GCE EXAMINERS' REPORTS

GCE (NEW)
MATHEMATICS
AS/Advanced

SUMMER 2022

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MATHEMATICS

General Certificate of Education (New)

Summer 2022

Advanced Subsidiary/Advanced

PURE MATHEMATICS A – AS UNIT 1

General Comments

Generally speaking, this paper contains more E grade marks and fewer A* or A grade marks than examination papers in previous years. Good solutions were seen to all questions. However, there were parts of the paper where candidates did not seem well prepared.

Surprisingly, almost all candidates did well in question 10, but, in question 1, seemed unaware that the inverse of $\mathbf{e}^{\boldsymbol{x}}$ is $\mathbf{ln}\boldsymbol{x}$, which is a fact they used in question 10. The responses to question 16 were weak, showing that candidates' knowledge of vectors is insecure, although this may also partly be attributed to question 16 being the last question on the paper.

A common problem is the standard of algebraic skills of the candidates. In many questions, candidates managed all the A level work, but lost many marks failing to finish the questions satisfactorily owing to their inability to solve a pair of simple simultaneous equations, or solve a quadratic equation accurately.

In questions involving some geometry, such as the coordinate geometry or the circle questions, candidates would greatly increase their chances of success if they **drew a good diagram** right at the start showing all the relevant information; the geometry would then be clear at a glance. Additionally, an incorrect answer could be spotted at once and hopefully corrected.

Comments on individual questions/sections

Q.1 Many candidates seemed unaware that the inverse of e^x is $\ln x$.

Q.2 Many candidates were able to express all three terms in the form $a\sqrt{3}$. However, they failed at the last hurdle where collecting terms was required. Many did not know how to deal with the denominator of –2 in the middle term. Some simply stopped whilst others multiplied by 2 but failed to correct this in the final answer.

Q.3 Responses to this question would benefit from a diagram drawn approximately to scale, showing all the information given in the question.

Parts (a), (b) and (d) were well done generally, with the occasional sign error made in calculating the gradient.

In part (c), there was a very simple method rarely seen and a relatively easy method used by the majority of candidates. However, some candidates failed to use the fact that triangle *OAC* is right angled at *C*, and used some very long and multi-stepped methods involving the sine or cosine rules.

The answer in part (e) was simply 4 times the answer in part (c). Some candidates replicated the work done in part (c), which must have been very costly in time for one mark.

Q.4 This was a reasonably well done question, though some candidates made a variety of unexpected errors in the solution of the very simple quadratic equation. The most common mistake was losing the zero root. Many candidates failed to bracket the $2k$ and so failed to square the 2 when expanding and simplifying. The required inequality at the end was often incorrect.

Q.5 Part (a) was very well done. In part (b), some very strange quadratic curves were seen, including cubics, sine/cosine graphs, circles, or some joined up straight lines. In part (c), regions satisfying inequalities proved incomprehensible for many candidates.

Q.6 Part (a) was reasonably well done, though some candidates kept trying combinations of two positive numbers, which will get nowhere, as either one positive and one negative, or two negative numbers were required. Very few satisfactory solutions were seen to part (b), as candidates thought it was a sufficient proof if they found a pair of numbers that worked.

Q.7 Parts (a) and (b) were generally well done, with many candidates gaining full marks. In part (c), surprisingly, some candidates attempted a very roundabout method of finding the midpoint of *PQ* when the coordinates of *P* and of *Q* had already been found. This usually involved finding the equation of *PQ* again, even though it was given in the question, and then the equation of the perpendicular line passing through the centre, and finally solving these simultaneously to find the midpoint. As with question 3, a sensible diagram drawn after finding the centre and the radius would have helped enormously with part (d). Perhaps candidates would have seen that the sector *OPQ* is a quarter circle, making the solution very simple.

Q.8 This was a reasonably well done question with many gaining full marks in parts (a) and (b). Part (c) caused some problems with some candidates taking a stepwise approach 1000m at a time. Though this got them the correct answer, it was time consuming.

