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Examiners' Report January 2008

GCE

GCE Mathematics (8371/8373,9371/9373)

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Core Mathematics Unit C1
Specification 6663

Introduction

In general, this paper gave candidates ample opportunity to demonstrate their knowledge, understanding and ability. There were some easily accessible marks for routine work and standard techniques, while some parts of questions proved particularly challenging to all but the ablest candidates. Standards of algebraic and arithmetic manipulation were sometimes rather disappointing, commonly resulting in the loss of accuracy marks in some questions.

A major concern was candidates' failure to use brackets in algebraic expressions. This was particularly evident in Q7(b) and Q10(b). Fortunately, the form of answer required was given in both of these questions, enabling candidates to score full marks more often than not. Candidates should be encouraged to use brackets where necessary, and should realise, for example, that $1+p(1+2p)$ is not an acceptable alternative to $(1+p)(1+2p)$. Most candidates appeared to have adequate time to attempt all eleven questions.

In most cases there was sufficient space on the paper for solutions to be completed appropriately, although some solutions to Q4 spilled over onto the Q3 space or required a supplementary sheet. A particular concern is that spare space on the paper is sometimes used for 'rough' working. This is not good practice, since such working can easily be missed by examiners (and could occasionally be worthy of marks). Candidates should be advised to show all working, 'rough' or otherwise, in the space allocated for the question.

Standards of presentation were generally quite good, but as always some candidates penalise themselves by not showing their methods and working clearly. As mentioned in previous reports, it is good practice for candidates to quote a formula first before beginning to substitute values.

Report on individual questions

Question 1

Candidates answered this question well, with almost all of them recognising that integration was needed. A few were unable to integrate the 7 correctly and some omitted the constant of integration, but otherwise it was common to see full marks.

Question 2

Although many candidates obtained the correct answer in part (a), they were usually unable to use this to find $(16x^{12})^{\frac{3}{4}}$ in part (b). Even very good candidates tended to score only one mark here, with the most common incorrect answers being $16x^9$ and $12x^9$. Other wrong answers included those in which powers had been added to give $x^{\frac{51}{4}}$. Very confused algebra was sometimes seen.

Question 3

There were many completely correct solutions to this question. The majority of candidates knew the correct method of multiplying the numerator and denominator by $\left(2-\sqrt{3}\right)$ and many were correct in the arithmetic manipulation. Some multiplied incorrectly by $\left(2+\sqrt{3}\right)$ or by $\left(5+\sqrt{3}\right)$. A number of candidates were unable to square √3 correctly and it was disappointing to see marks lost though careless arithmetic. Only a small minority of candidates had no idea of how to start.

Question 4

In part (a), it was good to see many candidates quoting a formula for the gradient and so earning a method mark even if they made an arithmetic slip. Careless simplification of the gradient, for example $\frac{-7}{14}=-2$, was sometimes seen. Many candidates also quoted and used a correct formula for the equation of the straight line, but the requirement for the final answer to be in the form $ax+by+c=0$, with integer values of *a*, *b* and *c*, was overlooked by many. Others, particularly those starting with $y=mx+c$, made arithmetic errors and thus lost the final mark.

In part (b), most candidates knew the formula for the distance between two points but it was not always quoted. Despite occasional confusion with minus signs the correct answer was often seen, although there were sometimes mistakes in squaring 14 and problems in simplifying √245.

Question 5

Most candidates were successful in finding at least one correct term from their division in part (a), but mistakes here included dividing only one term in the numerator by *x* and multiplying by *x* instead of dividing. Just a few seemed unaware that √*x* was equivalent to $x^{\frac{1}{2}}$.The vast majority who scored both marks (a) went on to score full marks in part (b). Much of the differentiation seen in part (b) was correct, but occasionally terms were not simplified. Some candidates failed to cope with the differentiation of the 'easier' part of the expression, $5x-7$.

Question 6

In part (a), most candidates knew that a stretch was required. It was common to see full marks scored, although the final mark was sometimes lost because the maximum was not labelled. A common wrong answer for the maximum was (4, 10) instead of (2, 10). Other mistakes included stretches in the *x* direction instead of the *y* direction and stretches with scale factor $\frac{1}{2}$ instead of 2.

The most common mistake in part (b) was to reflect in the *x*-axis instead of the *y*-axis (scoring just 1 mark out of 3). It was not unusual in this part to see the required points carelessly mislabelled with minus signs omitted. Many candidates did not answer part (c), but for those that did there were several common wrong answers, particularly 5, –2 or 3.

Question 7

Although just a few candidates failed to understand the idea of the recurrence relation, most managed to complete the first two parts successfully. A major concern in part (b), however, was the widespread lack of brackets in the algebraic expressions. It was usually possible for examiners to interpret candidates' intentions generously, but there needs to be a greater awareness that, for example, $1+p(1+2p)$ is not an acceptable alternative to $(1+p)(1+2p)$.

The given answer to part (b) enabled the vast majority of candidates to start part (c) correctly, but the main problem with this part was in solving $2p^2+3p=0$, which proved surprisingly difficult for some. Attempts to complete the square usually failed, while the quadratic formula method, although generally more successful, often suffered from mistakes related to the fact that *c* was zero. Those who did manage to factorise the expression sometimes gave the answer $p=\frac{3}{2}$ instead of $p=-\frac{3}{2}$. It was clear that candidates would have been much happier solving a 3-term quadratic equation. Those who trivialised the question by giving only the zero solution (despite the condition $p>0$) scored no further marks in the question.

Part (d) proved challenging for many candidates. Some used the solution $p=0$ and some tried to make use of the sum formula for an arithmetic series. Few candidates were successful, but those who wrote out the first few terms were more likely to spot the 'oscillatory' nature of the sequence. Good candidates stated that even terms were all equal to $-\frac{1}{2}$ and therefore the 2008th term was $-\frac{1}{2}$. Quite a large number of candidates were able to express x_{2008} in terms of x_{2007}, but those who simply substituted 2007 into one of their expressions often wasted time in tedious arithmetic that led to a very large answer.

Question 8

Although those candidates who started part (a) correctly were usually able to derive the required inequality, many were unsure of what was required here. A substantial number of candidates failed to form a three term quadratic equal to zero before attempting to write down the discriminant. Weaker candidates simply wrote down the discriminant of the given quadratic expression in *k*, or perhaps solved the quadratic in *k* to find the critical values required for part (b). Some candidates substituted $k=x^2+kx+8$ into $k^2+4k-32<0$ and proceeded to waste time in producing some very complicated algebra.

In part (b), most candidates were able to find the critical values but not all offered a solution to the inequality. Many of those who found the correct set of values of *k* did so with the help of a sketch. The most common incorrect critical values were -4 and 8 (instead of -8 and 4). Some candidates lost the final mark because their inequalities $k>-8$, $k<4$ were not combined as $-8<k<4$. Generally, however, part (b) was well done.

Question 9

Most candidates realised that integration was required in part (a) of this question and although much of the integration was correct, mistakes in simplification were common. Not all candidates used the (4, 1) to find the constant of integration, and of those who did, many lost accuracy through mistakes in evaluation of negative and fractional quantities. Occasionally $x=4$ was used without $y=1$, losing the method mark. Evaluation of the constant was sometimes seen in part (b) from those who confused this constant with the constant *c* in

$y = mx + c$. Those who used differentiation instead of integration in part (a) rarely recovered.

In part (b), while some candidates had no idea what to do, many scored well. Some, however, failed to use the given $\mathrm{f}'(x)$ to evaluate the gradient, and others found the equation of the tangent instead of the normal.

Question 10

For the sketch in part (a), most candidates produced a cubic graph but many failed to appreciate that the minimum was at (1, 0). Often three different intersections with the *x*-axis were seen. More often than not the intersections with the *x*-axis were labelled but the intersection at (0, 3) was frequently omitted. A sizeable minority of candidates drew a parabola. Many unnecessarily expanded the brackets for the function at this stage (perhaps gaining credit for the work required in part (b)).

The majority of candidates scored at least one mark in part (b), where the required form of the expansion was given. The best approach was to evaluate the product of two of the linear brackets and then to multiply the resulting quadratic with the third linear factor. Some tried, often unsuccessfully, to multiply out all three linear brackets at the same time. Again, as in Q7, the omission of brackets was common.

Although weaker candidates sometimes failed to produce any differentiation in part (c), others usually did well. Occasional mistakes included not equating the gradient to 3 and slips in the solution of the quadratic equation. Some candidates wasted time in unnecessarily evaluating the *y* coordinates of the required points.

Question 11

Most candidates knew in part (a) how to use the term formula for an arithmetic sequence. Some, effectively using $a + nd$ instead of $a + (n-1)d$, reached the answer -7.5 instead of -6, while the omission of a minus sign was a surprisingly common mistake, leading to $30 + 36 = 66$ instead of $30 - 36 = -6$.

In part (b), many candidates equated the correct expression to zero to score the method mark, but mistakes in calculation were very common. Dividing 31.5 by 1.5 sometimes caused problems. Other approaches, such as counting back from the 25th term found in part (a), were sometimes successful.

Few students seemed to fully appreciate the connection between part (b) and part (c) but those who did invariably scored all the marks. Many ended up trying to solve an equation with two unknowns (S_n and *n*) or assumed that S_n was zero, which led to the commonly seen, incorrect $n = 41$. Many candidates seemed completely confused by part (c) and made no real progress. In the question as a whole, inefficient methods involving ‘listing’ terms were infrequently seen.

Core Mathematics C2
Specification 6664

Introduction

The paper seemed accessible at all levels, with candidates being able to make a start on most questions. Candidates showed a wide range of understanding, from the large number of well presented scripts, showing a good knowledge across all questions, to those candidates displaying a lack of comprehension of the basics, although very low marks were rare. However, despite there only being nine questions, there was a significant number of blank, or minimal, responses to the final question, suggesting that lack of time may have been a factor.

