Examiners' Report

Summer 2014

Pearson Edexcel GCE in Mechanics M3 (6679/01)

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Mathematics Unit Mechanics 3

Specification 6679/01

This was found to be an accessible paper for most students.

Those who work entirely in formulae until the final line of a calculation should be reminded how risky this is; if something goes wrong they could leave very little which is worth any marks. Values need to be substituted throughout the working. Also, surds are generally acceptable in any form.

Question 1

Most students made a good attempt at an equation of motion towards C with a correct expression for the acceleration and followed this with a correct vertical resolution to give the required second equation. Many good clear diagrams were seen and these were often part of a full solution using trigonometry correctly to eliminate the angle from the pair of equations and find OC. Those who left their equation of motion in terms of the generic "r" for the radius of the circular motion often incorrectly cancelled with $4r$, the given radius of the hemisphere. Occasionally attempts were made to use an equation of motion towards O, the centre of the plane face of the hemisphere.

Question 2

The majority of the solutions to the first part of the question were sound with very little incorrect work seen. However, marks were lost by those who did not make it clear that they were working on the surface of the earth. Nearly all students employed the integration method using the equation of motion to solve Q02(b) and could cope with the integration. Very few students omitted a constant of integration. The mistake that prevented correct solutions was usually the use of $\frac{R}{4}$ rather than $\frac{5R}{4}$ when obtaining a value for the constant.

Question 3

For Q03(a) fully correct answers were not frequently seen. Despite being given the masses in the question, some students tried to find expressions for the volume of the wax and the surface area of the shell in order to determine the ratio of masses. Many students were able to use the formula book to find correct distances to the individual centres of mass but often did not give them from a common point in their tables or equations. It seemed that some students did not realise they could use the formula book and simply guessed the distances. The majority of students who had the correct masses and distances went on to gain the required answer.

In Q03(b) students needed to use the distance from the centre of the plane face and again, those that had a diagram for this part often also had the correct solution. As ever, some students used the tangent ratio the wrong way up.

Question 4

Most students knew the correct method but a minority used equilibrium equations with Hooke's Law for both parts, meaning that the only mark available was for finding the reaction in Q04(b). The EPE formula was well known and rarely seen incorrect when it was used. A few wrote an equation in words featuring the word "Work" but did not include a distance. Their equation was therefore dimensionally incorrect and lost most of the marks.

Most errors arose from using a wrong mass (m instead of $2m$) either in the GPE term (both parts) or in the reaction in Q04(b). Consistent use of m throughout the question which would have been classed as a misread was rare. A relatively common error, was using $R\cos\theta = 2mg$ in Q04(b), wrongly assuming vertical equilibrium. Students should show this equation for R as a separate statement. This makes it much easier to award follow through marks when they are available. Very few attempted an equation of motion for either Q04(a) or Q04(b) but those who did generally used the full correct method and used the same method for both parts.

Question 5

Q05(a) was generally answered well. Most students knew that they should use the double angle formula for the integration and did so successfully. The substitution in of the limits was sometimes not sufficiently explicit for a 'show that' question, but there was nearly always some attempt at it.

Most seemed to know what was required in Q06(b), with very few trying to work with a lamina. The responses were fairly evenly split between those who used the double angle and separated to integrate $\frac{1}{2x}$ on its own, and those that realised that they could take $\frac{\mathrm{d}v}{\mathrm{d}x}$ as $\cos^2 x$ and use the integral from Q05(a). Most students knew that they needed to use the double angle formula to prepare $\cos^2 x$ and $x\cos^2 x$ for integration. There were some errors with this usually where students lost the $\frac{1}{2}x$ often because of the way they set out their working. Typically they would use the double angle formula and multiply out the bracket, writing down $\frac{1}{2}\pi\int\left(x\cos 2x + x\right)\,\mathrm{d}x$ correctly, then go on to separately calculate $\int x\cos 2x\,\mathrm{d}x$ and forget about the $\frac{1}{2}x$ when they went back to put all their separate bits together. Most realised that they needed to do the final division, but inevitably some π s were omitted.

Question 6

In Q06(a) nearly all students knew essentially what they needed to do, but the requirement to produce an inequality led many students to make fundamental errors which lost them many marks. Almost all students knew that they needed to produce an energy “equation” and resolve to the centre at some point. This was mostly done at the top, but a significant number took both equations at the general position. Whilst more complicated, this was almost always done accurately. Those students nearly always went on to use $\theta = 180°$ and had the added bonus just being able to slot in the necessary angles in Q08(b). The big problem with Q08(a) arose when trying to get an inequality. While the majority knew that they needed to make $T \geq 0$ this was not always done correctly and a minority used $v \geq 0$. A significant number set $\mathrm{T} = 0$ (either explicitly, or by complete omission) and then attempted to justify the inequality (or not) at the end. A fairly common mistake was to insert the inequality directly into the energy equation. This led to the required answer, but lost several marks.

Q06(b) was generally answered better than Q06(a) and many students that lost most of the marks in Q06(a) managed to pick up marks here. The principle at work seemed to be understood by most, but sign errors often led to one incorrect tension. Some students mixed up kT and T and failed to refer back to the question which told them that kT was the greatest tension and T the least.

Question 7

Q07(a) was almost always correct. In parts Q07(b) to Q07(d) there was a great difference between the attempts seen. There were a lot of extremely competent, fully correct solutions but equally many failed to prove SHM fully. The common mistakes were using a instead of $\ddot{x}$ not considering directions and not realising that the negative is essential ignoring the weight, using Hooke's Law in $T = ma$ with extension x and thinking they had proved it.

Students should be encouraged to write their equation of motion clearly as a first stage in Q07(b). It is quite common to see solutions which start with "$F = ...$" and then spend several lines of working dealing with the forces before eventually getting to "ma". Students should know that no marks will be available until they write an equation. On the other hand, those who did this usually had the correct signs and notation when they finally produced an equation. Several omitted the conclusion and many failed to realise the importance of using the given letters throughout the question; l was often dropped from both ω and the amplitude leading to a significant mark loss.

Q07(c) was not infrequently done using an equation of motion at the lowest point (a repetition of the proof in Q07(b) for some). This method proved beneficial to those who had a dimensionally incorrect ω.

In Q07(d) clear statements about which portion of the motion is being considered would not only make it easier to give credit for correct reasoning but might also help students to avoid mistakes. The $\frac{1}{4}\text{period} + \text{sine}$ solution was much less common than the $\frac{1}{2}\text{period - cosine}$ one; in both cases the fraction of the period was found far more often using a displacement than a fraction of T.

Grade Boundaries

Grade boundaries for this, and all other papers, can be found on the website on this link:

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