question on a new page.

Report on Individual Questions

Question 1

This was a good starter question with many fully correct solutions. A few candidates made an error in (a) and then used their incorrect answer instead of the printed answer in (b). The integration and manipulation of exponential and log functions was good.

Question 2

This was a challenging question for all but the strongest candidates. Part (a) was accessible although some did not realise it was a circular motion/energy question. Part (b) was not recognised as an oblique impact – on most scripts, there was no attempt to resolve the before and after velocities into components and candidates used $v = eu$ with resultant velocities instead of components perpendicular to the wall.

Question 3

The inclusion of only one relative velocity question was perhaps a relief to candidates who have difficulty with this topic. Many methods of solution were seen. In part (a), sine and cosine rule or vector methods occurred frequently with candidates often gaining full marks. Those using vector methods could dispense with a diagram – those relying on a diagram were not always successful, having the speed of 16 km per hour in the wrong direction. In parts (b) and (c) the most direct method was rarely seen – using the initial displacement with the relative velocity and forming a right angled triangle. The shortest distance can then be written down directly as 20sin30 and the time taken is the relative distance travelled divided by the relative speed, 20cos30/10**.** Some candidates used differentiation of |relative position| squared and others, the scalar product of relative position and relative velocity**.** These methods were often successful but wasted time because they were significantly longer.

Question 4

In part (a), many candidates failed to realise that they needed to consider the equilibrium position and obtained the printed answer by ignoring the mg term in $F = ma$. In (b), a few wasted time by solving the differential equation when the solution was given but full marks were often obtained in this part. A mark was sometimes lost in (c) because candidates gave the general solution of $\tan\omega t = 1$ instead of the time at which P first comes to rest.

Question 5

This question was a very good source of marks with many completely correct solutions. Candidates were confident in the use of conservation of momentum and Newton's law of restitution and coped well with the resulting algebra. There were some errors in (c) with candidates using m for both masses instead of m and km with $k = ½$ as printed. Several saved some calculation by realising that all the energy loss came from the components of velocity along the line of centres

Question 6

If candidates spotted that *L*OAB was $(45 - \theta)$ and *L*OBR was $(45 + \theta)$ then part (a) was reasonably straightforward. Unfortunately, many did not, and used the cosine rule which resulted in expressions involving $\sin 2\theta$ as well as $\cos 2\theta$. Credit was given for this as the trigonometry was correct but only the strongest candidates managed to obtain the printed answer from this approach. Those who did used some ingenious methods and are to be congratulated on the standard of their trigonometry! However, since the answer was given, all could progress to the next part of the question. The first three marks in (b) were almost always obtained but then some cancelled the $\sin\theta$ factor and lost one solution, others gave 0 and π, others gave just +0.723 and many gave a solution in degrees instead of radians. In questions involving calculus, candidates need to be reminded that they <u>must</u> use radians. Part (c) was usually correct.

Mechanics Unit M5
Specification 6681

Introduction

The size of the entry was such that any generalisations about the performance of candidates, or how they found the paper, are all but impossible. Clearly the candidates who entered for the paper were generally very well prepared and found the paper accessible with plenty available for them to show how much they could do. Overall the standard of the scripts was commendably high, showing that candidates entering for this module are very able mathematicians.

Report on Individual Questions

Question 1

More able candidates succeeded easily here in gaining full marks. Weaker candidates failed to treat the vectors properly as vectors, finding only the magnitude of the force x the distance. Some too had difficulty in finding *AB* as a vector quantity (from its magnitude and direction).

Question 2

Nearly all candidates provided good proofs of this standard result and set out their working clearly. Only the weakest candidates failed to make good progress in this question.

Question 3

Most could make good attempts at this question. All the general principles were well known with most gaining either full marks or making tiny slips in accuracy. All succeeded in working with vectors throughout in an appropriate way, which was very encouraging to see.

Question 4

Weaker candidates failed to write down an equation of rotational motion in part (a) and hence could make little progress here. More able candidates however had little difficulty with this question and scored full marks easily.

Question 5

Able candidates scored well here, though the question was found to be more challenging for others, with a number failing to realise that they would need both an energy equation (for the motion after the impact) and a momentum equation (for the impact itself). A number thought that they would only need the energy equation. Some arithmetical slips also occurred in the processing of the equations.