Q1, Q2, Q3(a), Q4, Q6, Q7 and Q9 (time permitting) all proved a reasonable source of marks, but to gain full marks on most of these questions did required a good understanding. Q5 proved taxing, and exposed weaknesses in this area, and Q8, particularly part (b), caused problems.

Often there was a lack of awareness of the magnitude of some answers displaying a rather mechanical approach to problem solving. A few examples are: giving an answer to Q2(c) less than 90, when a and r were both positive and the two given terms were 10 and 80; giving an answer greater than 700 in Q6(a); in Q9(b) giving a negative value of x. Checking the work may easily have added more marks.

Examiners would like to highlight again the "Advice to Candidates", that "Answers without working may gain no credit". There were cases on this paper where answers only were seen, with no working at all, to questions which required some reasoning shown. It is a good strategy at all times to show working but to see answers only in Q7(b), Q8(c) and Q9(b) was unexpected, and was considered unreasonable.

Report on individual questions

Question 1

The fact that $(x + 2)$ and $(x - 2)$ were both factors of the cubic was unfortunate and examiners needed to be eagle-eyed in marking part (a); some candidates clearly evaluated f(2) in answering (a)(ii). There were often arithmetic errors in evaluating f(–2), with 16 being a common answer, and consequently many candidates had not found a factor in (a) and needed to start from scratch in part (b).

Of those candidates who chose to use long division in (a), there was a considerable number who produced $(x + 2)(x^2 - 4)$ in (ii) and then went on to use this in part (b). Although the solutions $x = 2$ and $x = -2$ were then often still found, this was fortuitous and M1A0M1A0 was a common outcome. The most frequent loss of the final mark, however, was for giving the factors, not the solutions, to the cubic equation.

Question 2

This was a straightforward geometric series question and, as the mark scheme was quite generous in parts (a) and (b), most candidates were able to gain some marks. In part (a), the solution of the equations $ar^6 = 80$ and $ar^3 = 10$ often displayed poor algebraic skills, with results such as $ar^3 = 8$, $r^6 - r^3 = 8$ and $r^3 = 70$ too common. The vast majority of candidates stated or used a correct formula in (c), although sometimes $n = 19$ was substituted, and quite often the final answer was not corrected to the nearest integer.

Candidates who found $r = \frac{1}{2}$ in (a) usually went on to find $a = 80$, the same value as seventh term; a quick check of the work might easily have produced more marks.

Question 3

It was pleasing to see that most candidates could make some headway in part (a) and many candidates gained full marks. The usual errors of omitting brackets around $\frac{x}{2}$, and using $\left(\frac{10}{r}\right)$ for $\binom{10}{r}$, were seen, but not as frequently as on previous occasions. It was also common to see the coefficients of powers of x not reduced to their simplest form. Solutions to part (b) were variable, with many candidates not able to find the appropriate value of x to use; frequently 0.005 was substituted into a correct, or near correct expansion expression found in (a). Just writing the answer down, with no working at all, gained no marks.

Question 4

For the majority of candidates part (a) produced 2 marks, but part (b) was variable. Good candidates could gain full marks in (b) in a few lines but the most common solution, scoring a maximum of 4 marks, did not consider the negative value of sinθ. There were many poorly set out solutions and in some cases it was difficult to be sure that candidates deserved the marks given; a statement such as $5\sin^2\theta = 3 \Rightarrow$

$\sin\theta = \frac{\sqrt{3}}{\sqrt{5}}$, so θ = 50.8º, 309.2º, could be incorrect thinking, despite having two of the four correct answers.

Question 5

This was a more unusual question on logarithms, and whilst many full marks were gained by good candidates, this proved taxing for many candidates and one or two marks were very common scores. The vast majority of candidates used the first method in the mark scheme. The most common errors seen were, log3b + logb = log4b and $\log 3b^2 = 2\log 3b$, and marks were lost for not giving answers in exact form. Some candidates made the question a little longer by changing the base.

Question 6

Although this was accessible to all candidates and marks were gained by the vast majority of candidates, it was a little disappointing to see some of the errors made. The fact that BC could not be the largest side of the triangle did not stop answers of over 700m for BC, for example; a quick check of the working might have found the error. The most common mistake in (a), however, was to evaluate 740000 - 700000cos15º as 40000cos15º, and so BC = 197m (3 s.f.) was often seen; it was disappointing to see this error at this level.

In part (b) the most common strategy was to use the sine rule to find angle ABC. For the vast majority of such candidates AC was the largest side of the triangle, but there was a widespread lack of awareness that, therefore, ABC was the largest angle in the triangle. Whilst the good candidate's correctly gave the obtuse angle, the most common answers for angle ABC were 45.7 º or 45.8 º, which resulted in a maximum of 2 marks being available for this part. Candidates who used the cosine rule to find angle ABC, or who found angle ACB first, were much more successful.

Question 7

The first two parts were a good source of marks for most candidates. In part (c), the method of finding the area under the curve and subtracting the area under the line was the more favoured approach. In the majority of these cases the area under the line was found by calculating the area of the triangle rather than integrating, but in either case there was considerable success. Integration of the curve function was usually correct and the biggest source of error was confusion with the limits. It was surprisingly common to see

$$\int_0^6 (6x - x^2)dx - \int_0^6 2x dx$$ (or equivalent), and $$\int_0^6 (6x - x^2)dx$$ [or $$\int_0^8 (6x - x^2)dx$$] – 16

used, and it may be that parts (a) and (b) had in some way contributed to the confusion. Candidates who subtracted the line function from the curve function before integrating often earned the marks quickly, but sign errors were not uncommon. Candidates who used longer strategies were sometimes successful but there was clearly more chance of making one of the errors noted above. Some candidates calculated the area under the curve using the trapezium rule; the mark scheme enabled them to gain a maximum of two marks.

Question 8

Part (a) provided 2 marks for the majority of candidates but it was surprising, as the form was given, to see such "slips" as $(x - 6) + (y - 4) = 9$ or $(x - 6)^2 - (y - 4)^2 = 9$. There were some good solutions to part (b) but this did prove to be quite discriminating: Many candidates did not really attempt it; some actually used the given answer to calculate TP or PM, and then used these results to show that angle TMQ = 1.0766; and a large number of candidates made the serious error of taking TP = 6. It was disappointingly to see even some of the successful candidates using the cosine rule in triangle TMP, having clearly recognised that it was right-angled.

Part (c) was answered much better, with most candidates having a correct strategy. However, there were some common errors: use of the wrong sides in ½absinC; careless use of Pythagoras to give TP = 7 ($\sqrt{40 + 9}$); mixing up the formulae for arc length and sector area; and through inaccuracy or premature approximation, giving answers like 3.51 or 3.505.

Question 9

For the better candidates this was a very good source of marks, but it proved quite taxing for many of the candidates who were able to spend time on the question. In part (a) the $2x^2$ term in the given answer was usually produced but the work to produce $\frac{300}{x}$ was often unconvincing, and it was clear that the given answer, which was an aid for subsequent parts, enabled many candidates to gain marks that otherwise would have been lost. It was common to see steps retraced to correct an initial wrong statement, such as $A = 2x^2 + 4xy$, but sometimes the resulting presentation was not very satisfactory and often incomplete, and the ability to translate "the capacity of the tank is 100m³" into an algebraic equation was quite often lacking.

In part (b) the two most common errors were in differentiating $\frac{300}{x}$, often seen as 300 or –300, and in solving the correct equation $-\frac{300}{x^2} + 4x = 0$. It was surprising, too, to see so many candidates who, having successfully reached the stage $4x^3 = 300$, gave the answer $x = 8.66$, i.e. $\sqrt{75}$.

In part (c) the most common approach, by far, was to consider $\frac{d^2A}{dx^2}$, and although the mark scheme was kind in some respects, it was expected that the sign, rather than just the value, of $\frac{d^2A}{dx^2}$ was commented upon.

The method mark in the final part was usually gained although there was a significant minority of candidates who substituted their value of $\frac{d^2A}{dx^2}$, rather than their answer to part (b), into the expression for A.

Core Mathematics Unit C3
Specification 6665

Introduction

The paper proved accessible to the majority of candidates and nearly all made substantial attempts at every question. The general standard of presentation was good. Most candidates used their calculators sensibly and were able to produce proofs in which the steps of their reasoning could be followed. 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. There seemed to be more candidates than usual whose answers moved outside the area on the pages which is designated for answers and this caused the examiners some difficulties.

Report on individual questions

Question 1

A large number of candidates did not find this a friendly start to the paper, with quite a high proportion attempting the question more than once. There were many who dividing by x^2-1, showed insufficient knowledge of the method, stopping their long division before the final subtraction. Those getting as far as a linear remainder usually obtained the correct values of *a* and *c*, but the remainder was often incorrect. Errors often arose when not using the strategy of replacing $2x^4-3x^2+x+1$ by $2x^4+0x^3-3x^2+x+1$ and x^2-1 by x^2+0x-1. It was not unusual to see candidates who completed long division correctly but who then, apparently not recognising the relevance of this to the question, went on to try other methods.

Most of those who used methods of equating coefficients and substituting values found 5 independent equations but completely correct solutions using these methods were uncommon. Very few decomposed the numerator and, generally, these appeared to be strong candidates. Of those who attempted to divide first by $x+1$, and then by $x-1$, few were able to deal with the remainders in a correct way.

Question 2

In part (a), the majority of candidates were able to handle the differentiation competently and most were aware that their result had to be equated to zero. The subsequent work in part (a) was less well done with relatively few candidates completing the proof. Of those candidates who recognised the need to use the identity of $\sec^2 x = 1+\tan^2 x$, many were unsure what to do with the e^x factor. A common approach to completing this part of the question was to attempt a verification of $\tan x = -1$ by substituting one specific value, $x=-45°$ or $x=-\frac{\pi}{4}$, into their differentiated expression. This gained a maximum of 4 out of the 6 marks, as the examiners wished to see the general result established.

