GCE

MATHEMATICS

MM04 Mechanics 4

Report on the Examination

6360

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General

The overall quality of answers was very good with solutions being generally well structured and explained. Almost all students attempted all questions. The improvement in understanding concepts from rotational dynamics continued with more students able to successfully attempt the majority of parts in the relevant questions.

Question 1

This question was very well attempted. However students should be aware that when the request in a question is 'Show that..' full working needs to be shown with clear indication of how any formulae are being used. In the best solutions students began by stating that $\bar{x} = \frac{\int xy\,dx}{\int y\,dx}$ before evaluating the numerator and substituting 'A' for the denominator. Only a handful of students incorrectly attempted to use formulae appropriate to three-dimensional problems, a significant improvement on the past.

Question 2

This question was more successful than in the past with students showing a better understanding of taking moments and finding equivalent forces. The majority of students successfully set up and solved two equations. A minority of students set up the equations incorrectly using '$+a$' and '$-a$', not realising that the value thereby obtained was identical. Pleasingly, less students made errors with signs or incorrectly paired a force component with a non-perpendicular distance. Fewer students used the $\mathbf{r} \times \mathbf{F}$ approach; errors were made by some using this approach through reversing the order or not realising all components should in the $\mathbf{k}$ direction only. A few students gave magnitude answers for part b).

Question 3

This question was well answered. Almost all students chose to find the limiting P value for each case and then set up the inequality by arguing which value of P would be reached first. To score full marks, students had to clearly state why the inequality was needed by referring to sliding occurring before toppling. On occasions the inequality was reversed and not corrected. A more significant error was to use the mass of 0.4 kg when taking moments, leaving out g.

Question 4

This topic continued to be a good source of marks for most students. Part (a) was not always successful with a minority of students setting up appropriate equations correctly but then failing to obtain the given ratio; often reversing it. Part (b)(i) was most often solved by using the ratio established in part (a). Part (b)(ii) was well attempted although a few students made it overly complicated by not considering horizontal forces at A or B. Others left the answer as -100N, when the magnitude was requested. Use of notation on the diagram was better with only a few students becoming confused by only using tensions and interpreting a negative value incorrectly.

Question 5

A very good response was made to this question which was an improvement on similar past exam questions. The integration in part (a)(i) was carried out very well indeed with the integrand being correctly set up and justified. Very few marks were lost in this part of the question. In (a)(ii) a few students did not fully identify the perpendicular axis theorem, citing the parallel axis theorem instead. Part (b) was generally done well especially by students who considered the various pieces separately before putting them together. When marks were lost they were lost for the following reasons:

- incorrect use of parallel axis theorem
- use of $10ma^2$ instead of $5ma^2$
- assuming all rods had identical moments of inertia
- mixing up axes of rotations

Question 6

This topic was done well, with (c) proving to be the most challenging. Part (a) was almost 100% correct. When errors occurred in part (b) they were largely due to sign errors although a handful of students attempted $\mathbf{F} \times \mathbf{r}$. Best solutions seen in part (c) adopted a step by step approach which was easy to mark. Less worthy attempts included not reversing signs of the force of moment from earlier parts, using the magnitude of forces rather than the force itself and failing to appreciate that the coordinates of a point on the y axis means that $x = z = 0$. Notation occasionally lost marks with vector forces not being identified as such.

Question 7

The result in part (a) was well understood from MM2B and successfully established here. The printed answer being given in part (b) resulted in almost all students scoring full marks, having corrected any error to achieve the result. Part (c)(i) was not always fully explained; students must realise that every step must be justified to obtain full marks and indeed the best students always did this. In (c)(ii) there was a 50-50 split between differentiating or applying C = $I\ddot{\theta}$ to obtain the required result. The latter was always more successful. The last part proved to be the most challenging on the paper. Most students knew they had to use $F = ma$ in each direction but failed to apply it correctly. Typical errors included:

- mixed up components with sine and cosine becoming swapped over
- reversing a direction
- using an incorrect mixture of $4a$ and $4m$ or a and m
- mixing up $\ddot{\theta}$ and $\dot{\theta}^2$
- using weight as opposed to mass for the 'ma' side

For these reasons full marks in (c)(ii) were rare with many students scoring either 0 or 2 marks.

Mark Ranges and Award of Grades

Grade boundaries and cumulative percentage grades are available on the Results Statistics page of the AQA Website.

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UMS conversion calculator www.aqa.org.uk/umsconversion