Examiners' Report

Summer 2015

Pearson Edexcel GCE in Mechanics M4 (6680/01)

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Summer 2015
Publications Code UA042156

Mathematics Unit Mechanics 4

Specification 6680/01

General Introduction

The standard of work on this paper varied considerably and resulted in a wide spread of marks. The majority of students offered solutions to all seven questions and all questions proved to be accessible to well-prepared students. A minority of students were very selective over which topics they worked on.

Much of the work seen was of a high standard. A feature of successful work was the provision of explanations and clear diagrams, particularly where their absence meant that answers were either ambiguous or contradictory. In particular when dealing with momentum equations it is highly advisable to both define the variables, specifically the speeds, and indicate the direction in which they were acting. The use of a diagram will help the student to obtain correct equations and allow the examiner to recognise this is the case and ensure that there is no ambiguity which will lead to the loss of marks.

When students are checking through their work they should check carefully that what they have found is what the question asked for.

When working towards a given answer, students need to provide full and unambiguous working in order to score all the marks available.

Report on Individual Questions

Question 1

This was very competently and successfully completed by the vast majority of students. The method was clearly understood, but some students lost accuracy through slips in algebra or arithmetic.

The scalar product approach was a popular alternative but sometimes used incorrectly to find where the directions of travel were perpendicular.
Those few who chose the trigonometry approach were usually unable to reach a correct solution.

Question 2

Those students who drew the correct diagram of vectors were almost always able to reach a correct answer for the wind speed, but many students gave the direction the wind was blowing towards rather than the direction from which it was blowing, as asked for in the question. A few students were working on a reflection of the correct diagram but still worked through the calculations easily.

Attempts using vectors were not common, and when seen, they were more likely to be successful if accompanied by a clear diagram.

Question 3

The majority of students were confident in applying the impact law and conservation of linear momentum parallel to the line of centres of the spheres. Those who used perpendicular components were generally more successful than those who used a modulus/angle approach. Students who introduced two unknown velocities in two unknown directions created additional work for themselves and often had difficulty in finding/eliminating so many unknown values.

A common error was to double the component of the speed parallel to the line of centres, rather than double the overall speed.

Question 4

The majority of students gave fully correct solutions to the first two parts of this question, reaching the given answers with clear supporting working.

The most common error in part (c) was not to divide to split the top heavy fraction. Many students did not have the constant term. The fraction, with a difference of two squares, was widely recognised and many students are familiar with the integration to give functions expressed as logarithms. Some students gave the answer as a hyperbolic function and then struggled to substitute limits to reach a final answer.

Having completed part (b) using integration, a minority of students attempted to apply *suvat* equations to complete part (c), despite it being clear that the acceleration was not constant.

Question 5

(a) Finding the correct extensions in the two strings caused difficulty for many students. Those who used a clearly marked diagram tended to be successful. Others treated the two extensions as equal, or defined their own x, not matching that in the question. A few tried to consider just one tension in the equation of motion. Some students managed to derive the given answer from incorrect working.

(b) Despite being given the general solution of the differential equation, several students set about deriving it for themselves, thus losing time and gaining no credit. The values of the constant coefficients were usually found correctly. The majority of students understood that the particle was at instantaneous rest when $\dot{x} = 0$, but there were some errors in solving the trig equation and some students working in degrees rather than radians.

Question 6

(a) Many students made little effort to answer this part of the question, some not even finding the potential energy of R. Not being given the length of the string proved an insurmountable problem for some students, some simply ignored the string lengths. The given answer left some students making unsupported leaps in their manipulation of the trig functions, and some changing correct work in incorrect attempts to reach the target answer.

(b) This section of the specification was well understood by most. The only problem was in giving a full set of solutions to the resulting trig equation – some students divided through by $\sin\theta$ and lost this root, others did not consider the negative solution, or gave their answer(s) in degrees.

(c) Most students considered the second derivative of the potential energy, but some had lost/discarded the factor *mgr* and made no comment that it would be positive. Many students did not notice the requirement for $\theta > 0$, so they considered more cases than necessary. Most students with correct working reached the correct conclusion about the stability of the position of equilibrium.

Question 7

(a) Most students showed a sound knowledge of the topic and gave good solutions. Many found the angle first and then the rebound velocity. Most students understood that they needed to show exact working to support an answer given in exact form.

(b) Although exact working was not required in this part, many students worked through the entire question in exact form. The more usual solution in this part was to calculate the angle of approach and then apply the same method as used in part (a) to find the final velocity as a multiple of u.

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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