Pearson Edexcel

Examiners' Report
Principal Examiner Feedback

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In Mechanics M1 (WME01) Paper 01

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<u>WME01 October 2024 Examiners' Report</u>

<u>General</u>

The vast majority of candidates were able to make attempts at all seven of the questions and the paper had a friendly start with the modal mark on both of the first two questions being full marks. There was a significant number of incomplete attempts at question 7, where candidates struggled to answer the final part. There were some excellent scripts but there was also a substantial number where the standard of presentation left a lot to be desired. This, in some cases, made it very difficult for examiners to follow the working and award marks accordingly.

Question 1 was, by a large margin, the best answered question and the final question, by an even larger margin, was the worst answered.

In calculations the numerical value of g which should be used is 9.8 m s^{-2}, as stated on the front of the question paper. Final answers should then be given to 2 (or 3) significant figures – more accurate answers will be penalised, including fractions but exact multiples of g are usually accepted.

N.B. **If there is a given or printed answer to show, e.g. as in 3(a) or 7(a), then candidates need to ensure that they show sufficient detail in their working to warrant being awarded all of the marks available and in the case of a printed answer, that they end up with <u>*exactly*</u> what is printed on the question paper.**

In all cases, as stated on the front of the question paper, candidates should show sufficient working to make their methods clear to the examiner and correct answers without working may not score all, or indeed, any of the marks available.

If a candidate runs out of space in which to give his/her answer than he/she is advised to use a supplementary sheet – if a centre is reluctant to supply extra paper then it is crucial for the candidate to say whereabouts in the script the extra working is going to be done.

Question 1

In part (a), most candidates set up a conservation of linear momentum equation with the correct terms. Sign errors were fairly rare and most proceeded to find the given expression for y in terms of x. Equating equal and opposite impulses was an alternative approach which was used successfully on occasion. A few optimistically wrote down the given answer despite previous sign errors but, nevertheless, many achieved full marks for this part of the question.

Part (b) involved finding the magnitude of the impulse. Again it was generally well done with almost all candidates knowing the definition of impulse and attempting to apply it to one particle. The main errors included not taking into account the change in direction, giving the answer as negative or dropping the 'mx' before reaching the final answer. Also some failed to substitute for y in terms as x as required.

Question 2

In part (a), although many correct solutions were seen, it proved challenging for a number of candidates. Those who wrote down a vertical resolution equation and a moments equation about C or D generally produced the neatest solutions. However, it was not uncommon to see multiple attempts at moments equations with candidates unable to eliminate the reaction forces. Interpreting the relationship $2R_D = 3R_C$ sometimes proved a stumbling block with some writing a vertical resolution equation as $2R_D + 3R_C = 75g$ or, more commonly, applying the relationship the wrong way round.

In part (b) most candidates appreciated that 'about to tilt' implied the reaction at C was zero and a fair number achieved full marks here. The most straightforward method was to take moments about D; common errors seen included omitting a term, an incorrect distance in at least one term or omitting 'g' inconsistently. Those who chose to take moments about a different point sometimes used a value for the reaction at D from part (a) rather than setting up another equation as required. A few assumed the reaction at D rather than C was zero showing a lack of understanding of the mechanics of the situation.

Question 3

Part (a) was well answered with the majority finding the change in displacement and dividing by 2 to give $\mathbf{v} = 15\mathbf{i} + 12\mathbf{j}$, followed by use of $\mathbf{r} = \mathbf{r}_0 + t\mathbf{v}$ to reach the required form of the answer in **i** and **j** form. A few candidates left the final form of their answer as a column vector which lost a mark, a few divided by 3 and some lost marks for not showing sufficient working.

In part (b), the vast majority of candidates realised that Pythagoras needed to be used and gave the answer as $3\sqrt{41}$ or 19.2. However, there was a further requirement to convert the units from km h^{-1} to m s^{-1} and only a small percentage of candidates gained both marks here. A few gave their answer as $15\mathbf{i} + 12\mathbf{j}$ and scored nothing.

