Pearson Edexcel

Examiners' Report
Principal Examiner Feedback

January 2019

Pearson Edexcel International Advanced Level
In Mechanics M3 (WME03/01)

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January 2019
Publications Code WME03_01_1901_ER

This paper started relatively easy but rapidly became more challenging. There was some evidence that some candidates were short of time to complete the paper as qu 6(b) was not always attempted. This final challenge involved the motion of a particle which had left its original circular path in a vertical plane. Surely candidates had tackled this type of question on a regular basis even if this particular one had a slightly different demand than normal.

Candidates must remember that when a question asks them to "show that..." every step of the working must be written down. Failure to do this was particularly evident in question 5 (a), where the integration was carried out but often the substitution of the limits was not shown. Simply following the quotient of two algebraic expressions, albeit in square brackets with the limits shown, with the answer shown in the question is not adequate. Some candidates had made mistakes in their integration anyway so stating the answer was wishful thinking on their part.

Numerical answers were generally rounded appropriately, either as demanded in the question or to 2 or 3 significant figures due to use of a numerical value for g.

Question 1

This was a straightforward start for most and the majority scored full marks. The most common error was using $a = \frac{\mathrm{d}v}{\mathrm{d}x}$ or $\frac{\mathrm{d}v}{\mathrm{d}t}$ instead of $v\frac{\mathrm{d}v}{\mathrm{d}x}$. Omitting a constant of integration was less common, but costly, as it led to a 2 term, rather than the required 3 term, quadratic. Where a mistake was made in producing a 3 term quadratic, many candidates then lost a mark by failing to show sufficiently detailed working in solving their equation.

Question 2

Not all candidates realised that the tensions in the two strings were different and that the angles were 30° and 60°. Those who did generally resolved vertically and used N2L along the radius scoring the first four marks. A few failed to calculate the radius correctly.
After that, a variety of methods was seen. Some did not find T_A and T_B specifically and others just found one and used it together with the resolution equation to continue.
The inequalities were not well understood – often only one was seen, which could be $T_A < 3mg$, $T_B < 3mg$, $T_B > 0$ or $T_B < mg$ since $T_A = T_B + 2mg$. $T_B < 3mg$ led to an answer which was not shown, causing some consternation.
There were very few cases of $\leq$ or = being used.
The next problem was connecting ω with S. Very few used S early in the solution and when it was used at the end, the direction of the inequalities sometimes caused problems even though the answer was given. Finally, some candidates calculated both inequalities correctly but failed to combine them as required for the final mark.

Question 3

The majority of candidates were successful with parts (a) (b) and (c).
In part (a) almost all used $v^2 = \omega^2\left(a^2 - x^2\right)$ to calculate ω; only a handful used $x = a\sin\omega t$ and $v = a\omega\cos\omega t$. It was not uncommon for sloppy working to lead to an incorrect value for ω, although full marks were usually obtained in parts (b) and (c) due to the follow through. Incorrect use of "2*a*" for the amplitude was occasionally seen which scored zero in (a).

Part (d) caused the most problems in this question. Although a significant number did arrive at the correct answer most scored a maximum of the first 2 marks because they could calculate a relevant time but did not know what to do with this, with some getting confused over the direction of travel. Those who did provide a correct solution chose a variety of routes, with the majority deciding to use the $\sin\omega t$ form for the displacement, despite the fact that the motion started at the end of the oscillation. Given that the symmetries of SHM allowed for various valid approaches to the correct solution (as well as some invalid methods that would lead to the correct answer), it would have been helpful for candidates to explain their working more clearly. Frustratingly, a significant number of candidates gave fully correct solutions in terms of *a*, and so the final mark was lost for not substituting $a = 5$.
A handful of candidates successfully used the reference circle in a neat solution to the problem.

Question 4

Part (a) was answered well by most candidates. When the answer is given it is advisable that candidates show clearly the separate equations they are using and clear working to make it clear how the answer was obtained. Marks were sometimes lost when candidates forced the result by fudging the lengths in their Hooke's Law equation.

Not many candidates got full marks for part (b). The most common fully correct approaches were to calculate the initial EPE and to show that this was less than the GPE required at *AB* or to set up an energy equation with KE being the difference of EPE and GPE and showing that v^2 would have to be negative. Errors in the initial EPE were often seen with some candidates confused over two strings or one string, mixing up the wrong extension with the wrong natural length. The most common response was to successfully calculate the initial EPE, but then to calculate the height reached incorrectly assuming that all of the initial EPE was converted to GPE. This height of $\frac{5}{3}l$ was then compared with $l\sqrt{5}$ Those who attempted an energy equation involving a final extension of *x* or distance moved up as *h* often struggled to arrive at the correct equation and usually did not or could not go on to solve it.

Question 5

Part (a) was generally done well and full marks were common. Most realised the necessity of showing detailed substitution of their limits, but a few went directly from their 2 integrated expressions to the given answer. Candidates should realise that when asked to "show" a result, far more explicit working is required and these candidates lost 3 of the available 8 marks.

Part (b) proved challenging and so a good discriminator. There were some excellent solutions but, although the general method was clearly known by almost all, the extra step of needing to deal with the bowl before involving the given masses proved too difficult for some. Failed attempts fell into 3 main categories:

- those who assumed that they should know where the centre of mass of the bowl was – usually at half or $\frac{3}{8}$ of its depth - and made no attempt to calculate it

- those who found the centre of mass of the bowl successfully but failed to realise the connection with (a) when finding the centre of mass of the liquid. Some guessed this value, others realised that $48r/65$ was relevant but used $r = 2$ and then added 3.

- those who attempted to do the whole calculation for the bowl and liquid in one go. These very rarely attempted to calculate relative masses as shown in the mark scheme alternative. More commonly, the volumes of the various elements were used as relative masses with the $5M$ and $2M$ either ignored completely or used as densities.

Question 6

Part (a) was successfully completed by the majority of candidates with the most common error seen being the difference of the KE terms being the wrong way round and a few cases of finding v rather than R.

Part (b) proved to be very challenging. Some used sine instead of cosine in N2L which led to very complicated trigonometry. Others only used energy and forgot about N2L so continued with v in terms of θ, never finding a value for the size of the angle. The method on the main scheme was not used often. It was more common to see a vertical equation of motion being used first but, because this led to a quadratic, correct solutions were rarely seen and if $\cos\theta$ had not been found the trigonometry was horrendous. Some used $s = ut + \frac{1}{2}at^2$ s but others used $v^2 = u^2 + 2as$ together with $v = u + at$ which tended to be more successful. The components of velocity were not always found correctly, with sine and cosine being interchanged.
There were some completely correct solutions but others gave up when faced with horrendous equations containing powers of sine and cosine. Fortunately it was the last question; some candidates were perhaps short of time as (b) was not attempted.

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