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GCE

GCE Mathematics (8371/8373, 9371/9373)

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Core Mathematics Unit C1
Specification 6663

Introduction

In general, this paper was a good test of knowledge, understanding and ability. Easily accessible marks were available throughout the paper for candidates competent in routine techniques such as differentiation and integration. While standards of algebraic and arithmetic manipulation were generally quite good, weakness in these areas was often seen in Q5, Q8(d) and Q9. Curve sketching in Q3 and Q10 was sometimes disappointing, especially when candidates were unaware of the correct shape of curve required for a particular function.
Most candidates appeared to have time to attempt all ten questions, although there was some evidence of incomplete work in Q9 and Q10.
In most cases there was sufficient space on the paper for solutions to be completed appropriately, but it is acknowledged that space for Q8 was tight and this led to a significant number of scripts requiring a supplementary sheet.
Standards of presentation were, as always, variable and while examiners try to give the benefit of the doubt where possible, some candidates penalise themselves by not showing their methods and working clearly. In particular, in questions involving the use of a formula, candidates should be encouraged to quote the formula first before beginning to substitute values.

Report on Individual Questions

Question 1

For most candidates, this was a straightforward question and full marks were very common. The fractional power caused some problems with $x^{3/2}$ occasionally appearing instead of $x^{-1/2}$. Apart from this the most common mistake was to differentiate -1 incorrectly to give $-x$. A few candidates integrated throughout, or added a constant to their differentiated expression.

Question 2

It was encouraging to see most candidates factorizing the quadratic expression in order to find the critical values for the inequality. Sometimes the critical values had incorrect signs, despite the factorization being correct, but the most common error was still a failure to select the outside region. Some candidates struggled with the correct symbolic notation for the answer and $-2 > x > 9$ was occasionally seen.
A few candidates chose to use the formula or completing the square to find the critical values, these approaches are less efficient in this case and often gave rise to arithmetic errors.

Question 3

Disappointingly, a significant number of candidates were unfamiliar with the rectangular hyperbola. Parabolas, cubic curves and straight lines were sometimes sketched. Attempts to sketch by plotting points probably wasted time and often led to unconvincingly shaped graphs. The required translation parallel to the y-axis was often performed correctly, although horizontal translations and other variations were sometimes seen. Many candidates were unaware of the concept of an asymptote, and even those who demonstrated understanding were often unable to write down equations of the two asymptotes. The asymptote equation $x = 0$ was often omitted.
In part (b), answers for the point of intersection with the x-axis sometimes contradicted what was seen in candidates' sketches, but this part was marked independently and many were able to

solve $\frac{1}{x}+3=0$ correctly. Others, however, were defeated by the algebra here or tried to evaluate $\frac{1}{0}+3$ to find a *y* value.

Question 4

This question was a good source of marks for most candidates. Almost all realised the necessity to form an equation in one variable and the majority could perform the appropriate expansion and substitution, leading to the correct 3-term quadratic. There seemed to be less reliance on the quadratic formula than had been seen in previous C1 papers, with most candidates trying to factorise and usually doing so correctly.
A disappointing number failed to score the final two marks because they finished after finding the two values of the first variable. Non-algebraic solutions were rare and, pleasingly, few candidates thought that $(x-2)^2 = x^2 + 4$.

Question 5

Although candidates who produced a totally correct solution to this question were in the minority, most knew that the use of the discriminant was needed.
The correct inequality, $(-2)^2 + 4(2)(k+1) < 0$, or equivalent, was generally seen only from the better candidates. A very common error was to take *c* to be $(k+1)$ instead of $-(k+1)$. Sometimes $b^2 = 4ac$ was used rather than $b^2 < 4ac$, giving access to only 2 of the 4 available marks. Algebraic manipulation was quite poor in this question, with many sign and bracketing mistakes being seen.
Weaker candidates sometimes tried solving the equation with various values of *k*, or rearranged to give $2x^2 - 3x - 1 = k$ and proceeded to solve $2x^2 - 3x - 1 = 0$, making no progress.

Question 6

Many candidates scored full marks on this question, or perhaps lost just one mark in part (b). Most established *k* = 24 in part (a), but occasional wrong values seen here included 12, 6 and 2. Although a few candidates started again in part (b) with the expansion of $(4+3\sqrt{x})^2$, the vast majority integrated the expression from part (a). The constant of integration was often omitted, but most other mistakes were minor.
Sometimes $24/(3/2)$ was wrongly simplified.

Question 7

In part (a) of this question, many candidates were able to integrate the expression successfully. Most errors came in the integration of $8x^{-2}$, where $\frac{8x^{-3}}{-3}$ was a popular suggestion. Some candidates, perhaps unsure about the notation, differentiated f '(*x*) instead of integrating it. A significant number, even those who correctly included a constant of integration *C*, omitted to use (2, 1) to find the value of *C*.
Those few candidates who attempted to find the value of *C* in part (b) were usually confusing this constant with the constant *c* for the straight line equation.
In part (b) most candidates knew that they were required to evaluate f '(2) to find the gradient of the tangent at (2, 1), but some were unable to do this accurately.
Some, having correctly obtained 4 for the gradient of the tangent, went on to find an equation for the normal through the point. Most candidates attempted to express their equation in the required form.

Question 8

Apart from those who made arithmetic slips, many candidates did well on the first three parts of this question. Some, however, managed the differentiation in part (a) but were unable to make further progress. Mistakes in the differentiation inevitably led to problems in part (c), since it was not then legitimately possible to obtain the given normal equation.

Part (b) was accessible to most candidates, although some did attempt to substitute $x = 4$ into the derivative from part (a) rather than into the equation of the curve. The inability to calculate the value of $4^{3/2}$ prevented some candidates from being able to show the given result convincingly.
Candidates often found part (c) difficult. Where the need to evaluate the derivative was not realised, many resorted to working backwards from the given equation and were unlikely to score any marks.
In part (d), a few candidates made no progress at all, not appearing to understand the demands of the question or not knowing how to find the coordinates of Q. In many cases the intersection with the y-axis instead of the x-axis was found. Those that used a sketch were generally more successful. There was sometimes careless arithmetic in the use of Pythagoras' theorem, and then those candidates who did correctly reach $24^2 + 8^2$ sometimes found the subsequent calculation difficult. Of those who reached $\sqrt{640}$, most made a good attempt to simplify the surd.

Question 9

There were many good attempts at this question, although few candidates scored full marks. The vast majority recognised that an arithmetic series was involved.
In part (a), most candidates found a correct expression, either directly or by using the formula $a + (n-1)d$. A few, however, offered a recurrence relationship.
There were occasional numerical slips in the evaluation of the sum in part (b), but many correct answers were seen. The majority of candidates used the sum formula rather than a list of terms. It was disappointing here to see frequent misunderstanding (or misreading) of the question leading to the answer 31, the tenth term rather than the sum of the first ten terms.
Those who realised the need for the sum formula in part (c) usually made good progress, but a significant number simply started to expand and proceeded to solve the given equation, possibly producing work that was relevant only to part (d). Those who did this often wasted time trying to use the quadratic formula on their expanded version of the equation. In the better attempts, the inequality was often introduced without justification at a late stage in the working, losing the final mark. Some candidates confused the sum (1750) with the first term of the series and made no progress.
In part (d), the majority of candidates found the value $\frac{100}{3}$ but did not continue to interpret this result in the context of the question. The final answer was often given as a fractional value, a negative value or a set of values of k.

Question 10

Weaker candidates sometimes made very little progress with this question. In general, however, curve sketching tended to be disappointing in part (a) but sound algebra was often seen in part (b). Most candidates recognised the cubic and drew a curve of the correct shape, but many placed the repeated root at (2, 0) rather than (0, 0). Many cubic curves also passed through the point $(-2, 0)$. The parabola commonly appeared upside down or on the negative x-axis. A significant number of candidates constructed a table of values and plotted points, suggesting a lack of knowledge of the respective families of curves. Plotted points from a table of values were often insufficient to establish the complete shape required. Occasionally these tables were used to find one or more intersection points for part (b).

In part (b), most candidates knew how to form the required equation, but there were occasionally sign errors in the algebraic manipulation. Instead of taking out the common factor x many divided through by x and failed to include (0,0) as one of the intersection points. Apart from slips, the resulting quadratic was usually well solved and, having found two x coordinates, most candidates continued and calculated the corresponding y coordinates. A common calculation mistake at this final stage gave $(-2,-8)$ instead of $(-2,-16)$, and a few candidates thought that all the y coordinates were zero. In many cases, answers to part (b) contradicted what was seen in candidates' sketches in part (a).

Core Mathematics Unit C2
Specification 6664

Introduction

This paper was accessible to the majority of candidates, with a relatively small number of non-attempts at questions seen. Candidates appeared to have had sufficient time to attempt all ten questions. In particular, Q1, Q2, Q4, and Q5 proved accessible to most candidates. As on previous occasions, there was evidence of loss of marks through basic errors such as poor use of brackets, confusion between degrees and radians and failure to give answers to the required accuracy. However, many correct, well-constructed solutions were also seen. A few candidates who needed extra pages for a particular question ignored the instructions on the front cover and used pages allocated to other questions. Candidates should be reminded that, in the rare event of needing extra pages for a question, they should use supplementary paper.