Question 6

Some good answers were seen. Most could obtain the forces as vectors and realised which equation was appropriate to use in part (a). In part (b), there was some confusion about which position vectors to use in finding the total moment of the system; some also failed to understand the meaning of the word ‘magnitude’, finding only **G** as a vector.

Question 7

This was found to be reasonable straightforward as a question on variable mass. The derivation of the given differential equation was generally good with nearly all correctly considering a small time interval appropriately. Parts (b) and (c) were also generally well done. In most cases, the question proved to be a good source of marks.

Question 8

Most could find the moment of inertia in part (a) correctly. However, there were many mistakes in parts (b) and (c). Many failed to consider an equation of rotational motion in part (b); and although most realised that they could do part (c) easiest by considering energy, there were a number of mistakes in dealing with the distances involved. Part (d) was generally approached correctly, but often incorrect previous answers led to an incorrect answer here as well.

Mechanics Unit M6
Specification 6682

Introduction

The size of the entry for the paper makes it almost impossible to make any generalised statements about the performance of candidates as a whole. The paper proved to be reasonable accessible and most of those who entered for the paper could make good attempts at significant parts of the paper.

Report on Individual Questions

Question 1

This was generally well answered with virtually all gaining full marks. The relevant formulae were well known and correctly used in the question.

Question 2

Again most gained full marks: the use of intrinsic coordinates was generally well known and the general principles applied correctly.

Question 3

This question caused more difficulty. Some evidently failed to realise that it was the moment of momentum about P which was conserved (rather than, for example, energy) and so could make no progress with a valid solution to the problem.

Question 4

Most could write down the correct initial equations. The more able candidates could then proceed correctly in integrating the equations of motion appropriately to arrive at the given answer.

Question 5

Again some good solutions were seen: candidates were clearly able to work with different axes from the traditional horizontal and vertical and apply the relevant equations of motion appropriately.

Question 6

This was probably the most testing question on the paper. Better candidates could derive the equation given in part (a), though some fudges, or unjustified assumptions, were seen by weaker candidates. The integration of the question to produce the answer in part (b) was generally well done. However, a fully correct answer to (c) was not seen at all: some could factorise the resultant quartic in r (using the hints provided in the question about the roots), but no one could even attempt to demonstrate that the remaining quadratic factor had no roots and hence never changed sign.

Statistics Unit S1
Specification 6683

Introduction

This paper was shown to be accessible to the majority of candidates and there was no evidence of them being unable to complete the paper owing to time constraints. It was clear that many of the candidates were confident with the work they had learnt in statistics at AS level. The order of the questions set reflected the level of difficulty very well, with the Venn Diagram and the Normal Distribution proving to be the most demanding questions.

Report on Individual Questions

Question 1

This question was a good source of marks with most candidates able to find the correct values for the mode and median, but too many getting the upper quartile wrong. A surprising number of candidates had problems with finding the standard deviation. In quite a few cases the square root was omitted but more often marks were lost due to the misinterpretation and misuse of standard formulae. This was not helped by some candidates ignoring given totals and calculating their own. In part (e) a large number of responses gave one reason rather than two.

Question 2

This proved to be a well balanced question giving strong candidates a chance to score well, but sufficient opportunities for weaker candidates to gain some marks. Some candidates appeared to guess the answers to p and q and then were able to carry these through into part (c). A significant number of candidates forgot that the total of the probabilities should be 1 and tried to 'solve' one equation while some candidates missed out the question completely. Some worked out the expectation although it was given at the start of the question.

Question 3

Graphs were well done and candidates are finally labelling axes, but poor choice of scale for the x-axis meant some struggled to plot the graph accurately. For a standard question part (b) was disappointing with many answers referring to correlation but not to a straight line or line of best fit. Part (c) was generally well answered with the inevitable loss of the last mark through lack of accuracy by using 3.9 or not reading the question for the 2 decimal places required for the answers. A significant minority also thought that b represented the product moment correlation coefficient. Responses to part (d) usually missed the context of the question and in part (f) the proximity to the range of values of x was often omitted.

Question 4

Parts (a) and (b) were generally well done though unexpectedly a few candidates failed to provide any sort of diagram. In part (c) relatively few candidates understood conditional probability in a fairly simple question. Poor attempts to use Bayes' theorem usually resulted in no marks being awarded. It was a pity that only a handful of the best candidates just wrote down the answer from the tree.

