Examiners' Report
Principal Examiner Feedback

January 2024

Pearson Edexcel International Advanced Level
In Mechanics M2 (WME02) Paper 01

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The majority of candidates offered responses to all eight questions on this paper. Many were well prepared, and gave concise and accurate solutions.

There were several instances of candidates losing marks because they had not checked that their answer met the requirements of the question. This was usually due to leaving the final answer as a negative value when it should have been positive, or leaving an answer as a vector when the magnitude was required.

Although it has been commented on in several previous reports, there are still many candidates who do not understand the level of detail required when responding to a question that has a given answer. Not only do they need to obtain the given answer, as printed in the question, but they also need to show sufficient working to confirm that they have obtained it correctly.

Another issue which causes candidates to lose marks is giving final answers to an inappropriate level of accuracy. In this paper there are two common causes of accuracy errors:

- the use of $g = 9.81$ when the rubric on the front of the paper clearly instructs candidates to use $g = 9.8$,
- giving answers as exact fractions following the use of a substituted value for g. Again, the rubric is very clear about the appropriate level of accuracy.

Candidates should be reminded that it is their responsibility to present their working clearly. Some handwriting is so small that it is barely legible, even when enlarged. Some solutions are long and have no indication of what the candidate thinks they are trying to do; a long explanation is not expected, but a diagram and a brief description of what an equation represents can make a lot of difference.

Question 1

(a) There were many fully correct solutions, with only a small number of errors in the differentiation. Most candidates understood that they needed to find the values of t for which the speed was zero. The most common errors were in the course of using calculators to solve the quadratic equation. In this particular case, division by 6 gives a very simple equation that candidates at this level should be able to solve without using a calculator. A small minority of candidates divided by t instead of differentiating.

(b) Many candidates did not recognise that to find the total distance travelled they needed to split the interval into two parts, one for motion away from O and one for motion towards O.

The displacement when $t = 2$ often played no part in the solution. Several candidates with a correct strategy then made arithmetic errors.

(c) The majority of candidates used a correct method to find the acceleration of the particle, but many did not go on to state the magnitude of the acceleration. Negative answers were common.

Question 2

(a) Almost all candidates understood the link between impulse and change in momentum. A few subtracted in the wrong order. The question asks for the speed of the particle, but several candidates left their answer as a velocity.

(b) The three methods in the mark scheme for finding the angle between the two velocities were all common. There were a few slips in the arithmetic but most errors were due to finding the angle between the impulse and a velocity, or finding the angle between a velocity and **i** or **j**.

Question 3

(a) The majority of candidates scored some marks in this part. Most stated a correct expression for the maximum friction, and many went on to multiply this by the distance travelled. Many candidates also found the gain in potential energy. The most common errors were to lose the factor of 6 from one of the elements, to consider only the work done against the friction, or to include the gain in potential energy twice. Very few candidates confused sine and cosine.

(b) There were many correct solutions to this part. Several candidates who considered only part of the work done in (a) included all the correct elements here. The most common errors were sign errors from candidates who still had the weight and the friction acting in the same direction. Other errors were due to omitting one of the elements from the work-energy equation.

Question 4

(a) Those candidates who started with a clear understanding of the elements involved in this folded lamina usually obtained a correct moments equation. The two most efficient approaches were to start with a square, remove a triangle and add a triangle, or to see the figure as two rectangles and a triangle with double the density. Candidates who tried to split the task into two stages by finding the position of the centre of mass of the square without the triangle and then a second stage to add a triangle often made errors in the process (which effectively doubled the work required). Some candidates found more complicated routes by splitting the shape into more pieces, by involving a trapezium, or by using an alternative axis for the moments. Many candidates did not score the final mark because they did not show sufficient working to support the given answer and / or they left their answer as $x = \frac{71}{40}a$, never mentioning the d that they had been asked to find.

(b) Many candidates spent time finding the vertical distance of the centre of mass from S, although that is not needed. There were also several attempts to find angles that were not required. Several candidates started by finding the position of the centre of mass of the lamina with the weight attached, although the problem can be solved without it. Candidates who chose to consider moments about A rarely considered the force acting at S.

Question 5

(a) Almost all candidates scored the mark for using the correct relationship between power, driving force and speed. Many candidates formed the equation of motion correctly and obtained a negative value for the acceleration. The question asks for the deceleration, so the final answer should be positive. Apart from the sign error at the end, the most common errors in the equation of motion were missing terms, including using a total mass of 600 kg.

(b) This part of the question proved to be more challenging. Most candidates did try to form an equation of motion for one part of the system, but several used the incorrect resistance, or no resistance. Sign errors were common.

Question 6

(a) Most candidates formed a correct equation for the moments of the forces acting about an axis through A. A large number then simply stated the given answer without ever stating the value they were substituting for $\cos\theta$, and consequently scored only 2 marks. A few candidates were confused about the direction of the normal reaction at C, usually treating it as a vertical force.

(b) The majority of candidates formed equations for the vertical and horizontal resolution of the forces acting on the beam. There were many fully correct solutions. Some candidates considered only the vertical component of the force acting at A. Candidates who chose to resolve parallel and perpendicular to the beam, or to take moments about a second axis, often considered only part of the force acting at A. A small number of candidates approached this task as a 3-force problem, and they usually produced concise and accurate solutions.

Question 7

(a) Many candidates did not pay sufficient attention to the information given in the question. In line 2 they are told that the particles are initially moving in the same direction, but several candidates had $6u$ and u in opposite directions. In the penultimate line of the rubric, candidates are told that the direction of motion of P is reversed as a result of the collision, but many candidates had $6u$ and x acting in the same direction. Consequently, although most candidates showed an understanding of the impact law and of conservation of momentum, many candidates started with incorrect equations or formed an incorrect inequality for the value of x. Several candidates started with the two correct equations but could not see how to use them to determine the possible values of e.

(b) A small minority of candidates did not attempt to express x and y in terms of u, so all they could score was the method mark. There were many correct solutions, but a significant number lost the final mark because they had lost m or u^2 in their final answer. The fact that one particle gains kinetic energy and the other loses kinetic energy created several sign errors, usually from candidates who considered the particles separately rather than considering the system as a whole.

(c) Many candidates demonstrated a good understanding of the conditions for a second collision between P and Q and the majority scored at least two of the three marks available. For the final mark, both limits were required, accompanied by correct inequalities.

Question 8

(a) There were several fully correct solutions. The most common error was to give an over-specified answer following substitution of a value for g. Some candidates did not have a correct strategy for finding the time taken to travel from A to B, and some confused the horizontal and vertical components of the velocity.

(b) Most of the candidates who started by finding the vertical component of a velocity corresponding to a speed of $5\,\mathrm{m\,s^{-1}}$ went on to obtain the correct answer. Some found the interval, but not the length of the interval, and some gave an over-specified answer. Some candidates were successful in considering the conservation of energy. A significant minority of candidates used $5\,\mathrm{m\,s^{-1}}$ in a *suvat* equation.

(c) Many candidates understood how to obtain the perpendicular velocity, and gave fully correct solutions. In some solutions the vertical component of the velocity was stated as being positive and it was not clear that the candidate realised that the particle would be moving downwards – a simple diagram would have helped to confirm this.

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