Examiner's Report
Principal Examiner Feedback

October 2019

Pearson Edexcel International A Level

In Mechanics M2 (WME02/01)

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General

The majority of candidates found the early questions on this paper very accessible, with many candidates scoring close to full marks on the first two questions. There were several blank responses to question 8, but as the candidates are free to answer the questions in any order it is difficult to tell whether this was due to the context of the question or due to their being short of time.

Although it has been commented on in all recent reports, there are still large numbers of candidates losing marks through giving their final answers to inappropriate accuracy, or through using $g = 9.81$. If $g = 9.8$ has been used in the working then the final answer should be given to 2 significant figures or to 3 significant figures, as stated in the rubric to the paper. An exact multiple of g is acceptable, unless the question specifies a particular level of accuracy, but an answer given as an exact fraction or in surd form is not. In practice, candidates would probably be advised to give their answers to 2 significant figures.

The best work was clearly set out, with clearly labelled diagrams. Candidates should take care when naming unknown forces: if they are all labelled as "*F*" then this is not helpful to the candidate or to the examiner, and errors usually follow.

Candidates should be reminded that when a question has a given answer it is particularly important to show full and clear working to confirm that the answer has been obtained correctly.

Candidates should avoid erasing and/or overwriting solutions. The usual outcome is an illegible mess. If a solution needs to be replaced, is should be crossed through and rewritten on clean paper

Question 1.

This question was generally well attempted with most candidates taking moments about the y-axis and the x-axis correctly. Both moments equations were often combined in a single vector equation.

The majority of candidates used $y = 2x$ correctly to form an equation in k.

Most errors were due to slips in the algebra and arithmetic, but some candidates used a total mass of 3 (the number of particles?), rather than $(k+4)m$.

Question 2.

The majority of candidates understood how to use the rate of working to find the driving force provided by the engine. Errors in setting up the equation of motion were rare, but there were some slips in the algebra and arithmetic in the course of rearranging this as a quadratic in U.

Most candidates used their calculators to solve the resulting equation and while this could score full marks, any slip in producing the equation led to the final 2 marks being lost. Some candidates took the precaution of showing the solution using the quadratic formula, but that formula needs to be used correctly to score the method mark.

Many candidates did not score the final A mark due to giving their answer to more than 3 significant figures, following the use of $g = 9.8$.

Question 3.

(a) The majority of candidates recognised the need to differentiate **v** in order to obtain an expression for **a**. The differentiation was usually correct. The question asks candidates to find the force acting as a vector, but many used $|\mathbf{F}| = m|\mathbf{a}|$ rather than $\mathbf{F} = m\mathbf{a}$ and lost two marks.

(b) There were many fully correct solutions, with only a minority of candidates overlooking the initial position of Q. A small number of candidates attempted to make inappropriate use of the *suvat* equations.

(c) Most solutions were based on the velocity of Q, but a few candidates incorrectly considered the displacement. Many candidates started correctly, usually stating the correct initial equation $2t + 10 = 9t^{\frac{1}{2}}$. Those candidates who recognised this as a quadratic in $\sqrt{t}$ usually went on to find the correct values for $\sqrt{t}$ and t. Some candidates attempted to square both sides of the initial equation to obtain a quadratic in t, but there were many algebraic slips. The most common error was incorrect squaring which usually resulted in an equation similar to $4t^2 + 100 = 81t$.

Question 4.

(a) This was answered very well, with nearly all candidates setting up a correct equation and most showing sufficient working, including the substitution of the value of $\cos\theta$, to confirm how they had achieved the given result.

(b) The majority of candidates chose to resolve horizontally and vertically, and they usually started by stating a pair of correct equations. Those candidates who chose to take moments or to resolve parallel and perpendicular to the rod were more likely introduce sign or trig errors, or to omit a term from an equation. A particular issue in this question was the need for clear labelling of forces, and a clear distinction between the normal reactions at Q and at A. Failure to do this led to several errors when trying to use $F = \mu R$.

Question 5.