Question 5

A lot of waffle was seen in many responses to part (a). Many candidates lost marks due to illegible handwriting and muddled English and a large variation in the quality of answers was seen. Most candidates gained some but not full marks. In part (a) many could only supply one valid reason for the use of statistical models and in part (b) candidates need to be reminded to read the question carefully as many ignored the random variable and hence lost one or two marks. The whole or part of this question was completely missed out by a surprisingly high proportion of students.

Question 6

A number of candidates seemingly had not covered Venn diagrams as many had poor diagrams or none at all. Those who knew what to do usually worked straight through and gained full marks. The mark scheme allowed a fairly generous follow through of marks which allowed some marks even after a dubious Venn diagram. Conditional probability worked better here though there were still difficulties and again more poor attempts at Bayes' theorem. In part (d) there were many good answers but a common form of error was to mistake mutually exclusive for independence. Only a few realised that they had just found P(A/B') and it wasn't P(A). Poor accuracy again caused some to lose a mark in part (c) when correct answers were truncated to 2 dps.

Question 7

A straight forward Normal question answered well by some candidates and not so well by others. Part (d) proved a good discriminator between those who understood the meaning of independence and those who didn't, though some were sidetracked into trying to justify the assumption rather than questioning it with some strange results.

Statistics Unit S2
Specification 6684

Introduction

The paper seemed to be accessible to the students and most managed to attempt all the questions. The paper discriminated effectively between the weaker and strong candidates, with many of the former achieving very few marks in the last 3 questions. Many candidates are becoming better at ensuring that they do not lose marks unnecessarily by, for example, ensuring that results of hypothesis tests are placed in context, working is shown clearly and distributions are stated. This indicates that they are being prepared for the examination more effectively. However, there is still a substantial minority who still lose marks too easily.

Report on Individual Questions

Question 1

A few candidates did not recognise tossing a coin as being a Binomial situation and thus gained no marks. Most candidates coped well with the question and full marks were not uncommon. The main error came in part (b) where many candidates forgot to consider both possibilities and got an answer of 0.0625. In part c the most common error was to try to use a binomial approach.

Question 2

Many candidates did well on this question and gained all 9 marks.
In part (a) nearly all candidates realised the Poisson distribution was appropriate but not all stated the parameter of 1.5. Often this was stated in part b which did not gain the marks.
In part (c) many candidates used a Poisson distribution with a parameter of 4.5 rather than cubing the probability of $X \geq 1$ from a Poisson 1.5.
Part (d) was done very well by all candidates; the main error being the statement $P(X>4) = 1-P(X \leq 3)$

Question 3

Most candidates got a mark of 7 out of the 8 possible.
In part (a) only a minority of candidates considered the regions $X<-1$ and $X>5$ and indicated them on their graphs.
Most were able to state the correct answer by calculation or by symmetry in part (b). In part (c) the errors arose from using ½ instead of 1/12 in the formula. Those using integration sometimes forgot to subtract $E(X)^2$.

Question 4

Most candidates correctly used a Po(3) distribution although a significant minority attempted to used a Normal distribution**.** The most common error was using $P(X>7) = 1 - P(X \leq 6)$

Question 5

There is an increasing number of candidates who are able to attempt questions of this type successfully. However, many still have difficulty with the calculus required and/or calculating and using the cumulative distribution function.
Part (a) was completed successfully by many candidates who showed clearly how the given solution was achieved.
In part (b) only the weaker candidates had problems in calculating the integral required.
In part (c) the question was completed entirely successfully by a minority of candidates. The most common error was the failure to use an upper variable limit and a lower limit of 2 for the integration. Those using the equivalence method to find the constant of integration were usually successful. A few candidates failed to show the full distribution function F(x) omitting $x \leq 2$ and $x \geq 3$.
Some candidates did some quite remarkable lengthy, but incorrect, algebraic work on the cumulative distribution function in part (d). Generally however candidates did manage to substitute but a number forgot to say that F (x) = ½.