Report on Individual Questions

Question 1

Part (a) was answered well with many correct solutions. A few candidates integrated f(x). Some candidates had difficulty differentiating the constant term. The most common incorrect solution was $f''(x) = 6x$. In part (b) a few candidates used f(x) or $f'(x)$ as their integral. However, most integrated successfully and substituted accurately. Occasional arithmetic slips were seen.

Question 2

Part (a) was usually answered well with many candidates showing understanding of the structure of a binomial expansion. Common errors included the use of x or $2x$ instead of $-2x$ and the careless use of brackets. Some candidates did not spot the relationship between parts (a) and (b) and started again with the expansion of $(1 - 2x)^5$, others used the whole of their answer to part (a) when they only need to use $1 - 10x$. A number of candidates substituted a value for x and then attempted show that their expressions were approximately equal and there were also a few who tried to fool the examiners by writing the given answer after several lines of incorrect working.

Question 3

Most candidates were able to state the general equation of a circle in the form $(x - a)^2 + (y - b)^2 = r^2$. However, it was more common to see the coordinates of a mid-point misquoted as $\left(\frac{x_1 - x_2}{2}, \frac{y_1 - y_2}{2}\right)$ and the formula for the distance between two points misquoted as $\sqrt{(x_2 - x_1)^2 - (y_2 - y_1)^2}$. Some candidates were not able to make any progress beyond stating the general equation of a circle and a few found equations of straight lines. However, most found the coordinates of the mid-point, attempted to find the radius and substituted their values into the equation of the circle. There was some confusion between the diameter and radius; a common error was to give r^2 as $\frac{d^2}{2}$. Some did not simplify their $\left(\sqrt{5}\right)^2$ and others confused r and r^2. A few candidates successfully used $x^2 + y^2 + 2gx + 2fy + c = 0$ and occasionally a successful solution was obtained by using a general point P (x, y) on the circle, the equations of two straight lines and the result that the angle subtended by a diameter is 90°.

Question 4

The majority of candidates used logarithms in an appropriate way and scored full marks for this question, although some candidates only got as far as $x = \log_5 17$. The most common error was to disregard the instruction to give the answer to 3 significant figures. Trial and improvement was seen occasionally. A few candidates incorrectly tried to find x by writing $x = \sqrt[5]{17}$.

Question 5

Many candidates gained full marks for this question. Candidates who attempted long division in part (a) rather than using the factor theorem lost both marks and those who showed that f(–2) = 0 but failed to give a conclusion lost the accuracy mark. Parts (b) and (c) were usually answered successfully although some candidates showed a lack of understanding of the difference between factorising and solving. The majority of candidates used long division in (b) rather than inspection. Some lost the final mark in part (c) by giving only two solutions (usually –3 and 1) rather than three.

Question 6

Most candidates used the appropriate trigonometrical identity and many continued to find a correct quadratic equation in $\sin x$. However, poor algebraic manipulation (mainly sign errors and careless use of brackets) led to a number of candidates obtaining quadratic equations that were harder to solve than the correct one. Other errors seen included sign errors in factorising, more than 2 solutions given to the equation $\sin x = \frac{1}{2}$ for $0 \leq x < 2\pi$ and solutions given as decimals rather than multiples of π. A number of candidates gave solutions in degrees first. Some of these candidates then showed a misunderstanding of the required method for converting their solutions to radians. Weaker candidates incorrectly substituted $1 - \cos x$ for $\sin x$ or made no progress at all with this question.

Question 7

Many candidates successfully expanded and integrated the given expression for y although the usual errors, such as sign slips, were seen. A few candidates took the wrong approach to the question by differentiating or using the trapezium rule. Some candidates evaluated only one integral, usually using limits of 0 and 2 for this. The majority of candidates understood the need to find two areas. Many correctly found the area under the curve between 0 and 1. However, several incorrect methods were used to find the area bounded by the curve and the x-axis between $x = 1$ and $x = 2$. These included the use of the trapezium rule and using areas of rectangles and triangles. Obtaining and explaining the negative answer to the integral between 1 and 2 and convincing examiners of a final valid answer for the total area caused some difficulties.

Question 8

Some candidates did not understand the need to differentiate in part (a) and put $C = 0$. This should have resulted in an equation with no real values of v. However, these candidates often employed some creative algebra to obtain an answer of $v = 70$. Most candidates attempted to solve $\frac{dC}{dv} = 0$ but a few had difficulty rearranging their equation in a form from which they could find a value of v. Most of the errors seen came from incorrect differentiation of $\frac{2v}{7}$. A few candidates attempted a solution by trial and improvement for which only two out of five marks were available. Most candidates used the correct method to find the differential in (b); the most common error was to give $\frac{d^2C}{dv^2}$ as $\pm 1400v^{-3}$. Some candidates lost the accuracy mark in (b) because they neither substituted their value of v from (a) nor gave any other convincing indication as to why $\frac{d^2C}{dv^2} > 0$ (e.g. $v > 0$ as speed). Part (c) was usually done well.

Question 9

Although many candidates used correct methods in this question, some accuracy marks were lost carelessly by failure to give answers in the format requested. As in Q6, some candidates had difficulty in working with radians. Most candidates quoted a correct form of the cosine rule (one form of which is in the formulae book) in part (a) and were able to substitute the correct values. However, some had difficulty in making $\cos PQR$ the subject of the formula or evaluating $\left(6\sqrt{3}\right)^2$. Candidates who found $\sin(\frac{1}{2}PQR)$ were usually successful. Some candidates used the given answer in (b) to find the angle in (a) and so no credit was given in (a) if no valid method was seen. Despite the instruction in the question, a number of candidates gave the answer as 120° and attempted to use this in subsequent parts of the question. In part (b) the formula $\frac{1}{2}r^2\theta$ was usually sometimes misquoted, usually involving the loss of the $\frac{1}{2}$ or inserting π. Some candidates were quite creative at their attempts to reach the stated answer! Using a variety of methods, most candidates were able to attempt to find the area of the triangle in part (c) but it was common to see the answer given as a decimal rather than the exact answer of $9\sqrt{3}$. The methods in part (d) and (e) are well known to candidates and were applied successfully, although a few ignored the request for answers to be given to one decimal place.

Question 10

In part (a), as was found the last time this was tested in June 2005, a number of candidates failed to demonstrate complete understanding of the required proof. Common errors included giving the nth term as ar^n rather than ar^{n-1} and rewriting the sum in reverse order rather than multiplying by r. In part (b) many candidates appreciated the link with part (a) and attempted to use the correct formula. However, the first term of the series was often stated incorrectly as 100 and occasionally $r = 100$ was seen. A number of candidates wrote out terms and added them on their calculators which usually resulted in the correct answer being given. The majority of candidates answered part (c) correctly. Some had difficulty finding r, often resulting in an answer of $r = 3$. These candidates showed a lack of understanding of the condition for a sum to infinity to exist even though $|r| < 1$ is stated in the formula book. A similar problem occurred in part (d). A substantial number of candidates gave no answer to this part. Common incorrect answers included $r > 0$, $r < 1$ and $0 < r < 1$.

Core Mathematics Unit C3
Specification 6665

Introduction

This paper proved a little more demanding than the previous two set on this specification but, apart from Q8(ii), all of the questions were accessible to the majority of candidates and nearly all made substantial attempts at all questions. This specification makes considerable demands on candidates' abilities to provide proofs of trigonometric and algebraic results and, to obtain high marks, is it essential for candidates to be able to produce reasoned and clear chains of arguments which lead to stated conclusions. Often a number of facts relevant to a proof are produced but they are not ordered into a logical sequence leading to the required result. It needs to be emphasized that when candidates are asked to prove or obtain a result involving an exact surd then the use of calculators is not appropriate. Attention needs to be drawn to the rubric "You must show sufficient working to make your methods clear to the examiner. Answers without working may gain no credit." In a question on numerical analysis, the examiners expect to see working which demonstrates the method used and shows sufficient accuracy to justify the degree of accuracy given for the answer. 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.

Report on Individual Questions

Question 1

The great majority of candidates were able to expand $\sin(2\theta+\theta)$ correctly and replace $\sin 2\theta$ by $2\sin\theta\cos\theta$. However the identity $\cos 2\theta = 1-2\sin^2\theta$ seemed less well known and this often led to inaccurate or, more frequently, to unnecessarily lengthy proofs. Errors sometimes arose due to incorrect bracketing, $\left(1-2\sin^2\theta\right)\sin\theta$ being written as $1-2\sin^2\theta\sin\theta$. However, fully correct solutions to part (a) were common. Part (b) was also well done but, as noted in the introduction above, there were candidates who thought that a decimal answer from a calculator would be acceptable. The commonest error seen in exact manipulation was to evaluate $4\left(\frac{\sqrt{3}}{4}\right)^3$ as $3\sqrt{3}$, not recognising that the cube applied to the 4 as well as the $\sqrt{3}$.

