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Examiners' Report Summer 2007

GCE

GCE Mathematics (8371/8374,9371/9374)

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Specification 6663

Introduction

There were many good responses to most questions, with candidates showing that they knew which techniques to select and also how to use them. However, a substantial number of candidates had difficulties with many basic skills such as the use of brackets - they were often omitted - and the solution of simple equations. Once again quadratic equations caused difficulties; apart from simple factorising, which was often carried out accurately, many candidates stumbled with the use of the formula which was often quoted incorrectly or a promising start spoilt by poor processing.

Report on individual questions

Question 1

This proved an easy starter for most candidates. Some identified this as a difference of two squares, and simply wrote down 9 – 5, but most opted to multiply out and sign slips spoilt some answers with 9+5 appearing quite often. Others thought that $3\sqrt{5} = \sqrt{15}$ and some wrote $3^2 = 6$.

Question 2

There were many correct responses to both parts of this question. In part (a) some reached $\sqrt[3]{4096}$ but could not simplify this expression but most managed $\sqrt[3]{8} = 2$ and usually went on to give the final answer of 16. A few attempted $\left(\sqrt[4]{8}\right)^3$ but most interpreted the notation correctly. Part (b) revealed a variety of responses from those whose grasp of the basic rules of algebra is poor. Most simplified the numerical term to 5 but often they seemed to think the x terms "disappeared" and answers of $5^{\frac{1}{3}}$ or $5^{\frac{4}{3}}$ were common. Dealing with the x term proved quite a challenge for some and $(5x)^{\frac{4}{3}}$ was a common error. Some candidates tried to "simplify" a correct answer, replacing $5x^{\frac{1}{3}}$ with $\sqrt[3]{5x}$. On this occasion the examiners ignored this subsequent working but such a misunderstanding of the mathematical notation used in AS level mathematics is a legitimate area to be tested in future.

Question 3

Most knew the rules for differentiation and integration and could apply them successfully here. A few failed to write $4\sqrt{x}$ as $4x^{\frac{1}{2}}$ but they often benefited from the follow through mark in part (b). In part (c) the x^3 term was usually correct but some failed to simplify $\frac{4x^{\frac{3}{2}}}{\frac{3}{2}}$ correctly whilst others forgot the + C.

Question 4

This question was answered well with most candidates quoting and using the appropriate arithmetic series formulae. In part (a) the majority obtained 403 and some wrote their answer as £4.03, there was the usual crop of arithmetic errors with $2 \times 199 = 298$ or 498 being quite common. In part (b) the sum formula was usually quoted and used correctly but again arithmetic slips (e.g.$408 \times 100 = 4080$ or $10 + 398 = 418$ or 498) were often seen and some made errors with the units giving the answer as £40800. There were some cases of candidates trying to use the $n\frac{(a+l)}{2}$ formula and misreading the *l* for a 1.

Question 5

There were very mixed responses to this question; some answered it very well with neat sketches and clearly identified asymptotes but others appeared to have little idea. In part (a) most candidates knew that a translation was required and the majority knew it was horizontal and to the left. A few moved their graph up and a number of candidates ended up with graphs cutting both axes. Many identified the intersection with the *y*-axis as (0, 1.5) but some ignored this part of the question. It was clear in part (b) that a number of candidates still do not know the meaning of the term asymptote but many did give $x = -2$ and slightly fewer gave $y = 0$. However a number of candidates gave answers of $y = -2$ and $x = 0$, often despite having a correct dotted line on their sketch, and some gave other non-linear equations such as $y = \frac{3}{x}$.

Some candidates gave no answer to part (b) despite having the lines $x = -2$ and $y = 0$ clearly identified on their diagram.

Question 6

In part (a) most tried the simple substitution of $(x – 4)$ into the second equation. Some made a sign error ($-4x$ instead of $+4x$) and proceeded to use this incorrect equation in part (b). Some candidates did not realise that part (a) was a first step towards solving the equations and repeated this work at the start of part (b) (sometimes repairing mistakes made there). The major loss of marks in part (b) was a failure to find the *y* values but there were plenty of errors made in trying to find *x* too. Those who attempted to complete the square were usually successful although some made sign errors when rearranging the 2 and some forgot the $\pm$ sign. Of those who used the quadratic formula it was surprising how many incorrect versions were seen. Even using the correct formula was no guarantee of success as incorrect cancelling was common: $\frac{-4 \pm \sqrt{48}}{2}$ was often simplified to $-2 \pm \sqrt{24}$ or $\frac{-4 \pm 4\sqrt{3}}{2}$ became $-2 \pm 4\sqrt{3}$.

Question 7

The quality of answers to this question was better than to similar questions in previous years. Most used the discriminant to answer part (a) and, apart from occasional slips with signs, were able to establish the inequality correctly. A few realised that the discriminant had to be used but tried to apply it to $k^2 - 4k - 12$. In part (b) the majority were able to find the critical values of -2 and 6 but many then failed to find the correct inequalities with $x > -2$ and $x > 6$ being a common incorrect answer. Some candidates still thought that the correct regions could be written as $6 < k < -2$ but there were many fully correct solutions seen often accompanied by correct sketches.

Question 8

Many of the comments made on the June 2006 paper would apply here too. Many candidates were clearly not familiar with the notation and a number used arithmetic series formulae to find the sum in part (c) although this was less common than in June 2006.

Apart from those candidates who had little idea about this topic most were able to answer parts (a) and (b) correctly. In part (c) many attempted to find a_4 using the recurrence relation and those who were not tempted into using the arithmetic series formulae often went on to attempt the sum and usually obtained $40k + 90$ which they were easily able to show was divisible by 10. Some lost marks for poor arithmetic $30k + 90$ and $40k + 80$ being some of the incorrect answers seen.

Question 9

Most candidates were able to integrate correctly to obtain $2x^3 - 5x^2 - 12x$ but many forgot to include a +C and never used the point (5, 65) to establish that C = 0. The majority of those who did attempt to find C went on to complete part (b) correctly but a few, who made arithmetic slips and had a non-zero C, were clearly stuck in part (b) although some did try and multiply out the given expression and gained some credit.

The sketch in part (c) was answered well. Few tried plotting points and there were many correct answers. Sometimes a "negative" cubic was drawn and occasionally the curve passed through (1.5, 0) instead of (- 1.5, 0). There were very few quadratic or linear graphs drawn.

Question 10

A number of candidates did not attempt this question or only tackled part of it. In part (a) the y-coordinates were usually correct and the distance formula was often quoted and usually used correctly to obtain PQ, although some drew a diagram and used Pythagoras' theorem. Most of the attempts at part (b) gained the first two method marks but the negative index was not handled well and errors in the derivative were sometimes seen. Those with a correct derivative were usually able to establish the result in part (b). Some candidates thought that they needed to find the equations of the tangents at P and Q in order to show that the tangents were parallel and this wasted valuable time. It was unfortunate that the gradient of PQ was also equal to – 13 and a number of candidates did not attempt to use any calculus but simply used this gradient to find the tangents and tackle part (c). Errors in the arithmetic sometimes led to the abandonment of the question at this point which was a pity as some marks could have been earned in part (c). Those who did attempt part (c) were usually aware of the perpendicular gradient rule and used it correctly to find the equation of the normal at P. Mistakes in rearranging the equation sometimes led to the loss of the final mark but there were a good number of fully correct solutions to this part and indeed the question as a whole.

Question 11

The most popular approach to part (a) was to rearrange the equation into the form $y = mx + c$ and this quickly gave them the gradient of – 1.5. The examiners were only interested in the value of m for the accuracy mark which was fortunate for some as errors in finding c were quite frequent, these were usually penalised in part (b). Some tried differentiating for part (a), with mixed success, and others found two points on the line and used the gradient formula.

Part (b) was a straightforward 3 marks for many candidates but a large number lost out due to errors in rearranging their equation in part (a) or simply trying to solve a simple linear equation. A more serious error, that was seen quite often, was to equate the two equations as $3x + 2 = 3x + 2y - 8$. In part (c) the x-coordinates of A and B were usually found correctly although sign errors or poor division spoilt some attempts. The area of the triangle once again caused many problems. Some candidates drew a simple diagram which was clearly a great help but the usual crop of errors were seen. Assuming that angle *APB* was a right angle and finding *AP* and *PB* was quite common. Others used *AB* as the base, as intended, but thought that the height of the triangle went from the midpoint of *AB* to *P*. Some were nearly correct but failed to subtract 1 from the y-coordinate of *P*. Those who were successful sometimes split the triangle into two using a vertical line through *P* and thus made the arithmetic more difficult.

Core Mathematics Unit C2
Specification 6664

Introduction

This paper proved quite challenging for average candidates. While most coped well with 'standard' demands, many had difficulty with the questions involving trigonometry and logarithms. The understanding and use of radians in Q9 was a common weakness. In Q2 (remainder theorem and factorisation) and Q7 (coordinate geometry of the circle) good work was often seen, but in Q1 and Q10 standards of algebra and calculus were often disappointing. Occasional blank responses to the last two questions suggested that some candidates ran short of time, but in general all ten questions were attempted.
The solution space provided on the paper was adequate for most questions, but lengthy methods in Q8 led to some candidates running out of space and continuing their solutions on other pages or on supplementary sheets. Most candidates realised the need to show their working clearly, but there were inevitably some who penalised themselves by providing insufficient evidence to justify method marks.

Report on individual questions

Question 1

Although many candidates scored full marks on this question, others had difficulty dealing with $\frac{1}{\sqrt{x}}$. This was sometimes misinterpreted as $x^{\frac{1}{2}}$ or x^{-1}, leading to incorrect integration but still allowing the possibility of scoring a method mark for use of limits. Sometimes there was no integration attempt at all and the limits were simply substituted into $\frac{1}{\sqrt{x}}$. The candidates who performed the integration correctly were usually able to deal with their surds and proceeded score full marks, although a few left their answer as $-2+2\sqrt{8}$. Occasionally the answer was given as a decimal.

Question 2

In part (a), many candidates unnecessarily used long division rather than the remainder theorem to find the remainder. The correct remainder –16 was often achieved, although mistakes in arithmetic or algebra were common.
There were many good solutions to the factorisation in part (b). Candidates usually found the quadratic factor by long division or by 'inspection' and went on to factorise this quadratic, obtaining the correct linear factors. Sometimes time was wasted in justifying the given fact that $(x+2)$ was a factor. Some candidates were distracted by part (a) and assumed that $(x-2)$ was one of the factors, using the quadratic they had obtained from their long division in part (a). A few attempted to use the formula to find the roots of the quadratic but did not always continue to find the factors. It was common for solutions of the equation $\mathrm{f}(x)=0$ to be given, but this 'additional working' was not penalised here.

Question 3

This question was not particularly well answered, many candidates having difficulty coping with the constant k in their binomial expansion. Pascal's Triangle was sometimes used (rather than the binomial expansion formula) in part (a), and while terms did not need to be simplified at this stage, mistakes in simplification frequently spoilt solutions to parts (b) and (c). A very common mistake was to have kx^2 and kx^3 rather than $(kx)^2$ and $(kx)^3$. Candidates who made this mistake often produced $6k = 15k$ in part (b) and were then confused (but often proceeded to obtain non-zero solutions of this equation). The difference between 'coefficients' and 'terms' was not well understood, so $6kx = 15k^2x^2$ was often seen. Sometimes 'recovery' led to the correct answers in parts (b) and (c), but sometimes tried to solve an equation in two unknowns and made no progress.

Question 4

The typical response to this question scored full marks in part (a) and no marks in part (b). In part (a) the cosine rule was well known and most candidates managed to manipulate convincingly to achieve the correct (given) value of $\cos A$. A few experienced difficulty in making $\cos A$ the subject of their equation, and $61 - 60\cos A$ occasionally became $1\cos A$, but otherwise mistakes were uncommon. In part (b), however, the majority of candidates ignored the requirement for an exact value of $\sin A$. The most popular approach was to simply use a calculator to find A and $\sin A$ (≈ 0.66). A significant number of candidates, having used the cosine rule in part (a), thought that they ought to use the sine rule in part (b) and invariably made no effective progress. Others seemed to assume that the triangle was right-angled. It was pleasing to see good candidates producing correct, concise solutions via $\sin^2 A + \cos^2 A = 1$ or equivalent methods. The identity $\sin A + \cos A = 1$ made the occasional appearance.

Question 5

Most candidates were able to complete the table correctly in part (a), although some gave their answers to only 2 decimal places.

Use of the trapezium rule in part (b) was often clear and accurate, but the mistake of misunderstanding h was again all too frequently seen, with $h = \frac{2}{5}$ instead of $h = \frac{2}{4}$ being common. Bracketing mistakes were less common than in recent C2 papers, but there were still some candidates who wrote $\frac{1}{2} \times \frac{1}{2}(0+6) + 2(0.530 + 1.414 + 3.137)$ and then performed the calculation as written. A few candidates calculated and added areas of separate trapezia, which was accepted as equivalent. Part (c) of this question proved discriminating. While some candidates proceeded to score full marks very easily, using $\frac{1}{2} \times 2 \times 6$ as the area of the triangle, others wasted time by finding the equation of the straight line $(y = 3x)$ and integrating between 0 and 2. Many were confused and attempted to integrate $x\sqrt{x^3+1}$ by calculus, inevitably getting nowhere and never really showing any understanding of the demands of the question.

Question 6

Answers to part (a) were usually correct, although a surprising number of candidates seemed to think that –0.11 (rather than –0.107) was a 3 significant figure answer.
Part (b) caused many problems and highlighted the fact that the theory of logarithms is often poorly understood at this level. While many candidates scored a mark for expressing $2\log x$ as $\log x^2$, some wrote $2\log x - \log 7x = 2\log\left(\frac{x}{7x}\right)$. A very common mistake was to proceed from the correct equation $\log_3\left(\frac{x^2}{7x}\right) = 1$ to the equation $\frac{x^2}{7x} = 1$, using the base incorrectly. Candidates who resorted to changing the base sometimes lost accuracy by using their calculator. Weaker candidates frequently produced algebra that was completely unrecognisable in the context of logarithms, and even good candidates were seen to jump from $\log x^2 - \log 7x = 1$ to the quadratic equation $x^2 - 7x - 1 = 0$. Amongst those who scored full marks, it was rare but gratifying to see a justification of the invalidity of the 'solution' $x = 0$.

