Examiners' Report

Summer 2014

Pearson Edexcel GCE in Mechanics M1 (6677/01)

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Summer 2014
Publications Code UA039484

Mathematics Unit Mechanics 1

Specification 6677/01

General Introduction

The vast majority of students seemed to find the paper to be of a suitable length, with no evidence of students running out of time. There were some parts of all questions which were accessible to the majority. The paper discriminated well at all levels. Generally, students who used large and clearly labelled diagrams and who employed clear, systematic and concise methods were the most successful.

In calculations the numerical value of g which should be used is 9.8, as advised on the front of the question paper. Final answers should then be given to 2 (or 3) significant figures – more accurate answers will be penalised, including fractions.

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.

Question 1

Overall this was a well-answered question. Most attempted to resolve horizontally and vertically. A few students attempted to resolve along the string but were usually unsuccessful. The only common error here was sin/cos interchange. A small number attempted to use the sine rule, but the angles were usually wrong, often just using the angles shown in the diagram, rather than using an appropriate vector triangle. Lami's theorem was very rare, but generally done correctly. Students who answered Q01(a) correctly often lost marks in Q01(b) due to premature rounding of their tension. The only other common error was to use Wg instead of W in Q01(b). A small number assumed that the angle at C was 90^o and tried to resolve along the strings.

Question 2

There were many fully correct solutions to this question. The majority resolved correctly, although a small number did mix up sin/cos and some did omit one term from their equation of motion along the plane. Many wrote equations that initially equated weight and friction, but on realising that they needed an acceleration started again to give a correct solution. Omission of g was sometimes seen or g was included in the $ma\ g$ term. However, almost everybody included $F = \mu R$, which gained them at least one mark. Almost everybody was able to gain at least the method mark in Q02(b). As in Q01, there was an issue with premature rounding of the answer to Q02(a), leading to an inaccurate answer of 2.54 in Q02(b) if given to 3 significant figures. Some students also forgot to square root at the end.

Question 3

The majority of students produced decimal answers which were in the main rounded to 3 significant figures. It should be noted that, for questions where g is involved, students would be advised to consistently write numerical answers in an exact form in terms of g or to 2 significant figures. Some students are still using 9.81 for g and at least one took g as 10.

In Q03(a) some assumed that the velocity on leaving the ground was the impact velocity reversed, failing to realise that this made a fall of 2.0 m and a rise of 1.5 m untenable. The responses to this part were fairly evenly split between correct and incorrect answers. In the second part, merely quoting a formula scored no marks but using $I = m(v - u)$ with various sign combinations for non-zero u and v earned the method mark but many failed to earn the accuracy mark due to sign confusion.

A few students did not appreciate that “magnitude” demanded a positive answer. In contrast, Q03(c) was most often incorrect, with students failing to deal correctly with the opposing signs of the before and after velocities and so gaining only the method mark, or using $u = 0$ which scored M0. There were very few correct graphs in Q03(d) with the vast majority of students scoring one mark out of three. Many students did not have a negative velocity at any point and a number of students who had the correct shape for the graph lost the second mark because they included a continuous vertical line. Correctly shaped graphs were seldom fully labelled. In the final part, students were able to use *suvat* equations to find the time t_1 to reach the ground and the time t_2 to rise to 1.5 m but not all proceeded to finding $t_1 + 2t_2$. Many of those who did lose the final accuracy mark (1.74 instead of 1.75) was due to premature approximation.

Question 4

Students made this question more challenging than necessary by not taking the resolving option and using two moments equations. Many took moments about *B* and *C*, when *A* would have been an easier choice. The resulting simultaneous equations sometimes proved too difficult to solve. There were very few cases of students mixing up the tensions.

Q04(b) was generally found to be more challenging, although again full marks were scored by many. The most common mistakes were to use just k rather than kW for the load, to use Wg and kWg and to assume that the tensions from Q04(a) still applied. The additional force inevitably meant that more students got lost in the algebra and failed to get to a correct final answer, but the question still gave plenty of scope to score well. It is advisable that students make clear what each equation is referring to and making the multiplication by a distance explicit in moments equations, even when the distance is 1.

