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General Certificate of Education

Mathematics 6360

MM03 Mechanics 3

Report on the Examination

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General

AQA regrets that an error was made when this question paper was set, resulting in part (c) of question 7 being outside the specification and therefore invalid. The cotangent function used in the question requires knowledge from Core 3, but Mechanics 3 requires knowledge only from Core 1, Core 2 and Mechanics 1. Part (c) of question 7 was discounted when grades were awarded, with scripts treated as marked out of 71 and then scaled up to a mark out of 75.

In spite of this unfortunate error, there were many excellent responses to this paper. A high proportion of candidates attempted all questions and demonstrated a sound grasp of the relevant knowledge and skills. Some parts of the paper, however, proved to be too demanding for a number of candidates. Lack of understanding of the conservation of linear momentum and the impulse of a variable force were particular areas of candidate weakness. Many candidates showed a high level of competency with the methods of calculus and algebraic manipulation required for this paper. There was no evidence of lack of time for candidates to complete the questions.

Question 1

This question was answered well by the great majority of candidates. A small minority of the candidates seemed to be unfamiliar with the concept of dimensional analysis. Some candidates used L instead of L^2 for the dimensions of x^2 and a few candidates used LT^{-2} instead of MLT^{-2} for the dimensions of the force. Some candidates benefited from follow-through marks in part (b).

Question 2

Almost all candidates answered part (a) of this question correctly. Most candidates collected **i** and **j** terms to give a simplified result, but those who did not were not penalised. A small minority of candidates found the velocity of B relative to A. These candidates lost one accuracy mark.

For part (b), most candidates found the initial position vector of A relative to B before using the answer to part (a) to write down the required position vector at time t. Again, most candidates collected **i** and **j** terms. Some candidates found the position vectors of A and B at time t and then found the required position vector by subtraction.

Many candidates answered part (c) correctly. The most frequently used method was to write down $\left|{}_B\mathbf{r}_A\right|^2$, differentiate it by the chain rule and set the derived function to zero in order to find the required value of t. Some candidates used the scalar product of ${}_B\mathbf{r}_A$ and ${}_B\mathbf{v}_A$ to find the value of t when A and B were closest together. A small number of candidates, apparently, mistook the request as being for the time taken for the two helicopters to collide. These candidates attempted setting ${}_B\mathbf{r}_A$ to zero.

Question 3

A significant number of candidates did not answer this question correctly. These candidates did not know how to find the impulse of a variable force and they attempted to treat the force as constant.

A majority of those candidates who answered part (a) correctly used integration with appropriate limits to find the impulse. The others used the area under the force–time graph.

It was rather surprising to note that some candidates who answered parts (a) and (b) correctly attempted to answer part (c) by treating the force as constant.

Question 4

The main pitfall for candidates in part (a) was a sign error in applying the principle of conservation of linear momentum. Candidates who made this error had not taken into account the opposite direction of motion of the two spheres before collision. Part (b) of this question was well-answered by the candidates.

Question 5

The responses to part (a) were very good. The vast majority of candidates were familiar with the kinematics equations for the motion of a projectile.

Many candidates answered part (b)(i) of the question correctly. However, some candidates misunderstood the axes and substituted -1 instead of 1 for y. Evidently, because the answer was given, some of these candidates were able to rectify their mistakes but others gave wrong answers.

The candidates understood and used the condition for real solutions for the quadratic equation to arrive at the relationship requested for part (b)(ii). For part (b)(iii), almost all candidates substituted 5 for R. However, some candidates were unable to proceed further and solve the quadratic equation in u^2 in order to find the minimum speed of projection. There were other candidates who attempted to use differentiation to find the minimum speed. These candidates tried to minimize the expression $u^4 - 20u^2 - 2500$ rather than finding the minimum value of u.

Question 6

The great majority of candidates were well-prepared for this question and were able to use the principle of conservation of linear momentum and Newton's experimental law along the line of centres. However, some candidates were not able to give the answer requested in part (c) accurately.

Question 7

The responses to part (a) were very good, indicating the candidates' sound understanding and knowledge of the kinematics of projectiles launched onto inclined planes.

Some candidates used differentiation effectively to show the result for part (b). Full marks were awarded to these candidates even though the use of the given identity was requested. In using the given trigonometric identity in part, many candidates made a sign error.

Part (c) of this question was considered invalid due to the use of cot α and marks for this part were discounted when final grade boundaries were decided.

Mark Ranges and Award of Grades

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