Question 6

In part (a) many candidates were able to calculate the mean accurately, although some divided by random constants. Few drew up a table and many were unable to cope with the 5p coins. The most common error in calculating the variance was the failure to subtract $E(X)^2$.
Most candidates correctly identified 6 possible samples but some failed to realise that combinations such as (1,5) and (5,1) were different and so missed the other 3 possibilities. Only a minority of candidates were able to attempt part (c) of the question with any success, with many candidates having no idea what was meant by 'the sampling distribution of the mean value of the samples'. Most did not find the mean values and if they did, then they were unable to find the probabilities (ninths were common).Very few candidates achieved full marks.

Question 7

In part (a)(i) the null and alternative hypotheses were stated correctly by most candidates but then many had difficulties in either calculating the probability or obtaining the correct critical region and then comparing it to the significance level or given value. Most of those obtaining a result were able to place this in context but not always accurately or fully. Candidates still do not seem to realise that just saying accept or reject the hypothesis is inadequate.
In (a)(ii) although some candidates obtained the critical regions the list of values was not always given. Many candidates got the 9 but forgot the 0 and a minority gave a value of ≥ 9 but did not give the upper limit.
In part (b) there was a wide variety of errors in the solutions provided including using the incorrect approximation, failing to include the original sample in the calculations, not using a continuity correction and errors in using the normal tables. Again in this part many candidates lost the interpretation mark.
Most candidates attempting part (c) of the question noted that the results for the two hypothesis tests were different but few suggested that either the populations were possibly not the same for the samples or that larger samples are likely to yield better results.

Statistics Unit S3
Specification 6685

Introduction

This proved to be a fairly straightforward paper and most candidates were able to tackle all the questions with a good degree of success. The usual problem of hypotheses not being stated in terms of population parameters was an issue for a few (notably in Q7(b)) but conclusions were usually given in context.

Report on Individual Questions

Question 1

Most candidates calculated that there were 600 students in the school and they used classes and gender as strata. The calculations to determine the number of boys and girls from each class and the sixth form were often carried out correctly although sometimes they forgot there were 15 classes and simply suggested that a sample of 15 boys and 15 girls was taken rather than one boy and one girl from each class. The commonest omission was a failure to explain how the samples were taken from each stratum: labelling and using random numbers. There were a good number of fully or almost fully correct solutions from candidates who appreciated the depth of explanation required for a 7 mark question.

Question 2

This was a straightforward question and it was very well answered by the majority of the candidates. A minority did not understand the notation for a normal distribution and thought that N(20, 4) meant that the standard deviation was 4 not 2. The probability in part (c) was usually found correctly and errors in standardization were very rare.

Question 3

The mean was almost always correct and the majority of the candidates knew how to find an unbiased estimate of the variance. Most knew how to find 95% confidence limits although a few used 1.6449 and some thought the formula was $1.96 \pm \frac{\sigma}{\sqrt{n}}$. Occasionally the standard deviation of 25 was misread as a variance. The final part caused some confusion. Many students carried out the required calculation but some started to find the width of the interval and others did not attempt this part.

Question 4

This question was answered well and most candidates scored full or almost full marks. The Expected frequencies were almost always correct as was the calculation of the test statistic. Occasionally the hypotheses were the wrong way around and sometimes the conclusion was not given in context.

Question 5

The basic technique for testing for a difference between two means was well known and this question was usually answered well. The calculations were usually carried out correctly and the appropriate critical values used. Conclusions were usually given in context but in part (c) candidates often simply restated their conclusion from part (b) rather than attempting to summarise the overall findings by stating that the girls had improved more than the boys. In part (b) some candidates simply used μ_1 and μ_2 in their hypotheses and it was not possible to tell which referred to boys and which to the girls.

Question 6

Most candidates could use the Poisson tables to find the expected frequencies *r* and *s* but simply found 100xP(X =8) rather than ensuring that their expected frequencies added to 100. In part (b) some candidates failed to mention that the mean of 2 was part of the hypotheses but most candidates realized that there was a need to amalgamate the final 4 classes and the test statistic was often correct. The calculation for the degrees of freedom was usually correct and the rest of the test was carried out appropriately. In part (c) many realized that the degrees of freedom would be reduced by 1, but they often failed to mention that the expected frequencies, and therefore the value of the test statistic, would be different.