Question 7

In general, this question was very well done with many candidates scoring full marks.
Part (a) was usually correct, with most candidates realising that the required straight line l had to be perpendicular to the given chord. Some candidates unnecessarily found the coordinates of the point B, using a mid-point formula. Others, again unnecessarily, found the equation of the line AB. For most, part (b) provided useful verification of the accuracy of their equation of l, but a few persisted with a wrong y-coordinate for P despite $y = -1$ being given.
Those who failed in the first two parts of the question were still able to attempt the equation of the circle in part (c). This part was, however, where many lost marks. A common mistake was to calculate the length of PM and to use this as the radius of the circle, and even those who correctly identified PA as the radius sometimes made careless sign errors in their calculations. Some candidates knew the formula $(x-a)^2 + (y-b)^2 = r^2$ but seemed unsure of how to use it, while others gave a wrong formula such as $(x-a)^2 - (y-b)^2 = r^2$ or $(x-a)^2 + (x-b)^2 = r^2$ or $(x-a) + (y-b) = r^2$. The point (3, 1) was sometimes used as the 'centre'.

Question 8

Responses to this question were very mixed, with many candidates scoring marks in only one or two parts and with much misunderstanding of logarithms.
In part (a), most managed to write down $50000r^{n-1}$ as the predicted profit in Year n, although $50000r^n$ was a popular alternative. In part (b), showing the result $n > \frac{\log 4}{\log r} + 1$ proved difficult for the average candidate. Sometimes this was simply not attempted, sometimes candidates tried to 'work backwards' and sometimes there were mistakes in logarithmic theory such as

$50000r^{n-1} > 200000 \Rightarrow (n-1)\log 50000r > \log 200000$.

Disappointingly, many candidates failed to use the given result from part (b) in their solutions to part (c). Some worked through the method of part (b) again (perhaps successfully) but others used the sum formula for the geometric series, scoring no marks. Even those who correctly achieved $n > 17.08...$ tended to give the answer as 'Year 17' or '2022' instead of 'Year 18' or 2023.

After frequent failure in parts (b) and (c), many candidates recovered to score two or three marks in part (d), where they had to use the sum formula for the geometric series. Occasionally here the wrong value of *n* was used, but more often a mark was lost through failure to round the final answer to the nearest £10 000.

Question 9

Sketches of the graph of $y = \sin\left(x + \frac{\pi}{6}\right)$ in part (a) were generally disappointing. Although most candidates were awarded a generous method mark for the shape of their graph, many lost the accuracy mark, which required a good sketch for the full domain with features such as turning points, scale and intersections with the axes 'in the right place'. In part (b), the exact coordinates of the points of intersection with the axes were required. Many candidates were clearly uncomfortable working in radians and lost marks through giving their *x* values in degrees, and those who did use radians sometimes gave rounded decimals instead of exact values. The intersection point $(0, 0.5)$ was often omitted.

Part (c) solutions varied considerably in standard from the fully correct to those that began with $\sin\left(x + \frac{\pi}{6}\right) = \sin x + \sin\frac{\pi}{6} = 0.65$. The most common mistakes were: failing to include the 'second solution', subtracting from π <u>after</u> subtracting $\frac{\pi}{6}$, leaving answers in degrees instead of radians, mixing degrees and radians, and approximating prematurely so that the final answers were insufficiently accurate.

Question 10

Responses to this question that were blank or lacking in substance suggested that some candidates were short of time at the end of the examination. Although many good solutions were seen, it was common for part (b) to be incomplete.

The algebra in part (a) was challenging for many candidates, some of whom had difficulty in writing down an expression for the total surface area of the brick and others who were unable to combine this appropriately with the volume formula. It was common to see several attempts at part (a) with much algebraic confusion.

Working with the given formula, most candidates were able to score the first three marks in part (b), but surprisingly many, having found $x \approx 7.1$, seemed to think that this represented the maximum value of *V*. Failing to substitute the value of *x* back into the volume formula lost them two marks.

Almost all candidates used the second derivative method, usually successfully, to justify the maximum value in part (c), but conclusions with a valid reason were sometimes lacking.

Core Mathematics Unit C3
Specification 6665

Introduction

Most candidates seemed to have the time to do themselves justice; there were relatively few scripts with very low marks and good candidates were able to score high marks. Q2, Q3 and Q4 proved a good source of marks for the majority of candidates and although Q5, Q6, Q7 and Q8 proved more taxing, most candidates were able to find parts which they could answer with confidence.
Surprisingly Q1 was very poorly attempted by a disappointingly large number of candidates. Most candidates seem well versed in solving equations of the form ln $x = k$, or $e^{x} = k$, but solutions to the three termed equations set in Q1 often demonstrated a poor understanding of logarithmic and exponential work. In part (b) the most common wrong approach, by far, was to "take logs" (badly) of the individual terms so that $e^x + 3e^{-x} = 4$ became $x - 3x = \ln 4$;
the answer $x = -\frac{1}{2} \ln 4$ was very common.

Candidates needed a clear head to set up and solve an appropriate equation in Q8 part (c) and, not surprisingly, this proved a challenging final question on the paper, with only the better candidates being successful.
As usual, where a given result had to be derived, these often emerged from previous wrong work; this was most evident in Q2(a) and Q8(b). In the first case, a single sign error (in an otherwise good solution) often produced $4x^2 + 6x - 12$ in the numerator which, invariably, factorised as $(4x - 6)(x + 2)$ so that the given answer could be produced. In the second case it was a little more blatant, with 8.825 + 5.353 $(10\mathrm{e}^{-\frac{1}{8}} + 10\mathrm{e}^{-\frac{5}{8}})$ becoming the required 13.549.
Despite Q5(b) highlighting the notation for the inverse of a function, a significant minority of candidates produced the inverse of f in Q2(b) when it clearly asked for $\mathrm{f}'(x)$.

Report on individual questions

Question 1

There were some good solutions to this question, but generally this was a very poor source of marks; fully correct solutions were seen only from the better candidates In part (a), which was intended as a "nice" starter, statements like $x + 3 = 6$ and $\ln x = \ln 6 - \ln 3 = \dfrac{\ln 6}{\ln 3}$ were quite common, and even candidates who reached the stage $\ln x = \ln 2$ did not always produce the correct answer $x = 2$; $x = \mathrm{e}^2$ and $x = 1.99..$, from $x = \mathrm{e}^{0.693}$, were not uncommon.
However, it was part (b) where so much poor work was seen; the fact that this required to be set up as a quadratic in e^x was missed by the vast majority of candidates. Besides the serious error referred to in the introduction the following is a small selection of the more common "solutions" seen: $\mathrm{e}^x + 3\mathrm{e}^{-x} = 4 \Rightarrow \mathrm{e}^x(1 + 3^{-1}) = 4$ (which fortuitously gave $x = \ln 3$);
$\mathrm{e}^x + 3\mathrm{e}^{-x} = 4 \Rightarrow \mathrm{e}^x(1 + 3\mathrm{e}^{-2x}) = 4 \Rightarrow \mathrm{e}^x = 4$ or $\mathrm{e}^{-2x} = 1$;
$\mathrm{e}^x + 3\mathrm{e}^{-x} = 4 \Rightarrow \mathrm{e}^{2x} - 4\mathrm{e}^x = -3 \Rightarrow \mathrm{e}^x(\mathrm{e}^x - 4) = -3 \Rightarrow x = \ln\left(\dfrac{-3}{\mathrm{e}^x - 4}\right)$.

Question 2

The majority of candidates scored very well in this question. Those candidates who did not factorise the quadratic expression in the denominator in part (a) clearly had more work to do and usually only gained three marks, but they were a small minority and most candidates scored at least five marks here. The most common source of error was to omit the bracket around (9 + 2*x*) in the numerator, so that f(*x*) = $\dfrac{4x^2+6x-12}{(x+2)(2x-1)}$ frequently occurred.

In part (b) the vast majority of candidates attempted to use the quotient rule, and again any errors were through poor use of, or lack of, brackets; -2(4x – 6) = -8x -12 leading to $\dfrac{-16}{(2x-1)^2}$, being the most common.

It was surprising, this long into the Specification, to see how often $f'(x)$ was interpreted as $f^{-1}(x)$.

Question 3

It was pleasing to see the majority of candidates gain full marks in part (a), and there was an impressive number who went on to produce a completely correct expression in part (c). In part (b) most candidates knew that they were required to solve $e^x(x^2+2x)=0$, but often the solution $x = 0$ was omitted, or the coordinate**s** of the turning points were not given, or the *y*-coordinate for $x = 0$ was calculated to be 1.

The method mark in part (d) was often gained but to gain both marks required a correct conclusion and a substantially correct solution to the question.

Question 4

Most candidates are well versed in this type of question and this was another good source of marks for many candidates. There were some "fiddles" in part (a), as this was a given result, but generally this was well done. Part (b) was an easy two marks for using a calculator correctly, and the majority of candidates gained these; not giving answers to the required 4 decimal places did lose a mark, however.

In part (c) the majority of candidates chose an acceptable method, but it was quite common to see marks lost in either not giving a clear conclusion or in loss of accuracy in calculations.

Question 5

Most candidates did well in part (a), and in part (b) a wrong domain was the most common loss of a mark. In part (b) an incorrect graph was very common as also was the mark for the **equation** of the asymptote.

Although part (d) was correctly answered by many, some by using the symmetry of the graph, there was a considerable amount of confusion in finding the second solution, with $\dfrac{-2}{-x+3}=3$ and $\dfrac{2}{-x-3}=3$ common statements.

Question 6

Although some candidates had no idea how to proceed, most candidates were able to gain some credit in part (a). Usually finding R was not a problem, but mistakes such as $\cos\alpha = 3$ and $\sin\alpha = 2$, and $\tan\alpha = \frac{3}{2}$ were reasonably common and lost the mark for α.

Good candidates realised what was required for part (b), but in general this was poorly answered.

In the final part, again there were many complete and concise answers but marks (often the third M mark, and consequently the final A mark) were lost for not realising that there was a second solution. Many candidates worked in degrees throughout, which was fine if the final answers were then converted to radians, but often, in this case, the final mark was lost. There were very few approaches other than the one in the main mark scheme, and any there were had limited success.

Question 7

Solutions to part (a) were variable, both in presentation and marks gained; there were many concise, fully correct solutions from the good candidates but two or less marks were also quite common.

Those candidates who started with the left hand side of the identity often did well but it was not uncommon to see $\frac{1}{\sin\theta\cos\theta}$ written as $\frac{1}{2\sin 2\theta}$, even after a correct expression for $\sin 2\theta$ had been seen. Although starting with the right hand side of the identity was less common, it was good to see good candidates negotiate the hurdle from $\frac{1}{\sin\theta\cos\theta}$ to $\frac{\sin^2\theta+\cos^2\theta}{\sin\theta\cos\theta}$ and then conclude successfully. A common approach was to reduce both the left hand side and the right hand side to $\frac{1}{\sin\theta\cos\theta}$, but it was expected that a minimal conclusion (see mark scheme) was given in this case for the final mark.

The sketch, as in Q5, met with limited success. There appeared to be many candidates who had no idea of the shape of $y = \operatorname{cosec}\theta$, (sine and cosine curves being common), and many who did, found the fact that it was $y = 2\operatorname{cosec} 2\theta$ too difficult to deal with.

Many candidates who related part (c) to part (a) scored well in the final part; there were many totally correct solutions, but dividing 41.8º by 2 before subtracting from 180º, and not considering solutions for 2θ in the interval 360º to 720º, often meant that two or three marks were lost.

Common errors, from weaker candidates, were $\sin 2\theta = \frac{2}{3}$ becoming $\sin\theta = \frac{1}{3}$, and changing $\sin 2\theta = \frac{2}{3}$ to $\sin\theta\cos\theta = \frac{1}{3}$ and then choosing a inappropriate method to solve the equation.

Question 8

Part (a) was well answered, although candidates who gave the answer to 3 significant figures lost a mark.

In part (b) those candidates who realised that $x = 15.3526..e^{-\frac{1}{8}}$ usually gained both marks, but a common misconception was to think that $10e^{-\frac{1}{8}}$ should be added to the answer to part (a).

Part (c) proved a challenging final question, with usually only the very good candidates scoring all three marks. From those who tried to solve this in one stage it was more common to see D = 1 or 10 or 20 or 13.549, instead of than 15.3526.., substituted into $x = De^{-\frac{t}{8}}$. Many candidates split up the doses but this, unfortunately, often led to a complex expression in T, $3 = 10e^{-\frac{T}{8}} + 10e^{-\frac{(T+5)}{8}}$, which only the very best candidates were able to solve. One mark was a common score for this part.

Core Mathematics Unit C4
Specification 6666

Introduction

This paper proved to be accessible in parts and there was no evidence of candidates being unable to complete the paper owing to time constraints. There were some testing questions, particularly those questions involving the use of integration, which allowed the paper to discriminate across all ability ranges. It was pleasing to note that teachers have taken advice from previous Core reports and have encouraged candidates to use exact values in their solutions. This was borne out by candidates' responses to Q2, Q4(b), Q6(b) and Q7(c).

The attempts at the vector question were much improved on the previous three examination sessions. There were, however, a significant number of candidates who failed to synthesise the information given in part (b) of this question and choose the correct pair of relevant vectors to apply the dot product formula to.

There was evidence in Q3(b) and Q6(c) that some candidates, even the more able ones, struggled with basic algebraic manipulation. Examiners suggest that teachers may want to continually review the use of manipulative algebra throughout their delivery of the Core specification.

In Q6(b), 8(b) and Q8(d), it was found that there were some incorrect methods that candidates could use to arrive at the correct answers given on the mark scheme. The mark scheme, however, was designed to ensure that only those candidates who applied correct working and algebraic manipulation would be appropriately credited.

In summary, Q1, Q3(a), 4(b), Q5(a) and Q7 were a good source of marks for the average candidate, mainly testing standard ideas and techniques; and Q2, Q3(b) and Q6 proved effective discriminators. A significant proportion of candidates, however, were unable to make any progress with either Q2 or Q8 with some candidates failing to offer any response to these questions.

Report on individual questions

Question 1

The majority of candidates produced correct solutions to this question, but a substantial minority of candidates were unable to carry out the first step of writing $(3+2x)^{-3}$ as $\frac{1}{27}\left(1+\frac{2x}{3}\right)^{-2}$. Those who were able to do this could usually complete the remainder of the question but some sign errors and manipulation errors were seen. Another common error was for candidates to apply $\frac{n(n-1)}{2!}$ and/or $\frac{n(n-1)(n-2)}{3!}$ in the third and fourth terms of their expansion.

Question 2

Many candidates had difficulties with the differentiation of the function $u = 2^x$, despite the same problem being posed in the January 2007 paper, with incorrect derivatives of $\frac{du}{dx} = 2^x$ and $\frac{du}{dx} = x\,2^{x-1}$ being common. Those candidates who differentiated *u* with respect to *x* to obtain either $2^x \ln 2$ or 2^x often failed to replace 2^x with *u*; or if they did this, they failed to cancel the variable *u* from the numerator and the denominator of their algebraic fraction. Therefore, at this point candidates proceeded to do some "very complicated" integration, always with no chance of a correct solution.