Q.9 The response to this question was a bit disappointing as candidates were often let down by their algebra. Many got the incorrect determinant by failing to bracket $2k$. Additionally, the solution to the simple equation $4k^2 - 32k = 0$ proved difficult with the zero root often lost.

Q.10 This was an extremely well done question. Most candidates got full marks here.

Q.11 Part (a) was well done. A few candidates substituted $x = 0$ instead of $x = 2$ to find the gradient of the tangent.

Part (b) was also well done generally, though some candidates got the wrong limits when integrating for the area under the curve, using the y values rather than the x values.

In part (c), most candidates who attempted the question started off by considering where the gradient function is positive, or by considering the end points where the gradient is zero. However, they had difficulties solving the resulting quadratic equation, simply because it did not factorise.

Q.12 The factor theorem is well known to candidates and questions requiring its use are usually well done and part (a) was no exception. Part (b) was a very simple trigonometric equation. However, in its solution, a number of inexplicable errors were seen. Some candidates obviously had their calculators set to radian mode in spite of the 51° given in the question. Others, more seriously, thought cosine is distributive. The majority of candidates did not realise that −27° was relevant and lost the solution 12°.

Q.13 This was another generally well done question. Disappointingly though, most candidates simply expanded $(2 - 3x)^5$ using the binomial theorem rather than just picking out the relevant term. Some then failed to present the required answer and lost the last mark. Errors were made expanding $(-3x)^3$. Candidates who tried to work out $(2 - 3x)^5$ by multiplication were usually unsuccessful.

Q.14 Part (a) was a very standard question on local maximum and minimum, and was very well done by most candidates. A few candidates lost the constant term in the differential coefficient. Some candidates had the correct answer, then inexplicably, crossed out the constant term.

In part (b)(i), candidates were supposed to re-write the equation in the form $f(x) = -7$ and noticing that −7 is a minimum value in part (a), so that one of the roots must be a double root. In part (b)(ii), the rearrangement gave $f(x) = -6.5 > -7$, so there must be 3 roots. Very few correct solutions were seen, though in (i), the roots are sufficiently nice so that the cubic equation can be solved using the factor theorem. However, no credit was given for this.

Q.15 The laws of logs are generally well known and candidates were able to apply them correctly in this question. The exception is when the candidate decided to combine the second and third terms first but ignore the minus sign in front of the second term. Thus, they incorrectly used the addition law when the subtraction law should have been used. Generally, candidates' poor algebraic skills were evident. In expanding $(x^2y)^3$, many only cubed the y term and not the x^2 term. Candidates confused themselves by failing to cancel down common terms in the numerator and the denominator. Disappointingly, a number of candidates correctly obtained the pair of simplified equations and were then unable to proceed.

Q.16 The responses to this question were weak. In part (a), candidates did not seem to know the definition of a unit vector and simply found the modulus. Many correct responses were seen in part (b). The most common error was finding the complement angle to the required one. Extremely few attempts were seen in part (c) and even fewer correct ones, though this may be because it was the last part in the last question on the paper.

MATHEMATICS

General Certificate of Education (New)

Summer 2022

Advanced Subsidiary/Advanced

APPLIED MATHEMATICS A – AS UNIT 2 SECTION A

General Comments

Following a challenging two years in which examinations were not sat, a return to the normality of assessments was welcome. Although Section A in the paper proved challenging for many candidates, there were many good responses for all questions, which was pleasing to see. As is always the case, questions that involved explaining and reasoning were the most poorly answered.

Comments on individual questions/sections

Q.1 This question was the most well answered on the Statistics section of the paper. It was a fairly routine start to the paper. Part (a) was generally well answered, but the same could not be said of part (b). Far fewer candidates were happy to attempt part (b) than part (a) and, despite showing in part (a) that the events A and B were not independent, those that did attempt part (b), more often than not, used the condition for independence to calculate $\mathrm{P}(A \cap B)$. Using the incorrect $\mathrm{P}(A \cap B) = 0.18$ lead to an incorrect answer of 0.54.

