Examiner's Report
Principal Examiner Feedback

Summer 2018

Pearson Edexcel GCE
In Mechanics M3 (6679/01)

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Introduction

This was once again an accessible paper with much good work seen. The majority of students follow the instruction on the front of the paper and gave answers to 2 or 3 significant figures when a numerical value of g has been used but a few students still fail to take these instructions on board and still give more figures in their answers or exact answers or occasionally use $g = 9.81$.

There were responses where some of the work was close to illegible with fibre tips and very small writing making it very difficult to decipher symbols. Some students are reluctant to explain their thinking and just present a series of equations which also makes the work difficult to mark. Large, clear diagrams are helpful to both the student and the examiner.

Students lost themselves marks due to misreading their own handwriting. This year the combinations seen were 4/9, 5/*s*, *h/k*, *k/n*, *a/u*, *u/v*, 5/2, *g*/9.

Question 1

On paper this was a very straightforward question and many students will no doubt feel that they easily picked up all of the marks, though many will likely be quite disappointed. It is clear that more emphasis needs to be made on the additional requirements when asked to "show that". Very few students explicitly set up an inequality or equation for friction and separately resolved towards the centre before combining. This simple step was often the difference between 5 and 0 marks, with many students jumping in at a step too close to the given answer. Even when separate equations (or inequalities) were set up for friction and resolving, the direction of the inequality was rarely clearly justified. Many students started with an equation for friction, but made no reference to the fact that they were considering maximum friction. Others stated that friction was greater than the resultant force.

Question 2

Part (a) was relatively straightforward for those who could use Hooke's law and trigonometry successfully on their way to finding the modulus of elasticity. Calculation of the extension was usually correct, although often done as an aside and not displayed as clearly as it could have been. Marks were however lost by a considerable number of students for not giving the final answer to the required accuracy (as $g = 9.8$ was used in the question) where expressions with surds and g were frequently seen or students gave their answer to 4 significant figures.

In part (b) the elimination of T was the most common error seen with students substituting λ instead of the expression for T obtained in part (a). Another fairly common error was losing g in their equations. The majority of students gave the answer to this part to the required degree of accuracy although some gave an answer with surds within surds which is rarely acceptable. A small number calculated ω^2 correctly and then forgot that they had to square root to obtain the required answer.

Question 3

Students were familiar with this type of question and could correctly set up and solve the required differential equation. The most common approach was to use indefinite integration although some used definite integrals. An energy approach was less common and not always successful. Missing the minus sign was one of the most common errors and students must be aware of "fudging" their solutions - if they recognise the error part way through the solution they need to go right back to the beginning and correct the signs clearly. Entering distances into their equation or limits from the surface of the earth instead of from the centre of the earth was the most common mistake seen (using $x = 2R$ instead of $3R$), as was forgetting to give the final answer as a distance from the surface of the Earth, as required.

Question 4

Students had to recognise that an energy approach was needed to make progress and that EPE, GPE and work done against friction were all involved. They were free to choose what they used as the variable. Those who used the total distance travelled $OA = kl$ (as given in the question) had a more complicated EPE term to find but the others were simpler, and the ensuing quadratic contained only k. If students chose to use the extension in the string as their variable their EPE term was simpler, but the others more complex and the ensuing quadratic contained l and x, which put some students off attempting a solution. Those who ended up with an incorrect quadratic solved on the calculator lost the last three marks – it is essential that all working is shown. The question specified that k needed to be to 3 significant figures at the end but many overlooked this requirement.

There was some confusion over distances with some confusing the extension of the string with the distance moved in the EPE term and using the distance moved rather than the change in vertical height in the GPE term. Others put the friction into their energy equation rather than the work done against friction. A small number of students chose to split the motion into two parts, firstly until the natural length was reached, and then to when the particle came to rest. As this needed KE terms too, it lengthened the solution considerably and very few managed to reach the end successfully.

Question 5

Part (a) was a standard piece of bookwork which was well known to the majority of students. However, some managed to find ways to 'prove' the distance without any integration, or by integrating a simplified expression. Some students tried to use the volume of a full sphere but then needed to add a factor of 2 elsewhere to get to the given answer, rarely justifying this. It was surprising how many students chose to integrate to find the volume of the hemisphere, even though the result was given. In the majority of cases their work was accurate so they lost time rather than marks. Those attempting a polar approach were very rarely successful.

Part (b) was a standard question but the introduction of the density, k, caused some confusion, typically with it being used with the wrong hemisphere. Many students used the full mass with fractions and π, carrying it through multiple lines of working in their equation and cancelling towards the end. Those who used a mass ratio were far more accurate due to succinct equations which were far easier to work with. The majority of students omitted modulus signs in their final distance (as the sign of $(48-3k)$ is not known) and students should be encouraged to simplify their algebra as much as possible, including not leaving fractions within fractions.

Part (c) was mostly 'all or nothing' with students either realising the implication for the position of the centre of mass within the shape or not. Most students obtained the follow though marks.

Question 6

Part (a) was answered extremely well, with the majority of students scoring full marks. In most cases the separate equations were shown clearly and the combination to the given result was convincing.

Most knew how to tackle part (b), with very few using $V > 0$. By far the most common mistake was to leave the final answer as an inequality.

Part (c) was also answered very well, with most students understanding the requirement to set $\sin\theta$ equal to 1 and -1. If they realised that they could use the answer to (a), they nearly always progressed smoothly to the final answer. A significant number decided to start from scratch, but generally managed to correctly work through to the correct answer. Very few struggled to correctly use the relationship between the tension at top and bottom.

Question 7

Part (a) was almost always done correctly.

Part (b) again showed the great improvement in proving SHM, with many students picking up all 4 marks. Although less common than in the past, a significant number of students lost marks through working with a, rather than $\ddot{x}$. It was, however, extremely rare for students to forget to include a conclusion. Students should also remember to frame their solution around the question, rather than using general proofs, using e for extension (without defining it explicitly here or by use in part (a)). There were also still a significant number of students that knew the form that they had to arrive at and arrived there despite the forces in their equation!

Part (c) was generally answered fairly well, with the majority of students using the standard SHM approach. However, many students considered energy and this was usually successful (even if they had gone wrong in (b)).

Part (d) certainly proved more of a challenge. Whilst most students knew that they needed to consider the motion under gravity as well as the SHM, one (or both) of these usually caused a problem. For the gravity, by far the easiest approach was to find the time to $v = 0$. However, many first found the height reached by the particle and then found the time to this height. More than one student found the distance from the start of the motion to the top (0.9) but then subtracted from 1.2, leading to the correct distance, but no marks. Another common mistake was to find the total time from slack to taut once more, but forget to halve this, again giving no marks.

For the SHM part students were far more likely to be successful when considering $-0.2 = 0.4\cos 7t$. Those using sin or cos = + 0.2 often failed to complete correctly. In general, part (d) could be extremely simple if the correct choices were made, but the majority used the most difficult methods.

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