In part (b), candidates that had found $\frac{dy}{dx}$ correctly in part (b) were usually able to find the gradient and proceed to a correct equation. However, a significant number had their tangent passing through (0,1) to give an equation of $y=x+1$. A minority thought that the result $\tan x=-1$ in part (a) implied that the gradient in part (b) was -1.

Question 3

In parts (a) and (c), candidates need to be aware that showing that something is true requires them to give reasons and conclusions. In this part (a), it is sufficient to say that a change of sign in the interval $(2, 3)$ implies that there is a root in the interval $(2, 3)$. In part (c), it would be sufficient to argue that a change of sign in the interval $(2.5045, 2.5055)$ implies that there is a root in the interval $(2.5045, 2.5055)$ and, hence, that $x = 2.505$ is accurate to 3 decimal places.

In part (a), most candidates chose the obvious 2 and 3 and successfully found f(2) and f(3) to gain the method mark.

The majority of candidates now seem comfortable with the method of iteration. Part (b) was particularly well answered with only a minority of candidates making errors, mainly over issues of accuracy.

In part (c) candidates who chose $(2.5045, 2.5055)$ were more often successful than not. Although it is not a wholly satisfactory method, on this occasion the examiners did accept repeated iteration. The candidates were required to reach at least x_6, showing their working to 5 decimal places, which most choosing this method did, and to give a reason why they concluded that the root was accurate to 3 decimal places. This second requirement was rarely met.

Question 4

Most candidates scored well on this question. The mark scheme allowed a fair degree of tolerance so far as quality of sketching was concerned. An occasional problem in marking occurred when candidates used intermediate graphs, all on one set of axes, on their way to their final sketch. When this approach is adopted, it is important to label which curve is the final answer.

In part (a), very few errors were seen. Those seen were largely slips with regard to the signs of coordinates. In part (b), the commonest error was to attempt to reflect into the fourth quadrant rather than the second.

Part (c) caused the candidates a few more problems. They usually got the shape correct but a significant proportion of candidates failed to translate the curve to the left. The evaluation of the image coordinates proved demanding in this part and errors in applying the scaling factor were relatively common. It was surprising that there were substantial numbers of candidates who had both coordinates correct but produced a diagram contradicting this by not translating the curve.

Question 5

This question was well answered by a high proportion of the candidates and completely correct solutions to parts (a), (b) and (c) were common. Virtually all candidates gained the mark in part (a). A few thought the answer was 1000e.

Those who failed to get the correct answer in part (b) often substituted $R = \frac{1}{2}$ instead of $R = 500$. Logs were usually taken correctly but it was perhaps disappointing that a not insignificant number of candidates lost the final mark by failing to give the answer correctly to 3 significant figures. In part (c), most candidates scored the method mark even if they had struggled with part (b). Very few who had a correct value of c failed to go on to gain the second mark.

The graph in part (d) was generally less well done. A common error was to draw a curve of the type $y = \frac{1}{x}$ and this lost both marks. Occasionally candidates had the curve meeting the positive x-axis rather than approaching it asymptotically.

Question 6

Part (a) proved to be the most difficult part of this question. Those who had the foresight to choose the correct identities, produced the correct answer of $4\cos^3 x - 3\cos x$ quickly. Unfortunately many candidates were unable to produce correct double angle identities, or chose an ill advised version, making little headway as a result.

Part (b) produced better attempts with most candidates scoring some marks on this question. It was perhaps disturbing that the error $(1+\sin x)^2 = 1+\sin^2 x$ was not infrequently seen, resulting in the loss of 3 of the 4 marks in this part. Part (c) produced a great many correct solutions, the only consistent errors being a lack of knowledge of radians or the inability to find the angle in the fourth quadrant.

Question 7

In part (a), most candidates were aware that they needed to differentiate the given equation and this was usually done correctly although not always by the quickest method. A few did not know how to proceed from here but the majority that did, generally found the correct gradient of both the curve and the normal and subsequently a correct equation. Almost all candidates scored well on in part (b). However, many candidates lost the final mark as they gave their value of α in degrees, or their answer had come from $\tan\alpha = \frac{3}{4}$.

The majority of candidates treated part (c) as a continuation of part (b), though those that noticed the route via $\tan 2x$ found the answer came out very easily. Most candidates found one or two solutions and, occasionally, a third solution. However obtaining all four solutions was a rare occurrence.

Question 8

Part (a) was generally well done although a few made errors in changing the subject and some left their answers in terms of y. Part (b) was also well done. Very few attempted to combine the functions in the wrong order and most were able to perform the necessary algebra to obtain the printed algebra. In both parts (c) and (d), it was disturbing to see a relatively high proportion of candidates proceeding from $\frac{\text{numerator}}{\text{denominator}} = 0$ to $\text{numerator} = \text{denominator}$. This usually lost 4 marks in these parts. If this error was avoided, part (c) was usually well done, although additional spurious answers, such as $-\frac{1}{2}$ or answers deriving from $1-2x^3 = 0$, were sometimes seen.

It was an advantage to quote a formula for differentiating a quotient in part (d). If slips had been made, it was often very difficult to establish that a correct method had been used. In this case, the denominator was often wrong. Candidates forgot to square the appropriate function or squared the wrong one. Simplifying the numerator caused many problems and the incorrect $30x^2$ was almost as common as the correct $18x^2$. Those who did equate to zero and find a value of x often omitted to find the corresponding value of y.

Core Mathematics Unit C4
Specification 6666

Introduction

The paper was slightly more demanding than most recent Core Mathematics C4 papers but there were still a significant number of questions that were accessible to E grade candidates. There were some testing questions, particularly the vector question and also those questions involving the use of integration that allowed the paper to discriminate well across all ability ranges. Again, as mentioned in previous reports, it was pleasing to see candidates who were comfortable at this level working with exact values in their solutions.

In Q7(b), there was evidence that a significant number of stronger candidates did not spot that the integral needed to be split up as a partial fraction before it could be integrated. Also, only a minority of candidates were able to proceed beyond applying the substitution in Q8(d). Examiners therefore suggest that teachers review candidates' learning of the various integration techniques whilst revising Core Mathematics C4.

In Q4(ii) and Q8(d), it was found that there were some incorrect methods that candidates could use to arrive at the correct answers given on the mark scheme. The mark scheme, however, was designed to ensure that only those candidates who applied correct working would be appropriately credited.

In summary, Q1, Q2(a), Q3, Q4(ii), Q5, Q7(a) and Q7(d) were a good source of marks for the average candidate, mainly testing standard ideas and techniques; and Q4(i), Q6(c), Q6(d) and Q8(d) proved effective discriminators. A significant proportion of candidates, however, were unable to make any progress with either Q4(i) or Q8, 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), some candidates struggled to find either one or both of the y-ordinates required. A few of these candidates did not change their calculator to radian mode. In part (b), some candidates incorrectly stated the width of each of the trapezia as either $\frac{1}{4}$ or $\frac{\pi}{5}$. Nearly all answers were given to 4 decimal places as requested in the question.

Question 2

In part (a), a majority of candidates produced correct solutions, but a minority of candidates were unable to carry out the first step of writing $(8-3x)^{\frac{1}{3}}$ as $2\left(1-\frac{3x}{8}\right)^{\frac{1}{3}}$. Those who did so were able to complete the remainder of this part but some bracketing errors, sign errors and manipulation errors were seen.

In part (b), many candidates realised that they were required to substitute $x = 0.1$ into their binomial expansion. About half of the candidates were able to offer the correct answer to 7 decimal places, but some candidates made calculation errors even after finding the correct binomial expansion in part (a). A few candidates used their calculator to evaluate the cube root of 7.7 and received no credit.

Question 3

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 $\pi\int y\ \mathrm{d}x$, $2\pi\int y^2\ \mathrm{d}x$ or $\int y^2\ \mathrm{d}x$. Many candidates realised that they needed to integrate an expression of the form $(2x+1)^{-2}$ (or equivalent). The majority of these candidates were able to complete the integration correctly or at least achieve an integrated expression of the form $p(1+2x)^{-1}$. A few candidates, however, integrated to give an expression in terms of natural logarithms. A significant minority of candidates substituted the limits of b and a into their integrand the wrong way round. Only a minority of candidates were able to combine together their rational fractions to give an answer as a single simplified fraction as required by the question.

Question 4

It was clear to examiners that a significant proportion of candidates found part (i) unfamiliar and thereby struggled to answer this part. Weaker candidates confused the integral of $\ln x$ with the differential of $\ln x$. It was therefore common for these candidates to write down the integral of $\ln x$ as $\frac{1}{x}$, or the integral of $\ln\left(\frac{x}{2}\right)$ as either $\frac{2}{x}$ or $\frac{4}{x}$. A significant proportion of those candidates, who proceeded with the expected by parts strategy, differentiated $\ln\left(\frac{x}{2}\right)$ incorrectly to give either $\frac{2}{x}$ or $\frac{1}{2x}$ and usually lost half the marks available in this part. Some candidates decided from the outset to rewrite $\ln\left(\frac{x}{2}\right)$ as '$\ln x - \ln 2$', and proceeded to integrate each term and were usually more successful with integrating $\ln x$ than $\ln 2$. It is pleasing to report that a few determined candidates were able to produce correct solutions by using a method of integration by substitution. They proceeded by either using the substitution as $u = \frac{x}{2}$ or $u = \ln\left(\frac{x}{2}\right)$.

A significant minority of candidates omitted the constant of integration in their answer to part (i) and were penalised by losing the final accuracy mark in this part.