Question 7

Part (a) was not answered well. Some candidates mentioned that the data was unlikely to be joint normally distributed but the usual offerings simply mentioned ease of use or that the question was concerned with ranks. The remainder of the question was answered well. Only a few candidates failed to use ranks in their Spearman's formula and most stated their hypotheses in part (b) in terms of ρ .

Statistics Unit S4
Specification 6686

Introduction

There were a small number of candidates for this unit, many of whom were not thoroughly prepared and they were unable to answer several of the questions with any success. Many candidates made a reasonable attempt at Q2, Q3 and Q5, but struggled with the more involved questions towards the end of the paper.

Report on Individual Questions

Question 1

Part (a) was well done, but many candidates started with a confidence interval in part (b) that required a significant amount of manipulation and inevitably gave rise to errors. The incorrect comparison of 0.9 with the interval, rather than 0.81 was not unusual in part (c).

Question 2

Many candidates started well with correct definitions, but subsequently made lots of careless errors with hypotheses, inequalities and critical regions and lost accuracy marks as a result.

Question 3

A reasonable attempt at the proofs were usually seen here, but the use of the fractional variance in part (b) was missed by many.

Question 4

Parts (a) and (b) were attempted well, but a correct answer to part (c) was rare.

Question 5

Hypotheses were often incorrect in part (a), but calculations usually gained most of the available credit. Candidates are still forgetting to state their conclusions in the context of the question set.

Question 6

A reasonable start was made by most to show the calculations leading to the given answers, but accuracy errors usually marred the attempts in part (b) and correct answers in part (c) were rare.

Question 7

Candidates found this question very demanding and parts (a) and (b) were usually confused and incoherent due to accuracy errors.

Statistics Unit S5
Specification 6687

Introduction

This was the final time the unit will be offered and the small number of candidates who sat the paper tended to struggle with the more demanding aspects of the paper.

Report on Individual Questions

Question 1

This proved to be a good start for many candidates, with many correct answers seen to parts (a) and (b). However, responses often did not refer to the content of the question in part (c) and gained no credit as a result.

Question 2

A good source of marks for the better prepared candidates, but some of the weaker responses did not draw a detailed enough tree diagram or omitted the very first pair of branches.

Question 3

Candidates made a good start to this question as they could identify the distribution and were able to derive the given answer in part (b). However, only the best candidates were able to gain any credit in part (c) as many struggled with a complex expression involving exponential functions.

Question 4

Part (a) was attempted well, but the context was missed in part (b). A common error in part (c) was to use 6 rather than 36 and so accuracy marks were lost as a result.

Question 5

Again, the given answer proved to be a good source of marks in part (b). Parts (a) and (c) were answered well, but part (c) defeated most as the question was not interpreted correctly as the probability of ‘no cuts’.

Question 6

The complexity of the calculations in this question meant that candidates were required to show their working clearly if they were to gain partial credit if errors were made. Unfortunately this usually resulted in weak responses gaining very little in the latter parts of the question.

Question 7

A reasonable start for many meant full marks for the derivation of the given answer. The calculus in part (c) was often confused and incomplete and many variations on the answer to part (d) usually involved t/25 and so gained the first mark but not the second.

Statistics Unit S6
Specification 6688

Introduction

The paper proved to be accessible to the majority of students. Most candidates completed the paper within the time allowed and attempted the questions in the order set.

Report on Individual Questions

Question 1

This was not a popular question. Candidates had not learnt what a randomized block design is.

Question 2

The candidates were able to state their hypotheses clearly but had not learnt how to calculate the t value when testing the regression coefficient.

Question 3

A popular question which was well answered

Question 4

This question was not tackled well by candidates. The hypotheses were usually incorrect and the main error was in the calculation of the degrees of freedom.

Question 5

The candidates were either able to attempt this question and gain most of the marks or were unable to start it. The main error was incorrect hypotheses.

Question 6

This question was a good source of marks. Candidates were generally able to answer a and then either b or c. few candidates were able to do both parts b and c.

Question 7

This was a popular question. Parts a and b were well answered but few were able to make a start at part c.

Decision Mathematics Unit D1
Specification 6689

Introduction

The paper proved accessible to most candidates. Most candidates were able to make a good attempt at all of the questions. The work was generally well-presented, few additional sheets were used and efficient methods of presentation were more common. Candidates who failed to see the link between Q4 and Q4(c) often wasted a lot of time in answering part (c), this led to their experiencing significant time problems towards the end of the paper. The examiners were very disappointed in the standard of the calculator work seen in Q3, and of the graph work seen in Q6.

