AQA

A-LEVEL
MECHANICS 4

Mathematics MM04
Report on the Examination

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General
The overall quality of written solutions was very good. Candidates showed an improved understanding of topics related to rotational dynamics but sometimes fared less well with the more routine topics of frameworks or toppling and sliding.

Question 1
A very good opening question that allowed candidates to demonstrate their understanding of couples and of moments in two dimensions very successfully. A few candidates formed the two equations correctly but did not solve the resulting equations correctly. Taking moments in part b) proved very successful with many opting for use of **r**x**F.** On occasions there were errors involving an incorrect sign with clockwise/anticlockwise moments but these were far rarer than in the past.

Question 2
This question on frameworks proved far more demanding than usual. Part a) was well done, although some candidates thought the rod was in compression or did not state whether it was in tension or compression. Part b) was not done well and candidates did not seem to have an understanding of how to deal with the components of the force at the hinge. Those who used moments did generally well. The more common approach was to try to find all forces in each rod and then to end up at the right point. When this approach was taken all equations had to be set up correctly to score marks and too often candidates only found the horizontal component of the required force. The best solutions had a clearly marked diagram with notations such as T_{QR} and the horizontal and vertical components clearly marked at the hinge.

Question 3
Parts a) and b)i) were done particularly well. Candidates appear confident using the requisite formula for finding the x coordinate of the centre of mass in two dimensions. Several candidates did not realise the implication of symmetry in part a) and also integrated to find the y coordinate of the centre of mass. There were fewer incorrect formulas used this time.
Part b)ii) was more decimating and several errors were common:

- omission of the vertical component of the force P
- incorrect rearrangement to obtain an expression for P
- failing to set up the inequality correctly
- failing to fully explain reasoning used to justify why the inequality occurs

Question 4
Part a) was a standard request and generally done well. A few candidates incorrectly used **F**x**r.** There were more errors this year with the **j** component where candidates failed to have the correct sign. Almost all candidates knew they had to add the individual moments together. Part b)i) was well-answered but part b)ii) was more discriminating. Although many set up the correct equation at the start there were then a number of errors made:

- incorrect evaluation of the vector product with the **j** component often being written as -2x - 7z or 2x – 7z
- failing to realise that 2x +7z = -8 could be solved by choosing valid values for x and z
- identifying the wrong vectors for **a** and **b** in the equation of a straight line

Question 5
A mixed response here, with the more challenging parts being answered well but the more routine parts causing more difficulty. Part a) was done well although sometimes candidates used an incorrect value for *I*. A few candidates used integration to obtain the result from first principles. Part b) was not answered well, candidates do not appear to fully understand the parallel axis theorem. The correct formula is $I_G + md^2$, too many candidates did not use the moment of inertia about the centre of mass. Using the moment of inertia about the end of the rod leads to the correct answer but is a totally invalid method. Part c) was generally done well but if candidates had not scored both marks in part b) they could only score a maximum of two marks here. Part d) was done well and best attempted by considering the change in potential energy of each of the rods. Common errors in totals here resulted in 8mgl or 6mgl or various options with cumbersome roots. The use of conservation of energy is well understood and many correct answers were seen. Part e) was done quite well and this was an improvement on previous work seen in past examination series. Many chose to find the combined moment of inertia of the framework and the particle showing a good understanding of how conservation of angular momentum works. A few tried to use conservation of energy scoring zero marks.

Question 6
Candidates showed an improved understanding throughout this question. Part a) was well done with clear identification of the elemental piece and resulting integration. Part b)i) was done well although some candidates used a rather than 2a and on occasions the wrong trigonometric function was used. Some candidates used conservation of energy here but had to make a good attempt at differentiation in order to score the first mark. Part b)ii) was accessible to all candidates and fully correct solutions were often seen. Common errors were:

- to use variations of $2a\cos(\theta - 60^0)$
- to use only $2a\cos 60^0$ or $2a\cos\theta$
- omission of the ½ in the kinetic energy
- slips in the rearrangement of equation

Part b)iii) proved to be more 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 $mg\cos\theta$, $mg\sin\theta$, $mg + X\cos\theta$

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UMS conversion calculator