In part (ii), the majority of candidates realised that they needed to consider the identity $\cos 2x \equiv 1 - 2\sin^2 x$ and so gained the first method mark. Some candidates misquoted this formula or incorrectly rearranged it. A majority of candidates were then able to integrate $\frac{1}{2}\left(1-\cos 2x\right)$, substitute the limits correctly and arrive at the correct exact answer.

There were, however, a few candidates who used the method of integration by parts in this part, but these candidates were usually not successful in their attempts.

Question 5

This question was generally well done with many candidates scoring at least seven or eight of the nine marks available.

In part (a), the majority of candidates were able to use algebra to gain all three marks available with ease. It was disappointing, however, to see a significant minority of candidates at A2 level who were unable to correctly substitute $y = -8$ into the given equation or solve the resulting quadratic to find the correct values for y.

In part (b), implicit differentiation was well handled, with most candidates appreciating the need to apply the product rule to the $12xy$ term although errors in sign occurred particularly with those candidates who had initially rearranged the given equation so that all terms were on the LHS. A few candidates made errors in rearranging their correctly differentiated equation to make $\frac{dy}{dx}$ the subject. Also some candidates lost either one or two marks when manipulating their correctly substituted $\frac{dy}{dx}$ expressions to find the gradients.

Question 6

In part (a), a majority of candidates were able to subtract the given position vectors correctly in order to find $\overrightarrow{AB}$. Common errors in this part included some candidates subtracting the position vector the wrong way round and a few candidates who could not deal with the double negative when finding the **k** component of $\overrightarrow{AB}$.

In part (b), a significant majority of candidates were able to state a vector equation of l_1. A significant number of these candidates, however, wrote 'Line = 'and omitted the '**r**' on the left hand side of the vector equation, thereby losing one mark.

Many candidates were able to apply the dot product correctly in part (c) to find the correct angle. Common errors here included applying a dot product formula between $\overrightarrow{OA}$ and $\overrightarrow{OB}$; or applying the dot product between either $\overrightarrow{OA}$ or $\overrightarrow{OB}$ and the direction vector of l_1. Interestingly, a surprising number of candidates either simplified $\sqrt{(1)^2+(-2)^2+(2)^2}$ to $\sqrt{5}$ or when finding the dot product multiplied -2 by 0 to give -2.

Part (d) proved more discriminating. The majority of candidates realised that they needed to put the line l_1 equal to line l_2. A significant number of these candidates, however, were unable to write l_2 as $\mu(\mathbf{i} + \mathbf{k})$ or used the same parameter (usually λ) as they had used for l_1. Such candidates then found difficulty in making further progress with this part.

Question 7

The majority of candidates were able to show the integral required in part (a). Some candidates, however, did not show evidence of converting the given limits, whilst for other candidates this was the only thing they were able to do.

In part (b), it was disappointing to see that some strong candidates were unable to gain any marks by failing to recognise the need to use partial fractions. Those candidates who split the integral up as partial fractions usually gained all six marks, while those candidates who failed to use partial fractions usually gave answers such as $\ln(t^2+3t+2)$ or $\ln(t+1)\times\ln(t+2)$ after integration. A few candidates only substituted the limit of 2, assuming that the result of substituting a limit of 0 would be zero Few candidates gave a decimal answer instead of the exact value required by the question.

Part (c) was well answered by candidates of all abilities with candidates using a variety of methods as identified in the mark scheme. Occasionally some candidates were able to eliminate t but then failed to make y the subject.

The domain was not so well understood in part (d), with a significant number of candidates failing to correctly identify it.

Question 8

This proved by far the most difficult question on the paper and discriminated well for those candidates who were above the grade *A* threshold for this paper. Only a few candidates were able to score above 8 or 9 marks on this question.

Many 'fudged' answers were seen in part (a). A more rigorous approach using the chain rule of $\frac{dh}{dt} = \frac{dh}{dV} \times \frac{dV}{dt}$ was required, with candidates being expected to state $\frac{dV}{dt}$ and $\frac{dV}{dh}$ (or its reciprocal). The constant of proportionality also proved to be a difficulty in this and the following part.

Few convincing proofs were seen in part (b) with a significant number of candidates not understanding how to represent $400 \text{ cm}^3 \text{ s}^{-1}$ algebraically.

Only a minority of candidates were able to correctly separate the variables in part (c). Far too often, expressions including $\int \frac{dh}{0.4} = \int 0.02\sqrt{h}\ dt$ were seen by examiners. There were a significant number of candidates who having written $\int \frac{dh}{0.4 - k\sqrt{h}} = \int dt$ could not progress to the given answer by multiplying the integral on the left hand side by $\frac{50}{50}$.

Despite struggling with the previous three parts, a majority of candidates were able to attempt part (d), although only a few candidates were able to produce the correct final exact answer. A majority of candidates who attempted this part managed to correctly obtain $\frac{dh}{dx} = 2x - 40$ and then use this and the given substitution to write down an integral in *x*. At this point a significant number of candidates were unable to manipulate the expression $k\left(\frac{x-10}{x}\right)$ into an expression of the form $k\left(1 - \frac{20}{x}\right)$. The converted limits $x = 10$ and $x = 20$, caused an added problem for those candidates who progressed further, with a significant number of candidates incorrectly applying $x = 10$ as their lower limit and $x = 20$ as their upper limit.

A time of 6 minutes 26 seconds was rarity in part (e).

Further Mathematics Unit FP1
Specification 6674

Introduction

There were many good responses to all the questions and candidates showed that they knew which techniques to select and also how to use them. Most candidates had enough time in the examination to do themselves justice. There were relatively few scripts with very low marks and good candidates were able to score high marks. Q7 and Q8 proved more taxing, however most candidates were able to find parts which they could answer with confidence.

Report on individual questions

Question 1

This work was well understood by the majority of candidates. A few found the integrating factor to be e^{3x} but this was not common. Integration by parts was well managed. Usually the only marks lost were at the end, where either the arbitrary constant was forgotten or was not divided by the Integrating Factor.

Question 2

This question was well within the capabilities of even the least competent candidates. There were few candidates who failed to arrive at the correct solution eventually, although many made hard work of the algebra, especially where the factor was taken as $x+ \frac{1}{2}$ instead of $2x+1$.

Question 3

In part (a) most candidates showed that they were able to cope with algebra at this level although the denominator sometimes disappeared having been treated as if it belonged to an equation. Part (b) caused more difficulties than part (a). The critical value $x=1$ was often forgotten or mentioned and then not used. By far the most successful approach was the use of a sign table or number line. Even with the help of a graphics calculator those using a graph found it difficult to reach a complete solution and an algebraic approach considering all cases was rarely successful.

Question 4

This question was generally well done by most candidates. In part (a) a variety of methods using linear interpolation were used, with some working from first principles. The most successful used similar triangles or a standard formula. Some misinterpreted the question and continued to apply their method until successive roots agreed to 3 decimal places. The most common errors were due to rounding or to calculators being in degree mode.

In part (b) the majority of candidates were able to apply Newton-Raphson successfully. Most differentiated correctly and gained full marks. Where the differentiation was incorrect the most common error was in omitting the ½ and some missed out the +1.
In both parts of the question there was some evidence of incorrect calculator use. This was particularly noticeable in part (b).

Question 5

The method of partial fractions was generally very well done with the majority of candidates gaining the full marks in part (a). Some risked losing all marks by using the 'cover-up' method and showing no method. A few did not separate the function into 3 partial fractions which subsequently caused problems in part (b).

In part (b) the most popular method was listing terms but many made no further progress because they could not see which terms would cancel. Many of those who got this far went on to gain the full marks, showing a good use of algebra. Some elegant solutions involved regrouping the three terms therefore simplifying the summation process. Some candidates however tried to use $1/(\Sigma r)$ instead of $\Sigma(1/r)$ and tried to use the standard results in the formula book.

Question 6

This was a very accessible question for the majority of candidates with many scoring full marks. Occasionally in part (a) candidates thought $1/(-2 + i)$ was equal to $-1/2 + 1/i$ but these errors were very infrequent. Almost all were able to expand successfully and use $i^2 = -1$ to simplify their answer.

In part (b) some subtracted incorrectly but gained a method mark for knowing how to find the modulus of a complex number. The most common errors were in part (c) where the argument was given as $\pi/4$ or $3\pi/4$ instead of $-\pi/4$. Also in part (c) some tried to use $\arg(z/w) = \arg z - \arg w$. Marks were lost in part (d) for poorly labelled or ambiguous Argand diagrams.

Question 7

Candidates found this question more demanding. Mistakes usually centred round the calculation of the Particular Integral and were usually of an algebraic nature. So, for example expanding $-2(px^2 + qx + r)$ as $-2px^2 + qx + r$. This inevitably lost them at least 2 accuracy marks in part (a). The most common mistakes in calculating their Particular Integral were to select a one-term or two-term quadratic. There were very few problems with establishing the Complementary Function part of this question. Most candidates recognised $3m^2 - m - 2 = 0$ as the quadratic equation needed and proceeded to solve it correctly and write the Complimentary Function as $Ae^{(-2/3)\,x} + Be^x$. Once the solution was found most candidates proceeded to differentiate and substitute correctly. The method marks and follow through accuracy mark in part (b) helped to reward candidates who had gone astray in part (a).

Question 8

Most candidates started this polar coordinates question successfully only losing an accuracy mark for the values of θ, writing them as $\pi/3$ and $-\pi/3$ rather than $\pi/3$ and $5\pi/3$.

