Examiners' Report
Principal Examiner Feedback

Summer 2019

Pearson Edexcel GCE AS Mathematics
In Further Mechanics 2 (9FM0/4C)

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Introduction

Most candidates for this paper offered solutions to all seven questions. The best candidates showed a clear understanding of the topics covered and were able to apply their knowledge. Weaker candidates were able to achieve given results, but were not so confident without the guidance of a target.

The candidates are very proficient at using their calculators, but they need to be aware that if a question asks them to show a given result then full working is expected. Similarly, if they are asked to "use algebraic integration" then working is expected between the statement of the integral and the answer.

Candidates should not underestimate the value of a clearly labelled diagram. Many candidates are forming equations in unknown forces and unknown angles without giving a clear indication of how these fit in relation to the given information. It is quite common for these candidates to produce inconsistent equations and to confuse sine and cosine when resolving.

Question 1

Most candidates understood that the normal reaction between the shell and the bead acts through the centre of the hemisphere. The majority of candidates were able to form the two key equations, resolving horizontally for the circular motion, and resolving vertically. For many, the trig substitution to solve for ω was clear and they completed the question successfully. There were two common errors: several candidates assumed that the radius of the path of B was a, and several thought it was $\frac{\sqrt{17}a}{4}$.

Question 2

(a) Most candidates set up a correct differential equation in v and x, separated the variables and integrated correctly. This was a "show that…" question, so we needed to see the use of the boundary conditions to find the value of k and of the constant if integration. Many candidates did reach the given result correctly. Several candidates claimed to have reached the given result despite arithmetic slips in their working.

(b) Most candidates did follow the instruction to use algebraic integration, but there were some who simply wrote down an integral followed by the given answer. There were two possible approaches: those candidates who went back to the initial information and formed a differential equation in v and t had an easier integral to complete than those candidates who used the result from part (a) to form a differential equation in x and t. The latter group of candidates made several errors with the indices and with the coefficients in the integral.

Question 3

(a) Most candidates formed a correct moments equation, but they were not all comfortable with the integration. At this level it was surprising to see many candidates avoiding the integration of $(x-a)^n$ and preferring to attempt the expansion before integrating or to use integration by substitution. Those candidates who took the direct route usually complete the task correctly. Some candidates attempted $\int xy\mathrm{d}y$, but did not realise that this did not give them $\bar{y}$ for the shaded region. Several candidates did unnecessary work in checking that the value given for the area of L was correct.

(b) The majority of candidates realised that they needed to find $\bar{x}$ before they could find the required angle. Most attempted $\int xy\mathrm{d}x$, but several of them did not complete the multiplication or lost the x from $2x$. Here again, the integration proved to be challenging, with many candidates choosing to use substitution or to expand the function rather than use integration by parts.

Candidates who drew a diagram and identified the required angle usually adopted a correct method to find the angle. Candidates who did not have a correct value for $\bar{x}$ were still able to score two of the marks available. The most common errors were to look for $\tan^{-1}\frac{\bar{x}}{\bar{y}}$, $\tan^{-1}\frac{4-\bar{x}}{\bar{y}}$ or $\tan^{-1}\frac{\bar{x}}{4-\bar{y}}$.

Question 4

(a) This was a "show that .." questions, so candidates needed to do a little more than write down the integral followed by the answer. We expected to see the integration and evidence of use of the limits. There were many correct solutions, but also several that did not show sufficient working to earn all the marks.

(b) The two steps that were needed here were to find the position of the centre of mass of the pole, and then to find the tension in the cable. The majority of candidates formed a correct equation to find the position of the centre of mass of the pole. As there is no need to know anything about the forces acting at A, the next step should be to takes moments about A to find the tension. There were many errors in this process; candidates resolved the tension, although it acts perpendicular to the pole, and they did not always resolve the weights. Candidates who tried alternatives to taking moments about A usually forgot an element of the force acting at A. The final answer involved the use of g, so it should either be given as an exact answer in terms of g, or to 2 or 3 significant figures.

(c) Many candidates put forward valid reasons for the answer not being the true value of T. The most common incorrect suggestions were about the wall being rough / smooth. This is not relevant as the pole is fixed to the wall.

Question 5

(a) Many candidates set up the correct integral for a moments equation to find the distance of the centre of mass of S from O. The integral was straightforward, and they had no difficulty in reaching the given answer. A few candidates set up the integral by working from first principles, but most used a remembered formula. Several candidates did unnecessary work checking that the value given for the volume of S was correct. Some candidates offered no attempt to find the distance and simply used the given answer in part (b).

(b) The majority of candidates understood the basic process for finding the position of the centre of mass of P. The common errors were to make the density of C three times the density of S, not to use the different density at all, and to make an error in finding the volume of C. Having found their value for the distance of the centre of mass from the base, most candidates used this correctly to find the required angle.

Question 6

(a) The response to this question was very weak. Most candidates did demonstrate an understanding of Hooke's law, and they did write down an equation of motion involving the difference between two tensions. However, the majority of candidates had either not understood the information given or they had not read it with sufficient care. Most candidates had the particle attached to the midpoint of the unstretched string, so they were using incorrect lengths throughout their working. Several of those candidates who did reach the correct equation of motion did not explain how they knew that this represented simple harmonic motion.

(b) Many candidates demonstrated knowledge of the basic properties of simple harmonic motion and they were able to use their figures to find the values of the maximum speed and the maximum acceleration of P.

(c) Although the question is set up so that P is released from a position of maximum amplitude in the motion, many candidates worked from $x = a\sin\omega t$. On this occasion that did not prevent them from reaching the correct conclusion. Several candidates succeeded in finding a relevant time for their model, but only a minority used that value correctly to find the total time required.

Question 7

(a) The transverse component of acceleration is not something that many candidates were aware of. Some were adamant that in circular motion the acceleration was all directed towards the centre of the circle. Only the better candidates were able to explain that the situation was due to P being at instantaneous rest.

(b) Several candidates did draw a diagram, but it was common for them to use θ as the name of an angle that was not equal to the angle θ in the question. Many candidates were able to use conservation of energy to obtain a correct trig ratio for their angle. Those candidates who understood about the direction of the acceleration often went on to find the correct value for the magnitude of the acceleration. An exact answer in terms of g or an answer to 2 or 3 significant figures were acceptable. Because of the confusion over the angle θ, an incorrect answer of $19.5°$ was very common.

(c) This was much more like the sort of questions that the candidates had seen in their preparation. They showed a good understanding of how to use the circular motion and conservation of energy to set up the relevant equations, and many of them reached the correct conclusion.

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