MATHEMATICS

Paper 9794/01
Pure Mathematics 1

Key messages

There are several points that candidates would benefit from bearing in mind when sitting this paper:

- The benefit of careful time management
- The need to show legible and structured mathematical reasoning in their working towards an answer
- Making sure that the answer requested is actually given
- Where an answer is given in the question, working must clearly show how that answer is obtained
- Taking notice of the mark allocations for (part) questions as a guide to the amount of work that is likely to be needed in the solution
- The importance of checking answers for sense (and even possibility) before moving on.

General comments

The quality of work on view was impressive, and many candidates can be extremely proud of their performance. Almost all candidates managed to make an attempt at each of the 12 questions on the paper; while there were a few who seemed to have difficulty completing it, these were very much in the minority and lots of candidates were able to make three or four attempts at **Question12**, for instance.

Comments on specific questions

Question 1

In **Question 1**, a large number of candidates resorted to plotting points on a piece of graph paper when a 'sketch' had been requested. In itself, this is an irrelevance, but graph paper almost invariably carries with it the kind of unhelpful controlling influence of the squares (governing the scale), when all that the question wanted was a decently drawn parabola, with its vertex in approximately the right place and with the immediately deducible y-intercept of (0, 4) noted or marked on the diagram. The x-intercepts were not required for the 2 marks available; a number of candidates nevertheless found them, some by using the quadratic formula rather than by writing them down from the completed square form obtained in **part (a)**.

Question 2

This was one of the most successfully attempted questions on the paper. Apart from the small number of candidates who thought the question was about geometric progressions, those who decided that the common difference was +2.5, or those who misquoted one or other of the relevant formulae, almost everybody approached the issue of the inequality required in **part (a)** without using an inequality of any kind. Having (for the most part) solved the equation $100 - 2.5(n - 1) = 0$, the answer $n = 40$ was generally offered without any justification whatsoever. It would have been far better if candidates had created an inequality, $100 - 2.5(n - 1) > 0$, to begin with. Of course, the simplest way around this widespread fear of inequalities is to show that we obtain $u_{40} = 2.5$ and $u_{41} = 0$.

Question 3

This was, marginally, the most successfully attempted question on the paper. The only hurdle here was for those candidates who had their calculator in radian mode by mistake.

Question 4

This was the second most successful question for candidates, with very few errors in **part (a)** and only a very small number who overlooked the extra factor of $\frac{1}{2}$ when using the chain rule to differentiate in **part (b)**.

Question 5

This question was very successfully handled, for the most part, but elicited a large number of sign errors and quite a few lapses in the convincing demonstration of a **given** answer (a situation in which the working always needs to be more carefully laid out).

Question 6

The answer to **part (a)** was almost invariably correctly stated, though often accompanied by unnecessary amounts of accompanying working (for the 1 mark), especially given the presence of the command phrase, 'Write down …'.

A variety of approaches were used by candidates in **part (b)**, including some from candidates who had clearly studied the further topic relating roots and coefficients of a cubic equation. In general, there were two main approaches.

The least popular was to substitute $z = 3 + \mathrm{i}$ (or $3 - \mathrm{i}$) into the cubic and then compare real and imaginary parts. This is an excellent approach but does involve more working (for instance, one must square and cube a complex number) and provides the greater opportunity for making a mistake; indeed, this is what happened overall for candidates choosing to use this approach. Note that substituting $z = 2$, whilst a perfectly sensible (and easy) thing to do, leaves one having to find one more bit of information from somewhere; for the few who did it this way, the other bit of information was generally obtained from either the sum or the product of the roots.

The more popular approach was to multiply out $(z - 2)(z - (3 + \mathrm{i}))(z - (3 - \mathrm{i}))$. Those who first multiplied out the two brackets containing the complex numbers found it easiest, as all the imaginary bits cancel – though it was found much more easily still by those who constructed their combined quadratic factor via the sum and product of these two roots. Those who chose to multiply out in the left-to-right order indicated usually made a numerical error of some sort, with not a few complex values subsequently appearing for a and b (despite the question's clear indication that they were supposed to be real).

Question 7

A substantial proportion of candidates found this question difficult. Even amongst those who knew what it was that was required of them, the key issue of stating the derivative as a limiting case was often missed, with many candidates simply setting $h = 0$ rather than considering what happens as *h tends to* zero. Overall, the large number of complete non-starts made this the second-lowest scoring question on the paper for candidates.