Candidates were on the whole correct in the use of $\int \frac{1}{2} r^2 d\theta$ and many of them were successful in negotiating the expansion of $(3 + 2\cos\theta)^2$ including the use of double angles. The mistakes usually consisted of identifying appropriate limits and valuable marks were lost here. Some examples of this included finding the whole area of C1 using limits of 0 and 2π and then subtracting that part of C1 between $-\pi/3$ and $\pi/3$. This inevitably resulted in errors as some candidates forgot about the circle part of the problem and proceeded to subtract the area rather than add it. Some candidates struggled with integration to establish that the 1/3 of the circle needed was $(16\pi a^2)/3$. It was pleasing to note how many candidates made it correctly to the final answer although some found it unnecessary to simplify $\frac{76}{6}$ to $\frac{38}{3}$.

Mechanics Unit M1
Specification 6677

Introduction

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

In calculations the numerical value of g which should be used is 9.8, as advised on the front of the question paper (there are still some candidates using 9.81 or even 10 and this will lose them marks). Final answers should then be given to 2 (or 3) significant figures – more accurate answers will be penalised. If a question asks for a "magnitude", then a positive answer is required to gain the mark.

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.

Question 1

A good starter question enabling most candidates to obtain marks. A significant number of candidates gave an answer of -16 in part (a) rather than giving the magnitude of the impulse and lost a mark.

In part (b) 16 was a common incorrect answer resulting from an incorrect direction of motion for particle B i.e. $4 \times 5 - m \times 3 = 4 \times 1 - m \times 2$. A few candidates seemed unconcerned with a negative mass obtained from using ($+ m \times 3$) on the L.H.S. and there were also a few instances of candidates quoting and using the "formula" $m_1u_1 + m_1v_1 = m_2u_2 + m_2v_2$. It was rare to see correct solutions using Impulse and many included g in their Impulse-Momentum equation.

Question 2

Parts (a) and (b) were usually done correctly although there were a number of candidates who thought that velocity = distance/time and used this as a basis for the solutions to the first two parts of the question and there are still some who are unable to quote the '*suvat*' formulae correctly. The use of a "follow through" in the mark scheme was of great benefit to some students.

Part (c) caused more problems with many candidates using incorrect information in their equations. A few found the time to the top and then used the remaining time to work out the distance fallen.The continuity of the motion was the major stumbling block for students who produced incorrect solutions. Students wrongly used u=0, t=5 or the wrong acceleration here and there were many sign errors. A considerable number of students failed to use the '27' appropriately with students subtracting their answers from '27' or not even attempting this section. There are still students who forget that they need to explain work to the examiner rather than just quote an answer. The instructions on the front of the exam paper are clear.

Question 3

In the first part the majority were able to produce a reasonable speed-time graph – errors usually occurring due to the omission of time details; also a few had $V < 15$ and some candidates included a section for the time before $t = 0$.

In the final part, the majority considered the three separate parts of the journey with most errors occurring in the calculation of the distance covered in the second part, with many splitting the area into a triangle, whose height they incorrectly took as V, and a rectangle. There were several variations along this theme.

Question 4

Throughout this question candidates' answers were marred by confusion between 30°/ θ, cos/sin, and even horizontal/ parallel to the plane.

Part (a) caused a few problems and sometimes it was not attempted, even though parts (b) and (c) were fully correct. An exact fraction, using g = 9.8, was required so that recourse to inexact decimals lost marks.In part (b) a significant number of candidates lost the final mark by leaving their answer as 90.12. In the final part many candidates treated the 49 as a force up the slope, rather than horizontal, so failed to resolve up the slope thus failing to score any marks here.

Question 5

Apart from the minority of candidates who, in their moments equation, failed to multiply the tension by a length (dimensionally incorrect $\Rightarrow$ no marks) or those who omitted g , part (a) was well-answered. In the second part a number of candidates failed to re-arrange their moments equation to give an expression for the tension and made y the subject instead.
Most proceeded, in the final part, via an equation rather than an inequality and very few made the final verbal statement referring specifically to the positioning of the load rather than a defined 'y'.

Question 6

In parts (a) and (b) most were able to find the speed of the particle and were also able to obtain an appropriate angle associated with it. Many were then unable to use this angle correctly to obtain the correct bearing.

There were a great many correct solutions for (c), but also many incorrect attempts. The majority of errors tended to come from those candidates who had not read the question carefully enough and did not incorporate the velocity vector ($-5\mathbf{i} + 12\mathbf{j}$) into their working or from those candidates making errors with directions.Many candidates were able to visualise the situation well, realising that $7\mathbf{i}$ was involved, even though they may have made earlier errors in interpretation.

Question 7

Most candidates attempted parts (a) and (b) using simultaneous equations, with the most common mistake being to cancel out either m or g when it was not a factor in every term. This resulted in the m term of T being missing. A relatively large number of candidates also lost the final A1 mark for part (b) as they worked through the question using decimals.

The first section of part (c) for calculating the velocity of A after B hits the ground was often calculated correctly although a common mistake was to use $h/3$. A large number of candidates took this to be the new velocity and finished the question at this point. Some continued to calculate the new acceleration but then struggled to form the final equation and a number used either g as the acceleration or 4g/9.

Mechanics unit M2
Specification 6678

Introduction

It was pleasing to find the vast majority of the candidates showing a good understanding of the mechanics in this paper. The paper seemed to be accessible to most students - there were very few questions not attempted, even the later ones, and many candidates unsure of an answer had sufficient time to try an alternative approach. If a candidate finds that the space provided for their solution is not sufficient then they should use a supplementary sheet rather than continue their answer in the space provided for another question. The best solutions were accompanied by clearly labelled diagrams, with working and arguments clearly set out. Candidates should be reminded of the need to read the questions very carefully to ensure that their answer addresses the requests in the question – for example, were they asked to find the change in kinetic energy, or to find the loss in kinetic energy? Similarly, many candidates still lose marks due to inappropriate accuracy in their final answer to a question.

Report on Individual Questions

Question 1

This proved to be a very straightforward "starter" for most candidates and full marks were generally scored. Where students lost marks this was usually due to a lack of appreciation that the kinetic energy lost and the value of R should both have been positive. The methods used for part (b) were divided equally between the method using work done against R and the method of calculating the acceleration. A small minority of students became confused about the nature of the horizontal force acting in part (b), and duplicated the force by considering the sum of both work-energy and Newton's 2nd law.It was not uncommon to see candidates using their own notation, with F frequently being used for R. Many candidates gave the final answer as 4 N rather than the number 4.

Question 2

The candidates did well in this question compared to similar questions on previous papers.

(a) This was usually well answered with most candidates confident in using the **i** , **j** notation in the differentiation. A very small minority of candidates chose to integrate. The differentiation was well done but there was an occasional misread of $3t^3$ as $3t^2$.

(b) The majority of candidates used the **j** component of their velocity to find the value of t but some used the **i** component in error. A very small number used the **j** component of ***p***. Candidates starting with the correct equation, $9t^2 - 4 = 0$, often made errors in their attempt to solve for t; common incorrect answers included 2/9, 4/3 and 3/2. Some candidates demonstrated little understanding of what the question was asking for.

(c) Impulse was well understood but there were still some candidates confused between the initial and the final velocity. There were also some elegant solutions to provide the velocity in terms of t and going no further. Here too some candidates lost the final mark due to algebraic or sign errors.

Question 3

(a) This question was well answered with the great majority of candidates doing exactly what was required. The application of Newton's second law and resolution of the weight was usually correct and of course we always saw $\frac{1}{14}$. Candidates should be aware that in a question like this, where an answer is given, their working needs to demonstrate clearly how the answer is derived. Some candidates omitted essential working and did not convince us that they had reached the required answer. Others did not attempt to simplify their working, which they evaluated using their calculator, obtaining a decimal answer, which they then told us was approximately equal to $\frac{1}{14}$.

As usual, the more popular strategy in (b) seemed to be to use $F=ma$ and constant acceleration, rather than the work-energy principle. Some candidates repeated much of the working from part (a) to deduce that the total force acting parallel to the slope is 1250 N, others simply wrote it down as a straight forward deduction from the preceding work. For candidates who attempted to use the work-energy method, common errors included duplication of gravity or failure to include work done against resistance. Several candidates who used 550 N correctly in the first part went on to use 500 N in part (b) for no obvious reason.

Question 4.

Many candidates achieved full marks on this question, whilst others just missed out on the final mark because they did not notice the instruction to give their final answer correct to the nearest degree.

(a) Where there were difficulties these usually arose when a candidate tried to work with the geometry of the triangle, finding lengths of medians, etc in order to find the location of the centre of mass of the triangle – many seemed to be completely unaware of the simple result they could apply and invariably made algebraic errors in their work. Most candidates understood that the circle had been cut out of the triangle, but quite a few added the circle to the triangle in their working. A few candidates treated the triangle as if it were just three rods, and others confused the centre of mass of the triangle with the centre of mass of the set square in the course of their working.

(b) Most candidates correctly identified the required angle. A few did not use their answers from part (a) at all, they simply found the angle *BCA*.

Question 5

The open ended nature of this question produced varied methods, but the successful candidates tended to take moments about *A* or *B* only. It was surprisingly common to see no consideration of *g* or even a weightless ladder, both of which carried standard penalties. The frequent omission of *g* was particularly disappointing at this level. A large number of candidates had mainly correct methods but made errors in manipulation, particularly in dealing with the $\sqrt{3}$; a similarly large number confused 30° with 60° (or sine with cosine). Although most candidates tried to take moments, virtually none went for the direct (and simple) option of taking moments about the point of intersection of the lines of action of the reactions at the ground and at the wall. The better candidates were able answer this question in a couple of lines. Weaker candidates tended either to fail to take moments about any point or to get very involved taking moments about every point they thought relevant. Despite the less structured style of the question, this is a very familiar topic, so it was disappointing to find several candidates with little idea of how to tackle the problem.

Question 6

This question proved to be very challenging for many candidates. The best candidates worked through swiftly and efficiently scoring full marks in a relatively short solution. A number eliminated t rather than u in part (a), thus finding u first but this did not cause any great difficulty.