Question 2

Part (a) was very well done, the great majority of candidates gaining full marks. Part (b), however, proved very demanding and there were many who had no idea what is required to show a general algebraic result. It was common to see candidates, both here and in part (c), who substituted into the expression a number of isolated values of *x*, noted that they were all positive, and concluded the general result. Those who did complete the square correctly, obtaining $x^2+x+1=\left(x+\frac{1}{2}\right)^2+\frac{3}{4}$, did not always explain the relevance of this to the required result. Many tried calculus but, to complete the proof this way, it was necessary to show that $\left(-\frac{1}{2},\frac{3}{4}\right)$ was a minimum and this was rarely seen. Those who tried to solve $x^2+x+1=0$ or just calculated the discriminant often correctly concluded that the graph did not cross the axis but, to complete this proof, it was necessary to use the fact that x^2+x+1 has a positive coefficient of x^2 and this was not often seen. A suitable diagram was accepted here as a sufficient supporting argument. A correct argument for part (c) was often given by those who were unable to tackle part (b) successfully and this was allowed the mark.

Question 3

Many did gain the mark in part (a) but, again, the inappropriate use of calculators and decimals was common. The statement that $2\sin\frac{\pi}{4} = \sqrt{2}$ was not sufficient for credit and the examiners required some evidence that the candidate knew, or could show that, $\sin\frac{\pi}{4} = \frac{1}{\sqrt{2}}$. Part (b) was well done. The great majority found $\frac{dx}{dy}$ and inverted the result. The use of implicit differentiation was rare. Apart from a few who found the equation of the tangent, part (c) was well done. The commonest cause of the loss of the final mark of the question was that candidates who had a correct form of the equation of the normal, usually $y - \frac{\pi}{4} = -\sqrt{2}\left(x - \sqrt{2}\right)$, often were unable to manipulate this equation correctly into the form required.

Question 4

The techniques required to answer this question were well understood and fully correct answers to both parts of the question were common. In part (a), most used the quotient rule correctly and obtained $\frac{9 - x^2}{\left(9 + x^2\right)^2} = 0$. The solution of this equation caused some difficulty. Some gave up at this point but it was not uncommon to see candidates proceeding from this correct equation to $9 - x^2 = \left(9 + x^2\right)^2$ and it was possible to waste much time solving this. Those who obtained $9 - x^2 = 0$ usually completed the question correctly although some missed the solution $\left(-3, -\frac{1}{6}\right)$. There are candidates who attempt this type of question using the product rule. This is, of course, mathematically sound but it cannot be recommended for the majority of candidates. Negative indices are found difficult and, in this case, obtaining the equation $\left(9 + x^2\right)^{-1} - 2x^2\left(9 + x^2\right)^{-2} = 0$ and solving it proved beyond all but the ablest. Part (b) was well done. The commonest error seen was $\frac{dy}{dx} = \frac{3}{2}\left(1 + e^{2x}\right) \times e^{2x}$, which usually derived from the error $\frac{d}{dx}\left(e^{2x}\right) = e^{2x}$. Most could carry out the substitution and evaluation and the correct answer 18 was frequently seen.

Question 5

There were a minority who left this question blank, showing an incomplete knowledge of the syllabus. However, on the whole, this was the best tackled question on the paper and the great majority could obtain values for R and α and use these values to demonstrate a valid method to solve part (b). A few did get their value for $\tan\alpha$ inverted and obtained $\alpha = \frac{\pi}{6}$. The mark scheme allowed these candidates to gain 3 of the 4 marks in part (b). The wording of the question does imply that α is in radians and those who gave the answer as $60°$ lost one mark. Such errors are only penalised once in a question and if the candidate carried on into part (b) in degrees, they were allowed full marks there if their solution was otherwise correct. Part (b) was well done but the second solution $x = \frac{11\pi}{6}$ was often overlooked. A few candidates attempted part (b) by squaring. This comes out quite well but introduces a incorrect solution within the specified range and full marks were only given if this solution was rejected.

Question 6

The method for finding the inverse functions was well understood. Conversion from the logarithmic to the exponential form was generally good and the only real concern being a number of candidates who assumed that $\ln(4-2x) = \ln 4 - \ln 2x$. There was confusion between the domain and range of a function. In this case the range was more often correct than the domain. The sketch in part (c) proved difficult. Although many realised that the curve crossed the axes at $\left(0, \frac{3}{2}\right)$ and $(\ln 4, 0)$ the curve was often drawn curving in the wrong direction and it was surprising to see that a substantial minority of the candidates had $(\ln 4, 0)$ on the negative *x*-axis. Relatively few managed to draw in the asymptote or otherwise indicate that the curve was approaching $y = 2$. Part (d) was almost always correct but many did not realise that this was giving them a hint of how to approach (e). Many tried to find a direct algebraic, rather than a numerical, method of solving the equation.

Question 7

In part (a) almost all candidates knew what to do but many failed to state what the 'change of sign' represented. Candidates are expected to give a conclusion to their reasoning.
Part (b) belongs to the C2 specification and the majority could apply their knowledge here. There were, however, candidates who put $y = 0$ or $\frac{\mathrm{d}^2 y}{\mathrm{d}x^2} = 0$. Again, in part (c) most candidates used an acceptable method and found the correct solution. Long division was the most commonly used method. Sketching the quartic graph proved difficult for many. Candidates often failed to see the relevance of the previous parts of the question and sketches showing more than one stationary value, often contradicting the candidate's solution to part (b), were common. If the shape was correct in (d), the mark for part (e) was usually gained.

Question 8

There were many efficient solutions to part (i) as well as some very long-winded ones. The omission of brackets in $1 + \tan^2 x - (1 + \cot^2 x)$ led to some loss of marks, as did slips in sign. A common incorrect method was : -

$$\sec^2 x - \operatorname{cosec}^2 x = \frac{1}{\cos^2 x} - \frac{1}{\sin^2 x} = \frac{\sin^2 x - \cos^2 x}{\cos^2 x \sin^2 x} = \frac{\sin^2 x}{\cos^2 x} - \frac{\cos^2 x}{\sin^2 x} = \tan^2 x - \cot^2 x.$$

Part (ii) was rarely attempted. In (ii)(a) some managed to obtain $x = \cos y$, which obtained the first mark, but few gave either of the acceptable answers, $\frac{\pi}{2} - y$ or $\arcsin \cos y$. Fewer than 10% of the candidates obtained a correct answer to (ii)(b).

Core Mathematics Unit C4
Specification 6666

Introduction

This paper proved to be accessible and there was no evidence of candidates being unable to complete the paper owing to time constraints. There were some testing questions, particularly those questions involving the use of differentiation, which allowed the paper to discriminate well across all ability ranges. The attempts at the vector question, although much improved from the previous two examination sessions, continued to be disappointing with many candidates unable to work out the required angle in the final part. It was also pleasing to see that this paper afforded a typical E grade candidate the opportunity to gain some marks in many of the questions.

The first four questions gave a good introduction to the paper allowing candidates to demonstrate their algebra, differentiation and integration skills. The next three questions discriminated well between the varying abilities of each of the candidates. The final question was well answered by candidates of all abilities.

In Q2(b), less than 10% of candidates were able to gain the method mark. In Q3(b), it was found that there were many incorrect ways that candidates could arrive at the correct tangent gradient of $-\sqrt{3}$ or the correct equation of the normal. The mark scheme, however, was designed to ensure that only those candidates who applied correct working would be appropriately credited.

In summary, Q1, Q2(a), Q3, Q4 and Q8 were a good source of marks for the average candidate, mainly testing standard techniques; and Q2(b), Q5(b), Q6(b), Q7(b) and Q7(d) proved effective discriminators.

Report on Individual Questions

Question 1

The majority of candidates produced correct solutions to this question, but a substantial minority of candidates were unable to carry out the first step of writing $(2-5x)^{-2}$ as $\frac{1}{4}\left(1-\frac{5x}{2}\right)^{-2}$.

Those who were able to do this could usually complete the remainder of the question but some sign errors were seen.

Question 2

In part (a), most candidates used the correct volume formula to obtain an expression in terms of x for integration. At this stage errors included candidates using either incorrect formulae of $\pi\int y \, dx$ or $\int y^2 \, dx$. Many candidates realised that they needed to integrate an expression of the form $k(1+2x)^{-2}$ (or equivalent). The majority of these candidates were able to complete the integration correctly or at least achieve an integrated expression of the form $p(1+2x)^{-1}$. At this stage, however, a common error was for candidates to integrate to give an expression in terms of natural logarithms. A significant number of candidates were unable to cope with substituting the rational limits to achieve the correct answer of $\frac{\pi}{12}$.

The vast majority of candidates were unable to gain any marks in part (b). Some candidates understood how the two diagrams were related to each other and were able to find the linear scale factor of 4. Few candidates then recognised that this scale factor needed to be cubed in order for them to go onto find the volume of the paperweight. Instead, a significant number of candidates applied the volume formula they used in part (a) with new limits of 0 and 3.

Question 3

In part (a), many candidates were able to apply the correct formula for finding $\frac{dy}{dx}$ in terms of t. Some candidates erroneously believed that differentiation of a sine function produced a negative cosine function and the differentiation of a cosine function produced a positive sine function. Other candidates incorrectly differentiated $\cos 7t$ to give either $-\frac{1}{7}\sin 7t$ or $-\sin 7t$ and also incorrectly differentiated $\sin 7t$ to give either $\frac{1}{7}\cos 7t$ or $\cos 7t$.

