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.

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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).