Question 8

Overall, this was handled impressively by most candidates. There were, of course, those who clearly did not quite grasp how to collect together log terms, or how to remove the logs altogether, but they were very much in the minority. For the most part, the only real hurdle was the inclusion of the second solution, $x = -2$, which was gained from the resulting quadratic equation. Those who factorised the term on the left-hand side first had usually dispensed with this extraneous solution before it became a problem; the rest were split into two camps … those who checked the feasibility of their answers and those who did not. Upon testing, it becomes clear that the existence of $\log(x + 2)$ immediately demands that $x > -2$.

Question 9

This was the point on the paper at which the questions became a little bit more demanding, often including some greater attention to detail, or some extra level of technical proficiency, within the required solutions. In this question, there were many slips in signs; in powers of 2 that were often missing; in factorials being overlooked (sometimes even the sign itself as part of the denominators); and, most importantly of all, the most common error was to set $2\mathrm{C}(x) = \mathrm{C}(x^3)$ rather than the other way around. Another oddity (which was overlooked unless it actually interfered with the working that followed) was the highly unsuitable use of the ${}^{n}C_{r}$ notation for non-integers.

Around two-thirds of the candidates, however, managed to make good progress into this question and the greatest obstacle for them then was the justification that $p = \frac{1}{2}$ (rather than $p = \frac{5}{2}$). On this occasion, it was the intention to condone the absence of a justification for rejecting the otherwise valid solution $p = 0$ to the ensuing cubic equation (as this was obvious form the information given); though it should be pointed out that candidates may in future be required to do so, and be penalised for not doing so. Moreover, it is good mathematical practice for them *always* to undertake this step whenever they find themselves dismissing a case that arises, and not just allow themselves to be put in a position where they appear to 'reject it by oversight'. The simplest way to justify the final choice of p is to evaluate $C(x^2)$, the coefficient of x^2, for each possible value of p. Alternatively, examine $C(x^2)$ first, as many candidates did, and decide that it should lie between 0 and 1 in advance.

Question 10

This was another high-scoring question, though there were still plenty of opportunities to lose a couple of marks. To begin with, there were those to whom it was **not** obvious that this was a vectors question, and algebraic attempts were usually disastrous. Those who 'vectored' the two lines first usually progressed easily through the standard working for the intersection of two lines. However, a small but significant minority overlooked the need to justify that the lines did indeed intersect or failed to do so validly – by, for instance, checking one or both of their found scalar parameters in one of the two equations they had used to evaluate them in the first place. Others lost this checking mark by not making it clear what they were doing, usually by making a statement such as $\frac{4}{3} = \frac{4}{3}$; which, while definitely true, does not actually help explain what is going on. Nor does it help if they merely do a bit of indeterminate (or indecipherable) numerical scribbling somewhere on the page and then *claim* to have checked it: this is a small but important step that needs to be made in a clear and simple way.

Part (b) was almost always well-handled (with final answers in a mix of degrees or radians, sometimes both). However, just a few did not use the direction vectors of the two lines and lost all 3 of the marks available here.

Question 11

The two parts of this question were essentially independent of each other and were treated thus. **Part (a)** caused a few difficulties when candidates, required to justify a non-standard exact form for a trigonometric ratio using the standard exact forms from the specification (the 'famous' values for the sines, cosines and tangents of 30°, 45° and 60°, along with all their 'relatives' in other quadrants, etc.), chose instead to do this by quoting other less well-known exact forms, which just appeared out of the blue, presumably obtained from a helpful calculator.

In **part (b)**, most responses started off very soundly with the use of the 'Addition formulae' for $\cos(A \pm B)$ on the LHS of the given equation, then turning everything into a function of $\cos x$ only, $\sin x$ only or $\tan x$ only in order to obtain the correct answers (with only a small proportion of candidates missing the solution $\frac{5}{6}\pi$ in the second quadrant). A number of other successful solution approaches put in an appearance, some of which employed the 'Sum and Product formulae', suggesting that the candidates producing them might be further mathematicians.

Question 12

This last question, containing a minimum of structure, proved the most demanding question for nearly all candidates, around a third of whom were unable to score more than 2 of the 14 marks available. On the other hand, another third of all candidates scored 12 or more of the marks. The key steps were to separate the variables (almost all attempts managed this) and then to employ partial fractions work to re-write the P terms in an integrable form; this major step was not specifically sign-posted so candidates were required to work out how to go about it for themselves. As already indicated, this split the candidature into those who started well (and, to all intents and purposes, finished the question off completely), those who did not know how to start (and who then scored almost nothing) and those in-between who started the PFs work but struggled with either the accompanying algebra or the log integrals.