In part (b), many candidates were able to substitute $t=\frac{\pi}{6}$ into their gradient expression to give $-\sqrt{3}$, but it was not uncommon to see some candidates who made errors when simplifying their substituted expression. The majority of candidates were able to find the point $\left(4\sqrt{3}, 4\right)$. Some candidates, however, incorrectly evaluated $\cos\left(\frac{7\pi}{6}\right)$ and $\sin\left(\frac{7\pi}{6}\right)$ as $\frac{\sqrt{3}}{2}$ and $\frac{1}{2}$ respectively and found the incorrect point $\left(3\sqrt{3}, 3\right)$. Some candidates failed to use the gradient of the tangent to find the gradient of the normal and instead found the equation of the tangent, and so lost valuable marks as a result. It was pleasing to see that a significant number of candidates were able to express the equation of the normal in its simplest exact form.

Question 4

In part (a), nearly all candidates were able to form the required partial fractions accurately and efficiently. Most candidates substituted $x=\frac{3}{2}$ and $x=1$ into the identity $2x-1 \equiv A(2x-3)+B(x-1)$, but the cover-up rule and the method of equating coefficients were also used.

In part (b), some candidates failed to proceed much further, through not knowing how to separate the variables or not recognising that their solution to part (a) provided a clue as how to proceed to solve the differential equation.

Many candidates were able to write the general solution as an equation involving three logarithmic terms and a constant of integration 'c'. Some candidates, however, omitted this constant, whilst other candidates incorrectly integrated $\frac{4}{2x-1}$ to give either $4\ln|2x-1|$ or $\ln|2x-1|$.

In part (c), a majority of candidates realised that they were required to find the constant of integration and were able to evaluate this constant correctly. Only a minority of candidates, however, were able to use the laws of logarithms in the correct order to give their particular solution in the form $y=\mathrm{f}(x)$. There were a significant number of candidates who arrived at the incorrect particular solution of $y=\frac{(2x-3)^2}{(x-1)}+9$.

Question 5

In part (a), the majority of candidates were able to successfully differentiate the given equation to obtain a correct expression for $\frac{dy}{dx}$, although there were a small proportion of candidates who appeared to "forget" to differentiate the constant term of 0.5. Some candidates, as was similar with Q3, produced a sign error when differentiating $\sin x$ and $\cos y$ with respect to x. These candidates then went on to produce the correct answer for $\frac{dy}{dx}$, but lost the final accuracy mark. A few candidates incorrectly believed that the expression $\frac{\cos x}{\sin y}$ could be simplified to give $\cot x$.

In part (b), the majority of candidates realised that they needed to set their numerator equal to zero in order to solve $\frac{dy}{dx} = 0$. Most candidates were then able to obtain at least one value for x, usually $x = \frac{\pi}{2}$, although $x = -\frac{\pi}{2}$ was not always found. A surprising number of candidates did not realise that they then needed to substitute their x value(s) back into the original equation in order for them to find y. Of those who did, little consideration was given to find all the solutions in the specified range, with a majority of these candidates finding $y = \frac{2\pi}{3}$, but only a minority of candidates also finding $y = -\frac{2\pi}{3}$. Therefore it was uncommon for candidates to score full marks in this part. Some candidates also incorrectly set their denominator equal to zero to find extra coordinates inside the range. Also another small minority of candidates stated other incorrect coordinates such as $\left(-\frac{\pi}{2}, \frac{2\pi}{3}\right)$ or $\left(-\frac{\pi}{2}, -\frac{2\pi}{3}\right)$ in addition to the two sets of coordinates required. These candidates were penalised by losing the final accuracy mark.

Question 6

In part (a), candidates either replaced 2^x with $e^{x\ln 2}$ and applied the chain rule; or took logs of both sides of the given equation and then differentiated implicitly. A majority of the candidates were equally likely to correctly apply either one of these two methods. Weaker candidates, however, seemed oblivious to the fact that $x\ln 2$ and $\ln 2x$ are, in fact, different, and wrote them almost interchangeably.

Part (b) proved challenging for a significant number of candidates. Those candidates who used implicit differentiation in parts (a) and (b) were more likely to achieve the correct gradient. Such an approach avoided the errors seen when candidates were trying to handle indices. Such errors included either $2^{(x^2)} = 2^{x.x} = 2^x.2^x$ or $2^{(x^2)} = 2^x.2^2 = 4.2^x$ or $2^{(x^2)} = \left(2^x\right)^2$. Another common error was for some candidates to argue that since the derivative of 2^x is $2^x.\ln 2$, then the derivative of $2^{(x^2)}$ must be $2^{(x^2)}\ln 2$.

Question 7

In part (a), almost all candidates were able to find the position vector **c**.

In part (b), about half of the candidature was able to prove that OABC is a rectangle. The most popular way of achieving this was to prove that one of the corners of the rectangle was right-angled by taking the dot product between two relevant vectors. A few candidates instead used Pythagoras' Theorem to prove the same result. Many candidates wasted time by also proving that the opposite edges of the rectangle were both equal and parallel. A majority of candidates were able to correctly find the area of the rectangle. A few candidates incorrectly multiplied the base by the diagonal. More concerning was a sizeable number of candidates who used the formula $\frac{1}{2}$(base)(height) to find the area of a rectangle. A few candidates, who attempted the proof, then forgot to find the area of the rectangle.

In part (c), only a minority of candidates realised that that they needed to divide their answer in part (a) by 2. Some candidates wrote down the equations of the lines $\overrightarrow{OC}$ and $\overrightarrow{AB}$ and then produced about a page of working in order to find the point of intersection.

In part (d) candidates could use the rectangle to work out any angle (except for the right angle) in order for them to arrive at the correct angle. This led to at least seven or eight possible solutions that candidates could produce. Those candidates who were successful usually included and made reference to a diagram and were able to find the correct answer of 109°.

The most popular approach was for candidates to use the dot product formula to find the angle *ADC*. Although many of these candidates were able to apply the dot product formula correctly over half of them found an acute angle rather than an obtuse angle. This was because these candidates did not draw a diagram or did not properly consider the directions of their chosen vectors. A minority of candidates who drew a diagram and either applied the cosine rule or applied trigonometry on a right-angled triangle were usually successful.

Question 8

Part (a) was invariably well answered as was part (b). In part (b), some candidates incorrectly stated the width of each of the trapezia as $\frac{5}{6}$ whilst a few candidates did not give their answer to 4 significant figures.

The most successful approach in part (c) was for candidates to rearrange the given substitution to make *x* the subject. The expression for *x* was differentiated to give $\frac{dx}{dt} = \frac{2t}{3}$ and then substituted into the original integral to give the required integral in terms of *t*. Weaker candidates, who instead found $\frac{dx}{dt} = \frac{3}{2}(3x+1)^{-\frac{1}{2}}$, then struggled to achieve the required integral in terms of *t*. Most candidates were able to correctly find the changed limits although a sizeable number of candidates obtained the incorrect limits of $t = 2$ and $t = 4$.

Those candidates, who had written down a form of the required integral in part (c), were usually able to apply the method of integration by parts and integrate kte^t with respect to *t* and use their correct changed limits to find the correct answer of 109.2. Some candidates incorrectly used ‘unchanged’ limits of $t = 0$ and $t = 5$.

Further Pure Mathematics Unit FP1
Specification 6674

Introduction

The paper was very accessible, with the first three questions proving a good source of marks for the vast majority of candidates, and as Q6 was also a high scoring question low marks were rare. Q7 proved challenging, particularly part (a), which was only completed by the most able candidates, but part (c) also proved difficult for many and few candidates went on to give the correct answer to part (d).
Q4, Q5, Q7 and Q8 all required considerable algebraic or trigonometric manipulation, which the better candidates coped with very well but invariably weaker candidates found difficult and often produced considerable work for little reward. Despite this there was little evidence that lack of time was a factor.
When a part of a question has a given result to be derived candidates are reminded that they must provide sufficient working for examiners to be convinced, and also that it was usually given to help them in subsequent parts of the question; some candidates are happy to persist with their own incorrect result.

Report on individual questions

Question 1

Virtually all candidates completed this question and, although there were some common mistakes, notably simplifying $\frac{-2 \pm \sqrt{-64}}{2}$, or even $\frac{-2 \pm 8i}{2}$, to $-1 \pm 8i$, this proved a good starter for most candidates.
The most common approach was to use the quadratic formula, although the given equation was very easily and successfully solved by "completing the square". Other routes taken were to substitute z = a + *i*b into the given equation or compare
$\{z - (a+ib)\}\{z - (a-ib)\} = 0$ with the given equation and, although these were more time consuming solutions, it is good to report that these were usually very competently handled.

