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MM03 Mechanics 3

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General
There were some 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 proved to be too demanding for a number of candidates.

Some candidates lacked the ability to use a geometric approach to deal with the question on relative motion. Some candidates attempted to use the constant acceleration formulae to find the impulse of variable force. Almost all the candidates showed understanding of the principle of conservation of linear momentum and the experimental law of restitution. There was no evidence of lack of time for candidates to complete the questions.

Question 1
The great majority of the candidates were able to answer the opening question of the paper correctly and gained full marks. The candidates seemed well versed in dimensional analysis. However, a small number of candidates used MLT^{-2} instead of LT^{-2} for the dimensions of g.

Question 2
Most candidates answered this question well. A small number of candidates used the given initial velocity components to find the initial speed and the tangent of the angle of projection.

They then proceeded using the formula $y = x\tan\alpha - \frac{gx^2}{2v^2}(1+\tan^2\alpha)$.

For part (b), some candidates only found the two solutions of the quadratic equation in x and did not give the horizontal distance travelled by the particle whilst it is more than 1 metre above the plane. These candidates similarly gave two time limits for their answer to part (c). Many candidates failed to give the solutions to their quadratic equations to three significant figures.

Question 3
Many candidates had difficulty with the geometric approach to this question. Some candidates did not understand directions given as bearings. Although many candidates were able to resolve velocities in the direction of the unit vectors $\mathbf{i}$ and $\mathbf{j}$, some candidates committed sign errors in doing so. Some candidates were not able to find the bearings requested in this question because they were not able to draw clear and correct velocity diagrams. Only the small number of candidates who drew a clear diagram for answering part (a) recognised that the triangle was right-angled. These candidates simply used Pythagoras's theorem and the tangent ratio to answer this part of the question. Other candidates proceeded by resolving velocities. Many candidates found part (b)(ii) of the question too challenging. Often the candidates who answered this part correctly benefitted from carefully drawn diagrams. The most popular responses given for part (c) were no "cross wind", "calm lake", "instantaneous change of direction by the patrol boat".

Question 4
The candidates' responses to this question were generally very good. However, there was a small number of candidates who did not understand how to find the impulse of a variable force. These candidates attempted to answer parts (a) and (c) by treating the force $(t^3 + t)\,\mathrm{N}$ as constant. Almost all the candidates showed understanding of the equivalence of impulse and change of momentum in answering part (b).

Most candidates who answered part (c) correctly found the impulse of the variable force and used the impulse/momentum principle to arrive at the quadratic equation $t^4 + 2t^2 - 24 = 0$. They then used the formula to solve the equation to find the time taken by the particle to reach a speed of $12\,\mathrm{m\,s^{-1}}$. Some candidates attempted to solve this equation by taking the square root of each term separately in a bid to change the equation into a quadratic in t.

Question 5

The responses to this question were generally very good. Almost all the candidates were able to answer part (a) correctly, recognising that the momentum of the sphere B perpendicular to the line of centres was unchanged. The candidates were able to apply the law of restitution along the line of centres to find the coefficient of restitution requested in part (b). They were able to use the impulse/momentum principle to show the magnitude of the impulse exerted on the sphere A. Some candidates were not able to use a calculator correctly to find the answer to part (d). These candidates did not recognise the need for the use of the brackets facility on the calculator to calculate $m_B = \dfrac{2.165}{4.667 \times \cos 40^\circ}$.

Question 6

Many candidates were able to use the principle of the conservation of linear momentum and Newton's experimental law correctly to answer part (a) of this question. Many candidates were able to find the velocity of the sphere A. However, not all of these candidates were able to use the given fact that the direction of motion of the sphere A is reversed to form an inequality to answer part (b).

Even fewer candidates answered part (c) correctly. The challenge in answering the last part of the question was getting the signs of the velocities of the spheres correct as well as the direction of the inequality correct.

Question 7

The great majority of candidates were familiar with the equations of motion of projectiles on inclined planes. Many candidates gained full marks for part (a). In answering parts (a) and (b) of the question, a small number of candidates did not realise that the upward vertical component of g is negative. Some candidates failed to recognise that the component of the velocity of the particle along the inclined plane does not change on impact with 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.