Those candidates who attempted to integrate $k(u+1)^{-2}$ usually did this correctly, but there were a significant number of candidates who either integrated this incorrectly to give $k(u+1)^{-3}$ or $\ln \mathrm{f}(u)$.

There were a significant proportion of candidates who proceeded to integrate $u(u+1)^{-2}$ with respect to *x* and did so by either treating the leading *u* as a constant or using integration by parts.

Many candidates correctly changed the limits from 0 and 1 to 1 and 2 to obtain their final answer. Some candidates instead substituted *u* for 2^x and used limits of 0 and 1.

Question 3

In part (a), many candidates recognised that the correct way to integrate $x\cos 2x$ was to use integration by parts, and many correct solutions were seen. Common errors included the incorrect integration of $\cos 2x$ and $\sin 2x$; the incorrect application of the 'by parts' formula even when the candidate had quoted the correct formula as part of their solution; and applying the by parts formula in the wrong direction by assigning $\frac{\mathrm{d}v}{\mathrm{d}x}$ as *x* to be integrated.

In part (b), fewer than half of the candidates deduced the connection with part (a) and proceeded by using "Way 1" as detailed in the mark scheme. A significant number of candidates used integration by parts on $\int x\left(\frac{\cos 2x+1}{2}\right)\mathrm{d}x$ and proceeded by using "Way 2" as detailed in the mark scheme.

In part (b), the biggest source of error was in the rearranging and substituting of the identity into the given integral. Some candidates incorrectly rearranged the $\cos 2x$ identity to give $\cos^2 x = \frac{\cos 2x - 1}{2}$. Other candidates used brackets incorrectly and wrote $\int x\cos^2 x\,\mathrm{d}x$ as either $\int\left(\frac{x}{2}\cos 2x + 1\right)\mathrm{d}x$ or $\int\left(\frac{x}{2}\cos 2x + \frac{1}{2}\right)\mathrm{d}x$.

A significant number of candidates omitted the constant of integration in their answers to parts (a) and (b). Such candidates were penalised once for this omission in part (a).

Question 4

This question was well done with many candidates scoring at least eight of the ten marks available.

In part (a), the most popular and successful method was for candidates to multiply both sides of the given identity by $(2x+1)(2x-1)$ to form a new identity and proceed with "Way 2" as detailed in the mark scheme. A significant proportion of candidates proceeded by using a method ("Way 1") of long division to find the constant *A*. Common errors with this way included algebraic and arithmetic errors in applying long division leading to incorrect remainders; using the quotient instead of the remainder in order to form an identity to find the constants *B* and *C*; and using incorrect identities such as $2(4x^2+1) \equiv B(2x-1)+C(2x+1)$.

In part (b), the majority of candidates were able to integrate their expression to give an expression of the form $Ax + p\ln(2x+1) + q\ln(2x-1)$. Some candidates, however, incorrectly integrated $\frac{B}{(2x+1)}$ and $\frac{C}{(2x-1)}$ to give either $B\ln(2x+1)$ and $C\ln(2x-1)$ or $2B\ln(2x+1)$ and $2C\ln(2x-1)$. A majority of candidates were able to substitute their limits and use the laws of logarithms to find the given answer. Common errors at this point included either candidates writing $-\ln(2x+1)+\ln(2x-1)$ as $\ln(4x^2-1)$; or candidates writing $-\ln 5+\ln 3$ as either $\pm\ln 15$ or $\pm\ln 8$.

Question 5

In part (a), a majority of candidates were able to prove that the two lines did not cross, although some candidates produced errors in solving relatively straightforward "simultaneous" equations. A small number of candidates tried to show a contradiction by substituting their values for λ and μ into one of the two equations they had already used, sometimes with apparent success, as they had already found an incorrect value of one of the parameters! There were a few candidates, however, who believed that the two lines were parallel and attempted to prove this.

Part (b) was less well answered. Many candidates found $\overrightarrow{OA}$ and $\overrightarrow{OB}$, although there was a surprising number of numeric errors seen in finding these vectors. A significant proportion of candidates did not subtract these vectors in order to find $\overrightarrow{AB}$. Most candidates then knew that a dot product was required but there was great confusion on which two vectors to use. A significant minority correctly applied the dot product formula between $\overrightarrow{AB}$ and the direction vector of l_1. Common errors here included applying the dot product formula between either $\overrightarrow{OA}$ and $\overrightarrow{OB}$; or the direction vector of l_1 and the direction vector of l_2; or the direction vector of l_1 and twice the direction vector of l_2; or $\overrightarrow{AB}$ and the direction vector of l_2. A few candidates did not state the cosine of the acute angle as question required but instead found the acute angle.

Question 6

In part (a), a significant number of candidates struggled with applying the chain rule in order to differentiate $\tan^2 t$ with respect to t. Some candidates replaced $\tan^2 t$ with $\frac{\sin^2 t}{\cos^2 t}$ and proceeded to differentiate this expression using both the chain rule and the quotient rule. Very few candidates incorrectly differentiated $\sin t$ to give $-\cos t$. A majority of candidates were then able to find $\frac{dy}{dx}$ by dividing their $\frac{dy}{dt}$ by their $\frac{dx}{dt}$.

In part (b), the majority of candidates were able to write down the point $\left(1, \frac{1}{\sqrt{2}}\right)$ and find the equation of the tangent using this point and their tangent gradient. Some candidates found the incorrect value of the tangent gradient using $t = \frac{\pi}{4}$ even though they had correctly found $\frac{dy}{dx}$ in part (a). There were a significant number of candidates, who having correctly written down the equation of the tangent as $y - \frac{1}{\sqrt{2}} = \frac{3\sqrt{2}}{8}(x-1)$ were unable to correctly rearrange this equation into the form $y = ax + b$.

In part (c), there were many ways that a candidate could tackle this question and there were many good solutions seen. Errors usually arose when candidates wrote down and used incorrect trigonometric identities. It was disappointing to see a number of candidates who used trigonometric identities correctly and reached $y^2 = x\left(1-y^2\right)$ but were then unable to rearrange this or, worse still, thought that this was the answer to the question.

Question 7

Part (a) was generally well answered as was part (b). In part (a), there were a significant number of candidates, however, who struggled with evaluating $\tan\left(\frac{\pi}{16}\right)$ and $\tan\left(\frac{\pi}{8}\right)$ to 5 decimal places and a few other candidates did not change their calculator to radian mode. In part (b), some candidates incorrectly stated the width of each of the trapezia as either 1 or $\frac{\pi}{20}$. Nearly all answers were given to 4 decimal places as requested in the question.

Part (c) proved more demanding but it was still pleasing to see many correct solutions. Many candidates who attempted this part were able to integrate $\tan x$ correctly (given in formula booklet) although this was sometimes erroneously given as $\sec^2 x$. There were also a few candidates who attempted to integrate $\sqrt{\tan x}$. The substitution of limits caused little difficulty but sometimes a rounded answer was given instead of the required exact answer. Whilst most candidates used $\pi\int \tan x \, dx$, 2π was occasionally seen in place of π and more often π was omitted.

Question 8

Many candidates, who answered part (a), were able to separate the variables correctly and integrate both sides of their equation to obtain $\ln P = kt$. At this point a significant number of candidates either omitted the constant of integration or were unable to deal with the boundary conditions given in the question. Some candidates, for example, wrote down $P = e^{kt} + c$; and stated that $c = P_0$ to give the common incorrect solution of $P = P_0 + e^{kt}$. Other candidates used P_0 instead of P in their attempts, and then struggled to find the constant of integration. Some candidates, who correctly evaluated the constant of integration, did not make P the subject of the equation but left their answer as $\ln P = kt + \ln P_0$.

Those candidates who had successfully answered part (a) were able to gain most of the marks available in part (b). A few of these candidates, however, struggled to convert the correct time in hours to the correct time in minutes. Those who did not progress well in part (a) may have gained only a method mark in part (b) by replacing P in their part (a) equation with $2P_0$.

Those candidates who were successful in the first two parts of this question usually succeeded to score most of the marks available in parts (c) and (d). In part (c) some candidates incorrectly integrated $\lambda \cos \lambda t$. In part (d), a significant number of candidates found difficultly in solving the equation $\sin(2.5t) = \ln 2$. It was not uncommon for some of these candidates to write $t = \frac{\ln 2}{\sin(2.5)}$. Also, in part (d), some candidates did not work in radians when evaluating $t = \arcsin(\ln 2)$.

There were a significant minority of candidates who tackled this question with ease scoring at least thirteen of the fourteen marks available.

Further Pure Mathematics Unit FP1
Specification 6674

Introduction

Many of the questions on this paper were easily accessible to the majority of candidates, but some parts of Q3, Q4, Q6 and Q7 proved more demanding. The performance of weaker candidates tended to be 'patchy', with evidence of inadequate knowledge and understanding in some topic areas. There were only seven questions on the paper and in general candidates appear to have had adequate time to attempt every question. There was some evidence of time being wasted in multiple attempts at Q3 and Q7.
In general, standards of presentation were good, but solutions were sometimes spoilt by careless and confused use of notation.

Report on individual questions

Question 1

Various methods of solution were seen for this inequality. Some of these were graphical others were completely algebraic, but the basis of all methods was to find the 'critical values'. Candidates who failed to realise that $x = 3$ and $x = \frac{3}{2}$ were critical values were able to score at most 3 marks out of 7. Standards of algebra were usually good, although the equation $x^2 - 4x = 0$ sometimes yielded only one solution. Candidates who correctly identified all four critical values were generally able to obtain full marks.

Question 2

Most candidates knew that it was appropriate to use an integrating factor to solve this differential equation. Although a few did not appear to understand the method, the majority obtained either $\mathrm{e}^{\int -\tan x \, \mathrm{d}x} = \cos x$ or, incorrectly, $\mathrm{e}^{\int \tan x \, \mathrm{d}x} = \sec x$. Those with $\sec x$ as the integrating factor were faced with the challenge of integrating $\sec^4 x$, for which some interesting but time-wasting attempts were seen. Those with the correct integrating factor were usually able to proceed to a correct answer, but a few failed to calculate the value of the integration constant and some lost the final mark by not expressing the solution in the required form $y = \mathrm{f}(x)$.

Question 3

Responses to this question were often disappointing. Some candidates made no attempt at part (b) and/or part (c).
In part (a), most were able to expand the brackets correctly and score both marks for deriving the given identity. Many proceeded via $(r+1)(r^2+2r+1)$, etc., while some used more efficient binomial methods and just a few were familiar with the identity $a^3 - b^3 = (a-b)(a^2+ab+b^2)$.
Very disappointingly, method of differences proofs in part (b) were often poorly presented. While most candidates appeared to have a good understanding of how the proof worked, omissions and lack of detail sometimes spoilt solutions. Where a table of differences for each term was clearly set out and summation of 'each side' shown, candidates made it easier for

themselves to produce the correct expression $(n+1)^3 + n^3 - 1 = 6\sum r^2 + 2n$ (or equivalent). Common mistakes were to omit the -1 or to have 2 instead of 2*n* in this expression.
This part of the question required the result to be shown 'hence', so alternatives such as proof by induction scored no marks.

In part (c), it was pleasing that many candidates correctly used $\sum_{r=1}^{2n} r^2 - \sum_{r=1}^{n-1} r^2$ rather than $\sum_{r=1}^{2n} r^2 - \sum_{r=1}^{n} r^2$. Good algebra often followed this, leading to full marks. An alternative approach was to use differences in a similar way to part (b), but such attempts were very rarely successful.

Question 4

There were very few completely correct responses to part (a). Solutions based on the function $\mathrm{f}(x) = x^3 + 8x - 19$ needed to establish convincingly that the graph crossed the *x*-axis at only one point. The most efficient way to do this was to show that there were no turning points, but few candidates considered the sign of the derivative. Those who did differentiate sometimes argued that because $3x^2 + 8 = 0$ had no real roots the original equation had only one real root. Other possible methods included sketching, for example, the graphs of $y = x^3$ and $y = 19 - 8x$, showing that these had just one point of intersection. Weaker candidates tried to solve $x^3 + 8x - 19 = 0$ by using the quadratic formula.
Answers to part (b) were usually correct, but occasionally lacking a reason or conclusion. The Newton-Raphson procedure was well known in part (c), where many excellent solutions were seen.
Most candidates were able to choose a suitable interval to establish the accuracy of their answer to part (c), although a few thought that the interval from 1.728 to 1.730 was sufficient. Conclusions here should have referred to the accuracy of the root rather than just stating that 'there is a root in the interval'.

Question 5

This was a standard second order differential equation question, allowing most candidates to score well. Although arithmetic errors were frequently seen, marks of 9 or more out of 12 were common.
Most candidates solved the auxiliary equation correctly and obtained the complementary function $A\mathrm{e}^{-x} + B\mathrm{e}^{-2x}$, although $A\mathrm{e}^{x} + B\mathrm{e}^{2x}$ was occasionally seen.
The most popular wrong form for the particular integral was $y = cx^2 + dx$, and another wrong form $y = cx^2 + d$ (which happened to lead to the correct answer in this question!) was also used by a few candidates, but penalised for the 'unjustified assumption' that the coefficient of *x* in the P.I. was zero.
An unusual method for the P.I., seen from just a handful of candidates, was to use the theory of 'differential operators' to solve $(D^2 + 3D + 2)y = 2x^2 + 6x$.
Using the initial conditions to calculate the values of *A* and *B* often produced arithmetic errors, but most candidates were able to score method marks here.
It was disappointing that there were some candidates who had no idea of the method for solving a second order differential equation.

Question 6

The independence of different parts made it possible for most candidates to pick up marks throughout this question for their knowledge of various different aspects of complex number theory.
In part (a), just a few candidates did not understand 'complex conjugate', but the vast majority were able to obtain the given result without very much difficulty.

The value of $\left|\frac{z}{z^*}\right|$ in part (b) was usually found from $\sqrt{\left(\frac{1}{2}\right)^2+\left(-\frac{\sqrt{3}}{2}\right)^2}$, but sometimes by using $\left|\frac{z}{z^*}\right|=\frac{|z|}{|z^*|}$. The mistake $\sqrt{\left(\frac{1}{2}\right)^2+\left(\frac{\mathrm{i}\sqrt{3}}{2}\right)^2}$ was occasionally seen.

Part (c) proved difficult for the average candidate. For some, there was much confusion in the definition of 'argument', with statements such as $\arg z=-\frac{1}{\sqrt{3}}$ or $\arg z=\tan\frac{1}{\sqrt{3}}$, but 'recovery' was sometimes possible, perhaps with the help of a diagram. Common mistakes included the omission of minus signs and the use of $\frac{2\pi}{3}$ and $\frac{5\pi}{6}$ as arguments instead of $-\frac{\pi}{3}$ and $-\frac{\pi}{6}$.