Question 2

All but a handful of candidates knew what was required in this question and in the main it was solved very well; reflected by the mean mark of a little over six. The errors seen were the usual ones, namely: in setting up the form $\frac{dy}{dx} + Py = Q$, forgetting to divide the right hand side by x; having found the integrating factor, not multiplying the right hand side by it; and either not including a constant of integration or not dividing it by x^2 in the required form of the solution.
This was perhaps a straightforward question of its type and errors in finding the integrating factor were not as common as we have sometimes seen.
Of course, candidates who realised that multiplying through by x initially to give $\frac{d(x^2 y)}{dx} = x\cos x$ gained the first 3 marks in the mark scheme very quickly.
The various types of error usually led to $\int \cos x\, dx$, $\int x^2 \cos x\, dx$ and occasionally $\int e^{2x} \cos x\, dx$ or worse, rather than $\int x \cos dx$, being required; in the first case this was considered too trivial to gain credit and in the other cases, requiring a "by parts" approach, a complete method was required. Most candidates performed the integration by parts well, although sometimes, where steps were omitted, it was unclear whether candidates were differentiating or integrating *x*cos*x*.

Question 3

Another question where the majority of candidates were able to score well, particularly in part (a). Errors here were generally slips such as (pi)(-3i) becoming 3, not 3p, and the one that all examiners reported on, 36 (from 25 + 9) in the denominator being surprisingly common.

In part (b) candidates who used $\frac{b}{a} = \tan\frac{\pi}{4}$, were generally more successful than those who used arg z_2 – arg z_1 = $\frac{\pi}{4}$. In the latter case there was confusion between whether arg z = tan θ or $\tan^{-1}\theta$, with statements like $\tan p - \tan\frac{3}{5} = \frac{\pi}{4}$, and poor manipulation, such as $\tan^{-1} p - \tan^{-1}\left(\frac{3}{5}\right) = \frac{\pi}{4} \Rightarrow p - \frac{3}{5} = 1$, common mistakes.

Question 4

This was the first question to challenge candidates. The most common error in part (a) was to set up the false model $\frac{r^3 - r + 1}{r(r+1)} \equiv \frac{A}{r} + \frac{B}{r+1}$, but some candidates did not show sufficient working in deriving the given result.

In part (b) there were many very good solutions and the level of algebraic manipulation was generally high, particularly as there was no given answer here. However, some candidates were not well organised enough, which led to omitted terms in their solution, and such errors in grouping like 1 + 2 + …….. (n – 1) + 1 mistakenly being considered as 1 + 2 + ……….. + n.
The worst errors, from candidates who were not versed in the art of the method of differences, were to use $\sum\frac{1}{r}$ as $\frac{1}{\sum r}$, so that $\sum_1^n \frac{1}{r} = \frac{2}{n(n+1)}$ was quite common, and to use $\sum\frac{r^3 - r + 1}{r(r+1)} = \frac{\sum r^3 - \sum r + \sum 1}{\sum r^2 + \sum r}$. In the latter case, after the known formulae had been substituted, there usually followed a large amount of manipulation which was very time consuming but gained no reward.

Question 5

The majority of candidates solved this by considering the separate cases for x > – 2 and for x < –2, although weaker candidates only considered the first case, and those who squared both sides usually realised they had chosen an unwise strategy!
The fact that (1 – x) was a factor caused some problems. Some candidates who cancelled this factor never gave x = 1 as a solution, which caused trouble in part (b), and of those who did not cancel few realised that x = 1 was not a solution when x < –2.

In this question presentation was sometimes poor and often there were mistakes in the algebraic manipulation, and writing –x + 2 for $|x + 2|$ when x < –2 was also frequently seen. Candidates who considered critical values frequently left x = –2 as a solution to the equation, and again caused some confusion when answering part (b).

Marks gained in part (b) were usually very dependent on the competence of the work in part (a), and frequently unrealistic results were seen. For many candidates the given diagram did not prove as helpful as intended, but of those that did use the diagram some redrew it, which was not a particularly good use of their time.

Although the question had stipulated an algebraic solution to part (a) this was not the case in part (b) and so graphical calculator solutions were accepted, and it was not unusual to see some totally correct answers to part (b) following unrelated work in part (a).

Question 6

This question was almost universally well done, with only part (b) seeming to be less familiar. Candidates are now well prepared for such questions and good complete answers to parts (a) and (c) were the norm. Although part (c), testing knowledge of the Newton-Raphson process, was well done here, it is of some concern that some candidates show no, or very little evidence of their working. It is a dangerous strategy to feed all the data into the calculator because then wrong answers clearly gain no credit; it is advisable to show $f'(x)$ and relevant numerical intermediate results as often marks may then be gained if the final answer is incorrect.

Question 7

There is no doubt that part (a) proved the most challenging and least productive question for most candidates; with so many different approaches presented and so much work to sift through it was a challenge for Examiners too.

Although some candidates were not able to make any headway at all, the first method mark was often gained. The suggested starting point was y = $\frac{1}{x^2}$, but many candidates preferred to differentiate $x=\frac{1}{\sqrt{y}}$ or $x^2 = \frac{1}{y}$ implicitly with respect to t; some even used $x^2 y = 1$ as their start. The routes taken from thereafter were various, requiring different levels of manipulation to make much headway and a fully complete solution was rare; this certainly "differentiated" at the top end. The mark scheme was generous in the sense that four of the marks could be gained for a perfectly correct second order differential equation relating the three variables, but only the most able gained all four marks. Even those candidates who realised they had to differentiate a product often made such errors as thinking $\frac{d^2y}{dt^2} = \frac{d^2y}{dx^2}.\frac{d^2x}{dt^2}$ or omitting a term, such as writing $\frac{d}{dt}\left(-\frac{1}{2}x^3\frac{dy}{dt}\right) = \left(-\frac{1}{2}x^3\frac{d^2y}{dt^2}\right) - \frac{3}{2}x^2\frac{dy}{dt}$; the elusive term being $\frac{dx}{dx}.\frac{dy}{dt}$ or $\frac{d^2y}{dt^2}$ or $\frac{d^2x}{dt^2}$, depending on the route taken.

Part (b) was much more standard and although completed well by a good proportion of the candidates, the auxiliary equations $m^2 + m = 0$ *and* $m^2 + 1 = 3$ were seen too frequently, and confusion in the variables often resulted in loss of a mark.

Success in part (c) was a bit dependent on the result in part (b) and a common mistake of writing x = Acost + Bsin t + 3 resulted in loss of marks.
Part (d) was rarely correct. Even candidates who had negotiated parts (b) and (c) correctly usually did not realise that cos t = –1 was the required condition; the most common answers were $\frac{1}{\sqrt{3}}$, using cos t = 0, and $\frac{1}{2}$, using cos t = 1.

Question 8

In part (a) there was some confusion as to whether it was r$\cos\theta$ or r$\sin\theta$, or indeed r, that needed to differentiated with respect to θ. However, many correct solutions were seen, sometimes clearly aided by the given answers for r and θ.
Again this was a challenge to mark as there were so many different approaches with a large number of different correct equations that led to the given results. Some candidates chose to rearrange $r\sin\theta\cos^3\theta$, using either $\sin^2\theta + \cos^2\theta = 1$, or a double angle formula or a combination of both, before they differentiated, and some waited until they had differentiated before making a similar move. Solutions were, therefore, often not as concise as they might have been.

Part (b) was not done well by a large number of candidates, who had little structure to their work. One mark was often awarded, perhaps generously at times, for correct use of the cosine double angle formula, but a complete method was usually only seen from the better candidates. Many candidates spent much time on this part, often producing very unwieldy expressions, and it was not uncommon to see incorrect double angle formulae; $\cos^4\theta = \frac{1+\cos 4\theta}{2}$ was also seen too often.

Many candidates went on to gain marks for integration in part (c) although the downfall here came often in not realising that the first term could be integrated directly, or in giving the result as $\frac{1}{3}\sin^3 3\theta$; that error still allowed candidates to gain 3 marks, however, and that was a common score.

Mechanics Unit M1
Specification 6677

Introduction

The paper proved to be accessible to the majority of candidates and there was no evidence of shortage of time. The first five questions were very accessible but Q6 and Q7 provided some discrimination at the top end. Candidates are still reluctant to explain what they are doing and this does make the examiner's job much more difficult. When a numerical value of g is required, candidates must use 9.8 m s^{-2} ,as advised on the front of the question paper, *not* 9.81 m s^{-2} . Numerical answers which come from the use of a numerical value of g should ideally be given to 2SF and at most 3SF - some candidates are still giving over-accurate answers which will be penalised. Candidates should also be reminded that if a question requires a magnitude, then they should be giving a **positive number** as their answer. If candidates runs out of space in which to give their answer, then they advised to use a supplementary sheet – if a centre is reluctant to supply extra paper then it is crucial for the candidate to say, by specifying a page number, whereabouts in the question paper the extra working is going to be done.
The importance of large, clear and labelled diagrams cannot be over-emphasised.

1 Report on Individual Questions

Question

This proved to be a good starter for the majority of candidates, with most resolving horizontally and vertically, although a few chose to resolve parallel and perpendicular to *P*. Common errors included "24g" instead of "24"and the mixing up of sin and cos. *P* =24sin30 was also often seen. A small number attempted to use a triangle of forces with mixed success.