Good answers were often seen to Q1(b), Q2(b), Q5(a) and (b) and Q6(e). Poor answers were often seen to Q4, Q5(e) and Q6(b).

Questions requiring explanations (Q1(a), Q4(a), Q5(d) and Q6(d) and (e)) continue to cause problems for candidates.

Report on Individual Questions

Question 1

This proved a good starter question for the vast majority of the candidates. Part (a) required a clear explanation, and this proved tricky for some candidates, most were able to tackle part (b) successfully however. Some forgot to demonstrate the change of status step, a few tried to create paths starting or finishing at already matched vertices, others did not take into account their earlier alternating path when seeking a second one, some wrote down a multitude of alternating paths and did not indicate which they used, but generally part (b) was very well done.

Question 2

This proved an accessible question, but careless slips resulted in few gaining full credit. Not all candidates used Prim's algorithm correctly and of those that did, some did not clearly state the order in which the edge were selected – as directed in the question. A disappointing number of candidates used the nearest neighbour algorithm instead of Prim's algorithm. Many omitted to state the weight of the tree. The vast majority were able to draw the network in part (b). The majority did three pairings but many did not find all the shortest routes between the pairs. Some discarded any route involving more than one edge and some did not state the totals of their pairings. A few did not state a route and some found a semi-Eulerian solution.

Question 3

Most candidates completed the table but many did not precisely follow the instructions or else had difficulty in using their calculator correctly. This was therefore disappointingly done. Many candidates did not obey the directions relating to accuracy, stating an incorrect number of decimal places or significant figures or making rounding errors. Some very careless calculator work was seen, the values of D should have alternated in sign, but were often negative throughout and many candidates had difficulty in calculating values for E, either omitting the bracket, or the square root, or both. Very few listed all the E values as the output – with most stating only their final E value.

Question 4

This was often quite poorly done. Extremely poor use of technical terms and some very confused explanations were seen in part (a). Most, but by no means all, were able to state the value of C1 correctly but C2 proved more difficult. Many ignored the direction of the flow and simply found the sum of all the arcs cut, including that of CD which does not flow into the cut, and therefore should not be included, giving the very common incorrect answer of 802 for cut C2. Many did not make the link between parts (b) and (c) and wasted time using the labelling procedure and seeking flow-augmenting routes, rather than using the minimum cut to deduce the maximum flow pattern. This often led to time problems for these candidates later n in the paper. Few candidates gave a clear, unambiguous, diagram showing the maximum flow. Only a few found the correct second minimum cut, and many used the flows rather than the capacities or each arc. In part (e) only a few adequately explained that arc EF was capacitated (or both FT and FG were capacitated.) Few gave the correct value of the increased flow.

Question 5

Parts (a) and (b) were often well done – although many made slips such as stating 9 as the late event time for B instead of 8. A few included F as a critical activity. Most candidates were able to draw a cascade chart. There was a variety of techniques used to display the activities and floats, those who drew multiple lines sometimes ran out of space, and candidates using this method may need to return to the top of the chart to show the later activities. Many made slips displaying the lengths of the activities or their floats, and some omitted some activities. Part (d) was poorly answered, candidates were directed to use their cascade chart but few did so. Candidates needed to state a specific time and list all the activities that must be happening at that time. Part (e) was often poorly done with errors of duration and precedence being common, even amongst those using the correct number of workers.

Question 6

Most candidates were able to make some progress with part (a), most correctly stated the objective function but often the objective was omitted. The non-negativity constraints were often omitted and many had difficulty in finding the $x \geq 2y$ inequality. The examiners were all disappointed by the standard of the graph work seen in part (b). Lines were often imprecisely drawn or omitted, $x = 2y$ (if found in part (a)) was often incorrectly drawn. Labels, scales and/or shading were often omitted and the feasible region was not always indicated. Not all candidates used sharp pencils and rulers. If candidates are going to use the profit line method in part (c) they must draw in, and label, a profit line which should long enough to enable examiners to check the gradient. If candidates are going to use the point testing method they must state and test **every** vertex point in the feasible region, not just the most likely point. Many candidates did not state the profit, and of those that did, some did not state units. Those who drew a correct graph generally answered part (d) well. Part (e) was often well-answered but there were many irrelevant comments seen.