In the Argand diagram in part (d), z and z^* were usually correctly shown, but the position of $\frac{\mathrm{z}}{\mathrm{z}^*}$ was sometimes wrong.

Attempts at part (e) were often very good, the usual method being to expand $\left(x-\left(\sqrt{3}-\mathrm{i}\right)\right)\left(x-\left(\sqrt{3}+\mathrm{i}\right)\right)$. The use of 'sum and product of roots', a very efficient method here, was comparatively rare.

Question 7

There were many good solutions to this question, although few scored full marks.
It was part (b) that caused the most difficulty and that was sometimes omitted.
Some candidates spent too long plotting points for their sketch in part (a), but most were able to produce a closed curve in approximately the correct position. Indication of scale was required to score the second mark here.
In part (b), a few candidates started to differentiate $r\cos\theta$ instead of $r\sin\theta$, but most were able to produce a correct derivative and to proceed to find a quadratic in $\cos\theta$. Despite many correct quadratic equations, mistakes frequently occurred from that point onwards. Some of these mistakes were careless, others stemmed from an apparent expectation that the values of θ would be exact. Even candidates who had a correct solution for one value of θ (1.28) were often unable to produce the second value. The r coordinate of the required points was often missing or wrong.
In general, candidates were much happier with part (c), where there were many excellent solutions. There was, however, plenty of scope for mistakes, and these included slips in squaring $\left(5+\sqrt{3}\cos\theta\right)$, sign or numerical errors in applying $\cos^2\theta=\frac{1}{2}\left(\cos 2\theta+1\right)$ and integration slips. Sometimes the limits for integration were wrong or the $\frac{1}{2}$ was omitted from the area formula, losing the last two marks

Further Pure Mathematics Unit FP2
Specification 6675

Introduction

This proved a more demanding paper than some that have been set in recent years and there was evidence that many candidates ran short of time when answering the last question. The first 5 questions, however, proved accessible to almost all candidates and the great majority were able to make a sensible start to Q6 part (a) and to Q8, parts (a) and (b). The paper placed a premium on the strategic skills of candidates and, if wrong methods were chosen in Q4(b), Q5, Q6(a) and Q7(b), it was possible for candidates to spend a great deal of time on algebraic or calculus manipulations which could gain very little credit. Many candidates, however, showed great ingenuity with questions and in Q7, for example, the examiners were confronted with new and, frequently, very clever methods throughout the marking period.

The standard of algebraic manipulation gave some concern for a module at this relatively advanced level. It is perhaps understandable that in Q8, under time pressure, candidates should make elementary errors and, sometimes, make unjustified claims that they had proved printed answers. It was, however, disturbing to see elementary errors earlier in the paper. Commonly seen errors were $\sqrt{x^2+\frac{1}{2}+\frac{1}{16x^2}}=x+\frac{1}{\sqrt{2}}+\frac{1}{4x}$ in Q3 and $e^A \times e^B = e^{AB}$ in Q4.

The use of calculators was not always appropriate. In awarding marks in Further Mathematics, the examiners place considerable emphasis on the ability of candidates to show that results are obtained by an ordered sequence of mathematical reasoning. If candidates are asked to show that a result has a certain form, then enough detail of the calculation needs to be given to show how that form has been obtained and the numbers should not simply be put into a calculator which gives exact results. For example, in Q7, when asked to show that the final answer is in the form $k\ln\left(2+\sqrt{5}\right)-\sqrt{5}$, it is insufficient to write, without supporting working,

$$\left[\frac{\theta\cosh 2\theta}{2}-\frac{\sinh 2\theta}{4}\right]_0^{\operatorname{arsinh} 2}=\frac{9}{2}\ln\left(2+\sqrt{5}\right)-\sqrt{5}.$$

In this case a reference to the formulae $\cosh 2\theta = 1+2\sinh^2\theta$ and $\sinh 2\theta = 2\sinh\theta\cosh\theta$ would be appropriate, together with an indication of how they are used in the calculation.

Report on individual questions

Question 1

This proved a suitable start to the paper and many gained full marks. Not all candidates used the inverse hyperbolic form and many remembered a result of the form

$$\int \frac{1}{\sqrt{x^2-a^2}}\,\mathrm{d}x = \ln\left\{x+\sqrt{x^2-a^2}\right\}.$$

This is acceptable but there was some confusion about the last sign in this formula and use a remembered formulae is always a high risk strategy, as remembering a formula incorrectly leads to a considerable loss of marks. A difficulty which not infrequently arose was that candidates wrote

$$\operatorname{arcosh}\left(\frac{x+2}{3}\right)=\ln\left\{(x+2)+\sqrt{(x+2)^2-9}\right\}.$$

This is false but becomes true when the expressions are evaluated between limits. If the limits were given, then credit could be given but this is not a procedure to be recommended.

Question 2

Full marks were gained in part (a) by the majority of candidates. Part (b) required candidates to show some flexibility of thought, as the x-axis was not the major axis of the second ellipse. This led to a substantial minority of candidates obtaining a focus with complex coordinates, although few seemed to realise that this showed an error had been made. It was quite common for candidates to think that both foci were on the x- axis and that the distance between them could be found by simple subtraction rather than by the use of Pythagoras' theorem. However, there were a large number of completely correct solutions.

Question 3

To complete this question, it was essential to see that $x^2+\frac{1}{2}+\frac{1}{16x^2}$ factorised to $\left(x+\frac{1}{4x}\right)^2$.

This proved a difficult step and any earlier error made it impossible to proceed. If this factorisation was achieved then full marks were usually gained.

Question 4

Part (a) was well done by the majority and full marks were common. Part (b) was a slightly unusual question and many candidates failed to see the importance of obtaining $\tanh x$ equal to constant expression. It was not unusual to see supplementary sheets filled with the exponential manipulation with terms like e^{x-1}, in which the terms in e^x were never separated from the constants and which could gain no credit. Those who did obtain $\tanh x=\frac{\cosh 1}{1+\sinh 1}$ usually completed the question successfully.

Question 5

In part (a), it was important to make the right start. Those who chose the parametric form for the radius of curvature (it is given the Formula Booklet) usually made good progress with the question, although errors of detail were not uncommon. Those who chose the formula in $\frac{\mathrm{d}y}{\mathrm{d}x}$ and $\frac{\mathrm{d}^2y}{\mathrm{d}x^2}$ had great difficulty. The calculation is complicated and very few candidates realised that finding $\frac{\mathrm{d}^2y}{\mathrm{d}x^2}$ correctly required the chain rule. Full marks by this method were seen on no more than two or three occasions. Part (b) proved unexpectedly testing. It was intended that the minimum of y, -1, should just be written down but the values 0 and 1 were very common and those who used calculus to find the minimum often ended up with the maximum.

Question 6

Nearly all could start correctly and most could use parts correctly and show that the first term in their expression was zero. The next step required the integral to be de-composed into two parts using the argument

$$\int nx^{n-1}(8-x)^{\frac{4}{3}}\,\mathrm{d}x = \int nx^{n-1}(8-x)(8-x)^{\frac{1}{3}}\,\mathrm{d}x = \int 8nx^{n-1}(8-x)^{\frac{1}{3}}\,\mathrm{d}x - \int nx^{n}(8-x)^{\frac{1}{3}}\,\mathrm{d}x\,.$$

Substantial numbers of candidates were not able to do this and could not complete this part. The application of the reduction formula required candidates to recognise that the integral to be evaluated was $I_2 + 5I_1$. Not all could see this and some obtained $I_2 - 5I_1$. An unexpected error seen from time to time was evaluating I_8. Probably this arose from confusion between the upper limit of the integral and the subscripts in the reduction formula. Those who chose the correct method usually knew how to use the reduction formula and made good progress. The commonest error among these was evaluating I_0 incorrectly. -12, 6 and 16 were all commonly seen instead of the correct 12.

Question 7

The commonest error in part (a) was for candidates not to recognise that the differentiation of $\operatorname{arsinh}\left(\sqrt{x}\right)$ required the chain rule. This error was compounded in part (b) if the candidate chose to integrate by parts before substituting $x = \sinh^2\theta$. This required differentiating $\operatorname{arsinh}\left(\sqrt{x}\right)$ again and, invariably, candidates repeated their mistake. Those who used the substitution immediately could usually complete the indefinite integration if they recognised that $\operatorname{arsinh}(\sinh\theta) = \theta$. However many did not take up the hint in the question and an amazing variety of methods were seen. Possibly the cleverest was to find the area made between the arc of the curve and the *y*-axis and to subtract this from the appropriate rectangle. With inverse trigonometric and hyperbolic function this is always worth considering, if the conditions of the question allow it, as it avoids having to integrate the inverse function. The problems encountered in evaluating the integral are noted in the Introduction above.

Question 8

Those who immediately simplified their gradient to $\dfrac{2}{p+q}$ at the start of part (a), usually completed this part quickly but those who did not often became involved in unnecessarily complex algebra and, inevitably, ran short of time. The strategy of the question now defeated a substantial minority of candidates who tried to make a connection between part (a) and (b). There is no immediate connection between the parts which are brought together in part (c). Those who could find or write down the equation of a normal could usually show a suitable method for solving part (b). However, the commonest way of finding the *x*-coordinate required use of the formula for the difference of two cubes, or an equivalent algebraic manipulation, for its completion and many who claimed that they had proved the printed result showed no evidence of this. Part (c) was demanding and many ran short of time. However completely correct solutions were not uncommon. Among those who could demonstrate the method, solutions were often spoilt by incorrectly proceeding from $0 = 2(5a + apq)$ to $pq = -10$ or $pq = -5a$. Such errors, by obviously able candidates, were a possible indication of time pressure.

Further Pure Mathematics Unit FP3
Specification 6676

Introduction

The paper proved accessible, with standard methods well known. There seemed to be sufficient marks available for both the weaker and more able candidates. Candidates seemed to have sufficient time to answer the questions; even those who became involved in quite involved algebraic manipulation. As always there were candidates who did this advanced work well, only to spoil it with careless arithmetic or sign slips. Some candidates chose approaches that made answering the questions significantly more difficult that it could have been. Candidates should realise that often examination questions are written in such a way that the earlier parts give an indication to what methods should be employed in the later parts. Some very extended solutions were seen, with much crossing out and several examiners commented on the resilience and persistence of these candidates. Some very neat, elegant and concise solutions were also seen for some very able candidates, particularly in Q7 and Q8, which gave the more able candidates a chance to shine.

Report on individual questions

Question 1

This question proved to be a very easy opener with the vast majority of candidates scoring full marks. Any errors usually occurred in (b); namely using the incorrect power in calculating the value of the derivative, using h rather than 2h, using 0.22 rather than 0.2 for y_0 or poor manipulation.

Question 2

This question also proved very accessible with most scoring high marks. Part (a) gave rise to most errors with a failure to differentiate correctly. Some candidates rearranged to make $\frac{d^2y}{dx^2}$ the subject and then differentiated the quotient, these were sometimes less successful. A few candidates omitted the 2 from the final answer.

Question 3

Those who understood the relationship between eigenvalues and eigenvectors found parts (a) and (b) very straightforward. A substantial number of candidates tried to use a characteristic equation approach and got nowhere, others used a general vector $x\mathbf{i} + y\mathbf{j} + z\mathbf{k}$, often later substituting values for x, y and z, but making the question more complicated. The most popular method used in part (c) was to form and solve three linear equations, usually successfully, although sign errors caused unnecessarily heavy algebraic manipulation for some. A few inverted the matrix and were mostly successful, although sign errors once again appeared. A very few misread the question and treated the given vector as the object rather than the image. Surprisingly few checked their answer at the end.

Question 4

Most candidates were able to answer part (a) well, although a few did not highlight the fact that $\sin(-n\theta) = -\sin(n\theta)$. Those who expanded $\left(z^n + \frac{1}{z^n}\right)^6$ were very successful at arriving at the four values quickly, although some did not realise they had found $64\sin^6\theta$ and did not halve their numbers. Those who opted to expand $(\cos \quad + i\sin \quad)^6$ and take the real parts faced a much longer task with plenty of scope for error and many were not able to sustain the method to a successful conclusion. The integration was well done by most, although a few differentiated, most were able to give the exact answer without resorting to calculator.

Question 5

Those candidates who had been well prepared in induction had little difficulty with this question and many gained good marks. Some did not follow the instruction to use induction and tried to use series summation, gaining no credit, and some tried to work from both ends and meet up in the middle. A few did not tie all their results together and a number did not clearly show that their final factorised formula was indeed the result for (k+1) terms.

Question 6

Some candidates found the proof here quite a challenge, but a lot of excellent answers were also seen. Most correctly factorised the difference but then many stated that 80 was a factor of 15 – often stating that it was 6x15. A very few attempted to use induction, but most used the approach shown on the mark scheme. Most candidates were able to gain credit in part (b) but only the best were able to maintain a clear reasoned argument. Those who understood counter examples had little difficulty with part (c).

Question 7

Most candidates were able to make a good progress with parts (a) and (b), although many went on to divide their cross product by 2 at the end of (a) and most used **r.n = a.n** in part (b). Those who were able to write down the parametric form of the line in (c) continued without much difficulty. Some were not so familiar with this form of the straight line and used the cross product, generating three, non-independent, equations which, used together with the equation of the plane, often led candidates, after some algebra, to the correct result. Unfortunately sign errors and arithmetic slips led some candidates into difficulty. Some expanded the bracket and performed two cross products. Some candidates attempted to find the intersection without using the equation of the plane at all, often stating 'let x = 1'.Some mistakenly used the dot product. In part (d) the most popular method was to find two appropriate vectors and show one was a multiple of the other.

Question 8

This question produced the greatest diversity in approaches. Many weaker candidates could not make any progress with this question, and many dropped out as the question continued, but some of the more able candidates took this opportunity to demonstrate their quality by their elegant and concise solutions, which were good to see. Some very good solutions were found by initially rearranging the equation linking z and w, this leads to the solution to parts (a) and (b) very quickly. Some good solutions using arguments were also seen. Most good candidates were able to complete part (a) although some made heavy work of the algebra. Part (b) proved challenging for all but the best candidates, some of the approaches tried led to extremely long algebraic expressions, however the given answer encouraged and assisted even these candidates to battle through to the end. A surprising number of candidates made errors in sketching both the line and the circle in part (c) and very few scored all three marks.

Mechanics Unit M1
Specification 6677

Introduction

Overall the paper proved to be very accessible with candidates of all abilities given the opportunity to demonstrate what they could do. Moreover, the vast majority were able to complete it in the time allowed although see comment under Q7. The areas of the specification which continue to cause difficulty are the dynamics of connected particles and vectors.

In calculations the numerical value of g which should be used is 9.8, as advised on the front of the question paper. Final answers should then be given to 2 (or 3) significant figures – more accurate answers will be penalised.

