General Certificate of Education

Mathematics 6360

MM03 Mechanics 3

Report on the Examination

2010 examination – June series

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Set and published by the Assessment and Qualifications Alliance.

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Registered address: AQA, Devas Street, Manchester M15 6EX

General
There were a large number of excellent scripts, a significant number of which gained full marks. The candidates sitting the paper generally demonstrated a good understanding of most of the topics being examined, and there was a lot of confident and correct work. The topics which caused the most difficulty this year were the oblique collision (question 6) and determining whether a projectile lands at a higher or lower point on an inclined plane after a bounce (question 7).

Question 1
Most candidates found this question straightforward. However, some candidates were not familiar with the usual notation for finding the dimensions of the physical quantities. Some candidates wrote MLT^{-2} for the dimensions of g. A small number of candidates were unable to form the correct equation of dimensions with the appropriate indices.

Question 2
This question was answered very well and proved to be an easy source of marks for many candidates.

In part (a)(i), the candidates seemed comfortable with the kinematic equations of motion and the identity $\frac{1}{\cos^2\theta} = 1 + \tan^2\theta$. Very few candidates substituted 20 instead of -20 for y in answering part (a)(ii).

Some candidate lost an accuracy mark in part (b)(i) for premature rounding of the solutions of the equation for $\tan\theta$. Other candidates who wrote down inaccurate values for $\tan\theta$ but used the accurate values to find the values of θ did not lose any accuracy mark. Centres should remind their candidates to give the **final** answer to questions to three significant figures, unless stated otherwise, as stated in the instructions on the front page of the question paper. In part (b)(ii), a small number of candidates gave the result to less than three significant figures.

Question 3
This question was attempted well, with many candidates scoring full marks. The candidates were able to use the principle of conservation of linear momentum and Newton's experimental law correctly to answer part (a). However, in part (b), a small number of candidates seemingly forgot to find the speed of B immediately after the collision. These candidates lost the last method and accuracy marks.

Part (c) proved to be too challenging for a significant number of candidates. These candidates attempted to answer this part by substituting values such as 9 or 10 for x. The more able candidates stated that $v_B < 0$ for a further collision, and proceeded by solving an inequality to show the required result.

Question 4
The standard of work by candidates in questions on relative motion has improved substantially over the past few examination series. Many candidates scored full marks for this question. However, some candidates lost the marks for part (b) (answer given) due to not showing their method using the actual vectors. Most candidates answered part (c) by setting each component of the position vector of A relative to B to zero and showing the inconsistency in the solution for t. The approach of most candidates to finding the time for closest approach in part (d) was differentiation using the chain rule, though some successfully used the scalar product of

the relative position vector and the relative velocity. However, a small number of candidates who attempted to use the scalar product method used the wrong vectors.

Question 5

The vast majority of the candidates who attempted this question demonstrated understanding that the component of the velocity parallel to the wall did not change. Others' lack of understanding was apparent in their incorrect use of the trigonometric ratios in their application of the conservation of linear momentum and Newton's experimental law, ie $4\sin\alpha = v\sin 40^\circ$ and $v\cos 40^\circ = \frac{2}{3}\times 4\cos\alpha$ respectively.

Question 6

This question proved challenging for a large number of candidates.

Many candidates were unable to provide a valid reason as to why the components of the velocities of A and B parallel to the unit vector $\mathbf{j}$ were unchanged by the collision. The response here was often "because $\mathbf{j}$ is perpendicular to $\mathbf{i}$" or "because the spheres collide horizontally".

In part (b), a lot of candidates did not understand that the coefficient of restitution is the ratio of two speeds and not velocities. There were candidates who stated in part (a) that the components of the velocities parallel to the unit vector $\mathbf{j}$ are not changed, but then effectively ignored their own assertion when attempting to answer part (b).

Question 7

The vast majority of the candidates were familiar with the equations of motion of projectiles on inclined planes. Many candidates were able to gain full marks for part (a).

Part (b) proved to be challenging for some candidates. The typical mistakes committed here were applying restitution to the component of the velocity parallel to, instead of perpendicular to, the inclined plane, and incorrectly calculating of the angle of rebound. Some candidates found the angle of rebound but could not complete the answer. There were candidates who correctly considered the displacement of the ball perpendicular and parallel to the plane after the rebound to answer this part. Again, premature rounding of the time of flight after the rebound by some candidates was the source of inaccuracy in their stated value for the displacement parallel to the plane.

Mark Ranges and Award of Grades

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