Unfortunately, several candidates were completely unprepared to deal with the initial velocity in vector form. Many of these went on to recombine the components and find a speed and angle of projection, then faithfully worked on with sin/cos and $\sqrt{29}$ without realising that it came back to 2 and 5! The candidates who made the least progress were those who tried to use the equations of motion with the velocity in complete vector form and the displacement and acceleration as scalars.

Although it created considerable extra work, and invariably went wrong, a small proportion of candidates tried to break the task down by working from the point of projection to the highest point and then from the highest point to *B*.
Several candidates who arrived at a correct equation in u and t then went on to apply the quadratic formula inappropriately to obtain an expression for t in terms of u. A number also got the wrong answer for t in part (a) but did not then pick up the given answer of t=5; they persevered with their incorrect result and hence lost many more marks.

In part (c) we encountered all the usual errors, although it was good to find far fewer candidates making inappropriate use of $v^2 = u^2 + 2as$. Most students understood the need to find both the horizontal and the vertical component of the velocity at *B*. Several candidates were not sufficiently clear about the direction of motion, and made errors due to confusion over signs. A minority of candidates used conservation of energy without being required to do so, and were usually successful. Too many candidates lost the final mark due to an inappropriate level of accuracy in their final answers.

Question 7

This question was generally well understood and answered. Most errors were caused by poor presentation leading to carelessness. Candidates who kept all the velocities in the direction of the original velocities usually fared better than those who reversed one or more velocity. The clearest solutions included clearly annotated diagrams which made the relative directions of motion very clear. In the weaker solutions it was sometimes difficult to work out the candidate's thoughts about what happened in each collision - the question did not give them names for the speeds after the initial collision and this gave rise to problems for some candidates who often gave the same name to more than one variable. Candidates with an incorrect or inconsistent application of Newton's Experimental Law lost a lot of time trying to obtain the given answer for the speed of Q after the first collision.In part (b) although most candidates attempted to form a valid expression for the change in kinetic energy, the m and u^2 were too often discarded along the way.

In part (c), and to a lesser extent in part (a), the tendency to want to solve simultaneous equations by substitution, rather than by elimination, produced untidy and unwieldy expressions which often led to arithmetical errors; a shame when the original equations were correct. Most candidates interpreted the final part correctly, although too many wanted to substitute 11/10u rather than tackle an inequality - it was clear that many candidates were not confident in setting up an inequality. Some problems did occur where students assumed the reversal of the direction of motion of Q following the collision but failed to take account of this in setting up their inequality.

Mechanics Unit M3
Specification 6679

Introduction

Most candidates made reasonable attempts at the early questions, but the later questions proved more challenging, with the latter parts of Qs 6 and 7 being particularly discriminating. There was little evidence of shortage of time and there were a number of second attempts at questions, particularly at Q4.

A number of candidates had been taught to underline and to highlight relevant information in the questions and seemed to find this helpful. The standard of presentation was variable. Candidates would benefit from drawing large clearly labelled diagrams in their solutions to several problems to help them to sort out what they were required to find and to illustrate the intentions behind their attempts.

The given answers to parts of some questions were generally helpful to candidates but a small number ignored the given answers and carried on using their own incorrect working in subsequent parts of their solutions.

Question 1

Part a was generally well done although a few left *m* in their final answer.
Most answered part (b) correctly but several used $T\sin\theta$ instead of $T\cos\theta$ as the resolved part of T in the vertical direction, and others used $\cos\theta =$ 0.56/0.72 which was not appropriate.

Question 2

The most common solution involved using "$F = ma$" and replacing a by $v\frac{\mathrm{d}v}{\mathrm{d}x}$. Use of $\frac{dv}{dx}$ instead of $v\frac{dv}{dx}$ for acceleration was far less common than often in the past, and errors in the integration were rare. Those who used a minus sign in their initial equation rarely managed consistency throughout the question. (They should have used x = -2 with v = +/- 8 as their boundary condition) A small minority did not realise the need for calculus and tried to use constant acceleration formulae. Another group of candidates used the "work done approach" but a significant proportion of these candidates were not successful with this approach. It was surprising that so many candidates reaching the final line of the solution, could not solve the equation $\frac{32}{x} = 48$ correctly, obtaining 1.5 instead of 2/3 as their answer for x.

Question 3

Part (a) was well done, with the aid of the given answer. There was some uncertainty concerning the formula for the volume of a cone but most had the correct dimensions and ratios, and were not penalised. The position of the centroid of a cone was well known by most, though a common error was to use h/4 instead of 5h/4 for the smaller cone. Difficulties did arise from using a different point and then attempting to deduce the correct answer. Moments about a point O were taken without any attempt to say where it was in many cases, though a few candidates used a calculus method from first principles and were successful.

In part (b) candidates mainly used $\tan\theta = \frac{2r}{x}$, and obtained the correct answer. The common mistakes involved using r instead of 2r and finding the complementary angle. It was noticeable that candidates who failed to prove the required result in (a) generally made no attempt at (b), even though the information needed had been supplied.

Question 4

There were some excellent solutions but also a great many inaccurate and muddled attempts. Although the theory was well known, it was very common for one or more energy terms to be left out (most commonly the initial EPE or the GPE). Confusion between energy losses and gains often led to wrong signs, a difficulty which is easily dealt with by equating initial energy to final energy instead. Many candidates seemed unclear about the relative positions they were considering and there was a great deal of inaccuracy in identifying extensions, heights and positions of zero KE. In part (a) it was usually possible to follow the candidate's line of reasoning and identify the mistakes but many of the attempts at (b) used inconsistent initial energy values from a variety of locations and failed to follow the 'Advice to candidates' that their methods should be made clear to the examiner. The clearest solutions started with a very well labelled diagram showing all the significant points and identifying the extension associated with each. Statements such as "Energy at A = …... , energy at B = ……" helped to avoid muddled values and usually led to correct or nearly correct equations. By contrast, a great many attempts at (b) contained no statement at all but simply an equation of unidentifiable terms.

Question 5

Part (a) was almost always correct but (b) proved a great discriminator. The best candidates showed how straightforward this could be and solved it as concisely as on the mark scheme but the majority did much less well. Jumping to conclusions was their downfall in (b), with the familiar $R = mg\cos\alpha$ making many appearances. Do candidates pause to reflect how this could be worth 4 marks? Some tried to resolve vertically but forgot to include the friction ($R\cos\alpha = mg$) and arrived at an equally quick answer. Many of these candidates recovered in (c) and wrote a correct horizontal equation but others assumed that the acceleration was along the slope and gained no credit in part (c) either. It is easy to imagine the writers of the following solution passing rapidly on to Q6 delighted at the easy 12 marks they thought they had just earned!

"(b) $R = mg\cos\alpha, R = \dfrac{4mg}{5}$, (c) $F = \mu R = \dfrac{mv^2}{r}, \therefore v = ...$."

As always, significant numbers treated $\dfrac{mv^2}{r}$ as an extra force in an equilibrium equation, so ending up with equations parallel and perpendicular to the plane looking as if the acceleration had been resolved but with wrong signs. There were very few successful solutions which had used these directions. As a topic, circular motion remains poorly understood.

Question 6

Vertical circle solutions have continued to improve and candidates understood what was required. Part (a)was usually completed successfully with the printed answer providing a useful check. Part (b) caused more problems and was a good discriminator - some forgot the weight component, others resolved as mg $\cos\theta$ instead of mg $\sin\theta$. In part(c) many who had answered part (b) correctly achieved the first two marks but a significant group could not produce the correct angle.

Part (d) was often omitted. Some did not realise that the speed going up when the string was horizontal was the same as the original speed and wasted time on another energy equation. Some worked with a general position until the end which made the algebra more difficult.

Mistakes involved not using the top of the circle, having a wrong radius and having a negative mg in their Force = mass acceleration equation

Question 7

Relatively few candidates proved SHM successfully. The need for x double dot and a minus sign has been stressed many times before in reports. Mistakes included: all terms numerical with no x, arguing with a general 'a' term and both special cases mentioned in the mark scheme. Many recovered and scored full marks in (b) though sometimes x=0.2 and 0.6 were used as the amplitude. Part(c) was usually successfully tackled by using $v^2 = \omega^2(a^2 - x^2)$ but there were some candidates who thought that the string was slack when x = 0. The candidates using x = a cos wt and differentiating to find v, had to calculate t when the string became slack as an intermediate step and usually went wrong A third group used energy to solve this part and frequently obtained the correct answer.

In part (d) candidates who used a circle and angles subtended at the centre, not often seen, invariably found the correct answer in a very simple way. Many of those using asinwt and acoswt did not have a clear method in mind and combined a variety of x=0.2 and x=-0.2 along with a fraction of the period in attempting, usually unsuccessfully, to find the correct time. A few candidates thought that the time under SHM was simply the period.

The part of the motion that was under gravity was usually tackled correctly. There were, however, some excellent solutions to this question, candidates who appeared to be well drilled and competent and the question was a good discriminator.

Statistics Unit S1
Specification 6683

Introduction

This paper was accessible to all the candidates and there was no evidence of a shortage of time. Once again the use of notation for probabilities (in Q5 and Q7) and the normal distribution (in Q6) together with the calculation of the standard deviation (in Q2 (a)) and interpretation of histograms (Q3) were not always handled well.There were several cases on this paper where candidates were obtaining answers that were clearly quite impossible in the context of the questions (Q2, Q3 and Q4 in particular). Students should be encouraged to check that their answer is "reasonable", this is not just "good practice" but it might help some of them save valuable marks in the future.