Q.2 If question 1 was a familiar start to the paper, candidates soon found themselves in difficulty with question 2. This was the most poorly answered question in the Statistics section, with 8% of candidates not even attempting the question. Sadly, most candidates were underprepared to calculate the height of a histogram and many seemed to think that this was a discrete distribution. Responses to part (c) were much better and many candidates knew that different samples lead to different results, although most struggled to articulate themselves well.

Q.3 Part (a) required candidates to put the conditions for a Poisson distribution in the context of earthworms. Those that were able to recall the conditions, usually simply stated text book answers with no attempt to mention earthworms, which was a requirement in the mark scheme. Part (b) was fairly well attempted with the most common errors being using $\lambda = 11$ and using the cumulative function on the calculator. It is unclear whether candidates knew they were trying to find $\mathrm{P}(X = 5)$ and used the wrong calculator function, or if they thought that they were supposed to calculate $\mathrm{P}(X \leq 5)$. Part (c) was most easily answered using the statistical tables and many candidates were able to answer this part, although many were also unable to determine what the question was asking. A common incorrect answer, which it was felt deserved one mark, was arriving at $\lambda = 15$ which came from interpreting fewer than 13 to mean $\mathrm{P}(X \leq 13)$ which is 0.3632 when $\lambda = 15$.

Q.4 All parts of this question was generally well answered, although not all by the same candidates. The vast majority of candidates were able to answer the first part in (a). Candidates picked up marks fairly evenly in all parts of the question following that. Parts (b) and (c) required the words ‘on average’ and candidates were penalised only once for that omission. It was disappointing to see the stock answer “bigger sample size” so often in part (d). The question was structured to guide students in the direction of “using all the data”.

Q.5 Candidates, on the whole, seem to be getting better at answering hypothesis testing questions. Most were able to produce the correct hypotheses in part (a). Explaining what is meant by a critical region was not done well. Many candidates were able to calculate the correct critical region, but most candidates redid the test using the *p*-value rather than simply stating that since $40 > 35$, we could reject H_0. Once again, the most common error was calculating $\mathrm{P}(X = 40)$ and making a conclusion based on that.

Q.6 Although the data were presented in a simple form – histograms and box and whisker diagram – candidates had great difficulty articulating reasonable explanations in response to the questions asked. A simple comment on the skewness would have sufficed in part (a) and a reasonable proportion of candidates were able to offer that comment. There were also many responses referring to “fertility rate is going up in 1914 and decreasing in 2014” which clearly showed a lack of understanding. In part (b), although many candidates were able to correctly identify the negative decrease as an increase, there were just as many candidates who stated that “it is impossible to have a negative fertility rate,” which again shows a lack of understanding. In part (c), many candidates were able to find the best estimates in part (i) and (ii), although some chose a number other than the 2.5 and 6.5 required for the best estimate. In part (iii), candidates seldom referred to the decrease. There were many varied responses along the lines of “France is a richer country than Ethiopia,” which did not meet the requirements of the mark scheme.

Summary of key points

- There are certain routine calculations and processes that candidates should be very familiar with and should be able to calculate with ease.
- Candidates are encouraged to read their own responses, particularly if they are explanation responses and consider whether what has been written is legible and coherent.
- Hypothesis testing in a binomial context does not involve the calculation of $\mathrm{P}(X = x)$ in order to make a conclusion. Candidates should familiarise themselves with the critical value method which can also prove to be an effective use of time and effort in an exam.

MATHEMATICS

General Certificate of Education (New)

Summer 2022

Advanced Subsidiary/Advanced

APPLIED MATHEMATICS A – AS UNIT 2 SECTION B

General Comments

The paper allowed candidates of all abilities to display their knowledge and demonstrate their mathematical skills. It was apparent that there was sufficient time to answer Section B of the paper. All questions appeared to be generally accessible to most candidates, with the exception of question 10, which only a minority were able to tackle successfully.
Many exemplar solutions were seen for all of the questions in Section B.

