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GCE

GCE Mathematics (8371/8373, 9371/9373)

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Core Mathematics Unit C1
Specification 6663

Introduction

While the standard aspects of this paper provided easy access to marks for routine work, some parts of questions proved particularly challenging and were answered well by only the better candidates.

There were various points in the paper at which a poor choice of algebraic or arithmetic method produced unnecessarily awkward calculations. Sometimes this led to weak or rushed attempts at the later, longer questions, indicating clearly that "time management" was an issue for some candidates.

Standards of presentation varied considerably. Although many candidates managed to set out their working clearly and concisely, some penalised themselves by producing work that was difficult to decipher. Another problem was the failure to show sufficient working, particularly in "show that" questions with given answers. Candidates should be advised to show all working, "rough" or otherwise, in the space allocated for the question.

As mentioned in previous reports, it is good practice for candidates to quote a formula first before beginning to substitute values. This can sometimes earn a method mark that might otherwise be lost.

Report on individual questions

Question 1

Many candidates answered both parts of this question correctly. In part (b), however, some did not understand the significance of the negative power. Others, rather than using the answer to part (a), gave themselves the difficult, time-wasting task of squaring the 125 and then attempting to find a cube root. Negative answers (or ±) appeared occasionally in each part of the question.

Question 2

This question was generally answered very well, with most candidates scoring at least 3 marks out of 4. Omission of the integration constant occurred less frequently than usual and the terms were usually simplified correctly. Just a few candidates differentiated, and a few thought that the integral of x^n was $\frac{x^{n+1}}{n}$.

Question 3

Most candidates completed this question successfully, either by expanding the brackets to find four terms or by recognising the difference of squares and writing down $7-4=3$ directly. Common wrong answers included $11+4\sqrt{7}$, from $(\sqrt{7}+2)(\sqrt{7}+2)$, and 5, from $7+2\sqrt{7}-2\sqrt{7}-2$. Mistakes such as $\sqrt{7}\times 2=\sqrt{14}$ were rarely seen.

Question 4

Most candidates coped well with the integration, usually scoring the first two or three marks in this question. The majority then used the given point (4, 22) appropriately in an attempt to find the value of the integration constant, but mistakes in calculation were very common. The evaluation of $2x^{\frac{3}{2}}$ at $x = 4$ was a particular problem.
A significant minority of candidates failed to include the integration constant or failed to use the value of y in their working, and for those the last two marks in the question were unavailable.

Question 5

There were many good solutions to both parts of this question. In part (a) most candidates translated the curve parallel to the x-axis, although occasionally the translation was of $+3$ rather than -3 units, taking the curve "to the right". A common mistake in part (b) was to sketch $y = -\mathrm{f}(x)$ instead of $y = \mathrm{f}(-x)$, reflecting in the x-axis instead of the y-axis.
Just a few candidates failed to show the coordinates of the turning points or intersections with the x-axis, or carelessly omitted a minus sign from a coordinate.

Question 6

Good candidates generally had no difficulty with the division in part (a) of this question, but others were often unable to cope with the required algebra and produced some very confused solutions. A common mistake was to "multiply instead of divide", giving $2x^2 \div \sqrt{x} = 2x^{\frac{5}{2}}$, and sometimes $\sqrt{x}$ was interpreted as x^{-1}. Examiners saw a wide variety of wrong answers for p and q.
Most candidates were able to pick up at least two marks in part (b), where follow-through credit was available in many cases. While the vast majority used the answers from part (a), a few differentiated the numerator and denominator of the fraction term separately, then divided.

Question 7

Candidates who understood the demands of this question usually did well, while others struggled to pick up marks. In part (a), those who correctly used the discriminant of the original equation often progressed well, but it was sometimes unclear whether they knew the condition for different real roots. An initial statement such as "$b^2 - 4ac > 0$ for different real roots" would have convinced examiners. Irrelevant work with the discriminant of $k^2 - 5k + 4$ was sometimes seen.
In part (b) by the vast majority of candidates scored two marks for finding the correct critical values, although it was disappointing to see so many resorting to the quadratic formula. It was surprising, however, that many did not manage to identify the required set of values of k. The inappropriate statement "$1 > k > 4$" was sometimes given as the final answer, rather than "$k < 1$ or $k > 4$".

Question 8

In parts (a) and (b) of this question, it was common to see $(x+1)^2(2-x)$ unnecessarily (and often wrongly) expanded. The value $a = 4$ from part (a) was intended to help candidates to draw appropriately scaled sketches in part (b) and hence to be able to find the number of real solutions to the equation in part (c). Many, however, having correctly obtained the point (1, 4), did not use this in their sketches. While most candidates recognised that the first function was a cubic, many drew "positive cubic" shaped curves and many failed to correctly identify required features such as the minimum on the x-axis and the other points of intersection with the axes. Sketches of the rectangular hyperbola were generally satisfactory and only occasionally missing a branch or in the wrong quadrants. A few had wrong asymptotes such as $y = 2$.

It was not always clear in part (c) whether candidates understood that they should be looking at the number of intersection points of the curves. Their comments sometimes suggested that they were considering intersections with the x-axis. It was disappointing that some candidates ignored the instruction to refer to their diagram and wasted time by trying to solve the given equation algebraically.

Question 9

Although most candidates made a reasonable attempt at this question, only those who demonstrated good skills in algebra managed to score full marks.
The structure of parts (a) and (b) was intended to help candidates, but when the initial strategy was to write down (correctly) $3d = 32.5 - 25$, there was sometimes confusion over what was required for the two equations in part (a). Even when correct formulae such as $u_{18} = a + 17d$ were written down, the substitution of $u_{18} = 25$ did not always follow. The work seen in these first two parts was often poorly presented and confused, but credit was given for any valid method of obtaining the values of d and a without assuming the value of a.
In part (c), many candidates managed to set up the correct sum equation but were subsequently let down by poor arithmetic or algebra, so were unable to proceed to the given quadratic equation. Being given 55×40 (to help with the factorisation in the last part of the question) rather than 2200 sometimes seemed to be a distraction.

Despite being given the 55×40, many candidates insisted on using the quadratic formula in part (d). This led to the problem of having to find the square root of 9025 without a calculator, at which point most attempts were abandoned.

Question 10

The first three parts of this question were usually well done but part (d) proved particularly difficult and was rarely completed successfully.

Part (a) caused few problems, although a few candidates failed to put their answer in the form $y = mx + c$. The usual method in part (b) was verification that $(-2,7)$ satisfied $y = -\frac{1}{2}x + 6$, but other approaches included consideration of the gradient of the line joining $(-2,7)$ and $(2,5)$. In part (c), most candidates reached $AB^2 = 20$, which usually led either to the correct answer $2\sqrt{5}$ or occasionally to $4\sqrt{5}$.

For the most efficient method in part (d), the vital step was to find the *y*-coordinate of *C* in terms of *p*. Candidates who failed to do this were rarely able to make very much progress towards establishing a relevant equation. Those who did get started were often let down by poor algebra in their attempts to expand brackets and simplify the equation. Often the only working seen in part (d) was the solution (by formula) of the given quadratic equation.

Question 11

Responses to this question varied considerably, ranging from completely correct, clear and concise to completely blank. Most candidates who realised the need to differentiate in part (a) were able to make good progress, although there were occasionally slips such as sign errors in the differentiation. A few lost marks by using the given equation of the tangent to find the *y*-coordinate of *P*. Those who used no differentiation at all were limited to only one mark out of six in part (a). Even candidates who were unsuccessful in establishing the equation of the tangent were sometimes able to score full marks for the normal in part (b).

Finding the area of triangle *APB* in part (c) proved rather more challenging. Some candidates had difficulty in identifying which triangle was required, with diagrams suggesting intersections with the *y*-axis instead of the *x*-axis. The area calculation was sometimes made more difficult by using the right angle between the tangent and the normal, i.e. $\frac{1}{2}(AP \times BP)$, rather than using *AB* as a base.

Core Mathematics Unit C2
Specification 6664

Introduction

All questions were attempted by a majority of candidates but there was evidence of shortage of time in some cases. Some spent far too much time on Q5 and Q6 - particularly where long division was used as their method of solution for Q6.

Q1, Q2, Q3 and Q8 were answered well and candidates appeared familiar with the material being tested. The “proofs” at the beginning of Q5, Q8, Q9 and Q10 were generally poorly done however and were often the subject of much fudging. The basic algebraic and numerical errors seen were of concern and these errors frequently caused loss of the final marks where good understanding had been shown earlier in a solution. Candidates would be advised to check their answers carefully to avoid transcription and sign errors.

Report on individual questions

Question 1

This binomial expansion was answered well with a majority of the candidates scoring full marks. The most common errors involved signs and slips in evaluating the powers and binomial coefficients. A number of weaker candidates changed the question and instead expanded $(1 \pm 2x)^5$. This gained no credit.

Question 2

Most candidates expanded the brackets correctly and most collected to three terms although a significant number then reversed the signs before integrating. A few candidates differentiated or tried to integrate without expanding first but the majority scored the M mark here. Most substituted the correct limits and subtracted correctly, although those who evaluated f(4) and f(-1) separately often made errors in subtracting. A common mistake was the substitution of 1 instead of –1. A few split the area into two parts –1 to 0 and 0 to 4. The fraction work and the inability to cope with a negative raised to a power (here and in other questions) is quite a concern. Many candidates completed correctly and this question was reasonably well done.

Question 3

On the whole this question was also well answered with most students gaining more than just the two marks for completion of the table in part (a).

As in previous sessions the most frequent error was in finding h, with 2/6 being the most usual wrong answer. Many candidates used h = (b – a)/n and put n as 6. It is clear that what this formula represents is not fully understood. It was rare to see the simple method of subtracting one x value from the next one to get h.

There were not as many bracketing errors in the application of the formula this time as in previous examinations. Errors in substituting values inside the curly brackets included putting (0 + 4.58) + 2(3 + 3.47 + . . . + 4.39) as well as several instances of the first bracket correct but 3 also appearing in the second bracket. There was also some use of x values instead of y values in the trapezium formula.

Question 4

The better candidates produced neat and concise solutions but many candidates seem to have little or no knowledge of the laws of logs. Those who didn't deal with the 2logx term first usually gained no credit.

A significant minority dealt successfully with log theory to arrive at $\log\frac{4-x}{x^2}$ = 1 but were let down by basic fraction algebra, "cancelling" to obtain log {4/x} = 1, and even going on "correctly" thereafter to 4/x = 5, x = 4/5!