If a candidate runs out of space in which to give his/her answer than he/she is advised to use a supplementary sheet – if a centre is reluctant to supply extra paper then it is crucial for the candidate to say whereabouts in the script the extra working is going to be done.

Report on individual questions

Question 1

This was a straightforward starter question and a majority of candidates got off to a good start. A few thought that 20 /80 were complementary angles whilst some did not check that their calculator was in degree mode.

Part (a)

Most were able to resolve correctly (with the occasional inevitable confusion between sin and cos) although some attempted to resolve parallel to the string, giving $T = W\cos 20 + 12\sin 70$, but omitted one of the terms, thus scoring zero.

Part (b)

Even if scoring zero in part (a), most candidates were able to gain 3 marks for this part. It is disturbing to find that a significant number of candidates for a Mechanics paper do not know the difference between mass and weight. A few candidates used the triangle of forces but sometimes slipped up by failing to take the essential step of drawing a separate triangle of forces diagram. Increasingly rarely seen, a few candidates successfully used Lami’s theorem.

Question 2

Notwithstanding the usual sign errors, this question was more successfully answered than in some previous years.

Part (a)

Sign errors were frequent for this part with $I = 0.3(8-2) = 1.8$ being frequently seen. An extra g was not often seen but knowledge of the units for impulse – although not separately marked this time – was tenuous, with N or even N/s being proffered. The requirement for “magnitude” demands a positive answer [“(-)3” was marked down, as being an attempt to have it both ways].

Part (b)

Almost all candidates were able to write down a momentum equation (even if with sign errors) but $6m = 3$ far too often led to the deduction $m = 2$. Sign errors could lead to a negative mass, an outcome which should have alerted candidates to a problem; just dropping the negative sign should not be an option!

Question 3

Part (a)
Most candidates answered this correctly, usually taking moments about C, although a small minority took moments about A or D having first ascertained the normal reaction at C.
Part (b)
Candidates were less successful with this part. The successful answers usually took moments about D which they placed to the left of the centre of mass and called the distance AD 'x'. This method obviated the need to find the normal reaction at D. Among those others who were also successful, the majority took moments about A having ascertained the normal reaction at D and again calling AD 'x'. Some candidates created three unknowns: AD, DC and DB; these candidates were rarely successful in their answers, succumbing to the difficulty of unravelling a complexity of their own making. Other candidates failed for various reasons: some for incorrectly calculating the normal because they missed out the mass of the rod or one of the other masses, more usually the former, others because when they took moments about D they failed to take account of the mass of the rod, more usually, or one of the other masses. Some candidates were unsuccessful because they placed D on the right of the centre of mass and then ran into problems using $(7.5 - x)$ rather than $(x - 7.5)$.

Question 4

This question was well answered by many candidates.
Part (a)
Almost all drew a graph with the correct relevant sections, and most labelled the significant values on the axes.
Part (b)
A few candidates tried to apply the constant acceleration formulae to more than one section of the motion at a time, showing a complete lack of understanding of the problem and received no credit.. However, most tried to equate the area under the graph to the given distance, many successfully, but there were errors seen. These included treating the first two sections as a single trapezium (despite having five sides), using a wrong value for at least one of the dimensions, omitting a part (e.g. using just a triangle rather than either a trapezium or triangle and rectangle for the middle section), and omitting the '1/2' from the triangle area formula. Those candidates who approached the problem systematically and who made good use of brackets tended to complete the simplification correctly and reach the required answer of 11 m s^{-1}.
Part (c)
Many recognised a valid approach here by either using $v = u + at$ (or a combination of other constant acceleration formulae) or using the fact that the gradient represents the acceleration. Some candidates who did not gain any credit in (b) because of an invalid method often managed to achieve two out of the three available marks here by following through with their wrong V value. The many candidates who produced fully correct solutions thus far sometimes failed to achieve the final mark by giving their answer as negative when the (positive) deceleration was required.

Question 5

Part (a)
n a number of cases the vertical component of the tension was missing; a few missed out the weight, and a small minority "resolved" it. Some mixed up sine and cosine and a few subtracted 40 from 90 to give 60. There was some very poor algebraic manipulation, going from a correct first statement, to an incorrect value for R. *Part (b) M*ost candidates earned the B mark, for knowing that $F=uR$ and the majority could get $F = 1.2\cos 40$ (or $1.2 \sin 40$) and so, even getting part (a) completely incorrect, could gain 5 out of 6 marks for (b). As usual, rounding and accuracy, when using g, caused some problems

Question 6

Part (a)
Many candidates seemed to expect that the first part of the question would require equations of motion for each particle. Once into relevant calculations, however, most candidates were very successful in obtaining 2.8 m s $^{-2}$. The majority of successful candidates attempted this part directly using $s = ut + \frac{1}{2}at^2$. Others used a two step approach using $v = u + at$ to give v = 4.2, followed by use of another *suvat* formula to get 2.8. A very few tried a verification method which did gain them maximum marks at this stage.
Part (b) Candidates generally formed an $F = ma$ equation with the majority obtaining the correct equation and getting T = 3.5N. However there was still a sizeable number who mistakenly wrote T- 0.5g = 0.5a =1.4. It is noticeable that despite regular comment from Edexcel some candidates still use g = 9.81 which leads to marks being lost in a variety of places where accuracy matters. *Part (c)* Many candidates formed a relevant equation, using the correct forces, reaching the stage of T = 3.5 = (2.8 + g) m and then went straight to m = 5/18, resulting in the loss of a mark. For many candidates there is still a lack of dexterity with the manipulation of fractions. Moreover, there is still a sizeable number of candidates who try to use one equation of motion for the whole system, despite advice to the contrary in several recent examiners reports.

Part (d) In this part, modelling was being tested and candidates needed to show that they really knew what was happening. A large number of candidates gave the correct answer that “both particles move with same acceleration” , gaining the single mark available. However candidates who tried to play safe and included another irrelevant reason, such as same tension, had not shown full understanding of the model and therefore were penalised. Other wrong answers included saying that acceleration was constant.

Part (e) Here, candidates first needed to find the speed of the system when the particle hit the ground. This required the calculation of v = 4.2 which some candidates merely quoted. This is the part of the question where candidates began to lose marks and common errors at this stage included using an incorrect value for acceleration. The question then continued with testing vertical motion under gravity. Successful candidates used a variety of equivalent methods. Some worked out the time to the top , followed by a calculation of distance followed by a calculation for time to fall back to launch point, followed by the addition of the two times, giving the answer to the correct degree of accuracy. Some took a more direct approach and used $s = ut + \frac{1}{2}at^2$ or $v = u + at$, for the whole of the remaining motion i.e. up and down. Many only found the time to the top and lost the final two marks. Common errors involved use of incorrect accelerations, displacements and times. Again candidates seem to want to work in decimals rather than in fractions. Candidates should be encouraged to make greater use of diagrams.

Question 7

There was some evidence that a number of weaker candidates were unable to complete this question but it wasn’t clear whether they ran out of time or simply couldn’t do it.
In parts (a) and (b) some candidates confused the use of position vectors and velocity vectors.
Part (a)
This was well answered by most candidates. Where errors did occur they often involved adding the position vectors, not dividing by the time or miscalculating the time or else doing the subtraction incorrectly or the wrong way round.
Particular examples:-

errors in dividing by 2.5, particularly the **j**-component **o**f the vector.
errors in time, using 2.3 or 4.5 hours.
some candidates changed the time into minutes, others into seconds.

not enough care was taken in looking at the compatibility of length and time units.
use of inappropriate formulae to solve the problem .

A few candidates clearly did not know how to deal with it at all.

Part (b)

This was often correct. Errors that did occur were usually in the position vector, either using 8**i** +11**j** or else leaving it out completely. Also some candidates used a position vector for **v**. A few candidates found the speed or velocity. However for those who had an answer to part (a) most were successful in carrying it correctly forward into this part.

Part (c)

Most knew they had to equate the position vectors but a number did not then go on to equate coefficients of **i** and **j**. Those that did were largely successful in getting the right values out. Others tried to solve the equation for by crossing out all the '*t*'s or all the '**i**'s and '**j**'s. Some tried to divide vectors whilst others just substituted in random values for *t*.

*Part (d)*Relatively few got full marks here. Most ,who got part (a) correct ,were able to get the first mark. Common errors seen were finding the position at $t = 3$ and then using Pythagoras, or else using **v** x *t*. Some candidates just stated that the vectors were the same. Many of those who did carry out the correct calculations either left it at that, without making a statement, or else declared that the velocities rather than the speeds were equal. There were a few instances where 6**i** + 2**j** was taken as the second speed, with no obvious connection to their previous work, using the fact that the speeds must be equal! A few also guessed λ in part (d) and then placed this value at the end of a page of incomprehensible working in part (c).

Mechanics Unit M2
Specification 6678

Introduction

Examiners found a lot of high quality work, with many candidates able to present their responses clearly, concisely and using appropriate language. However, candidates need to be aware that if a question asks for a specific method to be used, e.g. the work-energy principle in Q4, then no marks will be available to those who use alternative methods, even if they do arrive at the correct expression. Similarly, some candidates would do better if they presented clearly labelled diagrams in support of their responses. This was particularly evident in the second part of Q3, where it was not always clear whether or not the candidate had identified the correct angle to find, and in Q7 where some candidates were clearly confused about the relative positions and the directions of motion of the three spheres. In Q8, a correct diagram would have made it very clear that all that was required in the last part was to find the areas of two triangles.

In calculations the numerical value of g which should be used is 9.8, as advised on the front of the question paper. Final answers should then be given to 2 (or 3) significant figures – more accurate answers will be penalised.
Most candidates offered responses to all eight questions, and there was little evidence of candidates running short of time.
If a candidate runs out of space in which to give his/her answer than he/she is advised to use a supplementary sheet – if a centre is reluctant to supply extra paper then it is crucial for the candidate to say whereabouts in the script the extra working is going to be done.

Report on individual questions

Question 1

Most candidates used the relationship between rate of work and driving force and found this a straightforward starting question. Common errors included the omission of g when finding the weight, multiplying 444 by 1000, misreading $\frac{1}{21}$ as $\frac{1}{12}$ or $\frac{1}{14}$ (the latter is rather curious but happened several times), and arithmetic errors in reaching the final answer.

Question 2

There were many correct solutions to this question. Only a small minority of candidates failed to differentiate **v** to find **a** in part (a), and most candidates obtained the correct value for the magnitude of the force in part (b). Incorrect answers were usually due to arithmetic errors, or originated from the sign error $\mathbf{a} = 6t\mathbf{i}+4\mathbf{j}$ in part (a). Other common differentiation errors gave $\mathbf{a} = 6t\mathbf{i}-4t\mathbf{j}$ or $\mathbf{a} = 6t\mathbf{i}+(1-4)\mathbf{j}$

Question 3

In part (a) the first stage of this question requires the candidate to divide the given lamina into appropriate sections. There are several options, large square minus small square, three small squares, a rectangle plus a square, or even dividing the shape into three right angled triangles. Most errors in finding the distance of the centre of mass from *AF* were due to sign errors in setting up the moments equation, errors in finding the distance from *AF* of centres of mass of the constituent parts, or equations which were dimensionally incorrect (usually missing *a*'s).
Some candidates saw the object as a collection of connected rods despite its being described as a lamina formed from a sheet of card.

Part (b) Although some candidates used the symmetry of the figure to determine the distance of the centre of mass from *FE* (or *AX*), many repeated the working from part (a). Some candidates did not appear to realise that they needed to find the distance of the centre of mass from one of the horizontal lines, or they simply assumed that it was *a*. Many candidates did not draw diagrams, making it difficult to determine exactly what they were trying to do. A few diagrams suggested that candidates did not understand what would happen if the lamina were suspended from *A*. It was expected that candidates would use the right angled triangle with $\frac{5}{6}a$ and $\frac{7}{6}a$, but it is possible to find the distances of the centre of mass from *A* and *F* and use the cosine rule, as some candidates attempted to demonstrate.

Question 4

Many candidates lost several marks on this question. Some simply did not attempt the question, other presented confident, but incorrect working.
Part (a) Many errors were made; some were simply a case of the ambiguous answer "loss of GPE = $-\frac{7mgh}{5}$", but it was also common to see both particles regarded as losing GPE, or the assumption that both particles move a vertical distance *h*.

Part (b) Some candidates clearly did not want to attempt this using work and energy. Those who did often tried to look at each particle separately rather than consider the system as a whole, and often ran into difficulties, double counting some elements. The normal reaction was usually identified correctly, leading to a correct expression for the work done against the frictional force. Two particularly common errors were the omission of the kinetic energy of *B* (giving an equation with $\frac{1}{2}mv^2$ rather than $\frac{3}{2}mv^2$), and double counting the increase in GPE for *A*.

Question 5

Part (a) A few candidates struggled to find their way into this question, sometimes attempting to start by taking moments about B, C or D rather than about A. Weaker candidates would have helped themselves by marking the unknown distance clearly on the diagram. There were however many correct solutions, with most errors due to omitting the distance from a term in the moments equation, or omitting g from the weight.

Part (b) Many candidates assumed that the resultant reaction on the hinge at A was perpendicular to the wall, or perpendicular to the beam. Candidates who attempted to use moments rather than resolving tended to be more prone to error. Those candidates who did find both components usually went on to combine them correctly to find the reaction. Inappropriate accuracy in the final answer was a common problem – 4s.f. is not appropriate having used an approximation for g.

Question 6

Part (a) There were several instances of a possible misread of $\tan\alpha = \frac{3}{4}$ in this question, although it was not always possible to tell whether the error was a misread or use of an incorrect expression $\tan\alpha = \frac{\cos\alpha}{\sin\alpha}$. Most candidates used the formula $v^2 = u^2 + 2as$ to find the maximum height. This was often found correctly, but a common error was to forget to square

their value for u. Some candidates made the task more difficult than necessary by adopting a method with two, or more, stages.
Part (b) Having found the time to travel a horizontal distance of 168m it is possible to find the vertical distance in one step, but many candidates elected either to find the time from the highest point to the ground, or to find the time from when the ball returns to the level of A until it reaches B. Candidates choosing one of these longer alternatives did not always match up their value for time taken with an appropriate value for the initial vertical speed. Having reached a value for vertical distance there was then some confusion about whether or not to add or subtract their answer from part (a).
Part (c) Whether using energy or an alternative approach, the most common error in this part of the question was to concentrate on the vertical speed and to ignore or omit the horizontal component. This resulted in many candidates scoring no marks here.

Question 7

Very few candidates noticed the link between part (a) of this questions and parts (b) and (c). This resulted in a considerable quantity of valid but unnecessary work. The marks allocated to the three parts of the question should give candidates an indication that each of the later parts is not expected to involve as much work as the first part.

