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General Certificate of Education

Mathematics 6360

MM04 Mechanics 4

Report on the Examination

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General

This paper proved more demanding than the previous two papers, largely due to question 6. The majority of the other questions differentiated appropriately. Questions 1 (couples and moments) and 2 (frameworks) proved most accessible, with good responses from candidates. It was pleasing to see that candidates tried to explain steps fully throughout.

Clearly, candidates' own grasp of pure mathematics skills heavily influences the outcome on this paper; for example question 3 (vector product), question 4 and question 5 (integration). There was no evidence of time problems.

Question 1

Marks were rarely dropped, although some sign errors did occur. There was a great deal of variation in the point about which to take moments. Candidates who chose point C tended to do better. A small number of candidates chose a point halfway down the rod, which meant that three individual moments were combined, creating extra work.

Question 2

This differentiated more than usual for this type of question, largely due to the requests in parts (a) and (b), which required explanation. In part (a), a mark was lost if candidates did not clearly explain the idea of resolving the whole system and therefore balancing the $100\,\mathrm{N}$ at G. In part (b), for both marks to be awarded candidates had to clearly refer to two axes of symmetry for the system. However, both marks were awarded if a candidate noted that forces had to balance at each joint, and then formed several equations to show that angles cancelled.

A small number of candidates made serious errors in parts (c) and (d) when they resolved all forces within a rod, not at a joint, effectively double-counting everything. The best solutions consisted of a clear labelled diagram with tensions marked correctly, and which only used two letters due to the symmetry of the situation. Part (e) was answered correctly by almost all candidates. The idea of replacing tensile rods with strings is well understood.

Question 3

Responses to this question were more varied. Candidates often lost a mark in part (b) through using $F \times r$ or by making an error with the determinant. In part (c), candidates must appreciate that, when answers are given, full working must be shown. There was mixed success with part (d), with either the vector product or scalar product method being used. Sometimes these were mixed together. Other errors consisted of using the vectors from the wrong triangle, eg OA and OB.

Question 4

Proving the moment of inertia was challenging for some candidates who failed to identify an appropriate elemental piece. Some excellent answers were seen, which correctly used appropriate notation to identify the elemental piece required. Part (b)(i) proved to be successful for almost every candidate. Surprisingly few candidates answered part (b)(ii) correctly, as a result of not realizing that a comment about external forces was required. Candidates were very successful at the last part, although a few tried to equate kinetic energy.

Question 5

There was a very pleasing response to this question. All marks were lost in part (a) if a two-dimensional formula was used. The best solutions in part (b) used a tabular approach before setting up the relevant equation. A common error was to have the centre of mass of the cone at

a distance of $3.5r$ from the base, instead of $2.5r$. The last part was well understood with the correct principle applied. The best responses included a clear labelled diagram showing the principle concerned.

Question 6

This was a demanding question, with many candidates scoring less than half marks. In part (a)(i), several candidates used the incorrect radius $6a$ in the incorrect formula to get the correct answer (no marks). In part (a)(ii), several candidates tried to equate energy but again used $6a$ not $3a$, clearly not realizing that it was the location of the centre of mass that was required. Attempts to differentiate to obtain the angular acceleration varied, although the mark scheme awarded an easy mark if sine was seen. Parts (b) and (c) were non existent for many candidates. The best solutions here used clear labelled diagrams indicating forces and accelerations. It was disappointing to see elements of M2 topics done so badly here.

Mark Ranges and Award of Grades

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