Report on Individual Questions

Question 1

Part (a) was answered very well and most candidates scored full marks here but responses to part (b) were mixed. Some thought that because both values were similar, but one positive and one negative, they "cancelled out" and others only commented on one of the tests or thought that the correlation coefficients were between the two tests. However a number of fully correct solutions were seen.

Question 2

The mean was calculated accurately by the majority of the candidates but the standard deviation calculation still caused problems for many. There were few summation errors but missing square roots or failing to square the mean were some of the more common errors.

Part (b) was poorly answered. The examiners were disappointed that such a sizeable minority failed to order the list and worked quite merrily with a median larger than their upper quartile. Some worked from the total of 2757 to get quartiles of 689.5, 1378.5 and 2067.5 whilst others used cumulative totals and obtained quartiles in the thousands but still failed to see the nonsensical nature of these figures. Those who did order the list used a variety of methods to try and establish the quartiles. Whilst the examiners showed some tolerance here any acceptable method should give a median of 198 but many candidates used 186. Those who knew the rules usually scored full marks here and in parts (c) and (d).

The examiners followed through a wide range of answers in part (c) and most candidates were able to secure some marks for correctly identifying patients B and F and in part (d) for describing their skewness correctly.

Question 3

The common error here was to assume that frequency equals the area under a bar, rather than using the relationship that the frequency is proportional to the area under the bar. Many candidates therefore ignored the statement in line 1 of the question about the histogram representing 140 runners and simply gave an answer of $12 \times 0.5 = 6$. A few candidates calculated the areas of the first 7 bars and subtracted this from 140, sadly they didn't think to look at the histogram and see if their answer seemed reasonable. Those who did find that the total area was 70 usually went on to score full marks. A small number of candidates had difficulty reading the scales on the graph and the examiners will endeavor to ensure that in any future questions of this type such difficulties are avoided. A small number of candidates had difficulty reading the scales on the graph and the examiners will endeavor to ensure that in any future questions of this type such difficulties are avoided.

Question 4

The first two parts of this question were answered very well. There were few problems encountered in parts (a) and (b) although a = 8.91 was a common error caused by using the rounded value of b not a more accurate version. Most candidates adhered to the instruction to give their answers to 2 decimal places. Problems started though when the candidates were asked to interpret the equation. Many candidates simply said that mileage increases with age and few who mentioned the 7.7 value remembered the thousands. A simple response such as "the annual mileage is 7700 miles" or "each year a car travels 7700 miles" was rarely seen.

In part (d) most could substitute $x = 5$ into their equation but once again the "thousand" was forgotten and the unlikely figure of 48 miles for a 5 year old car was all too common.

Question 5

This question was often answered very well. The Venn diagram was usually correct although a few forgot the box and some missed the "1" outside the circles. A small minority of candidates failed to subtract the "90" from the overlaps of each pair and this meant that any attempts to follow through in later parts of the question were hopeless as their probabilities were greater than 1. Part (b) was answered well although some wrote 0.1 instead of 0.01.

Parts (c), (d) and (e) were answered well too but some candidates simply gave integer answers rather than probabilities and a few tried to multiply probabilities together. The conditional probability in part (f) was often identified but some thought that $\mathrm{P}(C \mid A) = \frac{\mathrm{P}(C \cap A)}{\mathrm{P}(C)}$ and $\mathrm{P}(C \cap A) = 0.03$ was another common error.

Question 6

Most candidates knew that mean = median for a normal distribution and wrote down the correct value, others obtained this by calculating (190 + 210)/2. In part (b) many were able to illustrate a correct probability statement on a diagram and most knew how to standardize but the key was to identify the statement $\mathrm{P}(X < 210) = 0.8$ (or equivalent) and then use the tables to find the z value of 0.8416 and this step defeated the majority. Some used the "large" table and obtained the less accurate $z = 0.84$ but this still enabled them to score all the marks except the B1 for quoting 0.8416 from tables. In part (c) most were able to score some method marks for standardizing using their value of σ (provided this was positive!) and then attempting 1 - the probability from the tables. As usual the candidates' use of the notation connected with a normal distribution was poor: probabilities and z values were frequently muddled.

Question 7

Although many candidates found part (a) straightforward there were some surprising incorrect responses. Some simply gave $\mathrm{P}(R = 3)$ and $\mathrm{P}(B = 0)$ without making any attempt to combine them, others added and a few multiplied but obtained the answer 1/8. Part (b) was almost always fully correct but rather surprisingly they did not always see the connection with part (c). Whilst many scored full marks here, some thought all 4 probabilities were equal or they guessed that they were 1/8 like the others. A few had half a page or more of equations with a, b, c and d in them and usually little progress towards the correct answers. The methods for parts (d) and (e) were generally well known and many scored both marks for the mean, but a mixture of arithmetic errors and the omission of the $-\mu^2$ often spoiled solutions to part (e).

Statistics Unit S2
Specification 6684

Introduction

This paper was shown to be accessible to the majority of candidates and there was little evidence of them being unable to complete the paper owing to time constraints. Many of the candidates seemed to be confident with much of the work they had learnt in statistics at A2 level.

It was disappointing to see that some candidates did not relate their answers to the context of the question especially when, as in Q3, candidates were specifically asked to relate the theory to the context posed in the question.

Report on individual questions

Question 1

Nearly all candidates achieved at least one of the available marks but it was disappointing that there were not more attaining full marks.

(a) Too many candidates referred to the national census rather than a general definition. Some felt an enumeration was adequate and others failed to recognise that EVERY member had to be investigated.

(b) A failure to put the question in context and consider the consequences of testing every item meant that some candidates scored 0 in this part of the question. A few candidates did not read the question carefully and used cheap and quick as their reasons why a census should not be used when the question specifically said give a reason "other than to save time and cost".

(c) Many candidates mentioned a list; database or register and so attained the available mark. However, some did not seem to differentiate between the population and the sampling frame.

(d) Most candidates were able to identify the sampling units correctly, although those who had not scored in part (c) tended to say: "the sample of 5 cookers" in part (d).

Question 2

This question was well answered by the majority of candidates.

(a) This proved relatively straightforward for most, with the occasional response finding $P(X \leq 2)$ or using the binomial formula with $x = 3$.

(b) The most common error was interpreting 'more than 3' as $1 - P(X \leq 2)$.

(c) Answers to this part reflected good preparation on this topic with a high proportion of successful responses. Candidates who lost marks on this question did so because their response to part (b) was incorrect or they used $n = 20$. A few candidates gave the answer as $P(X = 6) = (\text{answer to part (b)})^6$.

Question 3

Most candidates were able to attempt part (b) successfully as these were fairly standard calculations. However, when required to apply Poisson probabilities to a problem it was only the better candidates who attained any marks in part (c).

(a) A sizeable proportion of candidates, whilst having learnt the conditions for a Poisson distribution, failed to realise that this applied to the <u>events</u> occurring. There were references to 'trials' and 'things' in some solutions offered.

b(i) Most candidates recognised Po(6) and were able to answer this successfully, either from the tables or by calculation. Common errors were using incorrect values from the table or calculating the exact value incorrectly.

(ii) Although many candidates attained full marks for this part, some were unable to express 'at least 5' correctly as an inequality and used $P(X \leq 5)$.

(b) Many of the successful candidates used a Po(3) to give a correct solution. Of the rest most candidates failed to realise that there were two ways for exactly one vehicle to pass the point and so only performed one calculation. This was often for P(1 car) and P(1 other vehicle), which were then added together. However there were some candidates who gained the correct answer via this method.

Question 4

The majority of candidates were able to attempt this question with a high degree of success

(a) Many candidates had a number of attempts at this part before getting a solution. In some cases, responses showed a lack of understanding between the p.d.f. and the c.d.f. This occurred when the candidate differentiated the given function then proceeded to integrate it. The most common error was to interpret the given function as the p.d.f., integrate it and put the answer equal to 1. A small number of candidates took the value of k =1/18 and used it to work backwards.

(b) The most common errors were to find F(1.5) or integrate the given function.

(c) There were many correct solutions with a minority of candidates being unsuccessful. Marks were mainly lost through, having differentiated correctly to find the function, not specifying the p.d.f. fully. A few candidates tried integrating to find the p.d.f.

Question 5

The majority of candidates appeared to have coped with this question in a straightforward manner and made good attempts at a conclusion in context, which was easily understood.

The hypotheses were stated correctly by most candidates – they seem more at ease with writing "p=" than in Q7 where λ is the parameter. Most used the correct distribution B(40, 0.3). Those who stated the correct inequality usually also found the correct probability/critical region and thus rejected H_0. The main errors were to calculate 1 – $P(X \leq 18)$ or $P(X=18)$. Some candidates used a critical region approach but the majority calculated a probability. A minority of candidates still attempted to find a probability to compare with 0.95. This was only successful in a few cases and it is recommended that this method is not used. Most candidates who took this route found $P(X \leq 18)$ rather than $P(X \leq 17)$.There were difficulties for some in expressing an accurate contextualised statement. The candidates who used a critical region method here found it harder to explain their reasoning and made many more mistakes.

Question 6

This question was quite well answered with a high proportion of candidates clearly understanding what was required of them. Most candidates used a Poisson distribution with a mean of 10, and then most used tables correctly to get the solution. A small minority used the formula.

(a) (i) The most common error in this part was to interpret:

$(8 \leq X \leq 13)$ as $P(X \leq 13) - P(X \leq 8)$ or even $P(X \leq 13) - (1 - P(X \leq 7))$.

(ii) Many excellent responses were given to finding the Normal approximation showing good understanding of finding the variance, using continuity correction and standardising. Those who lost marks gave the variance as 10, or did not use the continuity correction correctly or did not use it at all. A high proportion of candidates had no problems in finding the correct area.

