FURTHER MATHEMATICS

General Certificate of Education (New)

Summer 2022

Advanced Subsidiary/Advanced

FURTHER MECHANICS A - AS UNIT 3

General Comments

The paper allowed candidates of all abilities to display their knowledge and demonstrate their skills. It was apparent that there was sufficient time to complete the paper. Excluding question 7, this turned out to be of a similar accessibility to that of the Summer 2019 paper. Question 7 was the most demanding question on the paper with a low facility factor of $39 \cdot 3$, whilst question 2 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 and, as expected, it was answered successfully by the majority of candidates. Notably, many solutions to part (b) used the calculated value of the angular velocity from part (a), despite the fact that the linear speed was given in the question.

Q.2 This was the most successful question on the paper. Almost all candidates scored full marks on part (a). In part (b), the majority used the conservation of energy as instructed and they also realised that the value for the kinetic energy at the top of the platform could be inherited from part (a). A small number of candidates elected to use $v^2 = u^2 + 2as$ with $u = \pm 7.8$, $a = g$ and $s = 10$, which lead to a correct final result. However, this method gained no credit since the direction of projection was not provided and this method assumes a rectilinear path in the vertical plane.

Many candidates went straight to mathematical results without providing a supporting statement. For example, only a handful of candidates wrote something similar to the statements below,

Using the Conservation of Energy

Total energy at start (platform) = Total energy at end (water)

Part (c) of the question, on the work-energy principle, proved to be accessible to all, as the required speeds of 13 and 16 were provided to candidates. There was no penalty for using 16 instead of $\sqrt{\frac{6421}{25}}$.

Q.3 Almost all candidates were adept at tackling this style of 'collision' question. Furthermore, the use of algebraic quantities for the mass of each sphere did not pose a problem. Consequently, parts (a) and (b) were generally completed to a high standard, with only careless sign errors causing issues. The most frequently seen error was to assume that *A* and *B* were moving in the same direction before the collision. However, since the speed of B after the collision was provided, candidates were generally able to rectify any initial misconceptions. Disappointedly, very few provided helpful signposting such as 'Using Conservation of Momentum' and 'Using Restitution'.

Most candidates were familiar with the meaning of impulse, with a small number using poor, but condonable, notation. For example,

Change in momentum $= 36$

$(4m)(1.5-9)=36$

$-m=1.2 \quad \therefore \quad m=1.2$

It was encouraging to see that many candidates appreciated the significance of 'equal radii' in successfully answering part (d).

Q.4 Almost all candidates scored full marks in part (a). Part (b), which was less successful, provided a variety of attempted solutions. In (b)(i), the most successful candidates began by finding the vector $\mathbf{AB}$ and then were quickly able to deduce that $\mathbf{F_1} = \frac{3}{2}\mathbf{AB}$ or $\mathbf{AB} = \frac{2}{3}\mathbf{F_1}$, often by inspection. Many of these successfully calculated the dot product of $\mathbf{AB}$ and $\mathbf{F_1}$ in order to find the work done for (ii).

A much less succinct method was chosen by a significant number of candidates who tackled part (b)(i) by using $\mathbf{F_1}.\mathbf{AB} = |\mathbf{F_1}||\mathbf{AB}|\cos\theta$ and verifying that $\cos\theta = 1$. This approach meant that the work done in part (ii) had already been calculated, but not all candidates recognised this fact. For this particular approach, many considered the product of $|\mathbf{AB}|$ and $\mathbf{F_1}$ and hence concluded with an incorrect vector quantity for the work done. For example,

Work done $= 2\sqrt{29} \times (9\mathbf{i} + 6\mathbf{j} - 12\mathbf{k}) = \left(18\sqrt{29}\mathbf{i} + 12\sqrt{29}\mathbf{j} - 24\sqrt{29}\mathbf{k}\right)$

Q.5 Overall, attempts for this question were disappointing. Nevertheless, almost all candidates were aware that conservation of energy was required with 3 energy forms. Once again, very few provided clear signposting for their solutions and diagrams were often scrappy with no clear reference point. Incidentally, many candidates worked with the numerical value of g, before arriving at the printed result. Fortunately, as the expression for v^2 was given, candidates could progress irrespective of efforts in part (a).

Part (b) was very successful with the majority of candidates using the fact that $v = 0$ in the expression from part (a) to form and solve a quadratic equation with two solutions. Almost all candidates were able to interpret their solutions in their original context (AO3) and hence discard the negative value. Unfortunately, many used the formula method and made careless errors since they clearly did not check their solutions using their calculators.

A variety of successful solutions were seen for part (c), with methods such as Hooke's Law with $T = 2g$ and maximising v^2, with calculus being used in equal measure. Sadly, only a handful of candidates opted to complete the square which would have quickly revealed the desired results.

Q.6 It was promising to see that almost all candidates sketched an appropriate diagram and attempted to work parallel to the plane. In part (a), the most common error was incorrectly interpreting the meaning of 'deceleration is $0 \cdot 2\ \mathrm{ms}^{-2}$', in that $0 \cdot 2$ was used in Newton's second law. Therefore, the incorrect answer of $P = 95\ 000$ (W) was frequently seen.

Part (b) saw many successful fully correct solutions.

Q.7 Overall, this was the least successful question on the paper, with very few managing to achieve full marks. Many chose to ignore string BP and so dealt with a simple conical pendulum. Unfortunately, this approach gained no credit.

Supporting diagrams were rarely seen, as well as helpful signposting such as 'Using Newton's second law towards C' and 'Resolving vertically'.

Surprisingly for this unit, not all candidates were able to deduce that $\sin\alpha = 0.6$. Therefore, many candidates worked with $\alpha = \sin^{-1} 0.6$ and some candidates chose to evaluate $\alpha = 36.9^\circ$ to one decimal place, thus losing accuracy.

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

Summary of key points

- The most successful candidates sketched clear diagrams to help them interpret the questions.
- In general, candidates are not using the full functionality of their calculators, e.g. for checking solutions of equations, exact/surd forms. Marks continue to be lost due to premature approximation and failure to check solutions of equations.
- Very few candidates provided helpful signposting such as 'Using Conservation of Momentum' and 'Using Restitution', instead preferring to go straight to mathematical results without any explanation.