Part (a) There were many substantially correct answers to this part. Most candidates formed correct equations using restitution and conservation of momentum. The difficulties started with the speed of P – many candidates whose answer was the negative of the printed answer did not justify the change of sign using the information about the value of e, and those whose answer agreed did not appreciate the need to verify that their value for velocity was in fact positive. Candidates who changed the sign of their answer for the speed of P often went on to substitute incorrectly to find the speed of Q. There was also evidence of some confusion over the exact meaning of the question in part (aii), with several candidates starting by substituting in place of e.
Part (b) Most candidates elected to start the question afresh rather than use the results from part (a). Examiners were presented with confusing diagrams which were often contradicted by the working which followed. Alternatively there was no diagram and we had to decide for ourselves which direction the candidate assumed sphere *B* would move in after the collision with *C*.
c) By this stage in the working many candidates were working with an incorrect initial speed of *B*, and were then further confused about the possible directions of motion of *A* and *B* after their collision. This often resulted in a page or more of working to deduce a velocity for *B* after the collision with *A*, all for a potential score of one mark. Most candidates did demonstrate an understanding that they needed to compare the speeds of *B* and *C* to determine whether or not there would be a further collision.

Question 8

Completely correct solutions to this question were rare, with parts (b) and (c) proving to be a better source of marks than parts (a) or (d).

Part (a) There are several possible methods for finding the maximum speed in this interval. The expected method was to differentiate, find the value of t for which the acceleration is equal to zero, and use this to find the corresponding value of *v*. Candidates using this approach sometimes got as far as the value for *t* and then stopped as if they thought they had answered the question. As an alternative, candidates who recognised this as part of a parabola, either went on to complete the square (with considerable success despite the nature of the algebra involved), or found the average of the two times when the speed is zero to locate the time for maximum speed and hence the speed, or simply quoted formulae for the location of the turning point. Many candidates simply substituted integer values of *t* in to the formula for *v* and stated their largest answer. This alone was not sufficient. Although it is possible to arrive at the correct answer using trial and improvement, most candidates who embarked on this route failed to demonstrated that their answer was indeed a maximum – they usually offered a sequence of increasing values, but did not demonstrate that they had located the turning point in an interval of appropriate width.

Part (b) Many candidates answered this correctly – even those who did not differentiate in part (a) did choose to integrate here. There is a false method, assuming constant speed throughout the interval, which gives the answer 32 incorrectly by finding the speed when t = 4 and multiplying the result by 4 – many candidates used this without considering the possibility of variable speed and acceleration.

Part (c) This was usually answered correctly, but some candidates appeared to think that they were being asked to find out when $8t - \frac{3}{2}t^2 = 0$ or when $8t - \frac{3}{2}t^2 = 16 - 2t$.

Part (d) Those candidates who realised that the particle was now moving with uniform acceleration had the simple task of finding the area of two triangles, assuming that they appreciated the significance of $v < 0$ for $t > 8$. Alternatively they could use the equations for motion under uniform acceleration, with the same proviso. For the great majority of candidates, this was about integration and choosing appropriate limits. The integration itself was usually correct, but common errors included ignoring the lower limit of the interval, or not using s=32 when t=4, and stopping after using the upper limit of t=10. Some candidates thought that the limits for t should be from t=0 to t=6, and a large number thought that they should be starting from t=5. Very few of the candidates who found the integral went on to consider what happened between t=8 and t=10.

Mechanics Unit M3
Specification 6679

Introduction

The paper proved rather easier than the June 2006 paper and the majority of candidates found all questions on the paper accessible. There were many excellent scripts, showing a thorough knowledge of the specification. However there were scripts which showed very little knowledge of the mechanical ideas specific to this module and, hence, although there were large numbers of completely correct solutions, there were also a surprising number of blank or worthless responses. There was little evidence of shortage of time and complete attempts at the last question were common. The general standard of presentation was satisfactory and the use of calculators was, in general, appropriate.

Report on individual questions

Question 1

This question was a straightforward introduction to the paper. In part (a), nearly all recognised the use of integration and found the appropriate limits. In part (b), the majority used integration to find the *x*-coordinate instead of using the symmetry of the figure. This did waste time and was not always correctly done. Those who could remember a correct formula for the *y*-coordinate usually completed the question correctly.

Question 2

This question was, on the whole, well done with a great many candidates gaining full marks. Part (a) caused more problems than part (b) but many candidates who had difficulty with (a) went on to complete (b) successfully. There were a significant number of very weak attempts at (a) which tried to involve integration, often apparently trying to prove the result for the centre of mass of a cone. Among successful solutions, the most popular method was to treat the container as a cylinder without ends and combine this with one circular end. However the alternative involving the removal of a lid from a container closed at both ends was also quite common and was usually successful. Problems with (b) were rare and tended to arise only where candidates attempted to consider the curved surface, base and liquid as three separate items, ignoring the given M and often taking the masses as $2\pi h^2$, πh^2 and πh^3. Some, however, completed this method successfully by using the mass of the liquid as $3\pi h^2$. Geometrical solutions to either part of the question were uncommon.

Question 3

There were some unnecessarily complicated solutions to part (a), often involving the general inverse square law $F = \frac{Gmm'}{r^2}$. Candidates did not always make it clear that they were using the fact that the force on the rocket was *mg* at the surface of the earth, i.e. when $x = R$. It was not unusual to see this part of the question omitted. In part (b), the sign in Newton's Second Law was more often incorrect than correct. Provided an appropriate form was used for the acceleration, candidates could usually integrate correctly. Those who then used a constant of integration almost invariably used the boundary condition, $x = 2R$ when $v = 0$, correctly and, if they had the initial sign correct, gained full marks. Those who used definite integration often had trouble getting their limits the right way round. Although the use of definite integration is obviously a completely valid method, the evidence of the responses seen does suggest that those using this method are less successful in producing correct solutions. It was disappointing that candidates who obtained an answer $v = \sqrt{-gR}$ often attempted to explain this in terms of a loss of energy instead of realising that this was an obviously incorrect answer and using this as a cue to check their work.

Question 4

This proved to be the easiest question on the paper and full marks were very common. Those who failed to complete the question nearly always had the resolutions correct but failed to spot the trigonometric relation between the lengths. Methods of solution using a centrifugal force were very uncommon.

Question 5

The basic formulae for SHM were well known and many candidates scored well on this question but full marks were relatives uncommon; part (c) proving difficult to complete correctly. In part (a), some candidates tried to use $v = r\omega$ incorrectly and, as it happened, this gave, numerically, the correct period. It is, however, a false method and gained no credit in this part, although some follow through was allowed in the remaining parts of the question. Part (b) was generally well done and, in part (c), candidates generally knew how to find at least one time when *OP* was $\frac{1}{2}a$. However relating this to the total time for which $OP > \frac{1}{2}a$ proved demanding and $\frac{2\pi}{15}$ was commonly seen instead of the correct $\frac{4\pi}{15}$. Some very neat solutions were seen using the reference circle associated with SHM.

Question 6

Most candidates tackled this question well and, usually, if they were successful in part (a), they were also successful in part (b) . As in Q2, however, part (b) was correctly answered more often than part (a). In part (a), among the less successful candidates, most were aware that they had to use an energy equation but a fairly common mistake was assuming the velocity to be zero at the point of leaving the surface. Some candidates used memorised formulae involving an acute angle θ measured with the downward vertical. A few of these managed successfully to justify the changes needed to produce the required result for angle α but more tried simply to manipulate their signs. In part (b), it was pleasing to see that the majority found the most efficient way of completing the question, considering the change of energy between the lowest point and the point on the horizontal through *O*. A significant minority took the approach of finding the velocity where the particle left the surface of the sphere and working from that point to the point on the horizontal through *O*. Often, though, they did not make it very clear that they were doing this and some lost track of their zero level for the gravitational potential energy. There were very few valid projectile attempts. Most candidates attempting this method forgot that they had to consider two components and, although a few managed to calculate the correct vertical component of *W*, successful attempts to combine this with a horizontal component were very rare.

Question 7

Part (a) was well done. A correct use of Hooke's Law, combined with vertical resolution and the geometry of the situation, was the standard approach. A few made the error of not realising that there were two tensions for the resolution but only one for Hooke's Law. Many good arguments were seen in part (b). There were two main methods; using conservation of energy with three terms and showing $v = 0$, and finding the elastic potential energy loss and showing that it was equal to the gain in gravitational potential energy at the level of *AB*. There was a tendency for candidates to drop the *l* in their lengths. As energy is involved, this gave dimensionally incorrect solutions but candidates who did this could usually gain 4 of the 6 marks if their solution was otherwise correct.

Mechanics Unit M4
Specification 6680

Introduction

The standard of work seen in these scripts was very variable, ranging from those candidates who presented concise and clearly argued solutions to all six questions, to those who appeared to be only vaguely familiar with the content of the specification. Typically, those candidates who scored more highly used appropriately sized and clearly labelled diagrams to support their work. The very high proportion of apparent misreads in Q5 emphasises the need to read the questions very carefully. Although a number of blank responses to questions were seen, this appeared to be due to lack of knowledge rather than a shortage of time to complete the paper.

Report on individual question

Question 1

Candidates were generally able to obtain a correct relationship between the speed of the ball before and after the collision by resolving parallel to the wall. The vast majority then went on to find the loss in KE in one variable, but a significant proportion of these candidates did not then go on to find the fraction of KE lost. Some candidates found the loss in KE using only the components perpendicular to the wall. In most cases, however, these candidates then incorrectly went on to find the fraction of KE lost by using the perpendicular component of the initial velocity rather than the initial speed in their expression for the initial KE. Most candidates were able to obtain a correct equation in e and substitute to find a correct value for e.

Question 2

The vast majority of candidates found the driving force, correctly applied Newton's second law and were able to rearrange to obtain the given result in part (a).

In part (b) candidates were generally able to separate the variables correctly. The most popular method for integrating the expression in v was to use partial fractions, although this caused a number of candidates to make sign errors. The minority who used substitution (e.g. $x = u - v$) were generally successful. There was a significant number of candidates who integrated incorrectly, or who attempted to use integration by parts only to grind to a halt because they did not know how to complete the second stage of the integration, or worse still did not show any indication of the need for a second step in the integration. The vast majority of candidates preferred finding a constant of integration to using definite integration, but those who integrated correctly tended to obtain the final simplified result successfully.

Question 3

This was a very straightforward question which posed few difficulties for most candidates. Finding the potential function in part (a) caused the greatest number of problems. Many demonstrations of the given result left a lot for the examiner to infer from diagrams which were often poorly drawn. Methods involving $a\sqrt{2}$, the length of the light rod, or $a\sqrt{5}$, the distance of the centre of mass of BC from A, were seen and were often successful but much longer than direct calculation of the distances of the centres of mass of the rods below the level of A.
Having been given the potential function, parts (b) and (c) were routine and generally done well. Some candidates working with the centre of mass of the framework started with part (b), usually successfully, but did not then go on to complete the rest of the question.

Question 4

Relative velocity problems are usually an area of the syllabus in which candidates do not perform well – this question was no exception, with a disappointingly large proportion of candidates being unable to make any progress. Indeed, many demonstrated little appreciation of the fact that if *B* intercepts *A* then the velocity of *B* relative to *A* would be parallel to the line joining their initial positions.

Many candidates attempted part (a) by forming an expression for the speed of *B* relative to *A* and then differentiating with respect to time, rather than direction in their attempt to find the minimum possible value.

Concise and elegant solutions were seen; they were almost invariably preceded by clear and well labelled diagrams in which distances, velocities and relative velocities could easily be distinguished and the required velocity in part (a) could clearly be seen to be perpendicular to *AB*.

Explanations in part (b) were often not very convincing and in some cases consisted of a poorly drawn diagram with no verbal discussion.

Candidates who attempted vector methods had no success with this problem.

Solutions which were otherwise correct sometimes lost the last mark by not stating the time of day at which interception occurred.

Question 5

Candidates often failed to draw diagrams accurately showing *A* and *B* in the correct positions relative to each other; the mis-read directing the collision along **i,** where candidates expected it to be, instead of along **j**, as given in the question, was common. Many candidates who did read the question correctly then rotated the situation to conform to their standard model for the problem rather than dealing with the given situation from first principles. Some candidates who read the question correctly then drew diagrams with *A* and *B* in incorrect positions relative to each other, representing an impossible situation in terms of the final velocities.

A significant minority of candidates assumed and found a change in the velocity perpendicular to the line of centres of the two spheres.

Sign errors were frequent and were the main source of errors in part (a). They often remained uncorrected even when the resulting velocity components implied that there would be no collision.

Candidates often thought that both spheres needed to be considered together to find the impulse between them, rather than considering the change of momentum for just one sphere. Another common error was to combine the components of the velocity to find speed before attempting to find the impulse.

Most candidates made some progress in finding the angle of deflection of the direction of motion of *A* by finding a relevant angle but many gave the obtuse angle between the directions rather than the deflection. The dot product method was extremely rare.

Question 6

Part (a) Most candidates started by finding the correct value for the equilibrium extension. Those who were able to obtain the given result convincingly initially included the natural length in their equation. The question did ask candidates to refer to a simple diagram in their explanation – some of the diagrams suggested that candidates had little appreciation of the situation described in the question.

Part (b) A significant number of candidates omitted this part of the question and others tried to obtain the given result by differentiating the relationship obtained in part (a). Those who began with Newton's Second Law, with the correct acceleration, generally scored full marks for this part although it was quite common to see confusion between $\ddot{x}$ and $\ddot{y}$ which was fudged to obtain the required result.

Part (c) Candidates were usually able to give the correct form of the general solution and then find values for the constants of integration by correct methods. Candidates who used only the complementary function in their working to find the values of the two constants scored little or nothing for the remainder of the question. Similarly, there were some candidates who did not obtain the correct form for the complementary function who could not then score many further marks.. Some candidates attempted to use incorrect initial conditions based on $t = 0$, $x = 0$, $\dot{x} = 0$, and using the result from part (a). Several candidates created additional work for themselves by working from the general form of the particular integral to deduce the given form, others substituted the given term into the differential equation to show that it works.

Part (d) Most candidates differentiated their solution to part (c) and put it equal to 0. Many candidates obtained the correct trigonometric equation $\cos 2t = \cos 7t$. The majority of candidates did not know how to solve this equation and stopped at this point. Those who were able to solve it generally used the correct sum/product formula, rather than the general solution for the cosine function.

Mechanics Unit M5
Specification 6681

Introduction

Overall the paper proved to be accessible with candidates of all abilities given the opportunity to demonstrate what they could do. Moreover, the vast majority were able to complete it in the time allowed. The questions which seemed to cause most difficulty were qu4, Q6(a) and Q8(c) i.e. questions involving those parts of the specification dealing with rotation. Despite comments in previous reports, some candidates continue to ignore the examiners' advice (and indeed the question!) when dealing with the period of a compound pendulum – see the comment on Q6. See also the comment under Q2, regarding the solution of vector differential equations. Candidates should note that methods which involve division by a vector and/or taking the logarithm of a vector will receive no credit, despite the fact that often the correct answer will emerge at the end.

