A-LEVEL
Mathematics

MM04 – Mechanics 4
Report on the Examination

6360
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General

The overall quality of written solutions was very good. The improvement in understanding concepts from rotational dynamics continued, and students showed a good understanding of all areas.

Question 1

This proved to be a good starter question, whereby students demonstrated their understanding of moments in 3D very successfully. It was pleasing to see that the vast majority of students included a final comment to complete the solution. Two types of error were noted: using $\mathbf{F} \times \mathbf{r}$ throughout rather than $\mathbf{r} \times \mathbf{F}$, or numerous errors made with particular components, most often the signs in the $\mathbf{j}$ component.

Question 2

Attempts at this question were generally very good. However, students should be aware that when the request in a question is 'show that' then full working needs to be shown with clear indication of the formulae used. However, there was a clear improvement when compared to responses to similar questions in the past. Only a handful of students attempted to use formulae appropriate to two dimensional problems: a significant improvement on the past. The students were most successful at parts (a) and (b). There were several common errors noted in part (c):

- using the distance from part (b) rather than the correct distance from the base
- using the incorrect radius of the base
- mixing up $\tan 30°$ and $\tan 60°$.

Students were very successful at finding the solution of the equation they had set up and showed a good understanding of algebraic skills.

Question 3

The vast majority of students scored full marks on this question. A small number of students failed to understand the modelling involved and tried to use the moment of inertia of a rod, thus scoring no marks. Some students did not use the correct distance for particle C. The weakest answers found the centre of mass of the particles and then applied md^2, which is an invalid method.

Question 4

This topic continued to be an excellent source of marks for most students. Part (a) was very successfully answered, with only a minority of students failing to identify the force as a tension. Parts (b) and (c) were almost always correct. Part (d) proved most discriminating, with sign errors resulting in a force of zero magnitude on occasions.

Question 5

This was more successfully answered than similar questions in the past, as students were clearly helped by the structure. Part (a) was almost always correct. More students used $\mathbf{r} \times \mathbf{F}$ in part (b) than ever before and were generally very successful. The weakest answers here tried to set up an equation whereby clockwise moments equalled anticlockwise moments, resulting in a final statement of $3p - 33 = 0$. Part (c) was well done, with most students checking the consistency of $p = 3$. On occasions, the magnitude was stated to be -24 Nm. Some students failed to score the final mark by not making explicit reference to a non-zero moment. Part (d)(i) was almost always correct, whilst part (d)(ii) proved most discriminating, with students either not realising that the resultant moment was zero and hence that the line went through the origin, or calculating the gradient of the line as –2 or 2.

Question 6

The result in part (a) was not always obtained correctly. Some students observed that $T_1 = 2mg$ and $T_2 = 4mg$, failing to appreciate the actual motion of the particles, whilst others jumped from writing two equations using $F = ma$ to the final conclusion, not showing how it was obtained. The printed answer being given in part (b) resulted in many students scoring full marks. However, on occasions, weaker students tried to work backwards and failed to show an understanding of the necessary equation of motion for a pulley. Part (c) was not successfully answered, with a significant number of students failing to generate a second valid equation in order to solve the system simultaneously. Many students found the angular acceleration of the system first before finding the two tensions and rightfully obtained full marks for parts (c) and (d). This proved to be the most challenging question on the paper.

Question 7

Students showed good understanding throughout this question. Part (a)(i) was well done with a 50–50 split between using a disc or cylindrical shell as an elemental piece for the cylinder. Weaker students essentially proved the moment of inertia of a disc, ignoring the fact that it was a cylinder, or used various incorrect formulas for the volume of a cylinder. The integration itself was not a problem. Part (b) was well done, with only a few students mixing up the parallel and perpendicular axes theorems. It was common for the incorrect mass or radius to be used. Part (c)(i) was more successful than similar requests in the past, with conservation of energy well understood. There had been a suggestion that asking for expressions "in terms of m, a, g and θ" could cause students to wrongly assume that all these variables necessarily needed to be present, but any sign of such confusion was treated sympathetically, and in practice it was very rarely seen. When errors occurred, it was usually because of the wrong radius, wrong mass or the use of cosine rather than sine for the potential energy. There was a mix or methods used to find the angular acceleration, with the differentiation method proving most popular. Part (c)(ii) proved most discriminating, with common errors being

- use of the wrong component
- use of the wrong mass or radius
- a mixture of incorrect resultant forces such as $2mg \cos\theta + Y$, $2mg \sin\theta - Y$, $2mg + Y\cos\theta$.

Mark Ranges and Award of Grades

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

Converting Marks into UMS marks

Convert raw marks into Uniform Mark Scale (UMS) marks by using the link below.

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