Another group were unable to proceed from log {(4-x)/x2} = 1, usually just removing the "log" and solving the resulting quadratic. Making the final M mark dependent on the previous two very fairly prevented this spurious solution gaining unwarranted credit.

A few obtained the answer with trial and improvement or merely stated the answer with no working presumably by plugging numbers into their calculator. Neither of these latter methods is expected or intended however.

Question 5

Part (a) caused much more of a problem than part (b). A large number of solutions did not really provide an adequate proof in the first part of this question. The original expected method, involving gradients, was the least frequently used of the three successful methods. Finding the three lengths and using Pythagoras was quite common although successful in a limited number of cases – there were many instances of equations being set up but abandoned when the expansion of brackets started to cause problems. Finding the gradient of QR as -3/2 and substituting to find the equation of the line for QR before using y = 4 to get a, was usually well done. Some used verification but in many cases this led to a circular argument.

In part (b) the centre was often calculated as (8, 3) or (8, 1) indicating errors with negative signs. There were several instances of (5, 4) arising from (4 + 2)/2 being thought to be 4 – maybe cancelling the 2's? The length of PQ was usually correct but frequently thought to be the radius rather than the diameter. The equation of a circle was well known but weaker candidates in some cases took points on the circumference as the centre of the circle in their equation, showing lack of understanding.

Question 6

In part (a) most who used the remainder theorem correctly used f(2) and f(-1) and scored M1A1 usually for 16+40+2a+b, the (-1)^4 often causing problems. A large number of candidates then mistakenly equated each to zero and solved the equations simultaneously, obtaining a = -20 and ignoring b = -16 so that they could go on in (b) to use f(-3) = 0 to obtain b = -6.

Those who equated f(2) to f(-1), as required, usually completed to find a although there were many careless errors here. Some candidates worked with f(2) – f(-1) and then equated to zero but not always very clearly.

The candidates using long division often made a small error, which denied most of the marks available:

- Omission of the "$0x^2$" term as a place-holder from the dividend resulted in much confusion.

- Failure to pursue the division until they had reached the constant term gave equations of the "remainders" still containing x.

- The almost inevitable habit of subtracting negative terms wrongly (e.g., 5x2 – (-2x2) = 3x2).

They usually made little progress, and penalised themselves by the excessive time taken to do the complicated algebra required.

In part (b) again the remainder theorem method scored better than the long division method. Most candidates who reached a = - 20 obtained the correct value for b, but there was some poor algebra, with the powers of –3 causing problems for some. A few used f(3) instead of f(-3) and a number did not set their evaluation equal to zero.

Question 7

There were no problems with part (a) in most cases, but a significant number used formulae for arc length, areas of segments, or areas of triangles instead of the correct formula for the area of a sector.

The main error in part (b) was taking π rather than 2π in their calculation. Many candidates converted into and out of degrees here making their working more complicated.

The method used in (c) was correct in most cases – but there was a sizeable minority who treated BDC as a sector thus scoring 0/4. A few cases were seen where DC was taken as base of the triangle ADC, calculated (via cosine rule) along with the height (found via first calculating one of the other angles) then used in ½ x base x height – much more complicated than 1/2absinC.

Question 8

In part (a) most candidates correctly substituted for (sinx)^2 but some lost the A mark through incorrect signs or a failure to put their expression equal to zero.

For part (b) most factorised or used the formula correctly and earned the B1. Unfortunately some who failed to achieve the given answer in a) carried on with their own version of the equation. There were many completely accurate solutions, but others stopped after 360 – 75.5 or did just 360 + 75.5 and some candidates tried combinations of 180 +/- 75.5 or 270 +/- 75.5. A few candidates mixed radians and degrees.

This question was answered well by a majority of candidates.

Question 9

Part (a) was a good discriminator. There were a few cases of "fudging" attempts to yield the printed answer using (k + 4)(2k – 15) = 0 or similar. Cancelling was often ignored by those using (k + 4) x $(k/(k + 4))^2$ = (2k – 15) resulting in cubic equations – generally incorrectly expanded.

Finding the printed answer in (b) was straightforward and most were successful at solving the quadratic equation. Some used verification and lost a mark.

Finding the common ratio in part (c) was answered well, though some candidates found r = 4/3 however.

The sum to infinity in (d) was answered well. Using 12 for "a" was the frequent error here.

Question 10

Part (a) required a proof. Common mistakes in the formula for the surface areas were to omit either one or both ends. Algebraic mistakes caused problems with rearranging to make h the subject and some candidates did not know the volume formula. This part was often not attempted or aborted at an early stage.

Parts (b) and (c) were answered well. Most candidates knew that they should differentiate and equate to zero although many could not manage to correctly evaluate r (poor calculator work) and it was common to forgot to evaluate V. Part (c) was often incorporated in (b) (and vice versa!), but generally contained all the elements necessary to score both marks. Most solutions used the second derivative here and there were relatively few of the alternative methods of determining a maximum point. Only a few candidates were unsure of the procedures for establishing the nature of stationary points.

Core Mathematics Unit C3
Specification 6665

Introduction

The paper proved accessible to the majority of candidates and nearly all were able to attempt all 8 questions. Not all were able to finish the last question but, in the majority of cases, this was probably due to an inability to interpret the model rather than a lack of time.

The general standard of presentation was acceptable. These papers are marked online and, if a pencil is used in drawing sketches of graphs, a sufficiently soft pencil (HB) should be used and it should be noted that coloured inks do not come up well and may be invisible. The number of candidates who gave answers which went outside the area on the pages designated for answers was fewer than in some previous examinations.

Most candidates used their calculators sensibly and were able to produce proofs in which the steps of their reasoning could be followed. However, some candidates use calculators, which give exact answers, inappropriately. For example, in Q6(b), in attempting to show that $\sin 15° = \frac{1}{4}(\sqrt{6} - \sqrt{2})$, a number of candidates quoted $\cos 15° = \frac{1}{4}(\sqrt{6} + \sqrt{2})$; a relation that is given by many modern calculators. However this result is not of equivalent difficulty to the result that the candidate is asked to prove and cannot be accepted as part of the proof.

The standard of algebra was generally acceptable but many candidates showed weaknesses in using brackets and they were often omitted. This can lead to a loss of marks. For example, in the proof required in Q6(a)(i), $1 - 2\sin^2\theta\cos\theta$ cannot be accepted as the equivalent of $(1 - 2\sin^2\theta)\cos\theta$ unless there is unambiguous evidence that it is interpreted this way.

Not all candidates were familiar with all the mathematics symbols appropriate to this specification. In question 2, $\mathrm{f}'(x)$ was sometimes interpreted as $\mathrm{f}^{-1}(x)$ and, in Q5, the notation $\frac{\mathrm{d}}{\mathrm{d}x}[\mathrm{fg}(x)]$ was not always understood.

Report on individual questions

Question 1

This proved a good starting question which tested the basic laws of differentiation; the chain, product and quotient laws. Almost all candidates were able to gain marks on the question. In part (a), most realised that they needed to write $\sqrt{(5x-1)}$ as $(5x-1)^{\frac{1}{2}}$ before differentiating. The commonest error was to give $\frac{\mathrm{d}}{\mathrm{d}x}\left((5x-1)^{\frac{1}{2}}\right) = \frac{1}{2}(5x-1)^{-\frac{1}{2}}$, omitting the factor 5. It was disappointing to see a number of candidates incorrectly interpreting brackets, writing $(5x-1)^{\frac{1}{2}} = 5x^{\frac{1}{2}} - 1^{\frac{1}{2}}$. Not all candidates realised that the product rule was needed and the use of $\frac{\mathrm{d}}{\mathrm{d}x}(uv) = \frac{\mathrm{d}u}{\mathrm{d}x} \times \frac{\mathrm{d}v}{\mathrm{d}x}$ was not uncommon. Part (b) was generally well done but candidates should be aware of the advantages of starting by quoting a correct quotient rule. The examiner can then award method marks even if the details are incorrect. The commonest error seen was writing $\frac{\mathrm{d}}{\mathrm{d}x}(\sin 2x) = \cos 2x$. A number of candidates caused themselves unnecessary difficulties by writing $\sin 2x = 2\sin x \cos x$. Those who used the product rule in part (b) seemed, in general, to be more successful than those who had used this method in other recent examinations.

Question 2

This type of question has been set quite frequently and the majority of candidates knew the method well. Most approached the question in the conventional way by expressing the fractions with the common denominator $(x-3)(x+1)$. This question can, however, be made simpler by cancelling down the first fraction by $(x+1)$, obtaining $\frac{2x+2}{x^2-2x-3} = \frac{2(x+1)}{(x-3)(x+1)} = \frac{2}{x-3}$. Those who used the commoner method often had difficulties with the numerator of the combined fraction, not recognising that $-x^2+1 = 1-x^2 = (1-x)(1+x)$ can be used to simplify this fraction. If part (a) was completed correctly, part (b) was almost invariably correct. It was possible to gain full marks in part (b) from unsimplified fractions in part (a), but this was rarely achieved.

Question 3

The principles of transforming graphs were well understood. Part (a) was generally well done and almost all candidates recognised that the transformation left the shape and the x-coordinates of the stationary points unchanged. The y-coordinates, however, were often given incorrectly. Part (b) was very well done and the majority reflected the correct part of the curve in the x-axis and it was pleasing to note that almost all candidates knew they had to draw a cusp and not round off the curve. A few drew the graph of $y = \mathrm{f}(|x|)$ instead of $y = |\mathrm{f}(x)|$.

Question 4

This proved a discriminating question. Those who knew what to do often gained all 6 marks with just 4 or 5 lines of working but many gained no marks at all. Although there are a number of possible approaches, the most straightforward is to find $\frac{\mathrm{d}y}{\mathrm{d}x}$, using the chain rule, and then invert $\frac{\mathrm{d}y}{\mathrm{d}x}$ to obtain $\frac{\mathrm{d}x}{\mathrm{d}y}$. Substituting $y = \frac{\pi}{4}$ gives the gradient of the tangent and the equation of the tangent can then be found using $y - y_1 = m(x - x_1)$ or an equivalent method. However, many confused $\frac{\mathrm{d}y}{\mathrm{d}x}$ with $\frac{\mathrm{d}x}{\mathrm{d}y}$.

Those who knew the correct method often introduced the complication of expanding $\cos(2y+\pi)$ using a trigonometric addition formula. Such methods were often flawed by errors in differentiation such as $\frac{\mathrm{d}}{\mathrm{d}y}(\sin \pi) = \cos \pi$. Among those who chose a correct method, the most frequently seen error was differentiating $\cos(2y+\pi)$ as $-\sin(2y+\pi)$.