Decision Mathematics Unit D2
Specification 6690

Introduction

The paper proved to be accessible to the majority of candidates, with most candidates being able to make a good attempt at all the questions. The questions requiring candidates to formulate a linear programming problem (Q3 and Q5) were often imprecisely done. Time did not seem to be a problem for the candidates.

Good answers were often seen to Q1 and Q6.

Poor responses were often seen to Q2 and Q5(c).

Report on Individual Questions

Question 1

This proved a good first question and a good source of marks for most candidates. A minority treated this as a minimising problem. A few made arithmetical slips. A minority did not apply the algorithm correctly with some failing to use the **minimum** number of lines at each stage and others failing to perform the appropriate addition and subjection to all relevant elements.

Question 2

This was poorly attempted by many candidates. Too many started at May rather than September and many forgot to include earlier values in later calculations. Some did not read the questions carefully and tried to make more than 5 or store more than 2 in any one month.

Question 3

Some candidates did not clearly define their decision variables, X_{ij} must be defined as a **number** and many omitted the units of 1000 litres. Most stated the objective and the objective function correctly. The unbalanced problem caused difficulty for some, although others handled it very well – either by adding a dummy or by using inequalities to describe the constraints. Many poor answers were seen with equalities and once more the 1000 litre units caused difficulty for some. Most remembered the no-negativity constraints.

Question 4

The vast majority of the candidates added the three zeros in part (a) and most added the 14. Part (b) caused some confusion, some felt that if there are n supply points then there must be n demand points too, most made it clear that the total supply was greater than the total demand but some wrote the weaker statement that the supply did not equal the demand. Most candidates were able to describe a degenerate solution in part (c). Some disappointing work was seen in part (d), some candidates had difficulty calculating the shadow costs and improvement indices, with negative signs casing most of the problems. Some did not find a valid stepping-stone route – using two empty squares or not using a negative improvement index as the entering square. Some did not introduce an exiting square – leaving a residual zero and thus creating an invalid solution.

Question 5

This was very poorly done by most candidates, with the exception of part (a) which was well done. In part (b) some candidates did not state which specific row/column dominated which row/column. Part (c) was certainly the most poorly handled part of the paper. Very few defined their variables and only around half the candidates remembered to make all the entries positive by adding eg 3. Very few indeed then correctly found the inequalities. Many created inequalities using the coefficients given by each row in turn rather than those given by the columns. Many candidates reversed the inequalities and very few correctly stated the objective.

Question 6

Most were able to make a good attempt at part (a), although some found a **cycle** rather than a minimum spanning **tree**. Some selected the least value as the best lower bound. Candidates were usually able to complete the table correctly but many got 168 instead of 167 for AF and FA, and 142 instead of 137 for CH and HC. Many made a good attempt at part (c) but some did not state the nearest neighbour route and some did not return to C. Most candidates correctly chose their least value as the best upper bound but some selected the greatest.

Grade Boundaries

January 2006 GCE Mathematics Examinations

The table below gives the lowest raw marks for the award of the stated uniform marks (UMS).

Subject Number	Grade Boundaries				
	80	**70**	**60**	**50**	**40**
6663	60	52	44	37	30
6664	64	56	48	40	33
6665	61	53	46	39	32
6666	61	53	45	38	31
6671	61	54	47	40	33
6672	61	54	47	40	33
6673	56	49	42	35	29
6674	53	46	39	33	27
6675	61	53	46	39	32
6676	56	50	44	38	33
6677	54	46	39	32	25
6678	64	56	48	41	34
6679	58	51	44	38	32
6680	53	46	39	33	27
6681	60	52	44	37	30
6682	61	53	45	37	30
6683	62	55	48	41	35
6684	59	52	45	39	33
6685*	84	74	64	54	45
6686	60	53	46	39	32
6687	60	52	45	38	31
6688*	82	72	62	52	42
6689	52	46	40	34	28
6690	57	50	43	36	29
6691	62	55	48	41	35
6692	60	53	46	39	32

*6685/6688 marks are out of **100**, all other marks are out of **75**.

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