Examiners' Report/
Principal Examiner Feedback

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GCE Mechanics M5 (6681) Paper 1

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General

The paper proved to be demanding for many of the candidates, although more accessible than last year's, most were able to complete it in the time allowed. Much of the work produced was clearly and logically presented but some candidates need to be reminded to include full explanations of methods used and a number of solutions were difficult to read and difficult to follow. Candidates also need to read questions carefully and ensure that they answer the question asked. Errors arising from failure to do this were quite common, particularly in question 3. By far the best source of marks came from the first two questions and the one that caused the most difficulty was question 3.

Report on individual questions

Question 1

This proved to be a very straightforward starter with most candidates earning full marks. Of the few errors seen, the most common were basic calculation errors. A few tried to use the vector product, instead of the scalar product, and then took a modulus of their answer to find work done.

Question 2

Many completely correct solutions were seen to this standard second order vector differential equation problem. The most common errors were using an incorrect auxiliary equation which led to an incorrect complementary function and failing to find a correct particular integral, with a few omitting this completely. The most common mistake was using $\mathbf{r} = \mathbf{j}$ as the P.I. rather than $\mathbf{r} = \mathbf{j}\mathrm{e}^{t}$.

Question 3

There were many incorrect attempts at this question. A large number of candidates used an impulse-momentum equation with an external impulse despite being told in the question that there were no external forces acting. This was a costly error as it led to an incorrect attempt at the resulting differential equation. Many of those who wrote down a correct conservation of momentum equation failed to eliminate t and then, finding themselves unable to progress, proceeded to assume that $\frac{\mathrm{d}m}{\mathrm{d}t}$ was constant. The few candidates, who had a correct momentum equation leading to a correct differential equation in m and v, generally went on to obtain the correct answer.

Question 4

Most scored the first two marks in part (a). However, a few read 3**j** as 3**i** in the force $\mathbf{F}_1$ which proved to be a costly error affecting the accuracy of the rest of the question. There were relatively few correct solutions, however, to the second part with many sign errors in the vector products and a significant number making the more costly error of omitting the moment of the resultant from their equation. There was more success in part (c) but again there were many sign errors. A number of candidates failed to realize that the fact that the three forces were equivalent to a couple meant that the third force $\mathbf{F}_3$ was the negative of the resultant found in part (a). These students were unable to find $\mathbf{F}_3$ and consequently were unable to make any headway with the solution.

Question 5

There were a significant number of completely correct solutions to this question but there were also a few candidates who seemed to have no idea on how to tackle it. The vast majority realised that they needed to resolve along the rod and perpendicular to it. However, many failed to appreciate that if the angular speed was constant the angular acceleration and therefore the tangential acceleration was zero. Most continued to attempt to find the magnitude of the resultant force using a correct method but it was a pity that a few candidates crossed out correct methods, being unable to obtain the printed answer, and then tried to solve the problem using only the equation along the rod which resulted in no method marks at all.

Question 6

A good number of correct solutions to this question were seen with the vast majority of errors arising from a confusion between linear and angular velocities. Some candidates produced equations with a mixture of linear and angular velocities which, being dimensionally incorrect scored no method marks. A few tried to use linear momentum and failed to appreciate the rotation of the rod and there was the usual smattering of sign errors. Others conserved energy as an alternative to the law of restitution which made the algebra more difficult.

Question 7

Candidates who knew how to solve this standard problem generally scored full marks, and it was pleasing to see many of these. However, it was disappointing to find that a significant number of students were unable to make any progress at all. A diagram is always helpful when dealing with a question like this and it was surprising to see so many attempts without the use of a diagram. Those who had their origin at the centre of the base of the cone had to deal with a more complicated equation for y or x and this increased the chance of mistakes. Of those who made a good attempt, the main errors were in an assumption that the radius was equal to the height, or an assumption that a right circular cone meant that there was a right angle at the vertex.

Question 8

Part (a) was straight-forward for the vast majority of candidates and there were many completely correct solutions seen for the second part also. Part (c) proved to be more difficult and some just didn't know how to proceed. Some of those who attempted to differentiate didn't appreciate that cos α was a constant whilst others couldn't apply the chain rule correctly. Those who square rooted before differentiating tended to be less successful than those who didn't. Those who took moments to find the angular acceleration often omitted the negative sign. The final part proved to be highly discriminating and very few candidates realised that they needed to use a small angle approximation and then use SHM to solve the problem. A large number tried to use the periodic time in their solution and got nowhere.

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