Part (c)

Most candidates first found the position vector of P, using $\mathbf{r} = \mathbf{r}_0 + t\mathbf{v}$ and $t = 1.5$, leading to $65\mathbf{i} + 42\mathbf{j}$. The most common method was to then equate this to the given answer in (a), equate the coefficients of $\mathbf{i}$ and $\mathbf{j}$, and form two equations. Solving both of these then led to $t = 8/3$ in each case and a clear conclusion that A also passes through P was stated.

Other successful methods included solving just one of the two equations for t, and then substituting this value in the other equation to obtain the appropriate value, followed by a clear conclusion.

Some candidates used directions to set up the equation $\frac{65}{42} = \frac{25+15t}{10-12t}$ and solved it to obtain $t = 8/3$. However, unless they went on to use this value to show that the position vector was $65\mathbf{i} + 42\mathbf{j}$, they received no credit. A significant number were also penalised if they used a decimal form for t e.g. 2.67.

A few did not use a correct method to find the position vector of P, using $t = 2.5$ rather than 1.5 and a significant number lost the final A1, either because they did not write a statement confirming that A passes through P or because they didn't solve *both* equations or both.

Question 4

In part (a), most candidates showed the given answer by either equating the area under the graph to 120 or using two *suvat* equations to form an equation in V only which was then solved to obtain $V = 3.2$ A few candidates wrongly tried to use a single *suvat* equation for the whole distance.

In part (b), the vast majority found the acceleration by either calculating the gradient of the first line on the graph or used $v = u + at$ to get to 16/45, 0.36, 0.356 or 0.35555…or better so 0.35 was not an acceptable answer.

In the third part, successful candidates drew a straight line with positive gradient from (6, 0) followed by a line parallel to the t-axis finishing at $t = 54$. To gain the next mark, candidates needed to correctly place 6 on the t-axis and 3.6 on the speed axis. For the final B mark, candidates were required to extend the original graph, parallel to the t-axis, as far as $t = 54$. Extending the line beyond $t = 54$ or ending it before $t = 54$ resulted in the loss of a mark. Solid vertical lines were also penalised. A few candidates incorrectly started the second graph at the origin and not at (6, 0) and some used 52 instead of 54.

Part (d) proved to be a challenging question and use of 120 m as the shared distance was common. A lot of students clearly realised that they needed to work out the area under the graph and many knew how to do it but interpreting "T" correctly on the graph was a major issue. The point at which the graph became horizontal ($t = T + 6$) was often seen as $t = T$. They were very few "trivial" errors such as omitting the 1/2 from a triangle or trapezium formula but the hurdles which needed to be jumped to achieve $T = 8$ were sufficient to ensure that only a select proportion only achieved it.

Question 5

Part (a) was generally well answered with many good solutions. However, a few candidates were unable to write down the equation of motion for P but then went on to use two correct equations in part (b). The majority of candidates solved these equations simultaneously for T and obtained the correct answer. The calculation gave an exact value of 36.75 and a significant number failed to round it to 2 or 3sf (as a numerical value for g had been used) and lost a mark. A few reversed one of their two equations of motion, a handful reversed them both and a small number used $g = 9.81$. Very few used the whole system equation.

Part (c) was poorly answered with many stating the force to be ($3g + 5g$). Some tried to use $2T\cos\theta$, with various incorrect values of θ and some used $\sqrt{T^2 + T^2}$.

The final part was a good discriminator. Most candidates did work with $a = g/4$ but those who didn't still managed to earn the A1ft mark. A few had difficulty coming to terms with $v^2 = g$ and 9.8 was often used for both the acceleration and the initial velocity in the final calculation. Several earned the second M1 in (d) if not the first. Weaker candidates didn't realise that they needed to do two separate calculations.