Question 5

In Q05(a) almost all students were able to use $\mathbf{F} = m\mathbf{a}$ to find the correct vector for the acceleration and then its magnitude or to find the magnitude of the force and then apply $|\mathbf{F}| = m|\mathbf{a}|$ to find the magnitude of the acceleration. As this was a 'Show that' question, students needed to earn their marks and show sufficient stages in their argument and all too frequently, stages were omitted resulting in loss of marks. In the second part several students scored no marks for using the force rather than acceleration vector and some contrived to use the scalar magnitude combined with an initial vector velocity which also lost all the marks.

Q05(c) was probably the most successful for students but a number left their answer as a vector and so gained no marks.

In the final part, many students calculated $(\mathbf{i} + 3\mathbf{j}) + 3.5(6\mathbf{i} - 4\mathbf{j}) = 22\mathbf{i} - 11\mathbf{j}$ to gain the first two marks. Few chose the simplest explanation of motion being in the same direction by factorising $(22\mathbf{i} - 11\mathbf{j}) = 11(2\mathbf{i} - \mathbf{j})$ and there were many responses referring to either the bearing or gradient of both velocities. A few students started with the parallel idea and found the time to be unique at $t = 3.5$.

Question 6

Q06(a) required the setting up of an equation to relate the magnitudes of two forces with the magnitude of their resultant and then Q06(b) involved finding the magnitude of their vector difference.

In the first part there were two possible approaches. The cosine (or sine) rule could be applied to the triangle of forces, or the forces could be resolved and the components squared and added. Both methods seemed almost equally popular; however, there were a significant number of students who were unable to identify any valid strategy. There was confusion evident between vectors and their magnitudes. A fairly common error was to use the wrong triangle (with $120°$ angle rather than $60°$). Occasionally the cosine rule was quoted incorrectly (or Pythagoras was attempted), and errors in squaring and simplifying were not uncommon. Some students identified the components correctly but failed to make further progress by not squaring and adding. Both methods resulted in a quadratic equation in X. It should be remembered that if a calculator is used to solve it then full credit can be achieved if the equation and answer(s) are correct. However, any error will lose the method as well as the accuracy mark. The final answer (5.93) was required to 3 significant figures, as stated in the question.

In Q06(b), either the cosine rule or use of components were valid approaches for determining the magnitude of the vector difference. Those who found X successfully in the first part sometimes gained no more credit by just subtracting the magnitudes of their vectors. On the other hand, some who made no valid progress in Q06(a) used their answer correctly to achieve 3 out of the possible 4 marks. A fairly common error was to use $\left(X - 20\cos 60°\right)$ rather than $\left(X + 20\cos 60°\right)$ as a component, or the wrong triangle with the cosine rule.

Question 7

This question was well answered by the majority of students. In Q07(a) most identified correctly individual equations of motion for the two masses and then solved them simultaneously to find the acceleration. Since the answer was given, any potential sign errors tended to be rectified but occasionally the answer did not strictly follow from the working. Sometimes the values ‘3’ and ‘4’ were used rather than ‘ $3m$ ’ and ‘ $4m$ ’ as given in the question. This was penalised as accuracy errors here, but all subsequent marks for the rest of the question were available. The most common error in finding the tension was to omit ‘ m ’ in the final answer despite it being included in the working.

In the second part nearly all students found the velocity correctly by using ‘$v^2 = u^2 + 2as$’; the only significant error seen was in using ‘ g ’ rather than ‘ $\frac{g}{7}$ ’ showing a lack of understanding of the situation

Q07(c) required a similar approach to Q07(a) but with one different mass. Since the answer was not given this time, there were some arithmetic and sign errors, but generally it was well done. Those who used a value of the tension from Q07(a) achieved no credit, as did those who tried to somehow use constant acceleration formulae.

The majority of students used an appropriate constant acceleration formula in the final part to find the maximum height reached, using the values of velocity and acceleration from previous parts of the question. Occasionally ‘ $\frac{g}{7}$ ’ or ‘ g ’ were used. Most, but not all, added ‘0.7’ from the initial part of the motion to reach the final answer as required.

Full marks for this question were often achieved and much good working was seen.

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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