An instructive error was seen when candidates changed the variable y to the variable x while inverting, proceeding from $\frac{\mathrm{d}x}{\mathrm{d}y} = -2\sin(2y+\pi)$ to $\frac{\mathrm{d}y}{\mathrm{d}x} = -\frac{1}{2\sin(2x+\pi)}$. This probably reflected a confusion between inverting, in the sense of finding a reciprocal, and the standard method of finding an inverse function, where the variables x and y are interchanged.

Question 5

Parts (a) and (c) were rarely correct. Relatively few candidates showed an understanding of the concept that the range of a function is the possible set of values of $\mathrm{g}(x)$ or $\mathrm{fg}(x)$ and those who did often failed to discriminate between "greater than 1" and "greater than or equal to 1". Part (b) was generally very well done and the confusion between $\mathrm{gf}(x)$ and $\mathrm{fg}(x)$ was rarely seen.

Part (d) proved very discriminating and many did not realise that they were being asked to solve an equation. Some thought that they were being asked to prove that $\frac{\mathrm{d}}{\mathrm{d}x}[\mathrm{fg}(x)] = x(x\mathrm{e}^{x^2}+2)$ and they could gain the first two marks. However those who started by differentiating $x(x\mathrm{e}^{x^2}+2)$ could gain no credit. Those who understood the question correctly often had difficulties in applying the chain rule to $3\mathrm{e}^{x^2}$. When the correct equation $2x+6x\mathrm{e}^{x^2} = x(x\mathrm{e}^{x^2}+2)$ was obtained and this simplified to $6x\mathrm{e}^{x^2} = x^2\mathrm{e}^{x^2}$, candidates often had problems with the e^{x^2} term not realising that, as e^{x^2} cannot be 0, it can be cancelled. Even strong candidates often omitted the solution $x = 0$ and full marks were rarely obtained on part (d).

Question 6

Part (a)(i) was well done and majority of candidates produced efficient proofs. Some candidates, however, failed to gain full marks when the incorrect use of, or omission of, brackets led to incorrect manipulation. Those who failed to spot the connection between parts (a)(i) and (a)(ii) rarely made any progress. Those who did make the connection often made sign errors and the incorrect equation $\sin 3\theta = -\frac{1}{2}$ was commonly seen. The majority of those who obtained the correct $\sin 3\theta = \frac{1}{2}$ did obtain the two answers in the appropriate range and the instruction to give the answers in terms of π was well observed.

Many candidates struggled with part (b) and, despite the hint in the question, blank responses were quite common. Those who did attempt to write $15°$ as the difference of two angles often chose an inappropriate pair of angles, such as $75°$ and $60°$, which often led to a circular argument. If an appropriate pair of angles were chosen, those who used $\sin 45° = \cos 45° = \frac{\sqrt{2}}{2}$ usually found it easier to complete the question than those who used $\sin 45° = \cos 45° = \frac{1}{\sqrt{2}}$.

Question 7

A substantial proportion of candidates did not recognise that, in part (a), the product rule is needed to differentiate $3x\,\mathrm{e}^x$ and $3x^2\,\mathrm{e}^x$, $3x\,\mathrm{e}^x$ and $3\,\mathrm{e}^x$ were all commonly seen. It was also not uncommon for the question to be misinterpreted and for $3x\left(\mathrm{e}^x-1\right)$ to be differentiated. Those who did differentiate correctly usually completed part (a) correctly. Part (b) was very well done with the majority of the candidates gaining full marks. Very few lost marks for truncating their decimals or giving too many decimal places.

In parts (c), candidates need to be aware that showing that something is true requires them to give reasons and conclusions. It would be sufficient to argue that a change of sign in the interval $\left(0.257\,55,\,0.257\,65\right)$ implies that there is a root in the interval $\left(0.257\,55,\,0.257\,65\right)$ and, hence, that $x=0.2576$ is correct to 4 decimal places. The majority of candidates did provide an acceptable argument. Fewer candidates than usual attempted repeated iteration, an method that is explicitly ruled out by the wording of the question.

Question 8

Part (a) was very well done and the majority gained full marks. A few candidates found the complementary angle or gave their answer in radians. There was some evidence of candidates running out of time in part (b) but, given part (a), it was possible just to write down the answers to this part and many were able to do this. Some very basic manipulation errors were seen; for example, proceeding from $5\cos\left(\theta-53.1°\right)=5$ to $\cos\left(\theta-53.1°\right)=0$. Those who were able to interpret the model in parts (c) and (d) and see the connection with part (a) frequently gained full marks very quickly. However the majority of candidates failed to spot any connection with part (a) and frequently just substituted $t=0$. Fortunately very few candidates attempted calculus and almost none of those who did recognised that differentiating functions in degrees is not a straightforward process.

Core Mathematics Unit C4
Specification 6666

Introduction

This paper proved to be accessible to many of the candidature and there was little evidence of candidates being short of time. This paper afforded a typical E grade candidate plenty of opportunity to gain some marks across many, if not all of the 7 questions. Q3(c), Q4(c), Q5(a) and Q7(c) which tested the synoptic element of the course caused some problems to a significant number of candidates.

A majority of candidates were able to obtain at least half of the marks available in the vector question, with many correct solutions seen in part (b) and part (c). A significant minority of candidates were unable to recall that if two lines are perpendicular then the dot product between their directions vectors is zero. Examiners were impressed with the minority of candidates who between them were able to apply a variety of different methods (6 were seen in all!) to find the position vector of *B*.

There was a significant improvement in comparison with June 2008 with candidates' attempts on the topic of "Connected Rates of Change" in Q5(b). It was disappointing to note, however, that a significant number of these candidates were unable to realise that they needed to use similar triangles in order to prove the formula for the volume of water in part (a) of this question.

In summary, Q1, Q3(a), Q3(b), Q4(b), Q4(c) and Q7(a) were a good source of marks for the average candidate, mainly testing standard ideas and techniques; and Q2, Q3(c), Q6(a) and Q6(b) were effective discriminators. A significant proportion of candidates, however, made little progress with Q5(a), Q6(c) and 7Q(c) with some candidates failing to offer any response to these questions.

Report on individual questions

Question 1

A significant majority of candidates were able to score full marks on this question. In part (a), many candidates were able to differentiate implicitly and examiners noticed fewer candidates differentiating 8 incorrectly with respect to x to give 8. In part (b), many candidates were able to substitute $y = 3$ into *C* leading to the correct x-coordinate of -2. Several candidates either rearranged their *C* equation incorrectly to give $x = 2$ or had difficulty finding the cube root of -8. Some weaker candidates did not substitute $y = 3$ into *C*, but substituted $y = 3$ into the $\frac{dy}{dx}$ expression to give a gradient of x^2.

Question 2

Q2 was generally well answered with many successful attempts seen in both parts. There were few very poor or non-attempts at this question.

In part (a), a significant minority of candidates tried to integrate $3(1+4x)^{\frac{1}{2}}$. Many candidates, however, correctly realised that they needed to integrate $3(1+4x)^{-\frac{1}{2}}$. The majority of these candidates were able to complete the integration correctly or at least achieve an integrated expression of the form $k(1+4x)^{\frac{1}{2}}$. Few candidates applied incorrect limits to their integrated expression. A noticeable number of candidates, however, incorrectly assumed a subtraction of zero when substituting for $x = 0$ and so lost the final two marks for this part. A minority of candidates attempted to integrate the expression in part (a) by using a substitution. Of these candidates, most were successful.

In part (b), the vast majority of candidates attempted to apply the formula $\pi\int y^2\,\mathrm{d}x$, but a few of them were not successful in simplifying y^2. The majority of candidates were able to integrate $\frac{9}{1+4x}$ to give $\frac{9}{4}\ln|1+4x|$. The most common error at this stage was for candidates to omit dividing by 4. Again, more candidates were successful in this part in substituting the limits correctly to arrive at the exact answer of $\frac{9}{4}\pi\ln 9$. Few candidates gave a decimal answer with no exact term seen and lost the final mark.

Question 3

Part (a) was tackled well by many candidates. The majority of candidates were able to write down the correct identity. The most popular strategy at this stage (and the best!) was for candidates to substitute $x = 1$ and $x = -\frac{2}{3}$ into their identity to find the values of the constants B and C. The substitution of $x = -\frac{2}{3}$ caused problems for a few candidates which led them to find an incorrect value for B. Many candidates demonstrated that constant A was zero by use of a further value of x or by comparing coefficients in their identity. A significant minority of candidates manipulated their original identity and then compared coefficients to produce three equations in order to solve them simultaneously.

In part (b), most candidates were able to rewrite their partial fractions with negative powers and apply the two binomial expansions correctly, usually leading to the correct answer. A significant minority of candidates found the process of manipulating $4(3x+2)^{-2}$ to $\left(1+\frac{3}{2}x\right)^{-2}$ challenging.

A significant number of candidates were unsure of what to do in part (c). Some candidates found the actual value only. Other candidates found the estimated value only. Of those who progressed further, the most common error was to find the difference between these values and then divide by their estimate rather than the actual value. Some candidates did not follow the instruction to give their final answer correct to 2 significant figures and thus lost the final accuracy mark.

Question 4

The majority of candidates identified the need for some form of dot product calculation in part (a). Taking the dot product $l_1 . l_2$, was common among candidates who did not correctly proceed, while others did not make any attempt at a calculation, being unable to identify the vectors required. A number of candidates attempted to equate l_1 and l_2 at this stage. The majority of candidates, however, were able to show that $q = -3$.

In part (b), the majority of candidates correctly equated the $\mathbf{i}$, $\mathbf{j}$ and $\mathbf{k}$ components of l_1 and l_2, and although some candidates made algebraic errors in solving the resulting simultaneous equations, most correctly found λ and μ. In almost all such cases the value of p and the point of intersection in part (c) was then correctly determined.

There was a failure by many candidates to see the link between part (d) and the other three parts of this question with the majority of them leaving this part blank. Those candidates who decided to draw a diagram usually increased their chance of success. Most candidates who were successful at this part applied a vector approach as detailed in the mark scheme. The easiest vector approach, adopted by a few candidates, is to realise that $\lambda = 1$ at *A*, $\lambda = 5$ at the point of intersection and so $\lambda = 9$ at *B*. So substitution of $\lambda = 9$ into l_1 yields the correct position vector $-7\mathbf{i} + 11\mathbf{j} - 19\mathbf{k}$. A few candidates, by deducing that the intersection point is the midpoint of *A* and *B* were able to write down $\frac{9+x}{2} = 1$, $\frac{3+y}{2} = 7$ and $\frac{13+z}{2} = -3$, in order to find the position vector of *B*.

