Pearson Edexcel

Examiners' Report
Principal Examiner Feedback

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In Mechanics 3 (WME03)

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Report on individual questions

Question 1

For the first question this proved problematic for some. There were many fully correct answers, but others clearly had problems with a situation which they seemed unfamiliar with. Almost all found the correct angular speed. It was a very common and costly error to assume that the friction caused the centripetal force and that R=mg. Candidates often worked with $F = \mu R$ rather than working with an inequality although many did adjust to the final correct inequality at the end. It was common for candidates to incorrectly assume that $\mu < 1$ in their final answer, perhaps thinking that a "range" needed an upper limit as well. A significant minority used $F \geq \mu R$. Some correct responses did not explicitly state that the friction was equal to the weight but wrote mg $\leq \mu R$.

There were a small but surprising number of responses that made the basic errors of using the diameter instead of the radius or using the radius as 35cm rather than in metres.

Question 2

This was very straight forward and was answered well on the whole, but part c) did cause problems for some.

Part a). The vast majority answered this fully correctly. Correct trigonometry was used with a correct vertical resolution. Occasional errors involved the use of only one component of the tension used or candidates doubling the tension found to give an answer of 15N.

Part b) No problems at all. Some used the whole string while other used the half string in equal measure.

Part c). There were many fully correct answers, but a significant number left this blank. It was evident that many candidates were unclear on when the bead was moving at its maximum speed. Some thought this was when it became slack and therefore EPE=0. Others involved EPE in an energy equation with kinetic energy in some attempt to find the speed.

Question 3

Fully correct answers were seen but most responses involved errors of some kind.

These errors varied. It was not uncommon to find the GPE and work done and one EPE term correctly, but the energy equation would then be missing an EPE term. Another error seen was to use a distance of 1m instead of 0.7. Occasionally there was a sign error in the energy equation or work done against friction was missed out entirely. A small number counted the GPE twice in the energy equation.

A small but surprising number of very poor responses were seen where forces were used in an energy equation or they did not consider energy at all but attempted to use constant acceleration.

Question 4

Generally, this question was answered well by most candidates, with part b) causing more problems than part a)

Part a). Most responses were correct and very few errors were seen in arriving at the correct given answer. Many used r instead of a as the radius in their working and then set r=a at the end, which was acceptable. A handful of very poor answers were seen where $\int \pi y^2 dx$ was not used or the expression for y^2 was incorrect. A few candidates divided by the volume of the whole sphere rather than the hemisphere.

Part b) was not answered as well as part a) but there were still many correct responses. Of these correct responses taking moments about O was the easiest and most successful approach used and the candidates who used this approach usually arrived at the correct answer for k. A small number who tried this were confused over the distances, usually a result of not drawing a clear diagram.

Finding the position of the centre of mass with O as the origin was probably the most common approach and most candidates were successful in finding these. However, some did not then know what to do with them or used these incorrectly and the most common error was to divide the wrong way up. This is likely a result of a poor diagram where there is then confusion over vertical and horizontal directions. A few unsuccessful candidates who tried this approach used moments with an extra term as they thought that the distances of either of the masses was not zero in their chosen direction.

Question 5

Generally, part a) was answered well with most candidates achieving full marks, but part b) was poorly answered.

Part a). Most candidates used the correct form $a = v\frac{dv}{dx}$ and could separate the variables. Indefinite integration was almost always used, use of limits was rare, and there were no errors seen in the integration. It was common to see candidates starting with $\frac{1}{2}v^2 = \int F dx$ or $\frac{d}{dx}(\frac{1}{2}v^2) = a$. A few candidates missed out the minus sign in their initial equation of motion.

Part b). This was sometimes left blank, but the majority could at least start with setting $\frac{dx}{dt}$ equal to the expression in a) and a few candidates did achieve fully correct answers. However very few candidates could proceed with the integration correctly as they did not get the integral into the correct form after separating the variables. Many of the attempts at integration were poor, indicating that the level of pure maths required in this context was too much for some.

A small but surprising number did not set $v = \frac{dx}{dt}$ at all but attempted non-valid approaches.

Question 6

Part a) was almost always answered correctly but the remaining parts caused problems for a significant number of candidates.

In part a) it was not uncommon for the extension to be found but the final answer left as $\frac{4}{3}a$. This had a knock effect in the other parts of the question and proved costly. However, some follow through marks were often gained for using their amplitude as $\frac{5}{3}a$, for example.

Part b). Usually the first 4 marks were earnt with a correct equation of motion, but many did not address the need to show that the string had not gone slack so that it was **only** SHM. It was not clear why, but it is likely that many did not realise the need to do this rather than an inability to do so. Those who did address this were usually successful in comparing the amplitude of $\frac{2}{3}a$ as being less than the equilibrium extension of $\frac{4}{3}a$ or equivalent. A few attempted to compare GPE and EPE often successfully.

A few candidates lost the fourth mark by not concluding that the equation meant SHM.

Some candidates used the symbol e in their equation to represent the equilibrium extension rather than $\frac{4}{3}a$. This was usually defined and seen in part a) so was acceptable. However, the use of general symbols in the equation to prove SHM should be avoided; values found or given in the question should be used.

In the setting up of the equation there was the occasional sign error. A few poor responses were seen where the variable x was not included in the equation or the extension was not measured from the equilibrium position.

Part c). There were many fully correct answers with $v^2 = w^2(a^2 - x^2)$ by far the most common approach used. A significant number did however score no marks by using the incorrect amplitude.

A few candidates did us an energy approach successfully but one or two of these missed out an EPE term in doing so, losing all 3 marks.

Part d). There were many fully correct answers given here but a significant number had difficulty or missed this part out altogether. Of the successful responses seen not many used the straight forward approach of setting $-\frac{1}{3}a = acoswt$ but instead set $\frac{1}{3}a = asinwt$ and added one quarter of the period to their answer for t. For those who did not gain full marks it was common to see a relevant time found for the first two marks but then no correct method to complete to find the required time.

Question 7

A significant number of these responses were half complete or left blank indicating that some candidates may have ran out of time. However, most candidates did struggle with parts b) and c).

Part a). This was very well answered with very few errors seen in setting up both the energy equation and the radial equation.

Part b). Fully correct answers were seen but these were by a minority of candidates. Most easily found the tension just before passing through B as 3mg by using $\theta=90^{o}$ in the expression from part a) but many could not proceed further or left this as their answer. Some did find the value of v^2at B but could not use this to find the tension of 8mg when the radius changed to 8a. Many simply failed to recognise that the instantaneous change in tension was due to the instantaneous change in the radius from 3a to 8a. A small number of poor responses kept θ in their answer and did not use $\theta=90^{o}$.

Part c) not many fully correct answers were seen. The majority could easily set up a correct energy equation from A to the wall or from E to the wall to find the speed or kinetic energy at the wall. Most of these correctly reduced this by a third but a few found one third of this instead. The second energy equation proved the most problematic. Of those who made a good attempt many used a radius of 3a and not 8a. A good diagram with the particle drawn above the level of EB when the string goes slack may have avoided this error. Almost all did set the tension to zero in their radial equation and gained the mark for this.

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