Question 2

Many candidates found this question difficult, particularly parts (b) and (c). Candidates must be encouraged to state clearly where they are taking moments about and to make use of clearly labelled diagrams, showing relevant forces and distances. In part (a), most candidates took moments about *C* but a significant number resolved vertically and then took moments about *A* to obtain the printed answer. Many candidates, in the second part, did not realise that the reaction at C was now zero, and this meant that they made little progress. The introduction of g was also common and several candidates found the mass of the rock instead of its weight. Candidates who used a new diagram in part (b) and took care to include distances seemed to be more successful than others. Many were able to pick up a follow through mark in part (c) for resolving vertically correctly, using an incorrect value for the weight of the rock. The final part produced a full range of answers, many of which missed the point.

Question 3

In part (a) most candidates knew the method and it was often fully correct but a number failed to find the magnitude of the force in the second part, with some, subtracting the squares of the components instead of adding them. Part (c) was well answered.

Question 4

This was also a good source of marks for many candidates. Most candidates knew to use conservation of momentum in the first part, but there were often sign errors leading to an incorrect value of "12" for *u*. In part (b), diagrams are advisable so that candidates can clearly define direction when using the Impulse-momentum equation. Some candidates threw away a mark for not giving a positive answer, as a magnitude was required. For the final part, most were able to find the acceleration, but often an extra force appeared when applying *F*=*ma*.

Question 5

Successful candidates used appropriate formulae and took care over signs. A significant number used energy methods.

In part (a), many candidates were able to get to the answer using only one equation but many used two or even more and there were many sign errors. These comments apply also in the second and third parts, where candidates often "dived in" and used the first formula that came to mind instead of stopping to think – all three parts could be done using only one equation. Candidates sometimes lost marks due to over-accurate answers being given after using g as 9.8m s^{-2}.

Question 6

Good candidates found this question reasonably straightforward, but many of the weaker ones lost significant numbers of marks because they thought that R = 30g. It was odd that many candidates could get part (a) completely correct but then were unable to make any progress at all with part (b) and didn't appreciate the similarity between them. Some marks were again lost due to over-accurate answers. A clearly labelled diagram in each part made a huge difference.

Question 7

Despite having asked for separate equations of motion for each mass in many previous papers, there were still some candidates who were unable to provide the correct equations. Parts (b) and (c) were generally correct if part (a) was, but there were some problems with over-accurate answers. Only a tiny minority were able to supply the correct answer to part (d). The next part, however, was the best-answered question on the whole paper, with almost everyone getting the two marks. Despite a familiar scenario in the final part, part (f) did provide a good discriminator at the end of the paper, and only the best candidates were able to see their way through to a correct solution.

Mechanics Unit M2
Specification 6678

Introduction

The general impression of the examiners was that the level of difficulty of this paper was comparable with previous years. Questions were generally well answered with some good diagrams and methods clearly shown. Candidates appeared to be well prepared and many completely correct solutions were seen. In spite of this familiar errors of missing g or extra g terms, problems with signs due to confusion over direction of motion, and also of misreading the questions were still seen a significant number of times. Some candidates are losing marks through inappropriate accuracy in their answers or through showing insufficient working. It was disappointing to find a number of candidates unaware that if g = 9.8 is used in a question, then answers cannot be given in the form of fractions or decimals to more than 3 significant figures.

Report on Individual Questions

Question1

Generally well answered but some candidates were confused with the difference between Force and Work. A few failed to give a clear answer to (a) and then used the correct value in (b). Many candidates avoided the work-energy approach in (a), being more confident finding the acceleration and hence the force acting. The use of *F* =   *R* was generally very good.
Some candidates had difficulties with signs – there was a lot of fudging of answers to achieve positive values for "work done" and for the coefficient of friction. Accuracy was an issue here. The use of g meant that answers had to be given to 2 or 3 significant figures and no more.

Question 2

A significant number either misread the question or failed to appreciate that the car was moving downhill with resistive forces acting in the opposite direction. This led to a number of sign errors. Despite being asked to give the answer to (a) in kW, a number of candidates left the answer in Watts. Missing forces - usually the component of weight – was a common error. A few candidates appreciated that their working from (a) was relevant in (b), but the majority started afresh, often including forces in one part that they overlooked in the other. Some candidates appeared not to realise that the car was still moving down the hill in (b). Having found a value for the acceleration, most candidates used a valid method to find the value of *T*, although several did this in two stages, having failed to spot that they could use $v = u + at$. Some candidates lost marks carelessly here by misquoting formulae (e.g. $v^2 = u^2 + 2at$). Candidates need to be careful with signs – a few ended up with equations which gave a negative time and then ignored this to give a positive answer.

Question 3

Many candidates reached for calculators in this question – it was unusual to see the simplified form (9 : 1 : 8) for the ratio of areas. Despite this, many solved the problem successfully. The most common error was in failing to subtract the area of the disc removed in the moments equation or in failing to subtract the moment of the disc removed. Candidates did not always choose to take moments about A, but many correct solutions were seen. A minority of candidates were either searching the formula booklet for inspiration or confused by more advanced work that they have studied, and attempted to use the formula for centre of mass of a sector of a circle. Candidates generally scored either full marks or no marks for (b). Some tried to bring in the areas from (a) and ended up with dimensionally incorrect equations that earned no marks. Several chose to take moments about a different axis and then usually neglected the reaction at the pivot.

Question 4

Many scored full marks in (a) and (b). It was pleasing to see that most used correct methods for momentum and impact law equations but disappointing to see a number of sign and arithmetic errors. Parts (c) and (d) proved to be more challenging. It did not help that some candidates confused themselves by giving every unknown speed the same name. Part (c) required the use of two correct equations solved simultaneously and many successfully showed that $e = \frac{3}{4}$. In (d) marks were often lost through poor explanation. For the final mark a clear statement backed up by a comparison of speeds was required.

Question 5

Some candidates were confused about the nature of contact forces and tried to introduce extra forces at either end of the string, but on the whole it was pleasing to see few such errors and many completely correct solutions. Common errors were in incorrect resolution with confusion between sine and cosine components, missing g in the weight terms and occasionally a failure to include distances in moments equations. Some candidates were baffled by the reaction at the wall and its link to friction – their answers suggested a relationship of the form (horizontal force) = μ x (vertical force) rather that an equation linking friction and the normal reaction.

Question 6

Candidates were confident in their solutions to this question with many scoring all but the last mark. It was pleasing to see much competent use of calculus and vector mechanics. Only a few failed to include a constant in working towards the given solution for (b). It was disappointing to find candidates with an incorrect answer in (b) attempting to fudge the given answer rather than look for the error in their working. Attempts to find the impulse $\boldsymbol{Q}$ were usually correct, but several candidates with a correct $\boldsymbol{Q}$ did not go on to find the magnitude. Errors in $\boldsymbol{Q}$ were often due to arithmetic errors in the subtraction, but some candidates did omit the mass. In (d), many candidates failed to score the final mark. There appeared to be little appreciation of the actual angle required, even from some candidates who had drawn a correct diagram.

Question 7

This proved to be the most challenging question. Although it looked as though some candidates had run out of time to complete this question satisfactorily, others had sufficient time to make multiple attempts. Some candidates failed to appreciate the nature of velocity direction and tried to use equations for constant acceleration without taking direction into consideration. The most successful way to answer the first part was to use the method suggested - conservation of energy. In (b) some failed to appreciate that the velocity at C was at an angle (not necessarily equal to .. and that the horizontal velocity at A was constant throughout. Few candidates answered this concisely. The greatest difficulties were encountered in (c). A significant number of candidates failed to appreciate the use of displacement in constant acceleration equations and broke up the problem, quite unnecessarily, into sections where the particle was travelling up and then travelling down, making the solution of the problem much more difficult than it needed to be. There are several possible approaches to this question, some of them producing pleasingly concise solutions.

Mechanics Unit M3
Specification 6679

Introduction

The paper was found to be accessible with plenty of places available for candidates to be able to show what they could do. More testing parts of questions, which acted as good discriminators, were to be found in Q4(d), Q5(b) and Q7(b).

Candidates seemed to find the space allotted in the answer booklets sufficient for their attempts, and there was little problem of candidates continuing answers for one question in the space allotted for another. Standard of presentation was however generally quite poor, with working often presented in a rather scrappy and unclear way.

Report on Individual Questions

Question 1

This proved to be a friendly starter question for almost all candidates and virtually all used the correct form of the expression for the acceleration in part (b) and integrated successfully. The initial conditions were also generally accurately applied, with only a few attempting to use a possible value for v when $x = 0$. In part (a), some explanations were not clear, and the most common cause for the loss of the mark was when candidates simply stated what would be happening after $x = 30$, and said nothing about the situation when $x < 30$.

Question 2

This tended to be often an all-or-nothing question. Several gained full marks, but others could not get started. Others too, could find the position of the centre of mass of the cone, but did not appear to realise that this must be vertically below the point *A*.

Question 3

Some excellent solutions were seen here with many gaining full marks. Of those who did not, some made a small slip in the processing (or occasionally in the signs of the work-energy equation, though such mistakes were rarer than might have been expected); weaker candidates made more fundamental errors, e.g. equating energy with force.