Question 5

A considerable number of candidates did not attempt part (a), but of those who did, the most common method was to use similar triangles to obtain $r = \frac{2h}{3}$ and substitute *r* into $V = \frac{1}{3}\pi r^2 h$ to give $V = \frac{4}{27}\pi h^3$. Some candidates used trigonometry to find the semi-vertical angle of the cone and obtained $r = \frac{2h}{3}$ from this. A few candidates correctly used similar shapes to compare volumes by writing down the equation $\frac{V}{\frac{1}{3}\pi(16)^2 24} = \left(\frac{h}{24}\right)^3$.

Part (b) discriminated well between many candidates who were able to gain full marks with ease and some candidates who were able to gain just the first one or two marks. Some incorrectly differentiated $V = \frac{1}{3}\pi r^2 h$ to give $\frac{\mathrm{d}V}{\mathrm{d}h} = \frac{1}{3}\pi r^2$. Most of the successful candidates used the chain rule to find $\frac{\mathrm{d}h}{\mathrm{d}t}$ by applying $\frac{\mathrm{d}V}{\mathrm{d}t} \div \frac{\mathrm{d}V}{dh}$. The final answer $\frac{1}{8\pi}$ was sometimes carelessly written as $\frac{1}{8}\pi$. Occasionally, some candidates solved the differential equation $\frac{\mathrm{d}V}{\mathrm{d}t} = 8$ and equated their solution to $\frac{4\pi h^3}{27}$ and then found $\frac{\mathrm{d}t}{\mathrm{d}h}$ or differentiated implicitly to find $\frac{\mathrm{d}h}{\mathrm{d}t}$.

Question 6

In part (a), a surprisingly large number of candidates did not know how to integrate $\tan^2 x$. Examiners were confronted with some strange attempts involving either double angle formulae or logarithmic answers such as $\ln(\sec^2 x)$ or $\ln(\sec^4 x)$. Those candidates who realised that the needed the identity $\sec^2 x = 1 + \tan^2 x$ sometimes wrote it down incorrectly.

Part (b) was probably the best attempted of the three parts in the question. This was a tricky integration by parts question owing to the term of $\frac{1}{x^3}$, meaning that candidates had to be especially careful when using negative powers. Many candidates applied the integration by parts formula correctly and then went on to integrate an expression of the form $\frac{k}{x^3}$ to gain 3 out of the 4 marks available. A significant number of candidates failed to gain the final accuracy mark owing to sign errors or errors with the constants α and β in $\frac{\alpha}{x^2}\ln x + \frac{\beta}{x^2} + c$. A minority of candidates applied the by parts formula in the 'wrong direction' and incorrectly stated that $\frac{dv}{dx} = \ln x$ implied $v = \frac{1}{x}$.

In part (c), most candidates correctly differentiated the substitution to gain the first mark. A significant proportion of candidates found the substitution to obtain an integral in terms of u more demanding. Some candidates did not realise that e^{2x} and e^{3x} are $(e^x)^2$ and $(e^x)^3$ respectively and hence $u^2 - 1$, rather than $(u - 1)^2$ was a frequently encountered error seen in the numerator of the substituted expression. Fewer than half of the candidates simplified their substituted expression to arrive at the correct result of $\int \frac{(u-1)^2}{u}\, du$. Some candidates could not proceed further at this point but the majority of the candidates who achieved this result were able to multiply out the numerator, divide by u, integrate and substitute back for u. At this point some candidates struggled to achieve the expression required. The most common misconception was that the constant of integration was a fixed constant to be determined, and so many candidates concluded that $k = -\frac{3}{2}$. Many candidates did not realise that $-\frac{3}{2}$ when added to c combined to make another arbitrary constant k.

Question 7

Part (a) was answered correctly by almost all candidates. In part (b), many candidates correctly applied the method of finding a tangent by using parametric differentiation to give the answer in the correct form. Few candidates tried to eliminate t to find a Cartesian equation for C, but these candidates were usually not able to find the correct gradient at A.

In part (c), fully correct solutions were much less frequently seen. A significant number of candidates were able to obtain an equation in one variable to score the first method mark, but were then unsure about how to proceed. Successful candidates mostly formed an equation in t, used the fact that $t + 1$ was a factor and applied the factor theorem in order for them to find t at the point B. They then substituted this t into the parametric equations to find the coordinates of B. Those candidates who initially formed an equation in y only went no further. A common misconception in part (c), was for candidates to believe that the gradient at the point B would be the same as the gradient at the point A and a significant minority of candidates attempted to solve $\frac{2t}{3t^2 - 8} = \frac{2}{5}$ to find t at the point B.

Further Mathematics Unit FP1 (legacy)
Specification 6674

Introduction

Although there were parts of questions in this paper that were taxing for many candidates, particularly Q4(a), Q5(d) and (e), Q6(a), (c) and especially (e), Q7(a) and Q8(a), most candidates could gain some credit in all questions.

It is always a pleasure to see good succinct solutions but, particularly in questions where a given answer has to be derived, candidates should be aware that marks will be lost unless sufficient working is shown

Long methods, or repeated attempts, in Q2, Q5(d), Q6(e) and Q8(a) and (b), may have prevented candidates from completing the paper, but generally lack of time did not seem to be a factor.

Report on individual questions

Question 1

This proved a good opening question for the majority of candidates. Most knew the results for the three separate sums involved in part (a), although $\sum_{r=1}^{n} 1$ was sometimes taken as 1, and the wrong constants in the other two sums were occasionally seen. The subsequent simplification required was usually good, but some candidates lost the final mark because of lack of sufficient working. In part (b), the correct strategy and answer were usually seen, although some candidates lost the marks by using $\sum_{r=1}^{20} \mathrm{f}(r) - \sum_{r=1}^{10} \mathrm{f}(r)$.

Question 2

Almost all candidates knew that complex roots occur in conjugate pairs and so gained the first mark. Errors in multiplying out $\{x-(3+\mathrm{i})\}\{x-(3-\mathrm{i})\}$ were seen, which caused problems in finding the other factor(s), but generally this was well done; those who did produce $x^2 - 6x + 10$ often went on to obtain the correct quadratic factor $2x^2 - 2x + 1$. There was a surprising number of candidates who, having reached $x = \frac{2 \pm \sqrt{-4}}{4}$ did not obtain the result $\frac{1 \pm \mathrm{i}}{2}$. Candidates who used the longer methods outlined in the mark scheme usually ran into difficulty, but some completely correct solutions were seen.

Question 3

Although there were many well presented, completely correct solutions, often solutions lacked a sound method and/or contained errors in the manipulation, which often changed the nature of the question. Candidates who multiplied both sides of the inequality by (x – 3) invariably assumed ($x-$ 3) positive and did not discuss the case $x < 3$, so finding only $x^2(x+1)>0$. Many candidates who started by considering $\frac{x^3+5x-12-4(x-3)}{x-3}>0$ often made "slips", which usually resulted in 4 critical values. The mark scheme was fairly generous, in trying to give credit, but it was often a taxing exercise. When graphs were used to help find the solution set of values of x, it was not always clear how relevant they were, particularly given the errors outlined above.

Question 4

Generally only the good candidates gave an acceptable answer to part (a).

Most candidates could apply the Newton-Raphson process in part (b), although differentiation of $\sin(x^2)$ caused problems. However, some candidates showed very little, or no working, which is a dangerous strategy; it is very difficult to give credit then, if answers are wrong.

The vast majority of candidates knew what was required to give a good solution in part (c).

Question 5

This was a good source of marks for many candidates, with the first 4 marks being gained by the majority. Part (a) was very well answered; it was rare to see a wrong answer, but some candidates lost a mark in (b) for not sufficiently identifying the points. There were many appropriate methods for answering part (c), and usually candidates gained at least the method mark but when using arctan(2/3) + arctan(3/2) the accuracy mark was frequently lost for giving a decimal answer and then stating that it was equal to ½π.

Candidates who recognised the significance of part (c), that PQ was therefore a diameter of the circle, usually gave concise answers to parts (d) and (e). However, many candidates set up equations in (a,b), the coordinates of the centre of the circle, and solved the resulting equations. This was not only a time penalty but also often contained arithmetic errors and so accuracy marks were lost.

Question 6

Many candidates were unable to find a cartesian equation for C_1, which may explain why in part (e) it was rare to see more than 1 mark gained; few candidates seemed to recognise that $r=6\sin\theta$ represents a circle and so the correct cartesian equation might have helped. Part (b) was usually correct and generally candidates knew what was required in part (c) even if the differentiation was not always correct; a minority of candidates solved $\frac{\mathrm{d}r}{\mathrm{d}\theta}=0$, and some candidates gave rather lengthy solutions. In part (e), thinking was usually confused. It was common to see the correct answer to (d), $r=6\sqrt{6}$, substituted in the equation for C_1, resulting in the statement $\sin\theta=\sqrt{6}$, or to find that for each curve the common tangent parallel to the initial line occurred where $\theta =$ ½π, despite part (c) saying otherwise for C_2.

Question 7

Those candidates with a good understanding of this topic were not phased by part (a), and there were many full marks scored for this question. However, those who did not realise that differentiation of a product was required in (a) were likely to score less than half marks overall. Part (b) was straightforward and marks were gained by the vast majority of candidates, slips in the roots of the auxiliary equation being the most likely loss of a mark.
In part (c) some marks were usually gained.

Question 8

Good candidates were able to score very well in this question but generally marks were variable, with weaker candidates often only able to gain marks in part (d) and possibly one or two marks in part (b). In part (a) the ability to differentiate y, a function of t, with respect to x was a challenge for many, with a significant minority of those who knew that they needed $\frac{\mathrm{d}y}{\mathrm{d}x}.\frac{\mathrm{d}x}{\mathrm{d}t}$ producing $(\ln t)\frac{\mathrm{d}x}{\mathrm{d}t}$.
In part (b) the most common error was to take the integrating factor as $\mathrm{e}^{\int \cot x \mathrm{d}x}$, but those who continued with this as sin$x$ were able to gain 3 of the 5 marks. Candidates who had been successful in the first two parts usually went on to gain the marks in part (c) but some candidates arrived at a correct solution, after completely wrong working, presumably by working back from the given answer to (c). Part (d) was independent of previous work and provided a few easy marks for many candidates, although it was not uncommon to see arithmetic slips and more serious algebraic slips such as assuming that $\frac{1}{a+b} = \frac{1}{a} + \frac{1}{b}$.