Comments on individual questions/sections

Q.7 This question was designed to lend itself to a variety of methods. Therefore, it was promising to witness that many different approaches were used, roughly in equal measure.

The most effective method was to initially find F by applying Newton's second law to the vehicle and trailer combined, followed by applying Newton's second law to only the trailer to find the tension in the tow bar. When dealing with the vehicle alone, a small number of candidates omitted the resistive force of $650\ \mathrm{N}$ and hence determined an incorrect T using $F - T = 1300a$.

A small number of candidates incorrectly included 'g' in their equations for Newton's second law. For example,

$$T - 320g = 500ga$$

Q.8 This was the most accessible question on the whole Unit 2 paper. Part (a) was done well by the majority of candidates who selected the correct 'suvat' equation to find the speed after 8 seconds. Part (b) was also answered successfully, but not always in the most efficient way. A significant number of candidates used two applications of the 'suvat' equations: initially using $v = u + at$ to find t, followed by $s = \frac{1}{2}(u + v)t$ to find the required distance. Whilst this is a legitimate approach, many candidates opted to prematurely round the value of $t = \frac{148}{3}$, before substituting into the subsequent equation.

Q.9 In general, the majority of candidates appreciated the need to isolate particles and to set up two equations using Newton's second law. However, several misconceptions were witnessed. Many candidates replaced the $150\ \mathrm{N}$ in the PA direction with either $15g$ or $150g$, meaning that incorrect equations such as $15g - T = 15a$ were frequently seen.

Part (b) was generally well answered, with 'follow through' marks being available for use of an incorrect acceleration from part (a).

Q.10 This was the least successful question on the entire paper. Remarkably, many candidates were unable to correctly interpret the bearing of the park relative to the house, thus making parts (a) and (b) inaccessible. Some chose to ignore the direction of the position vector of the shop and so simply dealt with $\frac{2}{3}\mathbf{j}$. As a result of the issues outlined above, correctly drawn and labelled diagrams were rarely seen. In part (b), many candidates opted for a prematurely rounded value as opposed to the exact surd form. For example, $\frac{2\sqrt{13}}{3}$ was frequently rounded to $2 \cdot 4$.

Q.11 Part (a) was very successful with almost all candidates using the fact that $v = 0$ to get the values of $t = 2$ and $t = 6$. As expected, the most frequent method was to factorise the quadratic, but some used the quadratic formula and hence made careless errors, which could have been avoided had candidates checked their answers using their calculators.

Part (b) was by no means a straightforward question as it was designed to assess problem solving (AO3) skills in a kinematics setting. Overall, responses were generally disappointing and few fully correct solutions were seen. Nevertheless, most candidates recognised that integration was required to obtain an expression for the displacement/distance, meaning that at least 2 marks were secured. Some were also able to correctly deduce that if the velocity is decreasing, then $t < 4$. However, most candidates then proceeded with

$$\int_0^4 (3t^2 - 24t + 36)\mathrm{d}t$$

and therefore did not account for the fact that v changes sign at $t = 2$, as established in part (a). Unfortunately, very few candidates considered a simple $v - t$ sketch of $v = 3t^2 - 24t + 36$ which may have assisted in determining $t < 4$ as well as emphasising the change in sign.

Summary of key points

- Many candidates continue to round prematurely, hence losing accuracy, rather than using exact forms from their calculators.

- In general, candidates are not using the full functionality of their calculators, e.g. for checking solutions of equations.

- Candidates do not always take enough time to draw clear, labelled diagrams, e.g. force diagrams (Q7, 8), $v - t$ graph sketch (Q11).

MATHEMATICS

General Certificate of Education (New)

Summer 2022

Advanced

PURE MATHEMATICS B – A2 UNIT 3

General Comments

This paper is of a similar standard to previous years, though there were less marks at the top end and rather more marks at the bottom end. Multiple excellent solutions were seen to all questions. Generally, candidates were let down by inadequate algebraic skills. In many questions, the A level work was successfully completed, but marks were lost in the subsequent work.