Question 4

Parts (a) and (b) were generally well done with the relevant principles clearly well known, and part (c) caused little problem. In part (d), only the better candidates realised that the particle still had some speed at its highest point, and several simply assumed that they had to find when it came to rest (which it never does!).

Question 5

Parts (a) and (c) were generally well done. In part (b), a fully justified derivation of the given answer was only rarely seen. Most assumed that they could put the maximum value of $\sin\theta = 1$ directly into the expression obtained in (a) without any more discussion.

Question 6

The principles here were generally well known. Mistakes occurred in part (a) with the accuracy of the integration concerned, several dropping factors involving the fractions. And in part (b), a number of candidates failed to realise that the integral they had calculated in part (a) was not necessarily the mass of the solid (especially when they had cancelled out a factor earlier).

Question 7

Part (a) was almost universally correct. Part (b) caused considerable problems: many assumed that they could find the acceleration as a (unspecified) 'a', and that if they showed that this was equal to '$-196x$' they had succeeded in showing that the motion was SHM. Such candidates failed to realise that any acceleration given as an unspecified a needs its direction clearly specified. Hence, without the use of an expression for $\ddot{x}$ as equal to $-196x$, they could make no progress. Weaker candidates also failed to see that the equation of motion had to include the weight as well. In parts (c) and (d) a common mistake was effectively to assume that the particle came to rest at the end of an oscillation within the simple harmonic motion. Nevertheless, more able candidates were able to complete the question accurately and overall, this proved to be a good discriminating question for the final one on the paper.

Statistics Unit S1
Specification 6683

Introduction

This paper was accessible to all the candidates and there was no evidence of a shortage of time. There was an issue over the layout of Q4 and some evidence that some candidates did not see parts (f) and (g) if they had turned the page. Many candidates actually answered the whole question on page 11 and still did not answer these two parts, but for some candidates it may have been an issue. The examiners were aware of this matter at the awarding stage and will try and avoid a similar situation arising in the layout of future papers.
There were a number of questions on this paper requiring a comment or interpretation and most candidates tackled these with some success. The examiners note with concern though that the use of notation for probabilities (in Q2) and the normal distribution (in Q7) together with the calculation of the standard deviation (in Q4 (c)) were not always handled well.

Report on Individual Questions

Question 1

Most candidates knew how to carry out the required calculations in parts (b) and (c) and these were usually completed accurately and with suitable working shown. Although the majority gave an answer of £17 in part (a) £60 and £-3 were sometimes seen. The coding on the variable *m* also caused some confusion with candidates using a value of 261 for $\sum m$ and then trying to combine this with the sums of squares given in the question.

In part (d) most knew that the correlation coefficient remain unchanged but some thought the value should be increased by 20 and a few candidates found new values of $\sum m, \sum m^2$ and $\sum tm$ and then seemed surprised when their correlation coefficient was unchanged. In part (e), the commonest response was to simply state that 0.914 represented strong positive correlation whilst 0.178 was weak correlation rather than attempting to interpret the values in terms of time spent shopping and amount of money spent as required. There were a number of sensible practical suggestions offered in response to part (f).

Question 2

The demand to draw a tree diagram in part (a) was probably a help to some candidates who may not otherwise have been able to get started. Part (a) was usually answered very well but a few did not interpret the conditional probabilities correctly and $P(D|A)$ was sometimes given as $\frac{3}{35}$ instead of 0.03. Sometimes $P(D \cap A)$ was confused with $P(D|A)$. Part (b) was answered well, especially part (i), although sometimes in part (ii), we saw the sum of the conditional probabilities instead of the intersections. Part (c) proved to be more of a discriminator. The correct formula was rarely quoted and even when it was seen the substitutions were often incorrect.

Throughout this question the use of correct notation was often poor: $P(C|D)$ was readily confused with $P(D|C)$ and $P(B \cap D)$ was often replaced with $P(B|D)$. It was also surprising to see how many candidates worked with percentages throughout; sometimes this led to a loss of marks if values marked on the tree diagram were not probabilities.

Question 3

There were many fully correct solutions to this question and the ideas and techniques were clearly understood well. A few candidates misinterpreted the inequalities in part (b) and some worked throughout in decimals rather than fractions and this led to errors usually in parts (c) and (d). Some candidates did not actually carry out their calculations in part (d), they simply assumed that 21.97 $-(4.47)^2$ would give them 1.97 and failed to appreciate that at least 4sf were required to obtain the printed answer. Part (e) was where most errors occurred though. Those who knew the correct formula usually obtained the correct answer, but there were a number who tried $2^2\,\text{Var}(X)$ and some who did not know how to deal with the minus sign.

Question 4

This question caused problems for many candidates. Part (a) did not always generate a comment about the skewness of the data and many who did eventually mention skewness thought it was negative. The calculation of the median in part (b) often caused difficulties. An endpoint of 19.5 was often used, but some thought the width was 9 not 10 and many simply opted for the midpoint of 24.5. The calculation of the mean in part (c) was sometimes the only mark scored by the weakest candidates and the examiners were disappointed at how many candidates were unable to find the standard deviation. Aside from the usual error of missing the square root or failing to square the mean, a number were using formulae such as $\sqrt{\frac{\sum fx^2}{\sum fx}}$. Most scored some marks in part (d) for attempting to use their values in the given formula, but the final mark required an answer accurate to 3 sf and this was rarely seen. In part (e) many failed to comment on the sign of their coefficient and there was often a discussion of correlation here rather than skewness. Of those who attempted the last two parts, part (g) was often successful, but in part (f), candidates often chose the mean because it used all the data rather than the median, which wouldn't be affected by the extreme values.

Question 5

Parts (a) and (b) were not answered well. Few mentioned the type of variable in part (a) and in part (b) many simple stated that the frequency equals the area rather than stating that it was proportional to the area.

Many were able to give a correct calculation in part (c) but they sometimes failed to state that the 0.8 related to each individual child; the question was a "show that" and a final comment was required. The calculation in part (d) was usually correct.

Question 6

Despite the unusual nature of this question it was encouraging to see most candidates having a reasonable stab at answering it. Most could come up with a reason or two in part (a) "quicker and cheaper" being the most common answer for 1 mark. In part (b) there were many good answers and a number of candidates realized that experimental data was needed at some stage and that the model may need refinement.

Question 7

Apart from the small minority who used σ^2 or $\sqrt{\sigma}$ in their standardization, this part of the question was answered well. A common mistake in part (b) was to think that $P(X < k + 100) = 0.2090$. The use of notation was often poor (with z values and probabilities often being equated) but many were able to find 0.7910 (from 1 – 0.2090) and often they also found $z = 0.81$ although a few rounded the 0.2090 to 0.20 and used $z = 0.8416$ from the table of percentage points. A number failed to standardize correctly and left the answer as $k = 112.5$ and others forgot that k was required to the nearest integer and left their answer as $k = 12.15$. Overall though this question was answered quite well.

Statistics Unit S2
Specification 6684

Introduction

The examination paper was accessible to all but a very small number of candidates and the majority were able to make a reasonable attempt at all the questions. The later questions discriminated between the good and the weaker candidates and it was encouraging to see a large number of completely correct solutions to all questions.

Reports on Individual Questions

Question 1

This relatively simple start caused problems with many candidates scoring 0 or 1 mark. In part (a) less candidates were able to provide both elements of the correct answer, clearly showing that they had failed to learn the basic required definition. Some of the candidates who correctly stated that a statistic could not contain unknown parameters in part (a) then stated that (ii) was a statistic in part (b) despite including the unknown μ.

Question 2

This was usually completely correct with very few errors.

Question 3

Many candidates achieved full marks for this question, demonstrating a good understanding of, and ability to use the binomial distribution and its approximation by the normal distribution. Part (a) was usually answered well with candidates either using the formula or tables. Weaker candidates still failed to appreciate that $P(X=5) = P(X\leq5) - P(X\leq4)$. A common problem for weaker candidates in part (b) was to translate the concept of 'more white than coloured' into a correct probability statement. Of those that correctly stated that $P(X\geq7)$ was required, a few were unable to equate this with 1- $P(X\leq6)$. In part (c) a common error was to use the original p=0.45 rather than the carried forward solution to part (b). Most of those identifying the correct distribution had little problem in calculating the probability accurately. The increasing number of candidates that are able to make a sensible attempt at a normal approximation to a binomial distribution suggests that there is an encouraging awareness of the importance of approximations from simple distributions. Most candidates calculated the parameters correctly here and were able to standardise using a continuity correction, although there is still an appreciable number who omit to use the 0.5 correction. A common error was to forget the $1 - \Phi(z)$ and stated $\Phi(z)$ as their solution.

Question 4

It was disappointing to find that a large number of candidates failed to attain both of the first 2 marks available. These were often the only marks lost by some, since the majority of candidates achieved most or all marks. In part (d) most candidates did attempt an approximation, although a minority calculated an exact binomial. Again, the common errors were to fail to use a continuity correction and the standard deviation when using the approximation and then not using the $1-\Phi(z)$. The simple calculation of 16 x the answer to part (d) was performed correctly by the majority of candidates attempting this part of the question. A common error was to attempt a binomial probability.

