Examiners' Report
Principal Examiner Feedback

Summer 2022

Pearson Edexcel International Advanced Level
In Mechanics 3 (WME03) Paper 01

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Overall candidates were able to make reasonable attempts to answer all questions on this paper and time did not appear to be a limiting factor. Candidates appeared to be well prepared for the exam: they were able to recall and use formulae and were familiar with standard proofs. This was particularly evident in question 1 on SHM and question 5(a) on Centres of Mass where many weaker candidates were able to earn most of the marks available.

Forming energy equations proved to be challenging for some candidates and it is worth noting that when an energy term is missing from an equation, no method mark is awarded. Candidates should be advised to give careful consideration to an energy equation because these can be costly errors.

Solutions were generally well presented with clear handwriting. One third of the marks on this paper were available for proving given answers and it was pleasing to see that amendments were made legibly.

In calculations the numerical value of g which should be used is 9.8. Final answers should then be given to 2 (or 3) significant figures – more accurate answers will be penalised, including fractions but exact multiples of g are usually accepted.

If there is a printed answer to show, then candidates need to ensure that they show sufficient detail in their working to warrant being awarded all of the marks available and that they end up with *exactly* what is printed on the question paper.

In all cases, as stated on the front of the question paper, candidates should show sufficient working to make their methods clear to the examiner and correct answers without working may not score all, or indeed, any of the marks available.

If a candidate runs out of space in which to give his/her answer than he/she is advised to use a supplementary sheet – if a centre is reluctant to supply extra paper then it is crucial for the candidate to say whereabouts in the script the extra working is going to be done.

Question 1

This question provided a straightforward start to the paper with candidates at all grades accessing full marks. They were able to use the number of oscillations per second to find the correct value for ω and recall the correct formula to find the maximum speed. Where there were errors in (a), these generally came from an incorrect value being used for the amplitude. A complete method was required for the method marks in part (b) and the vast majority successfully used $x = a\sin(\omega t)$.

Question 2

Although fairly routine, this question provided a significant challenge to candidates at all levels. It was necessary for candidates to introduce an angle into the solution with the most popular choice being the angle θ with the downward vertical. Whilst the correct form of acceleration was almost always chosen, difficulties arose where candidates did not account for the radius of motion being different to the radius of the hemispherical bowl. It was common to see candidates gaining full marks by forming a horizontal equation of motion and a vertical equation, eliminating $\sin\theta$ and $\cos\theta$ to find an expression for $\tan\theta$ and then finding the exact value for *OC*.

Question 3

This question was a good source of marks with most students scoring 9 or 10 of the 10 marks available. Candidates generally used $v\frac{dv}{dx}$ and differentiated successfully to find the appropriate deceleration. Sadly, some candidates lost the final mark in (a) because their answer was given as a negative acceleration rather than a deceleration. Whilst differentiating $\frac{1}{2}v^2$would also lead to the correct answer, it was rare to see successful solutions. Part (b) was very popular, with most candidates correctly integrating powers of *t* and *x*, finding the constant of integration and following through to reach the correct final answer.

Question 4

Part (a) was the first 'show that' question in the paper, requiring an energy equation to reach the given value for λ. Many students who began with Hooke's Law and equilibrium, realised their mistake when it led to an incorrect vale for λ. Whether by a first or second attempt, the majority were able to secure the four marks in (a).

To find the maximum speed in part (b), the most common approach found the extension $\frac{l}{8}$ at the equilibrium point and then formed another energy equation. This appeared to be the most successful method and usually earned full marks. Solutions using SHM were fairly frequent with $\frac{l}{8}$ often embedded in the working. This required forming the equation of motion at a general point and this was the most likely place for errors to occur.

Question 5

Whilst high achieving candidates were able to earn full marks in this question on centre of mass, part (b) provided significant challenge for those at lower grades.

Candidates at all levels were well-rehearsed using integration to find the centre of mass in (a); they formed and rearranged the appropriate curve equation before following through carefully to reach the given answer.

In part (b), working was much clearer amongst those who used a table and simplified their mass ratios before forming their moments equation. Occasionally marks were lost due to incorrect formulae for the volume of the hemisphere or cone. However, to gain full marks in (b), candidates needed to locate the combined centre of mass, and the ability to identify this became a distinguishing factor.

Question 6

This question proved to be one of the most challenging on the paper with just one in five candidates achieving all 13 marks. The routine process in part (a) was well answered, requiring the use of energy and the equation of motion to form an expression for the force *S*. The force *S* was defined in the question and the required expression for *S* was also given, therefore the final answer needed to correspond precisely. Candidates who chose to use their own letter instead of *S* were unable to gain the final mark in (a) unless a suitable substitution was made.

Part (b) was another 'show that' and many candidates were able to gain these marks, even after an unsuccessful part (a), due to the given answers.

At this point, there was a noticeable distinction in responses with only the high-achieving candidates accessing marks in (c). The most common and most successful approach considered projectile motion which relied upon the vertical component of velocity being used. The second most common approach used energy and was much less successful. It was common for these solutions to assign zero Kinetic Energy to the highest point, giving no consideration to the horizontal component of velocity which remains constant throughout the motion.

Question 7

This question, involving two elastic strings, brought the level of challenge expected for the last question on the paper. However, the seven available marks in parts (a) and (b) were once again given answers, supporting candidate access to this question.

In part (a), using Hooke's Law and equating the tensions led to the given answer which was as far as many weaker candidates could get. Beyond this point, an understanding of how the two extensions related to each other was required. In (b) it was not surprising to see an equation of motion with crossing out and over-writing as candidates tried to correct signs and extensions to reach the SHM equation.

Since SHM had been proven, the most obvious and successful approach to (c) was quoting and using a standard SHM formula to find the speed when $x = 0.8$. However, it was also fairly common to see candidates respond by forming an energy equation. Whilst some did so with ease, most did not form an equation that encompassed all three EPE terms.

For those candidates who understood what to do in part (d), they used $x = a\sin\omega t$ with $x = 0.8$ and $x = -1$ to achieve the correct final answer in just a few lines of neat working. Occasionally a solution found only one of the times, but generally candidates who attempted part (d) were successful.

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