(a). The most successful candidates split the shape into a large triangle, minus a small triangle and a rectangle. However, many were successful in using two small triangles plus a rectangle. A few candidates attempted to use a trapezium minus a rectangle, but none of these knew how to calculate the distance of the centre of mass of the trapezium from BC. A large number of candidates jumped straight from the vector equation for the position of the centre of mass to the given answer $y = \frac{7a}{4}$, without making it clear how this answer was derived. Some candidates lost accuracy marks by not expressing distances as multiples of a.

(b)There were several possible approaches to this part of the question, some producing concise accurate solutions and some that became very complicated. The majority of candidates recognised the symmetry of the figure, but a few candidates made an error in their vector equation in part (a) and worked through with an incorrect value for the horizontal distance of the centre of mass from B. Many candidates were able to find a relevant angle using the position of their centre of mass and the majority went on to combine this correctly with other angles in the diagram to find the required angle. A few candidates were successful in using the cosine rule.

Question 6.

(a) The majority of candidates understood exactly what they needed to do and they obtained the correct answer. Some candidates gave the answer as an exact fraction, which was not appropriate having substituted a value for g. Some candidates started by finding a correct expression for the maximum friction, but then they included a weight component when finding the work done against the friction. There were also a few trig errors.

(b) The method for finding the change in potential energy of an individual block was generally well understood and when a negative answer was reached, almost all candidates realised that they needed to give a positive answer. Although the question asks for the potential energy lost by the system, several candidates only considered the change in potential energy for one of the blocks.

(c) Many candidates did appreciate that they could use their results from (a) and (b), although some preferred to start afresh. There were several sign errors in forming the work-energy equation, although the most common error was to try to work with only one of the blocks. If only one block is considered then it is also necessary to consider the work done by the tension in the string, but this was usually overlooked. It was extremely rare for the instruction to use a work-energy approach to be ignored.

Question 7.

(a) Many candidates used the equation for CLM to arrive at the correct value of k. Some made sign errors in the CLM equation which resulted in an incorrect k.

The majority of candidates formed a correct expression for the total kinetic energy lost, but some considered only one particle. Some candidates had the correct four terms for kinetic energy but combined them incorrectly. A significant minority of candidate used an incorrect expression for kinetic energy.

Some candidates started with a correct expression for the change in kinetic energy but did not finish because they did not attempt to find the value of k.

(b) This part of the question proved more challenging with several candidates making sign errors or using inconsistent signs in their equations for CLM and impact law. Although it did not affect the later working, some candidates made an illogical decision about the direction of motion of A after the collision between A and B.

Most candidates did solve their equations to obtain an expression for the speed of B in terms of u and e. However, when candidates needed to consider a correct inequality several did not compare the velocity of B with the velocity of C and thought that the velocity of B should simply be positive.

Several candidates who did make a correct comparison of the velocities overlooked the upper limit for e or used "<1" in place of "≤ 1".

Question 8.

(a) All that was required here was to equate the two expressions for the vertical heights of the two particles and simplify the equation to obtain the given answer. Many responses did not do this.

(b) There were many fully correct responses. The common error was to give the final answer as 18.03 following the use of $g = 9.8$.

(c) There are several possible approaches here, and many candidates obtained the correct final answer The most popular approach was to equate the vertical distance to 10 and form a quadratic in t. Many candidates stated that one possible value was 2.99, due to premature rounding, and some candidates did not go on to find the difference between their times

(d) Most solutions started with an attempt to find c if this had not already been found. There were some errors with the signs ($c = -8$ being common) although most candidates went on to use correct signs in their expression for the velocity of Q. Whilst many candidates went on to obtain $54.9°$, or equivalent, most did not make a clear statement in words or in a diagram to describe the direction of motion.

(e) Most attempts were based on the velocity of P and several solutions reached the correct final answer. Most successful solutions used the first method given in the mark scheme, but the use of the scalar product was also popular. Whilst there was some ambiguity in the candidates' use of signs, these were usually correct by the final stage of the solution. Those candidates who worked with angles were more likely to make a slip with signs.

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