Question 5

The first two parts of this question caused more difficulties for candidates than the later parts. Standard calculations for a uniform distribution are well understood but applying them to a problem caused difficulties for weaker candidates. Stronger candidates had little problem with part (a) but others failed to give a full statement, missing either the values outside the range of the interval or the ranges for the different parts of the density function. In part (b) only better candidates were able to state correctly, and then solve, the two simultaneous equations. In the final part many candidates found $P(X<30) = 0.2$ but then failed to double this. A common alternative solution was to use the interval $0<x<75$.

Question 6

Weaker candidates found this question difficult and even some otherwise very strong candidates failed to attain full marks. Differentiating between hypothesis testing and finding critical regions and the statements required, working with inequalities and placing answers in context all caused problems. In part (a) a large number of candidates were able to state the hypotheses correctly but a sizeable minority made errors such as missing the p or using an alternative (incorrect) symbol. Some found $P(X=2)$ instead of $P(X\leq2)$ and not all were able to place their solution in the correct context. Not all candidates stated the hypotheses they were using to calculate the critical regions in part (b). In a practical situation this makes these regions pointless. The lower critical region was identified correctly by many candidates but many either failed to realise that $P(X\leq8)=0.9786$ would give them the correct critical region and/or that this is $X\geq9$. The final part was often correct.

Question 7

There has been a steady improvement over the years in candidates approach to the questions using given distributions. Weaker candidates are still prone to confusion, but many are able to identify and use the formulas for mean, median and mode correctly. In part (a) most candidates attempted to substitute 0.3 into the given cumulative distribution function but some did not take their answer from 1 to achieve the correct solution. Many candidates substituted the 2 given values in part (b) correctly but not all explained fully why this demonstrated that the median lay between them. When a solution is suggested, then care should be taken that an adequate clear explanation is given. The correct derivative was stated by many candidates in part (c) but some failed to give a full statement of the distribution, missing either the limits or the regions outside the given interval. Integrating $x\mathrm{f}(x)$ correctly and using the limits caused problems for weaker candidates in part (d). A small but appreciable number also made the statement that $16/12-9/12 = 5/12$. Not all those who differentiated the probability density function placed the differential equal to 0 to obtain the mode. Those who did so usually attained the correct solution. Nearly all candidates who attempted the final part of the question compared at least 2 of the mean, median and mode. The majority who had calculated these correctly were able to identify the skew as negative.

Decision Mathematics Unit D1
Specification 6689

Introduction

The paper proved accessible, and each question had parts accessible to all. Most candidates were able to make some attempt at all of the questions and good attempts at the more accessible questions. The work was generally well-presented and efficient methods of presentation were more common on most questions.

This paper has now moved to the ePEN system and consequently, candidates should be aware that colours are indistinguishable. This is particularly pertinent when answering the matchings question. Despite the reminder printed at the top of Q2, on page 4 of the answer booklet, some candidates made reference to the 'blue' or the 'red' lines. It is recommended that candidates use alternative notation, e.g. wavy, dotted, dashed lines to replace colour.
Candidates are recommended to complete tables and diagrams in dark pencil.

Candidates sometimes wasted time doing unnecessary work on Q4 - Q6, which may have caused time difficulties later in the paper.

Report on Individual Questions

Question 1

This proved a good starter question for the candidates with many gaining full marks. Some candidates were inconsistent in their pivot choice, the specification requires that they round up. Some incorrectly retained the pivot each time – often leading to a situation where they selected Nicky twice, once as the first pivot and once as the final pivot. Some candidates insisted on placing Nigel in the list – or locating the position in which Nigel should be added to the list. The binary search algorithm is both used to locate an item in the list and to demonstrate its absence. A few candidates confused binary search and quick sort.

Question 2

Some candidate ran out of space here and continued the question elsewhere. Most candidates were able to list the correct alternating path but a substantial number omitted to change status. Many did not list the improved matching in part (a). Part (b) was often very well done, but some candidates were not specific enough. In part (c) many candidates did not take into account their first alternating path when seeking their second.

Question 3

This question proved a good source of marks for very many candidates, but some candidates did not make much progress in parts (b) and (c). A VERY wide variety of responses were seen to part (a), covering most of the terms used in the applied mathematics, but the vast majority of candidates submitted an answer which at least resembled the word 'bipartite'. The most common error in (b) was failing to return to A; in some cases indeed it was impossible to do so. If candidates redrew the graph with the Hamiltonian cycle as a polygon, they were usually able to gain full marks. A disappointingly large minority did not redraw the graph and were unable to make progress.

Question 4

Most candidates were able to make good progress in part (a) and many gained all five marks. Some candidates made no attempt at the question. Some candidates incorrectly selected the 2 in the z column as their pivot – this leads to a negative value appearing as a basic variable and should act as an alarm call. A number of candidates did further iterations to find an optimal tableau, wasting time. Part (b) was often poorly done – with either P or 400 omitted, or two equal signs or sign errors. Part (c) was often well answered, although some candidates referred to a profit column, or y values, or to the profit equation in a confused manner.

Question 5

Whilst some very good, concise answers to (a) were seen, the majority of candidates had great difficulty, the use of technical terms was poor with many confusing vertices and edges. Many made reference to the handshaking lemma but then did not explain its relevance or made contradictory statements. Part (b) was often well done, although some candidates did not consider all three pairings of the odd vertices. Many candidates did not spot that the shortest route between C and D was via A. Some candidates wasted time seeking a route, when only the length was required.

Question 6

Most candidates knew that the dotted lines represented dummies, and candidates are better able to explain their purpose, but many candidates did not refer to the specific activities involved and tried to explain in terms of events, this was rarely successful. Most candidates completed part (b) correctly although there were a worrying minority that had two different values in the boxes at the final event. Some candidates wasted time calculating the total float for each activity in (c). Many incorrect total float calculations were seen, candidates MUST show their working here if they are to gain full credit. As always a few candidates found the sum of their total floats. Most candidates were able to find ‘a path’s worth’ of critical activities in part (d), but many omitted K, or included G. Most candidates were able to calculate a correct lower bound for the number of workers in part (e), but a surprisingly large minority divided 95 by 13, the number of activities. Disappointingly having discovered that 3 was the lower bound, many candidates used four workers in part (f). Some candidates drew a cascade (Gantt) chart instead of a scheduling diagram. Usually candidates were able to place the critical activities correctly – although K was often placed too early, but there were the usual errors to do with duration, precedence, omission and duplication of activities. Some of the scripts were very difficult to mark because of faint writing, lack of clarity of writing, the size of the letters, the boundaries between the activities being indistinguishable from the grid, heavy shading over the activities and so on.

Question 7

Parts (a) and (b) were often well-answered, the commonest error was imprecise use of language, especially use of the phrase ‘between 2 and 10’, without the word ‘inclusive’. Although there were the usual sign reversals and some strict inequalities seen, part (c) was often well-answered with the large majority of candidates successfully finding the first inequality. The second inequality proved more difficult, with the 2 often on the wrong side. Most candidates were able to draw $2x + 3y = 24$, but there was confusion (both ways) between $x = 2y$ and $y = 2x$. Some candidates made shading errors and even the best rarely followed the instructions to label the feasible region. Candidates MUST show their working when seeking maximum and minimum points. There was often no evidence of any method being used. If candidates use the point testing method, they should state the points they are testing and the result of the test, if they are using the ‘profit line’ method, they must draw in a clearly labelled profit line – and this must be long enough for examiners to confirm the accuracy of the gradient. Some candidates tested their point using the cost equation rather than simply totalling the number of passengers. Many candidates simply stated the maximum and minimum totals rather than the number of adults and number of children, many included 10 children despite having demonstrated in parts (a) and (b) that they understood that the maximum was 9.

Question 8

The great majority of the candidates were able to secure the first four marks, for parts (a) and (b). The arcs were usually labelled correctly with 2 values. Where these were incorrect, zeros often appeared. Candidates frequently obliterated or modified existing values, thus rendering them difficult or impossible to discern. The initial flow was correctly identified by most as 103, and the flow-augmenting route SBEGILT with flow 3 was a popular choice, at which point the question finished for a great number of candidates. All the remaining flow-augmenting routes involved backflows and many candidates were unable to make progress, even though it was stated in the question that they should be seeking to increase the flow to 124. Those who did understand the use of backflows were usually able to find correct flow-augmenting routes, with the odd arithmetic slips seen. Few candidates, even those who found correct routes to 124 were able to draw a correct flow in part (d), the commonest slip was to have a flow of 5 from D to E. Only a very few were able to link the maximum flow with a correct minimum cut.

Grade Boundaries

January 2007 GCE Mathematics Examinations

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

Subject Number	Grade Boundaries				
	80	**70**	**60**	**50**	**40**
6663	61	53	45	37	29
6664	62	53	44	35	27
6665	58	50	42	34	27
6666	58	51	44	37	31
6674	56	50	44	38	32
6677	62	54	46	38	30
6678	65	55	46	37	28
6679	56	49	42	35	29
6683	61	54	48	42	36
6684	66	58	50	42	34
6689	54	46	39	32	25

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