Further Mathematics FP1 (new)
Specification 6667

Introduction

This was a very accessible paper with all candidates able to respond to all questions and a high proportion of fully correct solutions were seen. The ones which discriminated were the two 'Proof by Induction' questions , Q4, Q6, Q9(d) and Q9(e), Q10(a) and Q8. Presentation was very good with little crossed out work and candidates' work very legible. There was no evidence of candidates being short of time.

Report on individual questions

Question 1

The first three marks were almost always gained. The majority went on to obtain two further roots either by use of the formula or, less often but equally successfully, completing the square. The formula was usually correctly applied for M1, but a few candidates made errors in simplifying. A common error among these candidates was to forget to square root of 4. Some candidates did not progress beyond the quadratic.

Question 2

Most candidates gained the first three marks for use of the summation formula. The anticipated error of -1 rather than –n for the final term was rarely seen. The best way to proceed was to cancel the numerical parts expand and factorise to obtain $n(n^2 +5n +2)$ and then factorise to the given answer. Some candidates made the question more difficult by keeping fractions, but most were successful in obtaining the required expression. Part (b) was accessible to all and was usually correct. Occasionally $S_{20} - S_{11}$ was seen and a few candidates substituted 20 and 10 into the $6r^2 + 4r - 1$.

Question 3

This question was usually awarded full marks. The one error was to use the wrong formula for mid-point by subtracting the coordinates rather than adding.

Question 4

The method of proof by induction seemed well known, but candidates did not always structure their solutions or use words to communicate their answers fully and so the B marks were not always gained. Just about everyone showed the result for n=1 and the majority gained the next three marks for generating the result for (k+l) from the result for k. There were some excellent solutions showing all the necessary steps in a logical order but there were also some rather confused solutions, which mixed k's and n's .

Question 5

This was another very accessible question with many candidates gaining full marks. In part (a) most solutions stated the conclusion about change of sign implying a root. In part (b) there were few errors in finding $f'(x)$ but occasionally the second term power was incorrect or the constant term of 20 was left at the end of the answer. In part (c) there were a few candidates who did not give the answer to the required accuracy. Many candidates showed no values of f(1.1) and $f'(1.1)$ in their working and a small number applied Newton-Raphson twice.

Question 6

Candidates found this induction question more tricky than Question 4 because they became confused over showing the result for n=1 and tended to start with n=2. For some this meant that they felt the need to show that the result for k+2 followed from the results for k **and** k+1. The notation also caused some candidates difficulty using both suffices and powers.

Question 7

In part (a) the method of finding the inverse of a 2x2 matrix was well known but sign errors caused some candidates to lose accuracy. Only a few candidates actually showed how they found the determinant, so that if they went wrong they lost a method mark. A common error seen was $-(2 + a)$. In part (b) the correct Identity matrix was almost always seen. There was a significant number of candidates who did not add the matrices correctly.

Question 8

In part (a) the most successful candidates used parametric or implicit differentiation to find the derivative. Those who started from $y = \sqrt{4ax}$ sometimes made errors with powers of ½. The equation of the line was seen in both the forms $(y-y_1) = m(x-x_1)$ and $y = mx + c$ and both methods were equally successful in obtaining the given answer. Part (b) was done very well but occasionally candidates found the equation of a general normal not the one through R which prevented them from completing part (c) and part (d). Those who did not complete part (a) used the given answer to obtain the gradient and intercept and thus gain marks in part (b). For those who had answered part (b) correctly, the remaining three marks in part (c) and part (d) were usually gained.

Question 9

In part (a) the majority of candidates knew about multiplying by the conjugate and very few failed to complete the arithmetic accurately to obtain 2-3i. In part (b) the quality of the diagrams varied a great deal. Some were carefully done using rulers and were easy to read. Others were little more than rough sketches, although using coordinates or a scale meant that the positions of both P and Q were usually clear. A variety of methods were seen in part (c). The most popular was to use arctan and decimals. A few tried the alternative of gradients and were successful as were those who attempted the converse of Pythagoras' theorem. A minority of candidates took a geometric approach based on similar triangles with mixed success. A significant number of candidates did not seem to know the 'angle in a semicircle' result in part (d) to enable them to deduce that PQ was a diameter which made finding the centre and radius relatively easy. Some let C be (a,b) and formed two quadratic simultaneous equations by equating OC, PC and QC. Not all were able to complete accurately. Another method was to find the equations of the perpendicular bisectors of OP and OQ and find their point of intersection. Again some were successful but many floundered in the algebra. A significant number of candidates did not attempt part (d) or part (e).

Question 10

Part (a) was the most challenging part of this final question for many. Those who had a method of looking at images of base vectors were usually successful but in general no method was seen leaving just a description. Part (b) and part (c) were rarely incorrect. There were some numerical errors in part (d) but most were successful although they did not always write the answer as coordinates. A few tried to post multiply by *E* and gained M0. In part (e) the common error here was to use 51 rather than 75 leading to an area of 2295 for ΔOR'S' and a final answer of 127.5 for ΔORS.

Mechanics Unit M1
Specification 6677

Introduction

The paper seemed to be of a suitable length for the vast majority but proved to be much more demanding than in previous years. In many cases candidates seemed to have great problems applying mechanics principles in slightly different scenarios, showing a lack of real understanding. Many candidates do not realise that a magnitude must be a positive number and many do not understand the difference between speed and velocity. The questions which proved to be the most demanding were Q6(b), Q7(b) and Q7(c). The best source of marks was Q4 followed by Q5. Overall, candidates who used large and clearly labelled diagrams and who employed clear and concise methods were the most successful.

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

Most candidates realised that they needed to apply $\mathbf{v} = \mathbf{u} + \mathbf{a}\,t$ and many arrived at $12\mathbf{i} - 16\mathbf{j}$ but then failed to go on and find the speed, losing the final two marks. This showed a lack of understanding of the relationship between speed and velocity. A small minority found magnitudes at the start and then tried to use $v = u + at$, gaining no marks. Some candidates lost the third mark because of errors in the manipulation of negative numbers.

Question 2

Only a relatively small number of candidates had a correct graph in part (a). There was a whole variety of incorrect attempts seen. Many of the graphs were curved and in some cases the path that the ball would take in the air was drawn. Of those who had a straight line many were reluctant to go below the t-axis into negative velocities and drew a speed-time graph instead. Part (b) was more successfully answered but a common error was to use a wrong time value. Students generally used constant acceleration formulae rather than the area under their graph.

Question 3

Almost all candidates attempted to use a conservation of momentum equation in part (a) but there were many who either did not draw a diagram at all or else drew one which did not show the directions of motion of each particle after the collision. This lead to problems in all three parts of the question. Few realised the significance of the question asking for the *speed* of B, and gave a negative answer $u(4 - 3k)$. There were also sign errors in the momentum equation and general problems dealing with the algebra. The second part required the significance of the range of values of k to be explicitly referred to in the identification of direction and there were a number of fully correct and often well-expressed solutions. However, many did not mention k at all and scored little. In part (c), many knew the relevant impulse-momentum equation and attempted to apply it to one of the particles but there was often confusion over direction and substitution of values and some gave a negative answer, losing the final mark.

Question 4

Part (a) was well answered with the majority of candidates realising that they had to take moments. A common and costly error was to omit the distance when taking the moment of one or both of the reaction forces. Some candidates took moments twice, usually about Q then about R but these tended to be less successful than those who took moments and resolved vertically. A few students missed off g's from their weight terms. In the second part, again the most productive method was to resolve vertically and use one moments equation. Those who opted to take moments twice had more algebraic manipulation to contend with, which at times was a problem. Poor diagrams often resulted in finding and using wrong distances.

Question 5

Part (a) was usually correct with the majority of candidates producing a correct diagram. A significant minority had the friction force acting down the plane. In the second part by far the most popular approach was to resolve parallel and perpendicular to the plane, producing two simultaneous equations in P and R. There were many who went on to solve these correctly, but a common error was to find R in terms of P, use this to find a value for P, but then forget to go back and use it to find the value for R. A few of the more able students appreciated the idea of resolving perpendicular to an unknown force, and resolved vertically to find R, without the need to solve simultaneous equations.

Question 6

Many were able, in the first part, to use tan to find an acute angle, scoring two of the three marks, but were then unable to identify and find the required angle. In part (b), the first mark was for adding the two vectors together but many students then stated that this sum was equal to $(\mathbf{i} - 2\mathbf{j})$ rather than a multiple of it and were unable to make any progress. In the final part, many who failed in (b), obtained $p = -2$ from the printed equation and, even if their $\mathbf{R}$ was wrong, were able to benefit from follow-through marks. It was amazing to see so many arrive correctly at $\sqrt{20} = m8\sqrt{5}$ then correctly write $m = 2\sqrt{5} / 8\sqrt{5}$ but then give $m = 5/4$!

Question 7

In part (a), most candidates were able to set up the two equations of motion, one for each of the two particles and most then went on to solve these correctly to find values for both T and a. A few persist in trying to use a "whole system" equation to find a, usually with limited success. In the second part the vast majority of candidates were unable to select the correct particle, forces or equation to score any of the marks. Part (c) also proved to be discriminating, with some weaker candidates not attempting it. Only a minority of candidates managed to produce a correct solution. Of those who did, many used the cosine rule applied to a vector triangle, or a resolution into two perpendicular components. Common misconceptions involved using just T + Tsin/cos alpha or answers involving components of 5g and 15g. Many had difficulty in identifying the correct size for the angle whichever method was attempted. A few very good candidates realised that the force acted along the angle bisector and scored five quick marks.

Mechanics Unit M2
Specification 6678

Introduction

The work seen was often of a very high standard, with candidates approaching each question with confidence. The best responses were clearly and concisely set out, supported by carefully annotated diagrams. Very few blank responses were seen, suggesting that the majority of candidates had studied the entire specification, and that they had sufficient time to offer responses to all questions.

However, accuracy was still an issue: where an approximate value for g is used, answers cannot be given to more than 3 significant figures. Some students did not read questions carefully and failed to give answers to the accuracy required. It was also disappointing to find several examples of poor algebraic manipulation and arithmetic, for example, many losing final A marks by dividing instead of multiplying, or making a sign error in the course of their working.

Candidates need to be reminded that where an answer is given they must show sufficient working and steps to reach the given answer. Similarly, candidates who use calculators to solve equations and show no evidence of correct method risk losing several marks if they make an error in entering data or in writing down their answer.

