# Examiner's Report
# Principal Examiner Feedback

## Summer 2019

## Pearson Edexcel International A Level
## In Mechanics M2 (WME02/01)

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## General

This paper tested all areas of the specification giving all candidates the opportunity to demonstrate their knowledge. Most candidates were able to start most of the questions and it was clear that there was a good understanding of the basic techniques required in M2.

Whilst there were many beautifully presented solutions, the presentation of solutions for "show that" questions was often disappointing, with work either poorly organised, so that the flow of an argument was not clear, or messily written, so that it was difficult to be sure that no mistakes were included. It should be emphasised to candidates that for a given answer, cancelling should be neat, so that the original terms are clearly visible, and that expanding and simplifying should be explicitly shown.

## Question 1

This question proved to be a very straight forward opening for most candidates. It was clear that almost all were very familiar with the topic and knew exactly what to do in both parts. It was rare for marks to be dropped in either part, although sign errors did occur, particularly in part (b). A small number of candidates dropped marks through giving a final to more than 3 significant figures, but this was rare.

## Question 2

The majority of candidates dealt with this question successfully, with most realising they needed to integrate twice to find displacement and it was rare to see attempts to use constant acceleration equations. The common mistake was to fail to use the initial velocity to find the constant of integration. Almost all candidates knew that they needed to find the time when $v = 0$ but many failed to show any working in solving the resulting quadratic equation. Most candidates realised that they needed to consider part (ii) in two sections, and most realised that they needed to use the magnitude of the displacement between 3 and 4, although there was not usually an explicit statement of what they were doing. There was some use of calculators to perform definite integration for the final part and this received full marks if correctly completed, but it was more likely for these candidates to subtract 6, rather than adding.

## Question 3

This was the first question to cause significant difficulties, with responses largely split between being perfect and scoring zero. Those who succeeded generally found the components of the final velocity. A few used the components of momentum, but these candidates were more likely to make a mistake in forming their equation. Attempts using the cosine rule were incredibly rare. Disappointingly, too many candidates treated the final speed as a velocity, either adding an **i** to the speed, or omitting the **i** from the initial velocity. Others found the magnitude of the impulse and attempted to use this in their impulse equation. None of these approaches scored any marks. Candidates who did correctly set up Pythagoras were likely to complete the question correctly, although there were mistakes in expanding and rearranging to a 3 term quadratic equation. Again, many showed no working in solving their quadratic, and

some clearly used their calculators and then attempted to retrospectively factorise the equation ($3u^2 - 15u - 281.25 = 0 \rightarrow (2u + 15)(2u - 25) = 0$).

**Question 4**

This individual parts of this question were answered well, although it was common for all marks to be lost on at least one part. In part (a) there were many correct solutions, usually delivered succinctly, but common mistakes were to include KE, include resolving for both particles or to add the GPE terms. This was also the question most likely to be penalised for over specifying the final answer as 41.16.

Part (b) was generally answered well done. It was unusual to see a mistake in writing down the friction, although this was not always explicitly stated. The most common mistakes here were to resolve the 1.5 again and some candidates also included the weight.

Part (c) tended to have more mistakes, with candidates either only including the KE of one particle or double counting energy terms, especially when attempting to use their answers from (a) and (b). It was also not uncommon for the answers to (a) and (b) to be added.

**Question 5**

It was pleasing that part (a) of this question was very well answered, with almost all candidates taking moments about A and clearly showing correct use of trigonometry. It should be remembered, however, that if you are going to cross through terms as you cancel in a "show that" question, it is important that the working is still clear.

Most candidates made a reasonable attempt at part (b), with vertical and horizontal equations being by far the most common approach. In this case the most likely mistake was sin/cos confusion, although some forgot to include the tension in the vertical equation. Most were able to eliminate $T$ and use $F = \mu R$ to produce an equation for $k$, although some candidates used $R = \mu F$. Candidates that attempted to form moments equations in (b) were far less likely to be successful in completing the question.

Part (c) caused significant difficulties, with the majority of candidates misinterpreting the reaction at $A$ as simply being the normal contact force, which tended to result in no marks. Candidates that understood what was required tended to be successful, although there were often mistakes with square rooting.

**Question 6**

Part (a) was very familiar work and many candidates were able to score full marks. As the directions were clearly given in the question, there was generally not much confusion with signs. Some candidates did find very elaborate routes for solving their equations, which increased the chance of a slip. The only recurring method error was to have Newton's Impact Law the wrong way round, but this was not common.

In part (b) almost all candidates found the correct speed of Q after the second collision and the time for Q to reach the wall. The remaining marks proved far more difficult, with many not

being able to find a strategy to find the complete time. All of the approaches in the mark scheme were seen, but the approach of finding the approach speed of $\frac{5w}{3}$ was both the most popular and the most successful. Work was often not presented well, with the times and distances being found not at each stage not clearly defined. As a result, some candidates successfully found the time from the wall to the second collision as $\frac{3d}{10w}$, but then failed to add on the time to the wall. Poorly laid out solutions also lead to algebraic slips, especially when dealing with fractions.

**Question 7**

Part (a) was generally answered well, with the majority of candidates following the prescribed method. The most common deviation from this was to attempt to find the centre of mass of the two rods and then use this to reach the overall centre of mass. This certainly over complicated the question and often the given result was not reached convincingly. In general, it was disappointing that candidates did not give as many clear steps as would have been desired to reach what was a given result.

Most candidates made a successful start to part (b), correctly finding $\bar{y}$, most commonly from *BC*. From there, although most realised that they needed to equate the ratio of the distances to 3/2, many did not realise that they needed to consider $6a - \bar{y}$. Those that did successfully produce an equation almost always went on to solve it correctly. Some candidates attempted to solve (b) by considering moments, but the trigonometry involved meant that these attempts were almost always unsuccessful. One clever method not mentioned in the mark scheme was to put the centre of mass into the equation of the line *AC*. Candidates taking this approach nearly always set their work out in a clear way and reached the correct answer.

**Question 8**

Part (a) was a relatively straight forward projectiles question, and most candidates handled it well. The most common error seen was not using -15 for the vertical displacement, leading to the answers for part (a) and (b and c) being reversed. Several candidates did not realise the time to land was given as 3s, which made their work extremely complicated, attempting to produce equations at a general time, which they were unable to solve to find $u$ and $\theta$.

In part (b) by far the most popular successful approach was to find horizontal and vertical components and then use Pythagoras, with a minority attempting to use energy. Whilst most knew the horizontal component from (a), it was not uncommon for the initial speed to be used in the vertical equation, rather a component of it. A significant number of candidates found a vertical component but then failed to use Pythagoras to find the speed.

In part (c), whilst most candidates knew what was required, very few gained the final mark. Although earlier in the question candidates were often confused over what was speed and what was a component of speed, most could identifiably be seen to attempt to use what they thought were horizontal and vertical components correctly. However, either due to earlier mistakes, or premature rounding, the correct answer was rarely reached, with 49.7 being a common answer.

Those who did reach 49.8, rarely included the description of “below” the horizontal, or drew a clear diagram to indicate this direction.

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