Comments on individual questions/sections

Q.1 This question provided a good start to the paper as most candidates obtained full marks. Some candidates did not correctly remember the formula for $\sec^2 x$. Others could not obtain the correct angles from values of $\tan x$.

Q.2 Part (a) was very well done. The only common error occurred when differentiating $\ln(5x)$ – many candidates forgot to use the chain rule. Part (b) was also well done, though many candidates left out the brackets around $1 - 3\sin 3x$.

Q.3 This was a generally well-done question. Some candidates did not know how to find the area of the right-angled triangle, and incorrectly used the formula $\frac{1}{2}r^2\sin\theta$ instead.

Q.4 Almost all candidates managed to gain the first two B1 marks for using the formula for sum to infinity of a geometric progression. The subsequent algebra left much to be desired and too many candidates thought $112\frac{1}{2}$ was the same as 56.

Q.5 A good question for many candidates until the very end. The integration of the third term was often incorrect with candidates ignoring the coefficient of x in the denominator. Many did not know how to halve the given expression and even more could not deal with the unequal coefficient in the third ln term when combining lns. A significant number did not have the constant of integration.

Q.6 Apart from the candidates who thought this was a question on geometric progressions, most candidates did this question well. A significant number of candidates found the sum rather than the 11^{th} term in part (a). A handful of candidates used $d = 20$ rather than $d = 0.2$.

Q.7 Another question which was generally well done by the majority of candidates. Some candidates had difficulty dealing with the $\sqrt{x}$ and obtained the incorrect upper limit for the subsequent integration.

Q.8 Candidates generally know the A level work well. However, a variety of algebraic and arithmetic errors were seen, and candidates had difficulties simplifying the resulting numerical expression into the correct fraction at the end. Some candidates had the incorrect index, commonly $\frac{1}{2}$, rather than the correct $-\frac{1}{2}$. Even $\frac{3}{2}$ was seen several times.

Q.9 This was a very simple question and finding the terms was generally well done by the majority of candidates. Some candidates used their calculators in the incorrect mode and got ridiculous answers for part (a). Others worked forwards rather than backwards in part (b) and found the 6^{th} 7^{th} etc terms in part (b). Types of sequences does not seem to be well understood. In the specification, apart from arithmetic progressions and geometric progressions, candidates should know about periodic, increasing and decreasing sequences.

Q.10 This question proved rather more difficult for candidates than was anticipated. Candidates did not factorise out the common factor x^2. They also ignored the hint in the question that $(3x+2)$ must be a factor of the numerator. Some candidates managed to fully factorise the numerator, but still did not cancel out the common factor, so that they had an extra root, $-\frac{2}{3}$, not realising that this value makes the expression undefined. Candidates who thought to use the factor theorem repeatedly usually did well.

Q.11 Part (a) of this question was reasonably well done. Part (b) was not so well done, with many candidates not realising that to maximise the expression, the required value for $\cos(x - 77)$ was –1. A few did not make the substitution suggested in part (a), making the problem very difficult.

Q.12 Part(a): Most candidates were not able to work out $ff(p) = f(0) = 10$. Some attempted to find an expression for $ff(p)$ in terms of p, which was not helpful.

Part(b): Most candidates were able to gain the two marks available here.

Part(c): A normal complete-the-square problem. However, many candidates had difficulties with the coefficient of x^2 not being 1. Many arithmetic and algebraic errors were seen. Typically, candidates factored out the 2, successfully completed the square and forgot to multiply the constant by 2 when removing brackets.

Part(d): Reasonably well done.

Part(e): The majority of candidates lost the mark for taking square root as they only displayed the positive root without explanation as to why the negative root was not included. In the sketch for g^{-1}, many candidates were penalised for displaying 'extra bits' which did not belong to g^{-1}.

