FURTHER MATHEMATICS

General Certificate of Education (New)

Summer 2022

Advanced

FURTHER MECHANICS B – A2 UNIT 6

General Comments

This is only the second paper to be sat for this new specification and so it was reassuring to witness that it was well received by most candidates. Although it turned out to be less accessible than the Summer 2019 paper, many high scoring scripts with exemplar responses were seen.

There was no evidence to suggest that candidates found the paper too long to complete in the allocated time, as most candidates managed to attempt all the questions on the paper.

Comments on individual questions/sections

Q.1 This was the least accessible question on the paper. In part (a), most candidates identified and used the result $a = v\frac{\mathrm{d}v}{\mathrm{d}x}$, with only occasional sign errors occurring and some forgetting to apply the chain rule when working out $\frac{\mathrm{d}v}{\mathrm{d}x}$. Several misconceptions and notational issues were also seen. For example,

$$a = \frac{\mathrm{d}v}{\mathrm{d}t} = -\frac{96}{(4x+9)^2} \qquad \text{and} \qquad a = v\frac{\mathrm{d}v}{\mathrm{d}t} = -\frac{2304}{(4x+9)^3}$$

Part (b)(i) was done very well, mainly by those candidates who were confident in part (a). Irrespective of earlier parts, (b)(ii) was very successful with almost all candidates managing to separate variables, obtain an expression for t and attempt a substitution to find T.

Q.2 Candidates demonstrated a very strong understanding of how to show that the motion was Simple Harmonic in part (a). The majority of mistakes made were in determining the centre of motion. Some opted to convert into the Harmonic form, which meant that the amplitude was easily deduced even if mistakes were made in determining the phase difference.

It was encouraging to see that almost all candidates correctly answered part (b).

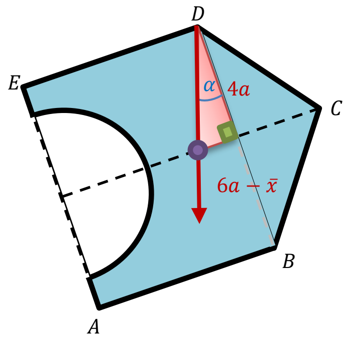
In part (c), most candidates easily established the correct form for the motion of particle *Q* and many correctly equated the two forms. A small number who used the Harmonic form were unable to progress to the final two marks.

Q.3 This was the most successful question on the paper. It was reassuring to see that candidates were not troubled by the algebraic context of the question.

Almost all candidates correctly wrote down the answer to part (a) by using symmetry.

In part (b), almost all candidates recognised the Pythagorean triple and also correctly subtracted the semicircle to get the final lamina. The most successful candidates constructed a simple table for $\bar{x}$ with columns for area and distance from AE.

For part (c)(i), the majority of candidates considered a simple sketch and so were able to identify the appropriate triangle. For example,



In part (c)(ii), a variety of attempts were seen, not all successful. Some went back to first principles, thus making the problem quite challenging. As expected, the most successful candidates considered the original lamina as a single mass positioned at a horizontal distance of $(6a - \bar{x})$ from BD.

Q.4 In part (a), almost all candidates successfully identified the trigonometric ratios corresponding to their chosen angle of either C or D. A small number of candidates considered the weights as masses and so $25g$ and $10g$ were occasionally seen.

Part (b) turned out to be relatively straightforward with the only issue being ambiguity over the direction of the reaction at A. Most high scoring candidates provided a supporting diagram with the angle clearly indicated.

Q.5 This was more accessible than the corresponding question on the 2019 paper. However, several misconceptions remain. In part (a), restitution was often erroneously applied to whole vectors as shown,

$$(\mathbf{i} + 3\mathbf{j}) - (-2\mathbf{i} - 5\mathbf{j}) = -\tfrac{2}{5}(\mathbf{u}_B - \mathbf{u}_A)$$

Consequently, some candidates had to deal with much more demanding, and often meaningless, equations. The most successful candidates produced a clear supporting diagram with before and after vectors shown, together with the line of centres.

Parts (b), (c) and (d) were generally done well, irrespective of any misconceptions in part (a). In part (c), many candidates found the velocity vector, $\mathbf{v} = -2\mathbf{i} + 3\mathbf{j}$, but did not calculate the speed as instructed.

Q.6 Candidates demonstrated a very strong understanding of how to apply Hooke's law in this 'two spring' setting. A variety of successful methods were seen throughout, with candidates using different notations and reference points for the various distances in the question.

In part (a), most candidates provided a sketch labelled with appropriate distances, enabling them to deduce that the total extension was $0 \cdot 8$.

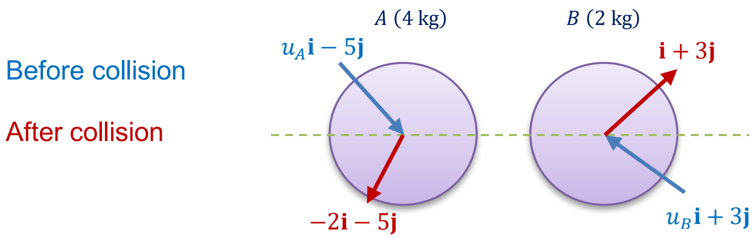
For part (b)(i), almost all candidates attempted to use Newton's second law with a net tension. However, many struggled to legitimately establish a general distance upon which to establish the Simple Harmonic Motion. The most proficient approach was to let x denote the displacement of P from C.

Part (b)(ii) also turned out to be accessible where the most frequent error was candidates incorrectly using $x = 0 \cdot 2$ for the point at which there is no tension in the spring AP. Therefore, many calculated a t based on $0 \cdot 2 = 0 \cdot 4 \cos 5t$.

Summary of key points

- Many candidates did not know that the law of restitution need only be applied along the line of impulses. Furthermore, if restitution calculations are needed, the line joining the centres of the spheres will always be parallel to either $\mathbf{i}$ or $\mathbf{j}$.

- The most successful candidates drew clear diagrams and constructed tables where appropriate to help them interpret the questions. For example, in question 5,



- Marks continue to be lost due to premature approximation. Candidates should be encouraged to use as much accuracy as possible, thus taking advantage of the exact form often produced by a calculator.