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MM03 Mechanics 3

Report on the Examination

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General

The paper provided sufficient challenge for the most able candidates, whilst allowing the weaker candidates to demonstrate basic skills. There were many excellent responses to the paper. A high proportion of candidates attempted all of the questions with confidence, demonstrating a sound grasp of the relevant knowledge and skills. There was no evidence of a lack of time for candidates to answer all of the questions.

There were two general issues that emerged in the marking of the candidates' scripts. The first issue was concerning instances where some candidates gave two solutions to a question and did not cross out either of the solutions. In such cases, both solutions are marked and the mean mark rounded down is awarded. Thus, from a correct solution worth seven marks and an incorrect solution worth zero marks, the candidate can gain only three marks. Candidates should therefore be advised to cross out the unwanted solutions that they have replaced. The second issue was the degree of accuracy for the results of calculations requiring the use of a calculator. There were candidates who lost accuracy marks because they did not give results "to three significant figures, unless requested otherwise".

Question 1

This question was answered generally very well. The candidates were familiar with the concept of dimensional analysis. A relatively small number of candidates committed errors in equating the corresponding indices from their equations of dimensions. Occasionally, candidates made the mistake of replacing $(ML^{-3})^{\beta}$ with $M^{\beta}L^{-3}$.

Question 2

There were many excellent answers to this question. For part (a), a small minority of the candidates found the velocity of Albina relative to Brian instead of the requested velocity of Brian relative to Albina.

For part (c), the most popular method used for showing whether the two runners collide was setting each of the $\mathbf{i}$ and $\mathbf{j}$ components of the relative position vector at time t to zero and solving each equation to find t. A significant number of candidates decided to use a scalar product method to answer this part. A small number of candidates showed misunderstanding by stating that for collision the $\boldsymbol{i}$ and $\boldsymbol{j}$ components of the relative position vector at time t should be equal.

Question 3

This question aimed to test the candidates' understanding of the Impulse/Momentum principle, where the force is a function of time. Many candidates answered this question correctly. However, some candidates evaluated the integral $\int_0^{0.1} 5\times10^3 t^2 \, \mathrm{d}t$ without having any need for it.

A large number of candidates lost one accuracy mark because they gave the value of t to less than three significant figures. There were candidates who attempted to use the constant acceleration formulae to find the acceleration, in a bid to find the required value of t. Some other candidates treated the force as constant and used Ft for the magnitude of the impulse.

Question 4

Almost all the candidates were able to use the principle of conservation of linear momentum to find the velocity of A immediately after collision for part (a). However, some candidates lost accuracy marks due to mistakes made in collecting and simplifying the $\mathbf{i}$ and $\mathbf{j}$ terms. The most widely used method for part (b) was finding the two angles by using the inverse tangents and then adding the angles. Some candidates used a scalar product method.

For part (b), the great majority of the candidates understood that the impulse exerted by B on A was equal to the gain in the momentum of A. However, some candidates made sign errors by treating the gain in momentum of A as a loss of momentum. Having found the requested impulse, some candidates then proceeded to find its magnitude, which was not needed. Many candidates understood that the direction of the line of centres of the spheres was the same as the direction of the impulse.

Question 5

Parts (a), (b) and (c)(i) of this question were answered well by many candidates. However, some candidates lost one or more accuracy marks for parts (b) and (c)(i). To answer part (c)(i), most candidates evaluated $10\cos 26.9°$ and $10\cos 74.4°$ to arrive at the correct conclusions. A small number of candidates stated that the can will be knocked off the wall if $10\cos\alpha > 8$, or $\cos\alpha > 0.8$, and then thought that this would imply $\alpha > 36.9°$.

Question 6

Many candidates answered part (a) successfully. Some candidates who used $\sin(90° - \alpha)$ and $\cos(90° - \alpha)$, instead of $\cos\alpha$ and $\sin\alpha$ respectively, could not then replace $\tan(90° - \alpha)$ with $\frac{1}{\tan\alpha}$ to arrive at the required result.

The great majority of candidates answered part (b) correctly, giving the result in surd form. However, part (c) of the question proved too challenging for a relatively large number of candidates. The main difficulty here was using the correct components of velocities to find the change in momentum perpendicular to the wall.

Question 7

Many candidates answered part (a) correctly. The candidates' approaches were about evenly divided between using ${v_y}^2 = u^2\sin^2\theta - 2g^2\cos\alpha.y$, and finding the time for the projectile to reach the greatest perpendicular distance and substituting it in $y = u\sin\theta.t - \frac{1}{2}g\cos\alpha.t^2$. Part (b)(i) was answered very well. Many candidates were able to use the given identity to answer part (b)(ii).

However, some candidates used $x = u\cos\theta t - \frac{1}{2}g\sin\alpha.t^2$, possibly confusing the scenario with one where the projectile moves up the plane. The majority of the candidates who answered part (b)(iii) correctly used the given identity and stated that OP is a maximum if $\sin(2\theta - \alpha) = 1$. Others were able to use calculus confidently to show the required result.

Mark Ranges and Award of Grades

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