Q.13 Part(a) was very well done by many candidates. Some tried solving the equation $f'(x) = 0$ and said all roots were imaginary, some found the discriminant to be negative and said there were no real roots, but hardly any notice that $6x^2 + 3$ must be positive for all values of x.

Part (b) was generally well done.

In part (c), some very strange sketches were seen.

Q.14 Most candidates started off well, with the first step in this question on integration by parts. However, many did not use integration by parts again in the resulting integral. With those who successful used integration by parts twice, many sign errors were made as they did not 'tidy up' their signs leaving lots of minuses about. The coefficient of 2 in the third term was often lost. Candidates obviously checked their answers using the calculator as, quite often, the correct answer 5.87 appeared in the final line unsupported by correct working further up the solution.

Q.15 The majority of candidates had difficulty finding an expression in terms of x for the area of the rectangle. They were not able to find y in terms of x, as they did not make use of the right-angled triangle with the hypothenuse as the radius of the circle, or remember the equation of a circle centred at the origin with a given radius. For the few candidates who had the correct expression for A in terms of x, most realised that the expression had to be maximised with respect to x. It is a great deal easier to maximise A^2, but no candidate spotted that short cut. One candidate did manage to maximise the expression by taking the x into the square root thus obtaining a quadratic expression in x^2 which could be maximised by completing the square.

Q.16 Surprisingly, many candidates did not realise that 'meeting the y-axis' meant $x = 0$. Instead, they found $\frac{\mathrm{d}x}{\mathrm{d}t}$, $\frac{\mathrm{d}y}{\mathrm{d}t}$ and hence $\frac{\mathrm{d}y}{\mathrm{d}x}$ which was only relevant in part (b). In part (b), all that was required was $\frac{\mathrm{d}y}{\mathrm{d}t} = 0$ (if $\frac{\mathrm{d}y}{\mathrm{d}t} = 0$, $\frac{\mathrm{d}y}{\mathrm{d}x}$ will also be 0), and $y = 0$ occured at the same value of t. Most candidates however, used $\frac{\mathrm{d}y}{\mathrm{d}x} = 0$ instead, which was also correct, though a longer method. Some managed to find t when $\frac{\mathrm{d}y}{\mathrm{d}x} = 0$, but did not complete the solution by showing that y is also 0 at this value of t.

Q.17 Most candidates managed to expand $\cos(\alpha - \beta)$ and $\sin(\alpha + \beta)$ correctly, but were then unable to factorise the expanded form into the required form. They did not think to expand the right-hand side to give the expanded form to show that the two are equal.

Part (b)(i) required candidates to substitute $\alpha = 4\theta$ and $\beta = \theta$ into the identity in part (a).

Part (b)(ii) hangs on the fact that the denominator is 0 when $\theta = \frac{3\pi}{4}$. Both of these proved difficult for many candidates.

Q.18 It was pleasing to see the correct substitution spotted by many. Sadly, candidates were then unable to deal with the simple bit of algebra required to write the expression into an integrable form. Either $(u - 3)^2 = u^2 - 9$, or $\frac{u^2-6u+9}{u^4} = \frac{-6u+9}{u^2}$, was often seen. Those that managed it, usually did very well on this question.

MATHEMATICS

General Certificate of Education (New)

Summer 2022

Advanced

APPLIED MATHEMATICS B – A2 UNIT 4 SECTION A

General Comments

Following a challenging two years in which examinations were not sat, a return to the normality of assessments was welcome. There were challenging parts to all the questions and completely correct scripts were a rarity. As is always the case, questions that involved explanations and reasoning were the most poorly answered. Having said that, there were some very thoughtful and insightful answers to 4(d) and 5(b). Candidates seem to have performed marginally better on Unit 4 than on Unit 2.

Comments on individual questions/sections

Q.1 This question was designed to ease the candidates into the paper, but it was not as well received as might be expected. Fully correct answers and completely incorrect answers were both extremely common, with comparatively few candidates scoring one or two marks. Candidates either knew exactly what was required in the question, or were completely baffled by it.

