FURTHER MATHEMATICS

General Certificate of Education (New)

Summer 2019

Advanced Subsidiary/Advanced

FURTHER MECHANICS A - AS UNIT 3

General Comments

This summer's paper turned out to be more accessible than the Summer 2018 paper. 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 complete the paper.

Notably, question 3 and question 7 were the most demanding questions on the paper, whilst question 4 was by far the most successful. Many high scoring scripts with exemplar responses were seen.

Comments on individual questions/sections

Q.1 This question provided a gentle start to the paper. Almost all candidates used Hooke's law in part (*a*) and then applied conservation of energy in part (*b*). However, a significant proportion of candidates did not interpret this question correctly, as the compressed length of $\frac{2}{5}\times 0\cdot 15 = 0\cdot 06$ was used instead of $\frac{3}{5}\times 0\cdot 15 = 0\cdot 09$, the actual compression of the spring. Thus, incorrect answers of $\lambda = 52\cdot 5$ and $v = 3\cdot 6$ were frequently seen. Fortunately, only two marks were lost due to this error.

It was encouraging to see the most able candidates working algebraically with $x = \frac{3}{5}l$.

Q.2 Part (*a*) was generally well answered, with only occasional sign errors occurring.

In parts (*b*) and (*c*), almost all candidates were aware of how to calculate the dot product of two vectors, but solutions often involved careless errors. Again, there were frequent sign errors and some candidates did not recognise that $\left(\mathrm{e}^{-t}\right)^2 = \mathrm{e}^{-2t}$.

More seriously, many candidates lost marks by failing to remove the unit vectors $\mathbf{i}$, $\mathbf{j}$ and $\mathbf{k}$, e.g.

$$\mathbf{F}.\mathbf{v} = 9t^3\mathbf{i} + 32t\mathbf{j} - 2e^{-2t}\mathbf{k} \qquad \text{and} \qquad \mathrm{KE} = \frac{9}{4}t^4\mathbf{i} + 16t^2\mathbf{j} + e^{-2t}\mathbf{k}\,.$$

Part (*d*) was only successfully answered well by the most able candidates.

Q.3 Overall, this was the second most challenging question on the paper. Nevertheless, parts (*a*) and (*b*) were very well answered. For a small number of candidates, misconceptions from question 2 were mirrored here by candidates incorrectly writing AB^2 as

$$AB^2 = (2-8t)^2\,\mathbf{i} + (-2+8t)^2\,\mathbf{j} + (-1+4t)^2\,\mathbf{k}\ .$$

Only the most able candidates managed to achieve full marks in part (*c*). The most common errors were incorrectly writing the quadratic equation as one of the following:

- $144t^2 - 72t + 9 = 600^2$
- $144t^2 - 72t + 9 = 600$
- $144t^2 - 72t + 9 = 0\cdot 6$

Unfortunately, many able candidates lost the final mark as they failed to interpret their solutions to the problem in their original context (AO3) and simply wrote $t = 0\cdot 2$ hours instead of 9.12 a.m.

Q.4 This was the most successful question on the paper. Almost all candidates scored full marks on parts (*a*) and (*c*). Part (*b*) was reasonably well done, with the most common error being the omission of either the component of weight down the slope, or, more often, the resistance of 2000 N in the Newton second law equation.

Q.5 As expected, most candidates recognised that the tension needed to be resolved vertically and hence scored full marks in part (*a*).

Part (*b*) was less successful as some candidates decided to stop once they had determined the radius of the horizontal circle. Disappointingly, some prematurely rounded the value of the radius, thus leading to an accuracy error in the length of each chain. Nevertheless, many exemplar solutions were seen in which candidates recognised the independence of θ and moved straight to $l = 5\cdot 77$ without evaluating the radius.

Q.6 It was reassuring to see that candidates were not troubled by the context of this question. Parts (*a*) and (*b*) were generally done well. Errors in part (*a*) were made in attempting to establish the potential energy component(s) for the energy equation. Many of these errors can be attributed to candidates not drawing a clear diagram and/or not making their point of reference clear enough.

Unfortunately, within parts (*a*) and (*b*), sign errors were often seen when rearranging equations, with many having to 'tinker' with their solution to try to convince examiners of the printed result for R.

In part (*c*), the most favoured method was to take $\theta = 180$ in the given expression for R in order to show that $R = mg > 0$. Surprisingly, very few decided to test for $R = 0$.

In part (*d*), very few candidates considered the loss in potential energy for use with the work-energy principle, instead opting for the slightly less efficient approach using kinetic energy.

Q.7 Overall, this was the least successful question on the paper with very few candidates managing to achieve full marks. However, part (*a*) was extremely well answered, demonstrating that candidates have a strong understanding of momentum and restitution, even in an algebraic setting. Candidates who used the ratio method to find e, the coefficient of restitution, were less successful as sign errors were much more common.

Many candidates were unable to secure the final mark in part (*b*) since the fact that $e = \frac{1}{2}$ was not initially used. As a result, the required loss in KE was often attempted in terms of e, thus giving terms such as $(1-e)^2$ and $(1+e)^2$.

The majority of candidates who attempted part (*c*) decided to replicate their argument from part (*a*). Given that only 3 marks were available, part (*c*) was designed to assess AO2 in providing the opportunity for candidates to deduce that

$$\text{Velocity of } B \text{ after } 2^{\text{nd}} \text{ collision } = \frac{1}{2}(1-e_1)\times\frac{3}{4}u,$$

using their answer from part (*a*), $v_A = \frac{1}{2}(1-e)u$, with e replaced with e_1 and u replaced with $\frac{3}{4}u$. Thus, candidates wasted valuable examination time as further calculation was not required.

Summary of key points

- The most successful candidates drew clear diagrams to help them interpret the questions.
- 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 the calculator.
- Many candidates did not consider the number of marks available for some questions and hence provided unnecessary work. This would be worth developing as good examination technique.
- Some candidates still believe that vector questions must always result in a vector answer.