Notice, in **(a)**, that the value of k can be found from the given information used in the given form of the answer, so it was important to show carefully where the 0.509 came from. Again, there were those whose working was muddled in some way and, for them, a magically appearing correct **given** answer was always going to be treated with scepticism.

In **part (b)**, the maximum answer required *is* 12 000 but it is not really as a result of setting $\frac{\mathrm{d}P}{\mathrm{d}t} = 0$; at least not in the way that was envisaged by many of the candidates, who thought that it was a maximum turning point rather than an asymptotic value. Again, the need for careful explanation was important in order to gain the second of the two marks in **(b)** and very few candidates dealt with the issue sufficiently carefully. There were a lot of slightly careless mathematical statements about how $e^{-kt} = 0$, or that $e^{-kt} \approx 0$, when they really should have been explaining that $e^{-kt} \to 0$ as $t \to \infty$.

MATHEMATICS

Paper 9794/02
Pure Mathematics 2

Key messages

In order to be successful, candidates need to have a good understanding of the entire content of the syllabus and also appreciate how to apply it in a given situation. They should be able to use mathematical conventions to express themselves clearly and make effective use of brackets. When asked to show a given answer, candidates should ensure that sufficient detail is given and not carry out too many operations in a single line of working.

General comments

In general candidates seemed well prepared for the examination and able to make an attempt at all questions. They seemed to have sufficient time to both complete the question paper and also to make further attempts at questions where they had not initially been successful. Candidates' presentation of their solutions was generally good, with clear detail shown of the method being used. This is essential if partial credit is to be awarded when the final answer is not fully correct; a method mark cannot be awarded if there is no evidence of the method that was actually employed.

Comments on specific questions

Question 1

(a) This was a straightforward start to the paper and the majority of candidates gained all three of the marks available. The most common, and the most efficient, method was to use the factor theorem. Some candidates attempted to use algebraic long division, but this was not always successful. A minority of candidates set up and solved simultaneous equations from a factorisation attempt; this was usually done correctly.

(b) This part of the question was also done very well, with nearly all of the candidates producing fully correct solutions, usually from the remainder theorem. Attempts at long division were usually successful, but some candidates did not gain the final mark as they did not explicitly identify the remainder in their solution.

Question 2

Most candidates were able to produce a fully correct solution to this question, with each step in their method clearly detailed. They were able to use the relevant identities to produce a quadratic in $\boldsymbol{sinx}$ which was then solved, usually by factorising but other methods were also seen. The two roots from $\boldsymbol{sinx = 0.5}$ were invariably correct. However, when solving $\boldsymbol{sinx} = -\,{}^2/_3$ some candidates obtained –41.8° and then stated that this was out of range so would not provide any further solutions. Others did continue and found two angles in the given range, but then spoiled their answer by not adhering to the rubric that specifies that angles should be given to 1 decimal place.

Question 3

(a) Most candidates could correctly identify the gradient of the line, but many were then unsure as to how to further proceed. Some simply gave $y = 3x - 1$ as their final answer, with no indication that logarithms could be involved in any way. Others could identify that the equation of the line must be of the form $\log_{10}y = 3\log_{10}x + c$, but were then unable to use the given points in an appropriate manner, with $\log_{10}2 = 3\log_{10}1 + c$ being the most common error.

(b) Candidates were more successful on this part of the question. As long as their equation was of the correct structure involving logs, they were able to gain credit for correctly applying log laws. Many gained one mark for using the power law correctly, but fewer candidates combined their terms before removing the logs; a common error was simply to remove the logs term by term. A significant minority of the candidates started part **(b)** with the correct equation, despite it not appearing in part **(a)**.

Question 4

All candidates were able to identify that this was a disguised quadratic and hence make a good attempt to find the roots, with some electing to work in terms of x^2 and others using a substitution. The more astute candidates continued to use inequalities in their solution, justifying why $x^2 + 4 < 0$ would not lead to any solutions and correctly solving $x^2 + 9 > 0$. These fully detailed solutions were however in the minority. The more common approach was to ignore the inequality signs, produce $x^2 = 9$ and then conclude with the expected inequality for x. Sight of the correct answer was given some credit but, with no clear indication of the inequality of $x^2 + 9 \geq 0$ that was being solved, it was not a fully justified solution.

