Examiners' Report

Summer 2014

Pearson Edexcel Internatinal Advanced Level
in Mechanics M3
(WME03/01)

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Mathematics Unit Mechanics 3

Specification WME03/01

General Introduction

Most students found this to be an accessible paper.

Presentation is important when writing solutions and there were cases seen where students had mis-read their own figures. 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

Q01(a) generally caused few problems. Almost all students were able to identify ω and most went on to successfully find the amplitude. This was generally done in a very straightforward manner, although a significant number used lengthy methods, rather than using the quotable formula used in the mark scheme.

Q01(b) was nearly always answered correctly.

Q01(c) proved a lot more challenging. The majority managed to identify that 0.25 was involved, but the vast majority then failed to realise that they needed to find a distance from the centre of the motion and so gained no more marks. If a student did realise that they needed to consider $\frac{1}{16}$, they nearly always added $\frac{\pi}{4}$ to get the correct result.

Question 2

This question was generally answered well but a large number of students failed to gain the final mark. Almost every student knew the approach required and found the mass of the triangle either through integration or using the area of a triangle. Most also attempted the correct integral for the moment, although a significant number did not identify the correct equation of the line. The integration was almost always carried out correctly, but many students dropped marks through either taking limits of a or $\sqrt{3}$. Hardly any students attempted to find the centre of mass of a solid.

The most significant problem with the question came in establishing the centre of mass of the whole triangle. Around half of the good attempts worked on the whole triangle from the start and so had no problem. Of the students who considered the top half hardly any mentioned symmetry to gain the final mark.

Question 3

Almost every student managed to successfully set up equations and then to work out the correct angles for this question. Hardly any students used an incorrect form for the acceleration and the radius was usually correct. The most likely source of problems was solving the resulting simultaneous equations. A fair number of students managed to get to the correct answers, but then left them in an over accurate form. This was sometimes a case of giving T_A to 4 significant figures, but more usually giving answers in fraction/surd form. It should be stressed to the students that where a numerical value for g has been used neither is acceptable.

Question 4

In Q04(a) the vast majority of students used $F = ma$, with virtually all taking $a = \frac{dv}{dt}$.

Although none actually wrote $v\frac{dv}{dx}$ this was implied by v^2 appearing, often leading to the loss of nearly all marks, as these students often failed to use an expression for *v* in Q04(b). For most students, the correct integration was performed and a correct value of c found. If they had not yet divided through by 0.4, they did so before attempting to reach a conclusion.

The vast majority of students only managed to show that *v* could never be 6, not that it could not exceed 6. The majority phrased their explanation in terms of limits (some spoke of asymptotes) but most failed to make a convincing statement that $\frac{10}{t+5} > 0$ or an equivalent that would justify a correct inequality for *v*.

Q04(b) and Q04(c) were generally found to be accessible. If *v* had been found, then nearly all integrated to find displacement. Most chose to find a constant, rather than going straight to definite integration, but this was usually correct and most went for a decimal answer, but a significant number left an exact result, which was acceptable since *g* had not been involved.

Even if Q04(b) had caused problems, most could answer Q04(c). A small number found $(v_2 - v_1)^2$ but this was rare. Most managed to gain full marks here.

Question 5

In Q05(a) around half of the students formed a correct energy equation. The mass was often left (consistently) as *m*, but this was not a problem. Students generally included sufficient working to show that the height change was $\frac{a}{2}$, but some did have just $a\cos 60°$. If a correct energy equation was formed, momentum was then almost always used correctly to achieve the given result. However, a very significant number of students formed an energy equation from the start of the question to after the collision. This should have led to a result similar to the printed answer, but with $\frac{2}{3}$ inside the root. At this point all students who took this approach simply wrote down the printed answer, rather than realising their mistake, and as a result scored 0 marks in Q05(a).

Q05(b) was probably the best answered part of the question, as students could use the printed result. Most did use 3*m*, although the 3 often only appeared on the second line of their working. A large number did not simplify their answer and so lost the final A mark.

Q05(c) was probably the most demanding question algebraically on the paper although many managed to correctly get through to the given answer. Whilst most used 3*m*, a significant number used *m* throughout. Generally students were consistent in their use of mass. Most students attempted an energy equation, but this was not always clearly from the bottom to the top. The most successful students were the ones that simplified this expression before considering the forces. Most students also attempted to resolve at the top to get an expression for the tension. Some though used the velocity found at the bottom and so lost marks from here on, but the majority used the expression that they had found from the energy equation. Most realised that they needed to set $T \geq 0$ and many went on to successfully reach the printed result. Some students who had perfect solutions then gave a strict inequality at the end and so lost the final mark.

Question 6

Whilst almost every student knew what was required in Q06(a), confusion over dimensions caused many to lose marks. Fully successful solutions were split between those who called the extension *pa* and those who called it *x*, before going on to find *p*. Of the many who simply put *p* into their equation, a large number simply dropped the *a* after the first line, so as to achieve the printed answer, rather than identifying the problem.

The proof of simple harmonic motion was fairly challenging. Probably the majority did use x, but a significant number used *a*. While most students did attempt $F = ma$, the most common approach was to call the extension *e*, which they never properly defined. There was also a tendency to eliminate terms, rather than having a clear *mg* term and a clear $\frac{9mg\left(\frac{2a}{3}\right)}{6a}$ term that would then cancel. Most who arrived at the required expression did then give a conclusion, although this was not always as clear as it could have been.

Q06(c) was answered well and even students who had not made much progress towards proving simple harmonic motion could identify the correct ω.

Very few realised the significance of the extension in Q06(d). Whilst some made mention of performing simple harmonic motion, they did not all include the notion of “complete”, which was required, since simple harmonic motion is taking place until the string became slack. The most common correct response was that the string would not go slack (some mention of taut) and the most common incorrect response was to refer to elastic limits.

Many students who had failed earlier managed to gain full marks in Q06(e), whilst those who had gained full marks so far often gained only one mark. The most common error was to include elastic energy at the end, making only the first B mark available. A large number chose to find the kinetic energy when the string went slack and then used the constant acceleration equations to find the distance for the final section. Others chose to find the velocity through simple harmonic motion formulae at the point where the string went slack.

Question 7

The correct mass ratios (sometimes full volume expressions, sometimes 1, 8, 9) and distances were shown, usually from the correct face of the solid. There was a lack of clear working moving from an equation to the printed answer. Given the fractions involved it would have been good to see how they were being combined/divided but most just went straight to the result. Students who found the distance from the other base always went on to find the correct distance with appropriate working shown.

Q07(b) was an accessible question of finding the angle in that no subtraction of distances was required. Virtually all students found the angle with the vertical, but most realised that they needed to subtract from 90^{o} to get the correct answer.

In Q07(c) quite a few students went straight in with $mg\sin\phi = \mu mg\cos\phi$. Some knew the result that on the point of slipping $\tan\phi = \mu$, but this was not enough for a 4 mark proof of a given answer. Most did give an answer to 2 significant figures but many went straight to the answer. It would have been preferable to show a more accurate answer, to demonstrate that the rounding was correct.

Grade Boundaries

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

http://www.edexcel.com/iwantto/Pages/grade-boundaries.aspx

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