In calculations the numerical value of g which should be used is 9.8, as advised on the front of the question paper. Final answers should then be given to 2 (or 3) significant figures – more accurate answers will be penalised.
If a candidate runs out of space in which to give his/her answer than he/she is advised to use a supplementary sheet – if a centre is reluctant to supply extra paper then it is crucial for the candidate to say whereabouts in the script the extra working is going to be done.

Report on individual questions

Question 1

This proved to be an easy starter and was mostly well done, although a few candidates insisted on including the weight, in spite of being told that "the only forces...".

Question 2

There were many correct solutions to this question, with the majority of candidates treating it as a second order equation in **r** rather than a first order equation in **v**. A few candidates treated it as a separable equation, dividing by the vector **v**, which was not considered to be an acceptable method. (Interestingly, if you find the value of **r** instead of **v** you get the same final answer) Many candidates insisted on using components which makes the problem much more difficult and much longer and, moreover, is not necessary.

Question 3

Most candidates realised that angular momentum was conserved. A few, however, tried to conserve energy despite there having been a collision, and they received no credit.

Question 4

A number of candidates correctly attempted to split the solid into discs with their centres on the x-axis and many arrived at the final answer. Some, however, assumed that the solid was a hemisphere when finding the density and an expression for y^2. The other common error was to take the moment of inertia of a disc to be $\frac{1}{2}\delta mx^2$ instead of $\frac{1}{2}\delta my^2$.

Question 5

Most candidates were able to find $\mathbf{F}$ and then went on to find the sum of the moments of $\mathbf{F}_1$ and $\mathbf{F}_2$ about *O*. A number then thought that they had found $\mathbf{G}$. Others mistakenly added the moments of $\mathbf{F}_1$, $\mathbf{F}_2$ and $\mathbf{F}$ about *O*. Many, however, did succeed in finding the correct value of $\mathbf{G}$, but some then forgot to find its magnitude. The most common accuracy error was in the signs when using cross products.

Question 6

The simplest (incorrect) method to get the printed answer in part (a) is by adding various pieces, each of mass *M*, which is what a significant number of the candidates did. The simplest correct method is by considering the ratio of the masses of the large disc and the small disc and hence the mass of the ring.
Part (b) using the perpendicular and parallel axis theorems was almost universally successful. In the third part, a few candidates seemed unaware of the use of the term "equation of motion" used in its rotational sense. Most, however, took moments about the axis and proceeded correctly. Common errors were to omit the minus sign, which was penalised when the period of SHM was needed, the 2 from $2a$, and thinking that half of the period was needed rather than a quarter of it. A few candidates ignored the instruction to use an equation of motion and started from a formula for the period of a compound pendulum, thus gaining no marks in part (c).

Question 7

Candidates who were successful in part (a) could either consider the change of momentum in a time δt or else use Newton's Second Law and consider the rate of change of momentum i.e. $\frac{\mathrm{d}(mv)}{\mathrm{d}t}$. Some candidates tried to do this part from memory, often apparently considering the alternative problem of a rocket ejecting fuel. Other difficulties included taking $\frac{\mathrm{d}m}{\mathrm{d}t}$ as λt or else putting *U* in the general equation for *v* and *t*.
Part (b) was usually successfully done, mostly by separating the variables. Many candidates argued part (c) correctly, but others compared appropriate values of *t* or *m* or *v* but did not then state any conclusion.

Question 8

The moment of inertia of the system was generally well done. The energy equation often led to the correct result, although sometimes after a few practice goes. Some candidates missed out the change in PE of either the particle or the rod.
Part (b) was usually successful apart from amongst those candidates who seemed to have little knowledge of rotational motion.
Many candidates made a sensible attempt at part (c), but made slips with the numbers. Some found the centre of mass of the rod and particle while doing this part. Common slips included putting an "*a*" in with the component of the weight or just calling the mass on each side "*m*", which was fine for those candidates using the centre of mass. Some candidates, however, thought that they needed to consider the tangential acceleration.

Statistics Unit S1
Specification 6683

Introduction

The demands of the paper were similar to previous years and the majority of candidates found the paper to be accessible, especially the earlier questions on the paper. There was a suggestion that some candidates may have run out of time as a minority did not attempt Q6 and Q7. The standard of work presented was high and many candidates clearly have a good understanding of the concepts and techniques presented here.

Report on individual questions

Question 1

Most candidates had little trouble with part (a). In part (b) a sizeable minority correctly identified negative correlation, but failed to put it into the context of the question. In part (c) again a sizeable minority did not attempt this part or multiplied their answer for part (a) by some arbitrary factor.

Question 2

Parts (a), (b) and (c) were generally well done, although in part (c) there were many with strange ideas of heavy instruments. In part (d) the majority of candidates were able to make a credible attempt at this with most giving one of the two possible solutions with a reason. The majority used the median and quartiles to find that the distribution was symmetrical. The use of the words ‘symmetrical skew’, similar to ‘fair bias’, is all too often seen but was accepted. Equal, even or normal skew were also often seen and were given no credit.
Part (e) was attempted successfully by a minority of candidates. A large number of candidates did not understand the distinction between z-values and probabilities. A lot gave 0.68 as z-value leading to the loss of the accuracy mark. Others tried to put various values into standard deviation formulae.

Question 3

This was generally well answered. The majority of the errors occurred in part (c) by rounding too early and getting 18.4 for a. The regression line was often inaccurately plotted. In part (e) many used chocolate content to justify answer and often did not use the regression line to get a suitable price. Some misunderstood the question and attempted to find the best value in the second part of part (e)

Question 4

Many candidates were able to determine the correct answer for part (a) but a very common error was to multiply the two probabilities, incorrectly assuming independence. Many candidates used the Venn diagram to attain the correct solution to part (b). The most common errors were to omit a box or add a third circle. In part (c), as is often the case in this type of question, many failed to realise this was a conditional probability

Question 5

Many candidates started well with this question, but a large number of inaccurate answers were seen for the latter parts. Part (a) was usually correct and part (b) was generally done well. In part (c) there were a lot of mistakes in finding midpoints and also $\sum f$. Most knew the correct method for finding the mean, but rather fewer knew how to find the standard deviation in part (d) although most remembered to take the square root. Part (e) was very badly answered, with the majority unable to interpolate correctly which was often due to wrong class boundaries and / or class widths. In part (f), although the majority got an incorrect numerical value, most picked up the mark for interpreting their value correctly.

Question 6

Part (a) was often done well but a substantial number omitted to subtract from 1; however most attempts standardised correctly with 4. The majority of candidates found part (b) required too much reasoning and either failed to add the 0.5 or got completely muddled in the use of the normal tables. A significant number did not understand the difference between a probability and a z value. A minority of candidates did not attempt this question.

Question 7

A sizeable minority of candidates did not attempt this question, but, when attempted, this question was well done with many candidates picking up most or all the marks. Rather surprisingly in part (a) the equation missing was $p+q=0.45$ and a few candidates divided one side of their second equation by 5. In part (b) nearly all of those who had two correct equations for part (a) were able to solve them simultaneously. In part (c) a substantial number of candidates were unable to make a successful attempt at this part of the question with many omitting it entirely. There were a large number of accurate solutions to part (d) with most of those making an error failing to use the given values. A number of candidates reworked $\mathrm{E}(X^2)$ for part (e) even though it was given. There were some mistakes in part (f) but most candidates used16 correctly, but some multiplied $\mathrm{E}(X)$ instead of $\mathrm{Var}(X)$.

Statistics Unit S2
Specification 6684

Introduction

This paper was shown to be accessible to the majority of candidates and there was little evidence of them being unable to complete the paper owing to time constraints. Many of the candidates seemed to be confident with much of the work they had learnt in statistics at A2 level. It was disappointing to see that some candidates did not relate some of their answers to the context of the question especially when, as in Q3, candidates were specifically asked to relate the theory to the context posed in the question.

Report on individual questions

Question 1

This question was answered very well with many completely accurate solutions. In part (a) some candidates neglected to specify a **continuous** Uniform distribution and in a lot of cases failed to show the graph for values of $x < 0$ and $x > 5$ with thick horizontal lines. In part (b) the mean and the variance were found correctly using the formulae. The integration method was rarely used. Most candidates were able to work out the probability in (c) using geometry but many failed to realise that for a continuous distribution the probability of an integer value was zero.

Question 2

The majority of candidates found this question straightforward. They were most successful if they used the probability method and compared it with 0.05. Those who attempted to use 95% were less successful and this is not a recommended route for these tests.
Most candidates knew how to specify the hypotheses with most candidates using 2.5 rather than 5. Some candidates used p, or did not use a letter at all, in stating their hypotheses, but most of the time they used λ. A minority found $P(X=7)$ and some worked with Po(5).
If using the critical region method, not all candidates showed clearly, either their working, or a comparison with the value of 7 and the CR $X \geq 7$.
A sizeable minority of candidates failed to put their conclusion back into the given context. Reject H_0 is not sufficient.

Question 3

This question was quite well done. Most candidates were aware of the conditions for a Poisson distribution but many lost marks as they did not answer the question in context, although the examination question actually specified this. A few did not realise that independent and random were the same condition. Cumulative probability tables were well used in part (c) and there were many accurate solutions using the Poisson formula.
Most candidates used a mean of 4.5 in part (d) and there were many accurate results.

Question 4

This question differentiated between candidates. It was disappointing to see the majority of candidates had no idea how to find the probability distribution of the median although quite a few specified the definition of a probability distribution. Several were able to write down the combinations but did not understand how to find the median and construct the probability distribution. There were few completely accurate solutions.

Question 5

This question was accessible to most candidates. Parts (a), (d) and (e) were generally well answered with a small proportion of candidates using Po(10) in part (d) and thus quoting that the mean and variance were the same. Part (b) caused a few problems as some used Po(0.1) and found P(X = 2) or used X~B(2, 0.1). In part (c) some candidates still did not correctly use P(X > 1) = 1 – P($X \leq$ 1). A similar mistake occurred in part (e) where they used P(X > 6) = 1 – P($X \leq$ 6).

Candidates need to be reminded of the rubric on the front of the question paper. It does say ‘appropriate degrees of accuracy’. Many rounded too early and did not realise that an answer to 1sf is not accurate enough. Answers of 0.001 were common in part (c)

Question 6

There was clear evidence that candidates had been well prepared for a question on hypothesis testing with many candidates scoring full marks on this question. Candidates who used the probability method were generally more successful than those who used critical regions. They were less familiar with writing hypotheses for p than for the mean and so used λ or μ instead of p. A few candidates mistakenly used a B(5, 1/7) or B(7,1/7) distribution. In a minority of cases the final mark was lost through not writing the conclusion in context using wording from the question.

Question 7

In part (a) a very large number of candidates thought that np and npq must exceed 5 rather than np and nq or that ‘n is large and p is small’ A minority of candidates gave the variance in terms of p and q not just p as stated in the question. In part b most candidates were able to apply a continuity correction successfully and use the normal distribution, although there were a sizable few candidates who had difficulty knowing whether to do ‘1 – or not’. It is recommended that candidates draw a diagram to help them decide which is the area required.It was rather disturbing that many candidates could not apply simple logical arithmetic to part (c). The most common error was to fail to take into account that the faulty DVDs still cost something to make even if they are not sold.

Question 8

This question has been a good discriminator. The majority of candidates attempted this question with varying degrees of success. In part (a) there were many good sketches with clear labelling but many lost a mark through not marking the patios clearly. In part (b) the most common mistake is to give the value of f(x) i.e. ½. Part (c) was a problem for a majority of candidates. It was evident that many candidates were not competent in finding the CDF of a function given in two parts. Finding F(x) for $0 \leq x \leq 3$ was reasonably well answered, but quite often candidates did not use the limits or simply wrote down the answers without showing any working. Candidates were less successful in finding F(x) for $3 \leq x \leq 4$, with few using limits correctly and many not taking into consideration the answer to the first part. Candidates who used the alternative method, using ‘+c’ and F(0) = 0 and F(4) = 1 were generally more successful in getting the correct F(x). Responses to part (d) would seem to reflect a lack of understanding of what the median is. Candidates quoted F(x) = 0.5 and the proceeded to put F(x) for $3 \leq x \leq 4$ = 0.5 and solve. It was rare to find evidence of candidates checking which part to use before setting up an equation. Many candidates solved F(x) = 0.5 for both parts and then not said which answer was the median. Another common error was adding F(x) for $0 \leq x \leq 3$ and F(x) for $3 \leq x \leq 4$ and then solving.

Statistics Unit S3
Specification 6691

Introduction

The paper proved to be accessible to the majority of the candidates and there was little evidence of a shortage of time causing difficulties. Most candidates know how to express hypotheses correctly and conclusions are usually explained correctly although sometimes the interpretation was highly convoluted. The standard of work presented was generally high and many candidates clearly have a sound understanding of the concepts and techniques, however there is clearly still some uncertainty over the use of notation, which was particularly apparent in Q6, and sometimes over the role of the null hypothesis in statistical tests.

Report on individual questions

Question 1

Part (a) was answered very well and the majority of the candidates scored full marks. There were occasional slips in the ranking or the arithmetic but a small minority failed to rank the data and seemed unperturbed when their resulting correlation coefficient had a magnitude greater than 1. In part (b) the hypotheses were sometimes given in terms of r_s, rather than , and, despite the clear message in the question that a one tail test was required a few persisted in using two tails. For the conclusion we will expect a correct statement about the significance (or do not reject H_0) followed by an interpretation in context. In this case the simplest conclusion would be to say that the competitor's claim is justified.

Question 2

Part (a) posed few difficulties for most candidates. The hypotheses were usually stated correctly in terms of "association" or "independence" and the calculations of the test statistic, and degrees of freedom were handled well. Most quoted the correct critical value (although some used the 5% value) and a correct conclusion generally followed. Once again the simplest interpretation was to remark that there is support for the Director's belief but many candidates gave correct, but more complicated, statements about insufficient evidence of any association between grades in Mathematics and English.

Part (b) was supposed to generate a response about the likelihood of some expected frequencies falling below 5 and the consequent need to amalgamate the groups. A good number of candidates identified this problem but some got side-tracked by the change in degrees of freedom which does not cause problems in performing the test.

Question 3

This should have been a straightforward question on a single-sample test for the mean but a large number of candidates scored poorly here. The first problem was the hypotheses; many stated these in terms of the mean before the holiday and the mean after the holiday as though a two-sample test was required. Those who did use the value 18 usually realised that a one-tailed test was required, the word "reduction" in the last line was the clue, and was usually used. The test statistic should have given a value of – 1.94 and some candidates lost a mark for losing the minus sign although of course a modulus test was acceptable. Those candidates who thought a two-sample test was required often had a curious test statistic based on the difference between the two normal distributions R~ N(18, 9) and $\bar{R}$ ~ N(16.5, $\frac{9}{15}$). Despite these difficulties most candidates were able to give a correct conclusion to their test.