Question 5

This question was generally well answered, with most candidates seeming to be familiar with real-life related rates of change. The most common approach was to find an expression for ${}^{dA}/_{dr}$, substitute into the chain rule and then rearrange. Some candidates made matters more difficult by deciding that the required derivative was ${}^{dr}/_{dA}$, and finding r in terms of A before differentiating. This latter approach was rarely successful. A few candidates started with $A = \pi r^2$ and then differentiated both sides implicitly with respect to t to produce a concise and efficient solution. Candidates should ensure that they read the question carefully; a not uncommon error was to use the radius, rather than the circumference, as 15 cm.

Question 6

(a) Candidates were familiar with the structure of the equation of a circle, and solutions to this part of the question were mostly correct. There were, however, a significant minority of candidates who used an incorrect formula to find the mid-point of a line segment.

(b) This part of the question was also done very well, with many of the candidates producing fully correct solutions. The most common approach was to eliminate y from the pair of equations and then attempt to show that the ensuing quadratic had no real roots. Most candidates used the discriminant, others used the full quadratic formula or completed the square, and a few actually found the complex roots. To gain full marks candidates had to justify that there were no real roots and then link this to the curve and the line thus having no points of intersection, and most explanations were suitably convincing.

(c) A slight majority of candidates differentiated the equation of the circle implicitly and this method was usually successful, resulting in a fully correct solution. A few candidates rearranged the equation of the circle to make y the subject and then differentiated using the chain rule; whilst this was a more complicated method it tended to be equally successful. The remaining candidates first found the gradient of the radius, and from this the gradient and hence the equation of the tangent. Once again, this method was usually successful although a small number of candidates used either A or B rather than the given (5, 8).

Question 7

(a) The majority of the candidates gained both of the marks available with ease. The more common approach was to find the value of λ and hence find a but some decided instead to solve a pair of simultaneous equations.

(b) Candidates were slightly less successful on this part of the question, but the majority still gained both of the marks available. Most candidates could recall the condition for two vectors to be perpendicular and could attempt to use this on the direction vectors, although some decided to use the full scalar product, including moduli, rather than simply using $a.b = 0$. On some scripts it appeared that candidates were attempting to use the $mm' = -1$ condition for 2D lines on the given 3D vectors.

(c) This final part of the question proved to be more challenging. Whilst the correct point of intersection was usually identified, the vast majority found it through calculation as opposed to observing that it was common to both parts of the question. Many candidates then were unable to identify an appropriate strategy that would allow them to make further progress. The most efficient method was to appreciate that the length of the relevant direction vector was 5 units, hence two were required in both directions. Other successful approaches were also employed, including setting up a quadratic in λ. Candidates who found the correct numerical values for λ were usually able to then find the correct position vectors, although some gave their final answers as coordinates and not position vectors and thus did not gain the final mark. A surprisingly common error was to find the correct values for λ but then substitute it back into an equation that was not commensurate with the initial set-up.

Question 8

(a) Nearly all of the candidates were able to carry out appropriate calculations to determine the consecutive integers between which the root was located. In order to gain full marks they had to both explicitly state this pair of integers and also explain their reasoning by referring to the sign change. Whilst many partially correct solutions were seen, fully justified solutions were in the minority.

(b) Many good solutions were seen to this part of the question, with candidates able to identify a suitable starting value and use the given iterative formula a sufficient number of times to be able to conclude with a value for the root. Whilst most candidates appreciated that, in order to determine p and q, they had to rearrange the given equation to a format that matched the question paper, others attempted to set up and solve simultaneous equations. Some candidates seemed to confuse significant figures and decimal places, and produced a final answer that was over specified. A number of candidates decided to use the Newton-Raphson method instead of the given iterative formula; this was an approach that did not gain any credit as it was not answering the question as posed.

(c) This final part of the question was poorly answered, and fully correct solutions were uncommon. Whilst the condition for convergence seemed to be known by many candidates, they did not seem to appreciate how it should be used to test a specific iterative formula. The most common misconception was to differentiate the original equation, or sometimes the formula from part **(b)**, rather than that given in **(c)**. Of the candidates who attempted to find the required derivative, most were able to do so successfully. Only the most able appreciated the need to test the derivative close to the known root; some used $x = 1$ or $x = 2$, and others attempted an algebraic argument rather than a numerical evaluation.

