Principal Examiner Feedback

Summer 2018

Pearson Edexcel GCE A Level Mathematics

Statistics & Mechanics (9MA0/03)

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SECTION B: MECHANICS

Introduction

Overall the quality of the scripts seemed very mixed with some clear and entirely correct solutions but a substantial number were well below standard, particularly for Question 9 and Question 10. There may have been some evidence of time being a limiting factor as some Question 10 answers seemed rushed or unfinished, although it is difficult to be sure whether time or ability was the main issue here.

Question 7 was the best answered with 54% of the students scoring full marks, closely followed by question 6 where 55% of students scored full marks. Question 9 was by far the most challenging where the modal mark was zero and just under half the students scored 6, or fewer, out of 13.

In calculations the numerical value of g which should be used is 9.8 unless otherwise stated. Final answers should then be given to 2 (or 3) significant figures – more accurate answers will be penalised, including fractions but exact multiples of g are usually accepted.

If there is a printed answer to show then students need to ensure that they show sufficient detail in their working to warrant being awarded all of the marks available.

In all cases, as stated on the front of the question paper, students should show sufficient working to make their methods clear to the examiner and correct answers without working may not score all, or indeed, any of the marks available.

If a student runs out of space in which to give his/her answer than he/she is advised to use a supplementary sheet.

Question 6

The vast majority of students recognised the requirement to integrate to find the position vector and subsequently to substitute the given values of t. Occasionally, these were substituted straight into the velocity vector but such instances were rare and much correct working was seen. Most proceeded to find the magnitude of the vector joining the two points to give the exact distance as a surd as required; only a very small minority went straight to a rounded decimal value.

Question 7

Part (a) was well done by the majority of students. Virtually all attempted to resolve vertically and then use '$F = ma$' horizontally to find the acceleration. A few omitted the vertical component of the tension when finding the reaction which simplified the problem and resulted in the loss of 3 of the available 6 marks. '$F = 0.14R$' was almost invariably used to deduce the value of the acceleration. Full marks were often achieved for this part of the question.

In the second part, many clear and concise explanations were seen for why the acceleration would be less if the brush were pushed rather than pulled. To achieve both marks it was necessary to comment on the pushing down increasing the normal reaction, which in turn causes an increase in the available friction and a consequent decrease in acceleration. Those who failed to refer explicitly to the reaction or, more commonly, failed to draw the final conclusion about the acceleration achieved one of the two available marks. Occasionally, there was some confusion between the 'reaction' force and the 'resultant' force. Further calculations were not required here although some included them in their explanations.

Question 8

The first part was generally well done with most students using a constant acceleration formula in vectors ($\mathbf{r} = \mathbf{u}t + \frac{1}{2}\mathbf{a}t^2$) to find **a,** using the given velocity and position vectors. The few who chose to integrate a constant acceleration vector, and then use the given information to identify the constants of integration, mostly did so successfully. The magnitude of **a** was almost invariably calculated correctly but, since the answer was given, it was important that there was some working shown. Those who had no valid method for finding **a** tended to achieve the method mark for calculating the magnitude of their vector. A small minority of students attempted to apply *suvat* equations to the magnitudes of the given vectors; by chance this led to an answer which rounded to the given 2.5 m s^{-2}. However, such attempts achieved no credit.

Part (b) provided a greater challenge. Here it was necessary to find **v** after 2 seconds and then use this as the initial velocity for the second part of the motion. The given direction of motion meant that the coefficients of the i and j components of velocity were equal which in turn led to an equation in *t*. The main errors were in either trying to equate coefficients for a position rather than a velocity vector or in using $7\mathbf{i} - 10\mathbf{j}$ (a position vector) as the initial velocity. Some students made no valid progress at all with this part of the question. There were, nevertheless, a fair number of entirely correct solutions seen

Question 9

In part (a), most students used a 'moments about A' equation to deduce the given expression for the tension in the rope. Since the answer was given it was important that the preceding working was sufficient and accurate but generally this was well done. In part (b), most used a horizontal resolution and the given expression for T to calculate a value of x. Errors in the straightforward algebraic manipulation were surprisingly common, sometimes leading to a dimensionally incorrect value. The most popular approach to part (c) was to resolve vertically to find the vertical component of the reaction. Occasionally a weight was omitted or the tension was not resolved, but there were a fair number of valid attempts. Again, slips in simplifying the expression were fairly prevalent and sometimes an incorrect value of x was being carried forward. Those who reached an answer which was a multiple of Mg generally gained the final method mark for dividing the components of reaction to find tanβ. Although there were some entirely correct solutions seen, there was evidence of confusion and lack of a systematic approach in other attempts.

Part (d) required a calculation of the maximum value of x which was possible for the rope not to break. This required a comparison of the given expression for T with the maximum possible ($5Mg$). Following correct algebra some students concluded that the weight had to be less than (rather than 'not more than' or 'less than or equal to') $5a/3$ from A and achieved 2 out of the 3 available marks. Those who wrote in general terms about why there was a limit to how far the weight could be placed relative to A could achieve no credit without an attempt to calculate a value of x.

<u>Question 10</u>

In the first part, the majority of candidates used '$v^2 = u^2 + 2as$' with a correct distance to derive the given expression for U^2. A few attempted equations involving t but not always successfully. In part (b), most started with the valid strategy of using horizontal and vertical equations ($s = ut + 1/2at^2$). Not all included the appropriate correct distance (-1.25) and there were occasional sign errors. By substituting for t and then for U (using the expression from (a)) it was possible to obtain a quadratic equation in tanα. Not all attempts were successful, with errors in simplification leading to equations with a variety of trig functions or else not quadratics. Alternatively, rather than substituting for t and U in the original equation, a quadratic in t could be found by an initial substitution for Usinα. The resulting value of t could then be used in '$20 = Ut\cos\alpha$' to find α. This method was seen successfully employed on occasion. Similarly, the motion could be split into two stages and the times to and from the highest points found. This approach was only very rarely seen. Some candidates made several attempts at this part of the question; <u>it is worth remembering that if none are crossed out only the last most complete solution will be credited.</u>

Reference to air resistance was by far the most common correct response about the limitations of the model in part (c). Other valid comments relating to spin, dimensions of the ball and wind effects were all seen on occasion. Most candidates who offered an answer managed to score the mark with comments such as 'the ball might hit something' or 'it is difficult to throw at exactly that angle' being only very rarely seen.

Those who attempted part (d) generally used a correct method to find the time, most commonly using their value of α to find U and then to find t (from $20 = Ut\cos\alpha$). An incorrect value of α carried forward meant 2 out of a possible 3 marks could be achieved. Some reverted to the vertical motion equation and calculated t from the quadratic. Others made no attempt at this part having presumably run out of time or having not found a value for α previously.