Question 6

In part (a), when a well labelled diagram had been drawn, it usually led to a correct set of equations. When resolving perpendicular to the slope, $R = 5g\cos\alpha$ was often seen but a more common error was to have F acting in the wrong direction. Some failed to multiply both terms in R by 0.25 and ended up with 14 but most picked up the B1 mark. A few candidates didn't even earn this mark when submitting blank solutions. Very few candidates resolved vertically and horizontally and very few confused sine and cosine when resolving. Isolated solutions with g omitted were occasionally seen, a small number gave their final answer to an incorrect degree of accuracy and a handful gave a fraction as their answer. A few candidates found both a maximum and a minimum value for *H* but usually offered the correct final answer.

Many candidates who made mistakes in part (a) produced fully correct solutions for the second part. Candidates often replaced 5*g* with 49 but this looked very like 4*g* on occasions which then confused candidates and examiners. Most candidates realised that the normal reaction would change. Occasionally *g* was omitted from the acceleration after correct working but overall calculations were accurate and the manipulation was sound. Rounding errors were far less common in Q6 than in Q5 but very rarely candidates used more than one *suvat* equation to get to their final answer. These attempts tended to lose marks through lack of accuracy in their final answer.

Question 7

In part (a), the majority of candidates attempted to apply an appropriate *suvat* method to find the time taken for the particle to travel back to its starting point. The most common approach was either to use $s = ut + \frac{1}{2}at^2$ with $s = 0$ or to take the time to the highest point and double it. Since the answer was given it was important that it followed directly from working. Those who wrote 0.81 x 2 = 1.63 or 0.82 x 2 = 1.63 were penalised; although it was possible that they had kept more accurate figures on their calculator, there was no evidence shown. Some circular arguments were seen where candidates used the given value of *t* to find the velocity and then use the newly found velocity to calculate T_1=1.63.

Part (b) proved significantly more challenging. To calculate the magnitude of the impulse when the particle rebounded it was necessary to identify the velocities immediately before and after impact. Some failed to realise that the speed immediately before impact was 8 ms^{-1}, the same speed as projection, and re-calculated it using the rounded 1.63 seconds as the time of flight which led to an inaccurate answer. When trying to find the velocity immediately after impact many candidates attempted to use a *suvat* equation but used 8 ms^{-1} somehow rather than zero velocity at the highest point. Although most made an attempt to use the impulse formula $I = m\,(v\text{-}u)$, the method mark was dependent on a valid method for finding *v* and so was often not awarded. Some just assumed both *u* and *v* were 8 or that one of the speeds was zero. The final answer was required to 2 or 3 significant figures following the use of g = 9.8 ms^{-2}.

Part (c) was sometimes omitted and, although there were some excellent solutions seen, many attempts contained no valid strategy and achieved no marks. It is possible that candidates were running out of time by this stage but there were scripts with a lot of working crossed out, possibly indicating a lack of clear thinking rather than a lack of time. The most straightforward method was to equate the heights of both particles at T_2 seconds using $s = ut + \frac{1}{2}at^2$. Common errors included using the same time for both particles, using t and t +1 as the times for the two particles but the wrong way round, and mixing T_2 and $T_2 \pm 1$ in the same expression e.g. $5T_2 - \frac{1}{2}g(T_2 - 1)^2$. Some adopted the alternative approach of finding the position and speed of the first particle after one second or a variation on that; however, these attempts were often difficult to follow and, although some were on the right lines, they were missing crucial elements; there was only one method mark available and this required a fully complete method. On the occasions when the correct set-up was seen, the final answer was sometimes incorrect due to poor algebraic manipulation. Those who correctly found t = 0.46 (corresponding to $(T_2 - 1)$) sometimes forgot to add 1 to gain the final mark. Again, the answer was required to 2 or 3 significant figures, following the use of g = 9.8 ms^{-2}, although over-accuracy was only penalised once per question.

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