Question 9

(a) Candidates were able to make some attempt to differentiate the given function implicitly, although a few neglected to use the product rule on the middle term. Most candidates could correctly find the coordinate of the y-intercept and then use this in their derivative, usually obtaining the correct gradient. The most common error was to substitute $x = 0$ into their derivative, but then leave their answer in terms of y.

(b) The more common approach was to start with an expression for the derivative in terms of x and y, and differentiate this using the quotient rule. The fraction was usually correct, but it was quite common for the other side of the equation to become 0 rather than the correct notation for the second derivative. The other approach was to carry out a second implicit differentiation. This method proved to be slightly less successful, with the differentiation of $3y^2\,{}^{dy}/_{dx}$ causing uncertainty in terms of using the correct processes and notation. Whichever method they had used, most candidates appreciated the need to substitute in their numerical values, but this step was not always shown explicitly, which resulted in no credit being given should the final answer be incorrect.

Question 10

(a) Most candidates attempted differentiation, usually using the chain rule but sometimes the quotient rule. Whilst many correct derivatives were seen, a number of candidates produced answers involving k in the numerator and/or an index of 1 rather than 3 in the denominator. Those with the correct derivative could usually gain the final mark for producing a convincing argument about why $x = 0$ was the only stationary point. Some candidates included in their solution an explanation about why $k^2 + x^2$ could not be 0, without appreciating that the argument should be that $(k^2 + x^2)^{-3}$ could not be negative.

(b) Whilst only the most able candidates were able to produce fully correct and convincing solutions to this part of the solution, nearly all of the candidates were able to make some attempt and gain some of the marks available. Most candidates were able to gain the first mark for a correct statement linking dx and du, and could then attempt to rewrite the integrand in terms of u, but there was some carelessness with the squared signs when substituting. Many candidates seemed familiar with the relevant identity and could thus simplify their integrand with ease. Others attempted to rewrite it in terms of $\sin x$ and $\cos x$; a much more lengthy method and one that was only occasionally successful. Those candidates who had obtained $\cos^2 x$ as their integrand were invariably successful in carrying out the integration using the $\cos 2x$ identity. A few candidates attempted to use integration by parts; whilst this was often successful it was certainly not the most efficient method. Most candidates could identify the correct u limits and gain a mark for using at least the upper limit in their integral. In order to gain full credit in this 'show that' question, there had to be explicit use of the lower limit as well; and this was a step that a number of candidates omitted.

(c) A number of candidates were able to identify an appropriate strategy and make a reasonable attempt at this final part of the question. The more common approach was to find the base and height of the rectangle in terms of k, but some instead integrated the equation of the tangent between relevant limits. There was then a clear attempt to subtract the area in part **(b)** from the area of the rectangle but sign errors when combining the two fractions were not uncommon.

MATHEMATICS

Paper 9794/03
Applications of Mathematics

Key messages

When answers are given in the question, candidates should be aware that sufficient detail is required to show examiners how the answer has been achieved. Where questions require explanation, these should be relevant to the context of the question.

General comments

The vast majority of candidates were well prepared for this examination, and able to make an attempt at every question within the allocated time. The standards of presentation and communication were high, though some candidates failed to include necessary detail when establishing given answers.

This paper proved relatively straightforward for the well prepared candidate. Many candidates demonstrated a good knowledge of the topics in the syllabus, and accordingly gained high marks. Only a very small minority of candidates were unprepared for the demands of the paper.

In the Statistics section, candidates must show calculations that they intend to perform on a calculator so that if an error in keying in the calculation can still gain method marks. When a wrong answer is seen without any working, examiners cannot second-guess what method has been deployed and can only award 0 marks.

In the Mechanics section, candidates are reminded to use clearly labelled diagrams to aid their solutions to demands.

Comments on specific questions

Section A: Probability

Question 1

(a) Well answered by the majority of candidates. A minority of candidates were confused when applying rules expressed in terms of events A, B and C to an example with events B, C and T.

(b) Also answered well by a significant number of candidates. The most common method employed was to compare $P(B) \times P(T)$ with P(B and T). Some candidates confused the condition for independence with the condition for mutually exclusive.

Question 2

(a) Correct answers were seen from the majority of candidates. A significant number of candidates treated the data as discrete.

(b) This was well answered by the majority of candidates. However, a significant number, when confronted with a negative z value, made errors in finding the corresponding probability.