Report on individual questions

Question 1

This question was tackled confidently and successfully by the majority of candidates. The solution was often broken down into several small steps and only put together using Newton's second law right at the end. Sign errors were rare and resolving errors even more so. A few candidates muddled the driving force with the resultant force, or ignored the 650 N, and hence scored few marks. There were also some candidates confused about g, omitting it in the weight term and/or including it in the mass term

Question 2

This question was answered well, with few instances this time of the reaction at the ground or at the wall being in the wrong direction.

In (a) candidates had little problem finding the frictional force acting but then the majority gave the answer to 4 significant figures, losing the final mark.

Most candidates then went on to take moments about A or B. Errors at this stage were usually due to terms being dimensionally incorrect – often leaving out the distance in one or more terms of the moments equation. Virtually all candidates went on to find a value for β, but this was not always expressed to the required degree of accuracy.

Most candidates demonstrated some understanding of what it meant to model Reece as a particle, but few were sufficiently precise in their responses. Many mentioned mass acting at a point rather than weight and few were specific about where the weight was assumed to act.

Question 3

Few candidates had problems finding the frictional force in part (a), but once again many candidates were insecure about finding work done. Many candidates found the net work done by the horizontal force and against friction, rather than simply the work done against friction.

As usual the most popular approach in part (b) was to find the acceleration of the block and then the velocity after 50 m using $v^2=u^2+2as$. A significant proportion of candidates who attempted to use the work-energy principle missed one or more terms. However, many of those candidates who misinterpreted part (a) were able to use their nett work done successfully to find v using this method.

Question 4

A few candidates were clearly confused by velocity being defined in terms of two separate functions. Nevertheless, virtually all candidates knew they had to integrate the relevant expression for velocity in order to find the displacement and they did this correctly in part (a). As the constant was zero in this part of the question, candidates who had overlooked it were not penalised. There were occasional mistakes such as differentiating instead of integrating, and some candidates who tried to use the equations for constant acceleration.

In part (b), although most correctly integrated the expression, for those that went along the indefinite integral route, the constant of integration was often just assumed to be zero because the displacement was zero at the start. Several candidates even demonstrated that the constant of integration was zero, apparently having no problem with equating 432/0 to zero! These candidates clearly did not realise that the expression was not relevant at the start. Those who found the definite integral were generally more successful. Other errors in part (b) included using t = 4, using t = 7 as a lower limit for the second integral (apparently not recognising the continuous nature of time), or reaching the correct solution but then adding the answer from (a) a second time.

Question 5

The majority of candidates applied the correct mechanical principles to solve this problem. Most were able to find the relative masses and the centres of mass of the semi-circle and the triangle and obtain a correct moments equation. Many candidates did not show sufficient working to demonstrate that their equation led to the given result in part (a).

In part (b) the most common error was to fail to realise that the two centres of mass were on opposite sides of the line BD and they hence had a sign error in their expression. Those who decided to take moments about a line through A, perpendicular to AD avoided this problem.

Candidates were generally able to use the given result to find the centre of mass of the semi-circle, although it was quite common to see it written incorrectly as 8π.

A clear diagram tended to lead candidates to identify the correct angle in part (c) and the correct method for finding it.

Question 6

Many candidates scored well in this question, with parts (a) to (d) generally answered correctly. However, a few candidates were confused right at the start with the vector form of the initial velocity and tried to bring resolution into the problem and so failed to find p and q.

Some candidates were initially confused about the direction of p and q – it was common to see attempts at parts (a) and (b) relabelled when a candidate discovered their error. In (b) there was often insufficient evidence that the given answer had been reached correctly – essential steps in the working were omitted. Some candidates used long drawn out trigonometric methods to find $\tan \alpha$ in part (d), often finding $\cos\alpha$ and $\sin \alpha$ before finally reaching $\frac{3}{4}$.

In part (e) most candidates used $s = ut + \frac{1}{2}at^2$ from the point of projection but there were a number of other possible methods which were also successful. It was evident that some candidates are relying on the use of calculators to solve quadratic equations. When the initial quadratic equation was incorrect, marks were often lost as a result of failing to show sufficient evidence of use of an appropriate method. It was common to see 4 used in place of 3.1 in the initial equation. Candidates using alternative approaches often got lost in the complexities of the logic of what they were trying to do.

The responses in part (f) showed that virtually all candidates could find (at least) one physical factor which could also be taken into account although a few miss-worded their answers to imply the opposite. For example, many suggested “air resistance”, but it was also common to see “no air resistance”.

Question 7

Candidates made a confident start to this question, but in parts (a) and (b), poor algebraic skills and the lack of a clear diagram with the directions marked on it hampered weaker candidates’ attempts to set up correct and consistent (or even physically possible) equations. The direction of P after impact was not given and those candidates who took its direction as reversed ran into problems when finding the value of e. Many realised that they had chosen the wrong direction and went on to answer part (b) correctly but some did not give an adequate explanation for a change of sign for their velocity of P. Algebraic and sign errors were common, and not helped by candidates’ determination to reach the given answers.

Parts (c) and (d) caused the most problems. They could be answered using a wide variety of methods, some more formal than others. Many good solutions were seen but unclear reasoning and methods marred several attempts. Too many solutions were sloppy, with u or d appearing and disappearing through the working. A few words describing what was being calculated or expressed at each stage would have helped the clarity of solutions greatly. Students need to be reminded yet again that all necessary steps need to be shown when reaching a given answer. Too many simply stated the answer $\frac{3d}{5}$ without the explanation to support it.

Mechanics Unit M3
Specification 6679

Introduction

Candidates produced much good work on this paper but some still feel that they should answer questions by quoting results. Mechanics questions should be read carefully as a slight misinterpretation of the situation described can lead to disastrous results. This was most apparent in Q5 and to a lesser extent in Q4 and Q7.

The number of complete attempts seen for Q7(b) suggested that candidates had sufficient time to complete all the work they were able to do.

Report on individual questions

Question 1

This was a straightforward opening question. As the positive direction was not defined by the question, a final answer of +16 or –16 was acceptable, provided the working shown supported the answer given. There were a few cases of $v\frac{\mathrm{d}v}{\mathrm{d}x}$ or even $v\frac{\mathrm{d}v}{\mathrm{d}t}$ being used for the acceleration; this rarely prevented candidates from integrating the other side of their equation with respect to t. A few candidates omitted the mass from their equation and there was a scattering of errors in integration and algebra when obtaining the constant.

Question 2

Most candidates resolved horizontally and vertically in (a) and then found the tangent of their angle between the string and the horizontal or vertical before proceeding to obtain the tension. It was not uncommon to see solutions which started with the Pythagoras equation in line 3 of the mark scheme. This is a risky approach as errors in this equation cause many marks to be lost if the equation is not derived from the resolving equations. Hooke's law and the formula for elastic potential energy were well known and frequently applied correctly in (b) to reach a correct answer. However, omission of some or all of the letters m, g and a in the final answer was fairly common.

Question 3

Candidates seemed to have great difficulty changing from revolutions per minute to radians per second. This seemed to be wrong at least as often as it was correct. A surprising number of solutions involved inequalities, not always the correct way round. Unfortunately, some gave their final answer as an inequality and so failed to answer the question as set. Many did not notice that the distance was given in centimetres and so used 8 instead of 0.08 in their calculation. Those who knew how to tackle this question produced succinct solutions.

Question 4

The methods and S.H.M. formulae were well known and many completely correct solutions were seen. However, it was disappointing to see how many candidates could not cope with the time aspect of this question; 12 hr 30 min is not 12.3 hr. Even those who converted correctly at the start sometimes forgot to reverse the process at the end, giving their final answer as 12.36.

Some candidates preferred to work with seconds, but on the whole they remembered to change their final answers appropriately. x was not always measured from the centre of the oscillation, resulting in the use of $x = 5$ rather than $x = 3$ in both parts of this question. In (b), $x = -3$ was seen quite often, almost certainly because the point in question was below the centre of the oscillation. The symmetry of S.H.M. would allow a correct result to be deduced from this and also from use of $x = \sin \omega t$, but the appropriate deduction was rarely seen.

Question 5

Many candidates used unduly complicated methods for both parts of this question. Some tried to use S.H.M. but very few attempted to establish the motion as being S.H.M. before quoting and using the standard formulae. In part (a) there was confusion between equilibrium and rest positions. Some candidates used Hooke's law and resolved parallel to the plane, finding the equilibrium extension and claimed that the particle was at rest at this point. They then proceeded to use the same extension (now correctly) in (b) to obtain the greatest speed. Energy methods often had a missing term or a gravitational potential energy term which was inconsistent with the positions involved. Alternative methods using Newton's second law and calculus were reasonably popular but many were incomplete.

Question 6

Part (a) was a standard solution quoted correctly using two integrals. The majority could handle the pure maths successfully. This part could be worked correctly without including π in either integral as it clearly cancels. However, this led some candidates to omit π when calculating the mass/volume of *S* in (b). Many candidates seemed to not know what approach to take in (b) and so made no attempt at all. Of those who attempted this part, most took moments about the join but every possible mistake concerning volumes and distances was seen. Some took moments about the centre of the plane face of the cylinder, not always remembering to recalculate the lengths involved or use the volume of the total solid.

Question 7

Vertical circle questions usually present problems for many candidates and this one was no exception. Not all seem to be aware that an energy equation and an equation of motion along a radius (in this case at *C*) should be sufficient to make a sound start on the question. There were incorrect signs in the energy equation which were then adjusted later to arrive at the given result. Similarly, incorrect trigonometric functions became correct ones. Part (b) was attempted by most of those who had achieved success with (a) but the projectile motion defeated many. Some could not relate θ correctly to the horizontal and vertical components of the velocity at *C*. A variety of methods were seen in (b). Some used the separate components, finding the components at *P* and finishing off with the tangent of the required angle. Others used an energy approach, working from either *A* or *C* to obtain the final velocity at *P* and finished off with the horizontal component and the cosine. Some made extra work for themselves by finding the final velocity and the final vertical component, finishing off with the sine of the required angle. The usual mistakes such as using $v^2 = u^2 - 2as$ when energy was required occurred.

Statistics Unit S1
Specification 6683

Introduction

This proved to be a fair paper that was accessible to nearly all candidates but offered scope for the stronger ones to excel. Many of the basic calculations (Q1, Q3 and Q4) were answered well but the interpretation of the calculated statistics proved difficult for some (Q1(c) and Q1(e), Q4(f) and Q5(e)). The more complex calculations, where formulae are not given, such as standard deviation and the use of interpolation are still proving a stumbling block for some candidates. The interpretation of probability statements (Q2) caused difficulties for many and the use of the notation for the normal distribution (Q6) continues to cause problems.