(b) This part of the question proved to be the most challenging. Conditions for both a Poisson and Normal approximation were quoted freely but in many cases, having stated that the Normal was the most appropriate, they then proceeded to state why the Poisson was not appropriate rather than why the Normal **was** appropriate. Again, a sizeable minority gave the reason for Normal as $np>5$ and $npq > 5$ rather than $np>5$ and $nq>5$

Question 7

This question appeared to be difficult for many candidates with a large proportion achieving less than half the available marks.

(a) The majority of candidates were unable to give an accurate description of a hypothesis test as a method of deciding between 2 hypotheses. There were more successful definitions of a critical region but many candidates achieved only 0 or 1 of the 3 available marks. Common errors included too much re-use of the word region without any expansion on it. Even those who could complete the rest of the question with a great deal of success could not describe accurately what they were actually doing.

(b) Although most of those attempting this part of the question realised that a Poisson distribution was appropriate there was a sizeable number who used a Binomial distribution. Again, the most common problem was in expressing and interpreting inequalities in order to identify the critical regions. Many found the correct significance level but struggled to express the critical region correctly. Answers with 15 were common and some candidates even decided that 4 to 15 was the CR.

(c) Those candidates that identified the correct critical regions were almost always able to state the significance level correctly, as were some who had made errors in stating these regions. Some still gave 5% even with part (b) correct.

(d) Candidates who had used a Binomial distribution in part (b), and many of those who had not, used p instead of λ in stating the hypotheses and went on to obtain a Binomial probability in this part of the question. In obtaining $P(X \leq 1)$ some used Po(9) from part (b) instead of Po(4.5). Most of those achieving the correct statement (failing to reject H_0) were able to place this in a suitable contextualised statement. There were some candidates who still tried to find $P(X=1)$ rather than $P(X \leq 1)$.

Question 8

The majority of candidates attempted this question.

(a) Most sketches were clearly labelled with a few omitting the value on the y-axis. Candidates should draw their sketch in the space in the question book, not on graph paper.

(b) A few gave the mode as 2 or 1.

(c) Most were able to find E(X) with only occasional errors in using $x\mathrm{f}(x) = 2x - 4$ or in substituting the limits.

(d) Finding the median proved challenging for a sizeable minority. Although most wrote that F(m) = 0.5, finding F(m) proved difficult. There were many exemplary solutions but those candidates who struggled got x^2-4x, but then failed to use the limits correctly or made arithmetic mistakes. It was common for those who had no real understanding to put $2x - 4 = 0.5$ and solve to get $x = 2.25$.

(e) In many cases the answers to this part reflected confusion in understanding the concept of skewness. In many cases where responses were incorrect there was little or no evidence of using the results found, or positive skewness was stated but the reason related to negative skewness.

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Decision Maths Unit D1
Specification 6689

Introduction

The paper proved accessible and the candidates seemed very well-prepared for the examination with good attempts seen on each question. The first four questions were often good sources of marks for the candidates, the last three proved more challenging. Time did not appear to be a problem and the paper appeared to discriminate well.

A significant minority of candidates answered all of Q1, Q2, Q3 and sometimes even Q4 on the lined pages intended for Q1 and Q2. Candidates should be encouraged to answer the questions in the spaces indicated in the answer booklet.

Some of the responses were difficult to read, sometimes due to poor presentation but most often because of the writing tools used. This was a particular problem in Q1, Q2 and Q7.

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

Candidates need to be familiar with the terminology used in this subject, there is still much confusion over basic terms such as arc/edge, node/vertex, path and route. 'Words' such as 'vertice', 'verticie' and 'verticy' were not uncommon. Poor understanding of terminology caused particular difficulty for the candidates in questions Q1, Q3,Q4, Q5 and Q6.

Question 1

Most candidates were able to gain some credit in part (a) (i) and (ii), but only the best gained full credit. Poor terminology was frequently seen and many confused vertices/nodes with arcs/edges. In part (i) many did not state that the path must start and finish at unmatched vertices and others did not make clear what was 'alternating' or wrote that it was 'alternating left and right'. In (a)(ii) many candidates did not state that the matching should be one-to-one and others explained that a matching consisted of one (and only one) edge. Part (b) was **very** well answered with almost all the candidates stating two clear, acceptable alternating paths, starting and finishing at an unmatched vertex on each side. Candidates should again be reminded about the use of colour in this type of question and should ensure that their responses would clearly identify any differences when photocopied; the use of different types of lines to show changed status of edges is useful with a common approach being - = - = - = - =. Some omitted to show/state the change status step and others omitted the final matching. Only the very weakest attempted to start their alternating paths from an already matched vertex.

Question 2

(a) Many excellent answers were seen here and the vast majority used the pivot selection seen on the mark scheme. There were however a number of flawed solution seen also. The most common errors were; random or inconsistent pivot choices; misordering of 21, 23, 16 on the first pass, misordering of 11 and 9 on the third pass and not selecting 20 as a pivot; only selecting one pivot per line. Some candidates used colour to indicate their pivots which should be discouraged. A very few bubble sorts were seen. In part (b) almost all the candidates were able to select the first two arcs, CF and GI but the three arcs of length 11 challenged many. There was often a lack of clarity concerning the order in which edges were rejected. Those who listed all the arcs, in order, and then ticked or crossed them gained the marks most efficiently. Some candidates wasted a great deal of time (and space) drawing numerous diagrams, each successive one having an extra arc.

Question 3

(a) Most candidates found this question an excellent source of marks. The majority were able to find the three pairings of the four odd nodes and only the weakest listed their arcs without pairing them. Most were able to determine a suitable route and find its length correctly. Part (b) caused difficulty for some candidates, particularly in part (i). Poor use of technical terms caused problems for candidates trying to make their meaning clear, others stated that each arc would be traversed 'at least twice' and some indicated that some arcs would have to be traversed four times. Most candidates gained the last two marks for 22km, with only a few omitting the units, but some incorrectly doubled their route length from part (a).

Question 4

This question was usually well done, and a rich source of marks for most candidates. Most were able to gain all four marks in part (a), but the dummies caused problems for some, leading to incorrect numbers at the start of activities E and H. Many calculated the floats in part (b) correctly and showed the three numbers they used to calculate each float as requested, others wasted time creating a table of all the early and late start and finish times and the durations, for all activities, but then did not indicate which numbers they had used to find the floats, so losing marks. Part (c) was usually well-answered but occasionally K was added to the list of critical activities. Most candidates were able find a lower bound of 3, but some attempted a scheduling or tried to draw a Gantt chart, again wasting time, others used an incorrect method such as 35/13.

Question 5

Whilst some very good answers were seen, particularly in part (a) this question proved challenging for many. Common errors in part (a) included: using activity on vertex; lack of arrows; not having a single start and a single finish and most common of all an incorrect second dummy. Many candidates were able to correctly draw activities A to D and place the first dummy but many either omitted the second dummy completely or placed it parallel to the first, but opposite in direction. Similarly in part (b) most candidates were able to explain the need for the first dummy, although the words 'precede' and 'proceed' were either confused or misunderstood. The reason for the second dummy was often omitted, of those who did attempt it the reason was often thought due to their being independent rather than needing to have a unique representation in terms of events.

Question 6

This question proved challenging for many candidates. In part (a) candidates often answered a different question and described the method used to calculate the value of a cut, of those who answered the question set many were able to gain some credit but few gained full credit for a detailed answer. Most were able to answer part (b) correctly and then able to find at least one correct flow-augmenting route and its value in part (c). Few were able to find all routes and flows up to 13 extra, although most coped with the routes involving backflow much more competently, some attempted to reverse or redirect the flow along individual arcs or send flows of negative value though the system.

The direction of flow along EF was often misinterpreted, or its value omitted, in part (d), but most candidates were able to produce a consistent diagram. Double arrows and numbers should not be used on a diagram showing the final flow pattern. In part (f) candidates are expected to refer to the max flow- min cut theorem and this part is therefore only available to those candidates who have found the maximum flow. There were three minimum cuts and most candidates were able to state one of them, generally those who drew the position of a minimum cut on their diagram in part (d) gained the marks more efficiently. Some candidates who attempted to list the arcs in a minimum cut omitted one of the arcs.

Question 7

This question proved challenging for many. Some candidates used very lengthy methods to determine the equation of the straight line in part (a), and many got the 2 on the wrong side. Many were able to determine the correct inequality but others reversed it. The lines in part (b) were sometimes very disappointing, many failed to label their lines and/or make y=60 distinctive, but most disappointing of all was the lack of ruler use and inaccurate plotting of axis intercepts. Part (c) was often well done with examiners following through on candidate's lines were possible. Many candidates identified an optimal point in part (d) but some failed to state that 70 was the total number of boxes, the method used was not always apparent to the examiners and candidates need to be reminded that they should always make their method clear on this 'methods' paper.

Most of the candidates who did display their method used point-testing. Almost all the candidates were able to find an objective function in part (e). Once again many candidates did not make their method clear in part (f). If point-testing candidates should list the points they are testing and show the value of the objective at each point. If using a profit line they should clearly draw a profit line - of good length and label it. Point testing proved a more popular method in this question, but few tested all five vertex points. Poor notation was often seen with a number of candidates writing $32x + 64y$ instead of $x = 32$, $y = 64$. Those who located the optimal point in part (e) were usually successful in calculating the profit in part (f).

Grade Boundaries:
January 2008 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	62	53	44	36	28
6664 Core Mathematics C2	62	53	45	37	29
6665 Core Mathematics C3	64	56	49	42	35
6666 Core Mathematics C4	55	49	43	37	31
6674 Further Pure Mathematics FP1	65	59	53	47	42
6677 Mechanics M1	58	50	42	35	28
6678 Mechanics M2	64	56	48	40	32
6679 Mechanics M3	55	48	41	34	27
6683 Statistics S1	63	56	50	44	38
6684 Statistics S2	62	54	46	39	32
6689 Decision Maths D1	57	50	43	36	29

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