(c) Producing a z value of 1.645 was seen often, with the majority using this or –1.645 correctly. A minority used tables incorrectly to find a probability rather than a z value from the given 0.05.

Question 3

(a) The majority of candidates showed the given regression line, showing enough detail. However, some struggled to draw a plausible regression line on the Insert with an appropriate gradient.

(b) The understanding of the idea of residual was not often shown. Many responses had both residuals in a vertical and a horizontal direction on the same diagram, while others showed line segments from each point perpendicular to their line.

(c) The question required candidates to state the sum of the residuals, but those who attempted this part often went into lengthy calculations, and usually resulted in an answer other than 0.

(d) This question proved to be challenging for a significant number of candidates. Candidates did attempt to square the two residuals, but these were often measured from the graph rather than calculated.

Question 4

(a) Candidates were familiar with the generic conditions for a random variable to be modelled as a geometric distribution, but the request was specific about modelling the given situation as geometric. It was not common to see these conditions used in the context of the described scenario.

(b) Both parts of this question were well answered. Many attempts at **part (ii)** used $(1 - p)^n$, with a minority of candidates using n as 2 rather than 3.

(c) Many candidates appreciated that this was a binomial distribution request and were able to use their answer to **part (b)(ii)** correctly. It was, however, common to see the omission of a binomial constant in their attempt at the required probability.

Question 5

(a) Answered well by the majority of candidates.

(b) Mostly correct answers seen, with only a minority omitting the multiplier of 2.

(c) Those who used a diagram in this part were usually more successful than those relying purely on calculations.

(d) Again, those using a diagram usually progressed well with this request. A common error was to find the total number of possible arrangements, but not finding the required probability. Others used the total number of arrangements from **part (i)**, rather than the total possible arrangements for this particular scenario.

Section B: Mechanics

Question 6

(a) Two possible approaches were possible, with the majority using the gradient of the slope to find the acceleration. Those who used a constant acceleration formula were just as successful. Only a small minority thought the acceleration was the length of the sloping line.

(b) Most candidates knew that the area between the graph and the t-axis gave the required distance. Others used constant acceleration formulae or a combination of the two methods.

Question 7

(a) A well answered question. The common approach was to use Newton's second law on the system as a whole, so that the tension in the tow bar could be ignored. The longer, but equally successful method, was to use Newton's second law on the car and on the caravan and then to solve these two equations simultaneously. A common error was for an attempt at Newton's second law on the car only, but to omit the tension.

(b) Again, a well answered question**.** Those who had used a clear force diagram earlier usually proceeded to obtain a correct answer, whether using Newton's second law on either the car or the caravan.

Question 8

(a) This was well answered by the majority of candidates. The most common problem occurred from those who quoted the equation of trajectory with proof, hence not responding to the request to express x and y in terms of t.

(b) The answers to these requests were split between those who used the equation of trajectory found in **part (a)** and those who attempted to find the times at which the small ball reached the wall and the horizontal ground. Those with a good strategy found 1.098 m but some forgot to add the 2.6 m to find the height of the wall. Similarly, a good strategy produced 62.7 m, but some omitted subtracting the 12 m to find the distance of A from the wall. A common misconception was to assume incorrectly that the ball passed over the wall when the ball achieved its maximum height.

Question 9

(a) This proved a good source of marks for candidates who had a strategy for this multistep calculation. Finding the normal contact force first to facilitate the calculation of the limiting friction was usually well done by the majority. Newton's second law was then used to find a deceleration or acceleration, albeit with the occasional sign error. This was followed by the use of a constant acceleration with an appropriate correct sign with the acceleration. The most common error seen was to neglect the component of weight in finding the acceleration.

(b) (i) As the particle was in equilibrium at B, the frictional force is equal to the weight component down the plane. It was far more often to see the maximum friction given as the answer.

(ii) This part was the least well answered on the whole paper. Candidates should be aware that the contact force has two components, which are the normal contact force and the friction. Considering the contact force entirely means that there are only 2 forces acting on the particle: weight and the contact force. As the particle is in equilibrium, the contact force and weight oppose each other.

Question 10

(a) Most candidates could deal with the impulse, with only the very occasional sign error.

(b) Most candidates made good attempts at a conservation of momentum and a restitution equation. The aim then was to consider the velocity of B being at least that of A, leading to the required range for m. Some candidates were often concerned about future collisions between B and C, or assumed that B must change direction so that A and B were now approaching each other.