Report on individual questions

Question 1

This proved to be a straightforward starter for most candidates who were able to tackle part (a) confidently, usually scoring full marks. Part (b) was answered well too; the correct formulae were selected and answers were usually given to 3 sf or better. Some candidates lost the final mark here for failing to give the full equation. Part (c) though was not answered well. There were plenty of comments about the gradient being positive or there being positive correlation or even skewness. Few realised that the instruction to "interpret" wanted an answer in context and comments conveying the idea that every extra hour spent on the programme yields an extra 9.5 marks were rare. Part (d) was straightforward again but some did not use their regression equation to find the estimate but rather tried to interpolate between the values of 3 and 3.5 given in the table. Part (e) had a mixed response. Many good candidates rejected Lee's comment on the basis that 8 hours was outside the range of the data and they secured the mark. Other, less successful, candidates simply calculated the value and then agreed with Lee or they rejected his claim on some other basis such as the difficulty of revising for 8 hours or 60 marks might take him above the total score on the paper.

Question 2

This question was not answered well. It was encouraging to see many attempting to use a diagram to help them but there were often some false assumptions made and only the better candidates sailed through this question to score full marks.

The first problem was the interpretation of the probabilities given in the question. Many thought $\frac{9}{25} = \mathrm{P}(E \cap B)$ rather than $\mathrm{P}(E \mid B)$. All possible combinations of products of two of $\frac{2}{3}, \frac{2}{5}$ and $\frac{9}{25}$ were offered for part (a) but $\frac{9}{25} = \mathrm{P}(E \cap B)$ was the most common incorrect answer. In part (b) a variety of strategies were employed. Probably the most successful involved the use of a Venn diagram which, once part (a) had been answered could easily be constructed. Others tried using a tree diagram but there were invariably false assumptions made about $\mathrm{P}(E \mid B')$ with many thinking it was equal to $1 - \frac{9}{25}$. A few candidates assumed independence in parts (a) or (b) and did not trouble the scorers. The usual approach in part (c) involved comparing their answer from part (a) with the product of P(E) and P(B) although a few did use P(E|B) and P(E). Despite the question stressing that we were looking for statistical independence here, many candidates wrote about healthy living and exercise!

The large number of candidates who confused $\mathrm{P}(E \cap B)$ and $\mathrm{P}(E \mid B)$ suggests that this is an area where students would benefit from more practice.

Question 3

Part (a) was answered well although a small minority of candidates insisted on dividing by n (where n was usually 4). Part (b), on the other hand, caused great confusion. Some interpreted F(1.5) as E(1.5X) , others interpolated between P(X =1) and P(X = 2) and a few thought that F(1.5) was zero since X has a discrete distribution. Although the majority of candidates gained full marks in part (c) the use of notation was often poor. Statements such as Var(X) = 2 = 2-1 = 1 were rife and some wrote Var(X) or $\sum X^2$ when they meant $\mathrm{E}(X^2)$. Many candidates can now deal with the algebra of Var(X) but there were the usual errors such as 5Var(X) or 25Var(X) or -3Var(X) and the common -3^2 Var(X) which was condoned if the correct answer followed.

Part (e) was not answered well and some candidates did not attempt it. Those who did appreciate what was required often missed one or more of the possible cases or incorrectly repeated a case such as (2, 2). There were many fully correct responses though often aided by a simple table to identify the 6 cases required.

Question 4

This question was usually answered well. In part (b) some did not realise that they needed to check the lower limit as well in order to be sure that 110 was the only outlier. Part (c) was answered very well although some lost the last mark because there was no gap between the end of their whisker and the outlier. Part (d) was answered very well and most gave the correct values for $\sum y$ and $\sum y^2$ in the appropriate formula. A few tried to use the $\sum\left(y-\bar{y}\right)^2$ approach but this requires all 10 terms to be seen for a complete "show that" and this was rare.

Part (e) was answered well although some gave the answer as -5.7 having forgotten the 10^{-3}, or failed to interpret their calculator correctly. Many candidates gave comments about the correlation being small or negative in part (f) but they did not give a clear reason for rejecting the parent's belief. Once again the interpretation of a calculated statistic caused difficulties.

Question 5

Part (a) was not answered well. Many candidates attempted to calculate frequency densities but they often forgot to deal with the scale factor and the widths of the classes were frequently incorrect. There are a variety of different routes to a successful answer here but few candidates gave any explanation to accompany their working and it was therefore difficult for the examiners to give them much credit. The linear interpolation in part (b) was tackled with more success but a number missed the request for the Inter Quartile Range. Whilst the examiners did allow the use of (n + 1) here, candidates should remember that the data is being treated as continuous and it is therefore not appropriate to "round" up or down their point on the cumulative frequency axis. Although the mean was often found correctly the usual problems arose in part (c) with the standard deviation. Apart from those who rounded prematurely, some forgot the square root and others used $\sum f^2x$ or $\left(\sum fx\right)^2$ or $\dfrac{\sum fx^2}{\sum fx}$ instead of the correct first term in their expression and there was the usual crop of candidates who used $n = 6$ instead of 104. The majority were able to propose and utilise a correct test for the skewness in part (d) with most preferring the quartiles rather than the mean and median. Few scored both marks in part (e) as, even if they chose the median, they missed mentioning the Inter Quartile Range. A number of candidates gave the mean and standard deviation without considering the implications of their previous result.

Question 6

Most candidates tried this question and the standardisation in part (a) was usually correct but a small minority used 25 as the standard deviation. The majority found $P(Z < 1.8)$ correctly but some gave the answer as 1 - 0.9641 and lost the second mark.

A clear diagram should have helped candidates with the next two parts for many gave answers to d and e where $d > e$. In part (b) many started correctly by calculating 1 - 0.1151 and using the tables to find $z = \pm 1.2$. However only the more alert chose the minus sign and they usually went on to score full marks in both parts (b) and (c). There were good arguments using the symmetry of the normal distribution in both parts (c) and (d). Some candidates who made little progress with (b) or (c) were able to draw a simple diagram in (d) and obtain the correct answer from $1-2\times0.1151$.

Statistics Unit S2
Specification 6684

Introduction

Candidates would appear to have had adequate time to do this paper. There were few questions where no attempt had been made to produce an answer.

The level of work was mixed. There were still a number of candidates who had little idea about significance testing but the choice of distribution was better than in previous years.

The standard of presentation was generally good though.

Report on individual questions

Question 1

This question proved to be a good start to the paper for a majority of the candidates. There were many responses seen which earned full marks.

The most common errors in parts (a) and (b) concerned the routine manipulation of inequalities. In part (a) $1-\mathrm{P}(X \leq 1)$ was often seen and in (b), while most candidates agreed that $\mathrm{P}(5 \leq X \leq 6)$ was the required probability, with many then choosing the standard technique of $\mathrm{P}(X \leq 6)-\mathrm{P}(X \leq 4)$, there were candidates who proceeded with a variety of methods. Incorrect expressions such as $\mathrm{P}(X \leq 6)-\mathrm{P}(X \geq 4)$ were seen not infrequently. A correct but inefficient method which was commonly used included: $\mathrm{P}(X=5)+\mathrm{P}(X=6)=\big(\mathrm{P}(X \leq 6)-\mathrm{P}(X \leq 5)\big)+\big(\mathrm{P}(X \leq 5)-\mathrm{P}(X \leq 4)\big)$

Part (c) was poorly answered. There were a significant minority of candidates who obtained a 'correct' answer for the mean in part (c), but who nevertheless lost the mark because their answer was not written, as instructed, correct to 2 decimal places. Many candidates were unable to calculate the variance. There were a variety of incorrect formulae used.

The general response to (d) was good, although many candidates simply gave the response that is appropriate for a more frequent type of question on the Poisson distribution requiring comment: ("singly/independently/randomly/constant rate").

Part (e) was particularly well done. Even the minority who struggled, or even omitted, some of the earlier parts of the question were able to gain both marks in part (e).

Question 2

The majority of candidates were able to correctly answer parts (a) and (b) although a minority were able to draw the p.d.f correctly in part (b) but were unable to do part (a). The most common variation was $\mathrm{f}(x)=\frac{1}{9}x$. A few candidates also used this incorrect version in part (c) (alternative version) and in (d). However, most of the candidates who started this question with an incorrect p.d.f. then went on to use the correct p.d.f. from (b) onwards, with no evidence of cognitive dissonance.

In part (c) the candidates who chose to go down the integration route were usually successful. Those who attempted to use the formulae were not particularly successful for a variety of reasons. There were errors in finding $\mathrm{E}(X)$ and or $\mathrm{Var}(X)$ or problems with the formula (incorrect rearrangement, failure to square). A variety of incorrect expressions were often seen in particular $\mathrm{E}(X^2) = (\mathrm{E}(X))^2$ and $\mathrm{E}(X^2) = \mathrm{Var}(X)$

Part (d) was accessible to a very large majority of candidates. Many of the candidates who had problems in the previous parts of the question were able to regain their composure and obtain both marks.

Question 3

Part (a) of this question was poorly done. Candidates would appear unfamiliar with the standard mathematical notation for a Critical Region. Thus $11 \le X \le 2$ made its usual appearances, along with $c_1 = 2$ and $\mathrm{P}(X \le 2)$.
In part (b) candidates knew what was expected of them although many with incorrect critical regions were happy to give a probability greater than 1 for the critical region.

Part (c) was well answered. A few candidates did contradict themselves by saying it was "significant" and "there is no evidence to reject H_0" so losing the first mark.

Question 4

Part (a), with its 'answer given', produced fewer problems than similar questions in previous papers. Most candidates were able to obtain the required value of *k*.

Part (b) was generally well done. There were a wide variety of methods used such as finding the area of a trapezium, others found the area of the triangle and subtracted from 1. Others obtained F(*x*). The most common fault was the use of incorrect limits, 7 was often seen as the lower limit.

Part (c) was a good source of marks for a majority of candidates. A few lost marks as a result of not writing their answers as an exact number. However, many provided answers as both exact fractions and as approximated decimals. The most common error was to find $\mathrm{E}(T^2)$, call it $\mathrm{Var}(T)$ and then stop.

Part (d) was not popular. Of those who attempted it, there were some long-winded methods involving calculus and ultimately incorrect answers. The most successful candidates did a quick sketch of the p.d.f. to find the mode.

