Examiners' Report
Principal Examiner Feedback

Summer 2017

Pearson Edexcel GCE
In Mechanics M5 (6681/01)

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General

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, and the paper proved to be much more straightforward than some in recent years, with certain parts of all questions accessible to the majority. There was a clear divide in the level of performance between the first three questions and the rest of the paper. Questions 4 and 5 proved to be the most challenging. There were many impressive, fully correct solutions seen to all questions. 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.

If a student runs out of space in which to give his/her answer than he/she is advised to use a supplementary sheet – if extra paper is not used then it is crucial for the student to say whereabouts in the script the extra working is going to be done.

Question 1

Whichever way this question was answered, the use of a scalar product (or equivalent work) was required. Most students using the work-energy principle were successful, although a few got muddled when deciding whether to use the equation of the line or its gradient. Students who tried to use Newton's Second Law and then constant acceleration formulae tended to use the whole force $6\mathbf{i} - 2\mathbf{j}$ rather than its component in the direction of the wire.

Question 2

In part (a), almost all students correctly used Newton's Second Law to prove this result. In the second part, the most popular way to solve this equation was by using an integrating factor, although a few forgot to multiply the RHS of the equation by it. Others successfully used an auxiliary equation to find a complementary function and usually remembered to also find a particular integral. Note that separation of variables was not an appropriate way to solve this differential equation since division of a vector by a vector is not defined.

Question 3

In the first part the majority of students were able to use the magnitudes of the given vectors to find expressions for $\mathbf{F}_1$ and $\mathbf{F}_2$ but a few then said that $\mathbf{F}_3 = \mathbf{F}_1 + \mathbf{F}_2$. For part (b), $\mathbf{G}$ was usually calculated correctly, although a small number incorrectly used **F** x **r** to find the vector product and the third part was correct on nearly all of the scripts. In the final part, since the additional force acted through *O*, the total moment of the forces about *O* was unchanged. The moment of **R** about *O* was therefore equal to the moment **G** found in part (b), but a significant number used – **G** and lost marks. Most students knew the technique for finding a point on the line of action of **R** and gave a correct equation for this line, remembering to include "**r** =" but there were some students who were unable to attempt this part of the question.

Question 4

Some students did not attempt the first part of this question. Of those who did, the general process was well known, but some students made it more difficult for themselves by a bad choice of variables. Splitting the triangle into strips parallel to *QR* was the simplest approach, with the length of the strips being 1.5 times their distance from *P*. Another technique was to use strips perpendicular to *QR* and find their moment of inertia about *QR*. The parallel axes theorem could then be used to change to an axis through *P*, but this theorem involves going via the centre of mass. A few students considered the two halves of the triangle separately and then sometimes said incorrectly that the density of the lamina was $\frac{m}{6a^2}$. For part (b), some students who had struggled with part (a) were successful with this part, using the more familiar formula $\frac{1}{3}Ma^2$.

Most students, in the final part, realised that they needed to add the results from the two previous parts to find the moment of inertia about *A* using the perpendicular axes theorem. Others just used one of the previous results. The majority correctly found the distance from *A* to the centre of mass of the triangle and remembered to include a minus sign in their equation of rotational motion. Any correct version of the period got the final mark, even if not simplified.

Question 5

Almost all students were able to obtain the printed answer in part (a) correctly, either using the moment of the momentum or by using $I\omega$ for the particle. A few however did not notice that the particle was brought to rest by the impact and so had an extra term in their equation. As ever, a few tried to use conservation of energy in this part and scored nothing. In part (b) the most common error was to omit the weight of the rod when resolving vertically. A few had incorrect dimensions in this part, generally by leaving out the *M* from "*ma*". The third part proved to be one of the most challenging on the paper. Some stated that the angular acceleration was 0 because the angular velocity was constant when the rod was vertical. The value given was an instantaneous velocity however. Others just said that, when θ is zero, $\ddot{\theta}$ is zero. What was needed for the first mark was a statement that $L = I\ddot{\theta}$ and that there is no force with a moment about *A* when the rod is vertical. For the second mark, the equation $X = ML\ddot{\theta}$ was needed, followed by $X = 0$. Some students considered the rod at a general point and then put in $\theta = 0$, which was fine.

Question 6

In the first part, most students were familiar with the standard process of showing that the incremental increase in momentum equals $-mg\delta t$ but some students incorrectly introduced m_0 at this stage and lost marks. The remaining part of the proof was less successful. They also needed to find an expression for $\frac{dm}{dt}$ and to swap from $\frac{dv}{dt}$ to $v\frac{dv}{dx}$ and then to $\frac{1}{2}\frac{d}{dt}\left(v^2\right)$. Some students divided through their initial equation by δx which was fine provided that they remembered to include $\frac{\delta t}{\delta x}$ on the RHS. Part (b) showed which students could rearrange equations accurately and efficiently. Some, unfortunately, did not substitute in $x = 0$ when replacing v with U. Most recognised that they could get a value for $(1+kx)^3$ and then cube root both sides, whereas a few expanded their bracket and gave up soon after.

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