Q.2 This question also divided candidates, many of whom lacked the knowledge, skills and understanding required at this level, and others who completed parts (a) and (b) with relative ease. The information was presented in a way that was not overly familiar to the candidates and many struggled to grasp the required information. Some candidates even simply added 0.3, 0.7 and 0.0 to get an answer of 1 for part (a). In part (b), there were two common errors: one was not understanding that the denominator that was required was the answer to part (a), and the other was in the calculation of the numerator. Understanding that $\mathrm{P}(C \cap F1)$ means that both event C and event $F1$ need to happen together and that this simply involves multiplying 0.4 and 0.7 was not well done. Part (c) was not well done at all. Many candidates failed to realise that this was a conditional probability question and therefore should have a division as part of the solution.

Q.3 This was the most poorly answered question on the paper. The correct distribution in part (a) was not given by many candidates. Common incorrect distributions included $U(1{,}9)$, $U(10{,}20)$, $U(0{,}40)$, and the normal distribution. Candidates could earn some credit, and most did so, by correctly calculating the mean and variance of their distribution. The responses to part (b) were disappointing. Instead of doing a succinct algebraic solution, candidates took it upon themselves to use trial and improvement and other such methods for calculating the range of values of X. Concerningly, some candidates implied by their work that they thought that this was a discrete distribution. The most challenging part of the question was limiting the values of X from $8 < x < 12$ to $8 < X < 10$. The candidates that used an algebraic method did slightly worse on this.

Q.4 Candidates seem to be comfortable using their calculators for answering simple probability questions from a normal distribution, as seen in part (a). In part (b), the majority of candidates found the probability of stopping in time, i.e. $\mathrm{P}(X < 20)$ and $\mathrm{P}(W < 20)$, rather than the probabilities of collisions. If they did this, it was almost inevitable that the candidates would use the wrong comparison (they never questioned why you're more likely to collide travelling at 20mph as opposed to 30mph), but were awarded marks for dividing the two probabilities, or multiplying or dividing by 50. The usual errors for hypothesis testing were all seen. These errors include incorrect hypotheses, not using $\sigma/\sqrt{n}$ and comparing test statistics with 0.05. However, candidates, on the whole, seem to be getting better at answering hypothesis testing questions. Part (d) was designed to encourage candidates to think about the reaction times of younger people and that younger people were more likely to have faster reaction times, which would throw the conclusion into doubt. Unfortunately, the most common answers were along the lines of "Only university students chosen".

Q.5 Although this subject content has been assessed in the 2018 and 2019 papers, it was rare to see a candidate score all five marks in part (a). The vast majority of candidates managed to make at least one mistake, either not using one tailed hypotheses, or not finding the square root of 0.746, or not using the correct critical value, or comparing the test statistic to 0.05, or comparing a positive critical value with a negative test statistic or vice versa, or not stating positive in the conclusion. In part (b), candidates were often able to give a conclusion supporting the headline, such as "there is positive correlation between house prices and reading scores so the data support the headline" or they were able to say "correlation does not imply causation, therefore, buying an expensive house does not make children read better", but not many candidates were able to make both statements in the discussion. Candidates seemed hesitant to say that the data both supported the headline and the data did not support the headline. Part (c) was reasonably well done on the whole.

Summary of key points

- Candidates should be encouraged to think about their answers in context.
- Candidates are encouraged to read their own responses, particularly if they are explanatory responses, and consider whether what has been written is a coherent response.
- Candidates are encouraged to familiarise themselves with conditional probability questions and be prepared to use their answers in the subsequent parts of the question.

MATHEMATICS

General Certificate of Education (New)

Summer 2022

Advanced

APPLIED MATHEMATICS B – A2 UNIT 4 SECTION B

General Comments

The paper allowed candidates of all abilities to display their knowledge and demonstrate their skills. It turned out to be less accessible than the Summer 2019 paper. For the final two questions on the paper, the attempt rate was slightly under 90%, suggesting that time may have been an issue for some candidates or some may have invested too much time on questions earlier in the paper.