There were a few good sketches in part (e) however; there were all sorts of alternatives. Many just gave a sketch of the original p.d.f.

Question 5

This question was attempted by most candidates with a good degree of success for those who were competent in using the Binomial formula. A number of candidates had difficulty writing 1% as a decimal and used 0.1 in error.
In part (b) the most common errors were to see 'at least 2' translated as $P(X > 2)$ or to write $P(X \geq 2)$ as $1 - P(X \leq 2)$. Many final accuracy marks were lost as a result of inadequate rounding in both parts (a) and (b).

In part (c) Po(2.5) ensured many scored at least 2 marks but $P(X \leq 4) - P(X \leq 1)$ was a common error.
A normal approximation was seen but not quite as often as in previous years.

Question 6

In Part (a) there are a sizeable number of candidates who are not using the correct symbols in defining their hypotheses although the majority of candidates recognised Po(7).

For candidates who attempted a critical region there were still a number who struggled to define it correctly for a number of reasons:

- Looking at the wrong tail and concluding $X \leq 3$.
- Incorrect use of > sign when concluding 11 - not appreciating that this means ≥ 12 for a discrete variable.
- Not knowing how to use probabilities to define the region correctly and concluding 10 or 12 instead of 11.

The candidates who opted to calculate the probability were generally more successful.

A minority still try to calculate a probability to compare with 0.9. This proved to be the most difficult route with the majority of students unable to calculate the probability or critical region correctly. We must once again advise that this is not the recommended way to do this question.
There are still a significant number who failed to give an answer in context although fewer than in previous sessions.

Giving the minimum number of visits needed to obtain a significant result proved challenging to some and it was noticeable that many did not use their working from part (a) or see the connection between the answer for (i) and (ii) and there were also number of candidates who did not recognise inconsistencies in their answers.

A number of candidates simply missed answering part (b) but those who did usually scored well.

There were many excellent responses in part (c) with a high proportion of candidates showing competence in using a Normal approximation, finding the mean and variance and realising that a continuity correction was needed. Marks were lost, however, for not including 20, and for not writing the conclusion in context in terms of the **rate** of visits being **greater**. Some candidates attempted to find a critical value for X using methods from S3 but failing to use 1.2816.
There were a number of candidates who calculated $P(X=20)$ in error.

Question 7

This question proved challenging in parts to some candidates but was attempted in full by many, with a high degree of success.

In part (a) most candidates were aware that they needed to integrate the given function and did so successfully, including the fractions. Problems generally arose in the use of the correct limits. It was common to see candidates use limits of 0 or 1 and 4 rather than using a variable upper limit. Several candidates chose to use a constant c rather than limits but often did not proceed to use F(4) =1 or F(1) = 0 to find the value of c. A large number of candidates who got the correct answer went on to multiply their expression by 9.

In (b) F(x) was defined well – candidates seem to be more aware of the need for the 0 and 1 and there were a limited number who had the wrong ranges for these.

The majority of correct answers in (c) were found by solving the quadratic rather than by the easier method of substituting 2.5 into the equation. Many of those who used the quadratic formula used complicated coefficients. Most went on to correctly find Q_1

There is still a great deal of confusion in the minds of some candidates over skewness with a number writing reasons such as $Q_1<Q_2<Q_3$. There was a tendency to write wordy explanations rather than the succinct $Q_3-Q_2>Q_2-Q_1$. This gained the marks but many candidates were unable to express themselves clearly.

There is still confusion between positive and negative skewness with a few candidates doing correct calculations but concluding it was negative.

A few candidates calculated the mean or mode and used mean > median > mode. These gained full marks if correctly found but used precious time doing unnecessary calculations.

Decision Maths Unit D1
Specification 6689

Introduction

This paper proved accessible to the candidates. The questions differentiated well, with each giving rise to a good spread of marks. All questions contained marks available to the E grade candidate and there also seemed to be sufficient material to challenge the A grade candidates also.

The examiners were pleased by the general standard of the candidates' responses, answers were, on the whole, well-presented and clear.

Some candidates are using methods of presentation that are too time-consuming. The space provided in the answer booklet and the marks allotted to each section should assist candidates in determining the amount of working they need to show. Some candidates wasted time in Q1 by writing too much explanation and some of the methods used in Q7(b) were lengthy.

Candidates are reminded that they should not use methods of presentation that depend on colour, but are advised to complete diagrams in (dark) pencil.

Report on individual questions

Question 1

Part (a) was done with mixed success. The majority of candidates gained full marks or three marks. The most common errors were to have HIJ after the second pass and neglecting to choose a pivot on the third pass with the entry MR. Most knew their alphabet, but not all. There was a temptation to go into too much detail about the choice of pivot, to the extent that examiners were not always sure that more than one pivot was being considered per iteration. It is an important feature of the quick sort that the number of pivots can potentially double at each iteration, so the selection of multiple pivots must be clearly shown. Some candidates did not abbreviate the names, by using the initial letter and this slowed them down.

Part (b) was usually very well done. The most common errors were not rejecting the pivot and not making a decision when Hannah was left. Some candidates added Hugo to the list and then found him, others confused Hannah and Hugo.

Question 2

Almost all the candidates gained full marks in part (a), with only a few ambiguous numbers on the diagonal arcs. There were also many fully correct solutions seen to part (b), although a few did not make the rejected arcs clear. Good presentation can be a great time saver here, many gave an ordered list of all arcs with just ticks and crosses by the rejections, others wrote long sentences about their decision to reject, due to cycles forming. Not all candidates stated the weight of the tree.

Question 3

There were many good attempts seen to part (a), which can be a challenging topic for candidates. The most common errors were: failing to have one end point; missing arrows – especially important on the dummies; omitting an activity, often J. Some candidates used activity on node. In part (b) candidates struggled to give good explanations for the two dummies, so full marks were very rarely awarded. Many did not give enough detail of the activities involved in the first dummy and did not make it clear that each activity has to be uniquely expressible in terms of its end events.

Question 4

There were many good responses seen to this question and the general standard of response was better than in previous years. The path from B to 5 was usually given followed by an improved matching. Some candidates tried to find a path, starting at F and often 'found' one, ending at D or sometimes 6, both of which are already matched, so this proved a good test of their understanding of 'breakthrough'. As usual some candidates did not make the 'change status' step clear, but the number failing to do so seems less than in the past. Those who had created 'fragments' of an alternating path in (a) were often unable to find an alternating path leading to a complete matching in part (c). Most candidates were able to make a good attempt at (b), but with some losing marks for not being specific enough with letters and numbers.

Question 5

Part (a) was very well done in general, with only a few slips. The most common was CD + EG = 44, and a few omitted the totals for each pairing. Some candidates used one or more even vertex, but most found the three pairings efficiently and concisely, with only a very few failing to pair up the six separate paths. A number of candidates did not read the question carefully and wasted time finding a route. Part (b) was less well done. Many candidates only considered arcs CD and EG (from part (a)), others chose C and G so that they could eliminate the longest path, others chose G and D because they had the 'highest valencies', others chose C and E saying that the path between them was the shortest (which is correct, but therefore CE should be the path chosen to be repeated).

Question 6

Most candidates were able to make progress in part (a) and there were many fully correct responses. There were a lot of errors seen in the order of, and calculation of, the working values and in the order of labelling. It is essential that the working values are listed in the correct order if the candidates are to gain full credit. Many candidates found the correct new route in (b) although a few found one of the slightly longer routes (ABEH or ABDGH) of length 166.

Question 7

While a number of candidates scored the full 12 marks on this question, many could only achieve a handful of marks.

The first two lines were often drawn correctly however $y=4x$ was frequently incorrect. The most common error was to draw $y = (1/4)\,x$, not drawing the line long enough, or not noticing the differing scales on the axes. The shading on two of the lines was often correct but only the better candidates were able to get the shading correct on all three lines, so many gave the FR as the central triangle. Many candidates did not label their lines. There continues to be evidence that candidates are not going in to the examination properly equipped with (30cm) rulers.

In part (b) candidates who gained full marks did so most frequently and easily by using the objective line method. If errors were seen in this method, it was often due to a reciprocal gradient, or an inability to read the scale on the graph accurately. A significant number of candidates continue to state they are using this method without showing any evidence of this, these gain no credit. If the objective line method is being used, the examiners need to see an accurately drawn objective line (of decent length). Those who chose to use the point testing method frequently lost marks through the inaccuracy of their extreme points, or by not testing all of their extreme points. There was a tendency to try to read the coordinates from the LP-graphs, and unsurprisingly the point ($15^5/_9$, $62^2/_9$) was therefore rarely seen. Candidates should be reminded that if they choose to use the vertex method they must show their complete working, and will be expected to use simultaneous equations to find the exact coordinates of any vertices. A few candidates stated that they were using this method but then tested points other than the vertices of their FR, another frequently seen error was to find the coordinates of the vertices but then not use them to find any F values.

Question 8

Many fully correct responses to part (a) were seen, but some common errors were: 13, 17 or 21 in place of the 19 at the end of C; 6 as the late time at the end of B; 18 instead of 20 as the early time at the end of G, often accompanied by an 8 at the end of the dummy; 14 instead of 10 as the late time at the end of A. Most candidates gave the correct answers in part (b), but B, E and/or L were often included as critical activities. In part (c) most candidates gained full marks, showing the three numbers used in the calculation of each of the floats. Some just stated the value of each float, losing two of the three marks. Many fully correct responses were seen to (d). Most were able to show the critical path correctly in part (d), but errors were often seen associated with activities B, C, D, G and/or L. A number used the diagram for scheduling and scored no marks. Part (e) was often poorly done. Candidates were instructed to use their cascade (Gantt) chart, but many calculated a lower bound and many made an attempt to schedule the activities. Candidates are expected to state a specific time and list the specific activities that must be taking place.

Grade Boundaries:

January 2009 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	59	51	43	35	27
6664 Core Mathematics C2	57	48	39	30	22
6665 Core Mathematics C3	60	52	44	36	29
6666 Core Mathematics C4	59	52	45	38	32
6667 Further Pure Mathematics FP1 (new)	62	54	46	39	32
6674 Further Pure Mathematics FP1 (legacy)	64	57	50	43	36
6677 Mechanics M1	49	42	35	28	21
6678 Mechanics M2	63	55	47	40	33
6679 Mechanics M3	63	56	49	42	35
6683 Statistics S1	57	50	43	36	30
6684 Statistics S2	65	57	49	41	33
6689 Decision Maths D1	64	57	50	43	37

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