Examiners' Report/
Principal Examiner Feedback

Summer 2016

Pearson Edexcel GCE in Mechanics M4 (6680) Paper 01

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Summer 2016
Publications Code 6680_01_1606_ER

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The paper was accessible to most students and many clear and well-presented solutions were seen. Most students offered responses to all six questions, with few blank responses being seen.

The standard of presentation of responses did vary considerably, from the concise and easy to read to the disorganized and barely legible. Students merely disadvantage themselves by adopting the latter approach, with sign errors and minor arithmetical and algebraic slips being more prevalent in such work, in addition to making it more difficult for the examiner to make an accurate assessment of the work. A clearly annotated diagram is usually an invaluable addition to any solution.

Elementary relations between trigonometric functions, such as $\sin(90-a)=\cos a$ and $\tan(90-a)=\cot a$ should be automatic at M4 level but many students did not deal with them well. This was particularly evident in questions 1, 2 and 6.

Question 1

Most students started with equations for conservation of momentum parallel to the line of centres and for the impact. Students who considered the components of the velocity of *A* after the collision tended to achieve more concise solutions than those who considered the magnitude and direction of the velocity. A clearly labeled diagram showing the direction of motion of *A* after the collision helped students to work through the trigonometry correctly. Some students were not able to complete their response because they did not also consider the motion of *A* perpendicular to the line of centres.

Question 2

This standard result either produced good concise solutions or long, complicated and often inconclusive attempts at solution. The fact that it is a well-known result did not help those students who put more effort into trying to fix the result than into working through the problem in a systematic way.

The better solutions used clearly labeled diagrams with components of positive magnitude shown acting in realistic directions. Those students who expressed everything in terms of the initial speed and α were often more successful than those who introduced a new variable for the speed at each stage and for each angle. Some students incorrectly assumed that the stages on the path of *P* were perpendicular to each other, and some thought that for the final direction to be parallel to the initial direction the path needed to be at angle α to the wall after leaving *Y*.

The most elegant solution seen expressed the velocity as a column vector with components parallel to the walls and used $\mathbf{v}=\lambda\mathbf{u}$.

Question 3

This was a very straightforward relative velocity problem on which students scored better than is often the case with this type of question.

(a) Nearly all students obtained the correct magnitude for the velocity of the car relative to the girl but the direction of the velocity caused some difficulty. Those students who started with a correct diagram for the velocities usually gave the correct bearing, but there were several unrealistic diagrams and some students did not use a diagram at all.

(b) There were several different methods of finding the shortest distance. Those students who expressed the relative position as a vector and then either took the scalar product with the relative velocity or used Pythagoras' theorem and calculus to find the shortest distance tended to be more successful, and avoided the rounding errors introduced by some students taking a more trigonometrical approach. Some students working through the triangles on a diagram had the right angle at the wrong vertex of the triangle and ended up with a calculation involving tangent rather than sine of their angle.

Question 4

(a) Some students would have benefitted from a clearly labeled diagram showing the positive direction of the kinematic variables (x, $\dot{x}$ and $\ddot{x}$) and the directions and magnitudes of the forces involved. Most students scored the marks for their initial equation of motion, but they did not always give a clear explanation of the derivation of the given answer. Some students had $v = -\dot{x}$ and the resistance acting in the direction of x positive.

(b) Very few students took the direct route of setting $\ddot{x} = 0$ and $\dot{x} = -8e^{-1}$ here, preferring instead to find values for the unknowns A and B and substitute for t to find d. Many answers were incorrect due to errors in finding the values of A and B.

(c) Most students found a correct expression for $\frac{dx}{dt}$ but it was common to see $\dot{x} = 8e^{-1}$ used in place of $\dot{x} = -8e^{-1}$, resulting in an incorrect value for B (and for A if the student was using this route as part of their solution to part (b)). Most students did score the final mark for finding the value of their x when $t = 0$.

Question 5

(a) The first part of this question was a familiar task, and most students gave a convincing account of the relationship between x, y and ut. Despite this hint, many students made the mistake of trying to form an equation of motion in x not thinking about the fact that this represents an extension of a string having no mass.

(b) Many students did not recognise the differential equation given in part (a) as simple harmonic motion, so they set about using a full method for solving a second order differential equation rather than going direct to the solution for SHM and to use the standard simple solution for the initial condition $x = 0$. Students were often successful in answering the question, but after doing much more work than use of standard SHM results would have needed.

(c) Most students did differentiate their x to find $\dot{x}$, but many did not appreciate that the question was asking for $\dot{y}$.

(d) This part of the question proved very difficult for most students. Those with a clear understanding of the model, who realised that they needed to start by finding the speed of the car when the string goes slack did often reach the correct final answer.

Question 6

(a) The majority of students were confident in dealing with a standard problem of this type. The clear indication of a fixed reference level relative to which GPE was being calculated was very common, and most had a correct expression in terms of θ for the extension in the string. Many students found the extension by using the cosine rule in triangle ABC, but some took the shorter route of using the fact that ABC is isosceles. Most students simplified their expression for the potential energy correctly to achieve the given result.

(b) The differentiation of the expression for the potential energy was usually correct, and most students reached a correct expression for $\sin\theta$ in terms of k. The next step was more difficult, with several students not using $\sin\theta < 1$ to reach the given inequality for *k*.

(c) The majority of students clearly understood what they needed to do to determine the stability of the position of equilibrium but there were several errors in the differentiation and then in evaluating the derivative. Students were expected to reach a value for the second derivative, not simply to make a guess at whether it would be positive or negative.

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