Question 10 was the most demanding question on the entire paper with a low facility factor of $25 \cdot 9$, whilst question 8 was the most successful of the mechanics questions.

Many exemplar responses were seen for all of the questions in Section B.

Comments on individual questions/sections

Q.6 Most candidates were able to deduce that $\sin\alpha = \frac{3}{5}$ and $\cos\alpha = \frac{4}{5}$, from the trigonometric ratio provided. However, some candidates chose to evaluate $\alpha = 36 \cdot 9°$ to one decimal place, thus losing accuracy. Fortunately, candidates were not penalised for making this approximation. Some also struggled with the idea of thrust and were not able to interpret a negative answer if their diagram was labelled with the force pointing in the direction AB.

Q.7 Part (a) was generally very well answered, with almost all candidates considering moments about some chosen point. Mistakes were often due to a poorly drawn diagram. Disappointingly, some candidates did not work in terms of g, deciding instead to fully evaluate all forces and, in some cases, dividing by g at the end to give the required result. A significant number of candidates did not resolve vertically, opting instead for two applications of moments: one about X, another about Y. Those who considered 'moments' about points other than X or Y were less successful overall.

Part (b) was less successful, as many candidates did not realise that the reaction at X was zero and that moments about Y was required. Also, a small number of candidates assumed M to be a weight, giving an incorrect answer of $M = 20g$.

Q.8 Almost all candidates identified that a normal reaction to the plane was required and followed it up with the result $F = \frac{2}{9} \times R$ for limiting friction. Many also proceeded with an application of Newton's second law with a net force up the slope. The most common error was the omission of the component of weight down the slope. It was disappointing to witness a large number of candidates prematurely approximating individual terms whilst determining the net force. For example,

$$380 - 153 \cdot 2 - 193 \cdot 0 = 90a \quad \Rightarrow \quad a = 0 \cdot 37(555 \ldots).$$

Fortunately, there was no penalty for this. Very few used their calculator to deal with the terms collectively as shown below

$$a = \frac{380 - 90g\sin 10° - 90g\cos 10°}{90},$$

thus retaining full accuracy. A small number of candidates did not include a g in either their reaction or friction force.

Part (b) turned out to be accessible even to those who were unsuccessful in part (a). For those candidates who chose to use inequalities, they were used effectively. Many successfully deduced that, in order for the washing machine to remain at rest, the component of weight down the slope must be less than or equal to the limiting friction. A persistent misconception was to assume that the limiting friction was $F = 20g\cos 10°$ from part (a).

Q.9 Many candidates were unable to determine the correct differential equation in part (a). Consequently, those candidates also struggled in part (b). However, some candidates who were initially unable to arrive at the printed result, successfully 'worked backwards' to determine the correct differential equation.

A large number of candidates managed to secure full marks in part (c), irrespective of any issues in earlier parts.

Q.10 Unfortunately, this was the least accessible question on the whole paper. Sadly, very few candidates achieved full marks. Learners may now be expected to derive the general formulae for projectiles and so it was disappointing that efforts in part (a) were below par.

Nevertheless, performance in part (b) was much better since it involved application of the printed result in (a). Many were able to successfully interpret and use the position vector of the tree and hence determine the values of $\tan\theta$ as required. Some unnecessarily calculated the values of θ and prematurely rounded. As expected, this lead to inaccuracies in any subsequent distances calculated.

For those who attempted part (b)(ii), many spent needless time calculating the value of x for both values of $\tan\theta$. This could have been avoided by correctly interpreting the question as it states that the ball lands short of the flag, meaning that only $\tan\theta = 1$ needed to be considered.

Summary of key points

- Many candidates continue to round prematurely, hence losing accuracy rather than using exact forms from their calculators

- The most successful candidates sketched and labelled clear diagrams to help them to interpret questions, e.g. force diagram for rod with distances (Q7), diagram with forces parallel and perpendicular to the inclined plane (Q8).

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