Question 4

Although most candidates answered part (a) correctly a surprising number failed to do so some not appreciating the difference between the mean number of defective items and the proportion. Part (b) was usually answered well with only a few using n as 100 instead of 20. Most candidates knew about combining classes in part (c) but they didn't always calculate the degrees of freedom correctly and this sometimes led to them failing to reject the binomial model.
There were many good responses to part (d) with candidates showing a sound understanding of the implications of rejecting the binomial model.

Question 5

Part (a) was answered very well with only a small minority of candidates using a biased estimator of variance. The test was carried out quite well too, certainly with more success than that in Q3, but a number of candidates lost marks for confusing standard deviation with variance in the denominator of their test statistic. Parts (c) and (d) were not answered well. In part (c) surprisingly few candidates emphasised that the central limit theorem enabled one to assume that $\bar{A}$ and $\bar{B}$, rather than A and B, were normally distributed, where A and B represent the weight loss using diet A and diet B respectively. Very few noted the assumption that $\sigma_A{}^2 = s_A{}^2$ and $\sigma_B{}^2 = s_B{}^2$ in part (d).

Question 6

Whilst many candidates scored well on this question, others barely knew how to start and would often score no more than a couple of marks for looking up relevant values in the tables. Despite this, few answered the question well with poor notation ($\frac{\sigma^2}{n}, \sigma$ or worse were often seen used for standard error) and an absence of words to explain what they were doing meaning that many solutions were a jumble of figures and symbols from which the examiners could sometimes see the correct answer emerging.

Question 7

Many candidates scored well here but the usual confusion between 4S and T caused some to stumble and only the better candidates dealt with the modulus sign correctly in part (c).

In part (a) a number of candidates formed the distribution $X = L - 4S$ and went on to show X~N(0.1, 0.89) but some then struggled to find P(X > 0) and an answer smaller than 0.5 was often seen. In part (b) some candidates thought that T = 4S but many did interpret T as $S_1 + S_2 + S_3 + S_4$ even though this was rarely explicitly stated. A common error in dealing with the probability calculation was to treat it as 2P[($L - T$) < 0.1], others found z = 0 and z = - 0.31 but then gave the answer as 0.5 + P(Z < - 0.31). A clear diagram, which was rarely seen, may have helped them.

Statistics Unit S4
Specification 6686

Introduction

Overall the paper worked well enabling nearly all candidates to demonstrate what they knew but also allowing the stronger candidates to show their true potential. Most candidates found the first 4 questions very accessible and many scored highly here. Q5(a), 6 and 7(c) proved to be good discriminators and only the better candidates made significant progress through these.

Report on Individual Questions

Question 1

This proved to be a good starter question and most candidates gave good solutions. A minority carried out a two sample test and a few did not interpret their conclusion in terms of the question. In part (b) many mentioned that the blood pressure had to be normally distributed. Whilst this is a sufficient condition the required answer was that the differences in blood pressure was normally distributed. Only a handful of candidates spotted this.

Question 2

This question was generally well answered. In part (b) a minority of candidates did not draw the conclusion that U is unbiased. Part (c) caused the most problems. Many did not use Var $(n\bar{X}) = n^2$ Var $(\bar{X})$ and although most had part (a) correct they did not use Var $(\bar{Y}) = \frac{\sigma^2}{m}$. These candidates demonstrated poor algebraic skills in an endeavour to get the correct answer, even though the answer was given

Question 3

This question was well answered with a large proportion of the candidates getting full marks. In part (b) the pooled estimate was worked out correctly by many candidates but they then failed to use the square root of it in their calculations of t. Many concluded that females were shorter than males rather than it being the forewing length which was shorter

Question 4

Most candidates realized that the Chi squared distribution was required in part (a) and gained full marks. In part (b), many candidates carried out the test correctly but did not write their conclusion in the context of the question

Question 5

The vast majority of candidates realized that Poisson distributions should be used in this question. The concepts of size and power were generally well understood, but a minority of candidates did not use lambda in part (a) or worked out $P(X > 3 / \lambda)$. Parts (b) and (c) were generally correct.

Question 6

This question proved to be challenging for many candidates. A common mistake was to use the t value of 2.624 in part (a) rather than the z value 2.3262. The candidates must learn when to use each test. In part (b) few candidates used both of their values found in part (a) and many did not use $\frac{\sigma}{\sqrt{15}}$.

Question 7

Parts (a) and (b) of this question were well answered with many fully correct solutions being given. Part (c) proved to be more difficult with a lot of candidates not being able to start this part of the question. Of those who did realise that μ and σ must be as big as possible a large percentage forgot to use the square root of their answer in part (b).

Decision Mathematics Unit D1
Specification 6689

Introduction

The paper proved accessible and the questions seemed to be in increasing order of difficulty. Many candidates answered Q2 in the space provided for Q1 and some then forgot to complete Q1 having realised their error.

Some of the responses were difficult to read, sometimes due to poor presentation but most often because of the writing tools used.

Candidates should be reminded that they should use blue or black pen or dark pencil ONLY when completing their answers. Highlighters, tippex, coloured pens and faint pencil should not be used.

Candidates need to be familiar with the terminology used in this subject. Poor understanding of terminology caused particular difficulty for the candidates in Q1, Q4, Q5 and Q6.

Report on individual questions

Question 1

This was an accessible question. The majority of the candidates understood that edges should not cross. Many candidates suggested that the same graph could be both planar and non planar, inaccurately illustrating their answer with drawings of a planar graph with arcs crossing which they claimed was non planar prior to redrawing. Many stated that a planar graph had to contain an Hamiltonian cycle. Poor terminology was frequently seen with, for example, vertices and edges being confused. A number thought that a planar graph could be drawn without lifting pen from paper.

Question 2

Many candidates are more practised at finding a matching and an alternating path, with many more candidates able to start and finish at an unmatched vertex on each side. Candidates should again be reminded about the use of colour in this type of question and should ensure that their responses would clearly identify any differences when photocopied; the use of different types of lines to show changed status of edges is useful with a common approach being - = - = - = - =. A number of candidates did not make their 'change status' step clear. Only the most able were able to gain full marks in part (a) by identifying that, if a complete matching is to be found, there must be same number of vertices on each side of the bipartite graph. Part (c) was again well answered with many candidates being able to explain this accurately.

Question 3

Although there were many very good responses seen many candidates seemed to get into difficulty by the end of the second line. This question requires a methodical, accurate and diligent approach and the examiners were surprised at the number of candidates who found difficulty following the instructions. 126 was often seen in the second line of A, the 26 in x was often omitted, as was the 12, some candidates changed the A or y entries too early, or too late, and some candidates entered superfluous 'yes' and 'no' entries in the last two columns. Many candidates compressed their entries – so that they were no longer 'in line', others repeated entries, others wrote more than one entry in each box; this made it difficult to determine the stage at which the candidates were changing the entries. Only the best candidates were able to give the correct answer in part (b), with ‘the value of A when x = 0’, and ‘LCM’ being the most popular incorrect answers – although HCF, HCM and LCF were also seen.

Question 4

The three pairings were successfully found by most candidates, the majority of whom went on to find the correct lengths too, with a small but significant number getting 40 instead of 39. A lot of time was wasted on drawing the network and giving the actual route, and this occasionally resulted in failure to give the total length. Few candidates got both marks in part (b), most just looked at their repeated paring, or identified BH as the largest distance, or AB as the smallest edge on the graph. Poor notation was often seen here, such as reference to ‘the vertice DF’.

Question 5

There were many fully correct answers to (a) seen, but also many who applied the nearest neighbour algorithm instead. Many seemed to confuse arcs with vertices and did not list their arcs as required. Most candidates drew a tree in part (b) and almost all who got the correct tree also correctly found its weight. Many candidates were able to describe the mechanics of the algorithm in part (d), with the commonly seen reference to ‘crossing out rows’, but only the best were able to think about HOW the algorithm worked and secure both marks.

Question 6

Most candidates identified AEHK as a critical path, but far fewer correctly identified AEL. Most candidates were able to gain marks for the ‘critical’ part of the definition, often by reference to zero floats, but few addressed the ‘path’ part correctly. A number thought that a zero float was a consequence of the early and late times being the same. Many used ‘flow’ instead of ‘float’, many confused event and activity and arc with node. A number of candidates did not carry out a calculation in (d), and attempted to schedule at this stage, and some divided by the number of activities, but most correctly found the arithmetic lower bound. Part (e) was generally well answered, although some omitted an activity, or included K. Those who correctly completed parts (d) and (e) were usually successful in part (f), although some did not appreciate that their answer to (d) was only a lower bound, and evidently thought that the project had to be completed by only four workers. Although some cascade diagrams were seen, most candidates attempted a scheduling diagram. The most common errors were overlapping C with F, E with J, and length errors.

Question 7

The standard of response to part (a) was much better than has been seen in previous years, with fewer double equal signs and fewer inequalities seen. Part (b) proved more challenging, with reversed inequalities and slack variables inappropriately introduced and then often mishandled. Most candidates were able to identify the first pivot and then deal with the pivot row correctly, although some forgot to change the basic variable. The row operations were then usually correctly carried out, but arithmetic errors often started to creep in at this point. Many candidates incorrectly chose their next pivot as –3, pivots can never be negative, leading to negative values for the basic variables. A significant number of candidates used the numbers in the profit row as the values of the variables in part (d) and only the more able were able to gain credit in part (e).

Question 8

Although many good answers to parts (a) and (b) were seen, disappointingly many candidates were not able to find the value of the initial flow or evaluate the cuts correctly. Most candidates were able to find at least one flow-augmenting path, but few found all paths to 19, the ‘backflow’ paths causing most of the problems. Some assumed that I was the sink, rather than T. Very few candidates gained credit in (d), many had the right idea but either didn’t state a cut, or didn’t quote the theorem.

Decision Maths Unit D2
Specification 6690

Introduction

The paper proved very accessible and time did not seem to be a problem.

Some candidates structured their answers poorly and many made errors reading their own handwriting.

Good use was made of the tables in the answer booklet.

Candidates should be reminded that they should use blue or black pen or dark pencil ONLY when completing their answers. Highlighters, tippex, coloured pens and faint pencil should not be used.

Report on individual questions

Question 1

Part (a) was poorly done by a surprisingly large number of candidates. The majority of candidates made at least one mistake in calculating the additional distances, with a significant number making 3 or 4 mistakes. Numbers written into the grids were often difficult to read because of subsequent working. Most candidates found the correct NN route and length, although some omitted the return to A. Other candidates found the MST A-G and doubled this to give their upper bound. Part (c) was correctly done by a large majority of candidates. When errors did occur, it was either in finding the wrong tree or adding the incorrect arcs from A.

Question 2

This question was well done by the majority of candidates. Most completed (a) well, but a few found the wrong values for row maximin and column minimax, many did not make clear the link to show that the game was not stable. In part (b), most candidates clearly defined their probabilities and set up the three equations correctly, although there were then some errors when simplifying these. Many errors occurred when drawing the graph, including a lack of a scale, labels, ruler (!) and going outside the (probability) domain, as well plotting lines incorrectly. Some candidates did not draw a graph at all. A significant number of candidates chose the wrong intersection point to calculate the value of p. Most candidates went on to state their strategy and value of the game.

Question 3

This question was well done by the majority of candidates, with only a very small number reducing columns before rows or trying to maximise. A minority of candidates failed to state their final allocation. The majority of candidates failed to answer part c correctly, just multiplying their time by 20, instead of realising that work could happen concurrently.

Question 4

Although this question was generally done quite well, a significant number of candidates made some errors in their working. Part (b) was often poorly done with many candidates just stating that supply did not equal demand. In part (c) there were slips in the calculating of shadow costs and improvement indices. There were a number of candidates who stated 9 improvement indices, candidates should appreciate the difference between a cell being ‘empty’ and having a zero entry. (A very few alarmingly included negative numbers in their NW corner method, which has not been seen before.) A significant number of candidates made errors on the stepping stone route, some did not use the most negative improvement index, some choose an invalid route with 2 empty cells others left a 0 in cell 3D. Some candidates wasted time, applying the algorithm twice here. Part (e) was generally well done, although a small number of candidates failed to calculate new shadow costs. Many candidates did not state their cost to 2dp, as is expected in money calculations.

Question 5

This question was poorly done by a large number of candidates. There are two common approaches to this question. The majority of candidates used the ‘dividing by V’ method (alt 2 on the mark scheme). Common errors included failing to add 4 to the matrix, not defining their probabilities and not realising that they should be maximizing 1/V. When setting up the inequalities, some candidates used columns instead of rows, some did not fully divide by V and some reversed the inequalities or incorrectly introduced slack variables. Some candidates also forgot the non-negativity constraints. Those candidates who chose the ‘transposing’ method (alt 1 on the mark scheme) generally produced a better attempt, although a significant number did not correctly perform all three operations on the matrix (transpose, change signs and add 7). Many weaker candidates produced highbred versions incorporating elements of both methods. A substantial minority introduced 9 unknowns, often treating it as an allocation problem.

Question 6

This question was generally done well, with only minor numerical slips in some candidates working, or the omission of some stars (particularly GH and FH). A number of candidates incorrectly calculated the minimum route instead of the minimax. Only a few candidates attempted the other varieties (maximum, maximax or minimin) or tried to answer the problem by working forwards. As always a small number of candidates did not choose their states sensibly, and consequently had difficulty carrying the data found in earlier stages to the later ones. Most candidates successfully gave both routes.

Grade Boundaries:
June 2007 GCE Mathematics Examinations

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

Module	80	70	60	50	40
6663 Core Mathematics C1	60	52	44	37	30
6664 Core Mathematics C2	59	50	42	34	26
6665 Core Mathematics C3	59	52	45	39	33
6666 Core Mathematics C4	58	50	43	36	29
6674 Further Pure Mathematics FP1	63	55	48	41	34
6675 Further Pure Mathematics FP2	51	43	36	29	22
6676 Further Pure Mathematics FP3	54	48	42	36	30
6677 Mechanics M1	66	57	48	39	30
6678 Mechanics M2	58	51	44	37	31
6679 Mechanics M3	65	57	49	42	35
6680 Mechanics M4	57	50	43	36	30
6681 Mechanics M5	61	53	45	37	29
6683 Statistics S1	58	51	44	37	30
6684 Statistics S2	63	55	48	41	34
6691 Statistics S3	62	54	47	40	33
6686 Statistics S4	64	56	48	40	33
6689 Decision Maths D1	51	44	37	30	23
6690 Decision Maths D2	65	57	49	41	34

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