Pearson Edexcel

Examiners' Report
Principal Examiner Feedback

Summer 2023

Pearson Edexcel International Advanced Level
In Mechanics M1 (WME01) Paper 01

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General

The paper seemed to work well with the majority of candidates able to make attempts at all eight of the questions and the modal mark on question 1 was 6 (out of 7) and on the next five questions was full marks in each case. There was no evidence of time generally being an issue but see the comment lower down. There were some excellent scripts but there were also some where the standard of presentation left a lot to be desired. This, in some cases, made it difficult for examiners to follow the working and award marks accordingly.

Question 1 was very marginally the best answered question, and along with questions 2, 3, 4 and 6, was well received by candidates. Question 5 was found to be a little more testing but question 7 (the car and trailer question) was the most challenging with a sizeable number of candidates scoring zero. The last question also had a significant number scoring zero and whether this was down to weaker candidates running out of time or running out of ideas wasn't always clear.

In calculations the numerical value of g which should be used is 9.8 m s^{-2}. 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.

If there is a given or printed answer to show, as in 5(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 *exactly* 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 their answer than they are 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

This proved to be a friendly starter and candidates were able to make a good attempt at it. In part (a), the majority used the conservation of momentum principle. There was the occasional sign error but the vast majority wrote down a correct equation. A few attempted to equate impulses but this method tended to lead to more sign errors and so was less successful. A significant number of candidates, however, did not appreciate that speed is a scalar quantity without direction, gave their answer as negative and lost the final mark. The second part caused problems for those who continue to give imprecise answers like, 'to the left', 'west', 'changed' etc. when asked for a direction of motion. In part (c), most candidates were successful in setting up an impulse-momentum equation, but candidates still fail to help themselves in choosing which particle to consider. Here the initial and final velocities of B were both given in the question, so they should've used B. As in part (a), a significant minority failed to realise that the magnitude required a positive answer. The units also caught out many candidates with many omitting them completely or having no real clue as to what they should be. Of the two correct alternatives, kg m s^{-1} seemed more popular than Ns.

Question 2

In part (a), the majority were able to find $\mathbf{F}_3$ correctly but there was a relatively small proportion of the candidates who used $\mathbf{F}_3 = \mathbf{F}_1 + \mathbf{F}_2$. In the second part, most candidates found the correct resultant force and used trigonometry correctly to obtain a relevant angle, but a large number lost the final mark as they left the answer as 28^0 or 62^0 and did not go on to find the correct angle between the direction of **i** and the resultant force. A few gave their answer as a bearing or a compass direction. Part (c) was generally well-answered with most able to score 3 of the 4 marks available as the third mark was a follow through mark on an incorrect resultant force.

Question 3

Part (a) tended to be all or nothing and a majority were able to score all three marks. A few lost the A mark for leaving their answer in exact form. Sign errors were rare but those who did obtain a negative value for t^2 should have realised there was a sign error in their working rather than just ignoring it at a cost of two marks. The second part was less successful with some unable to make any progress. Many were able to find the acceleration but often the weight was missing from the equation of motion and a few used g as the acceleration. Some lost marks for not giving answers to 2 or 3 sf after use of $g = 9.8$ or for giving answers as fractions.

Question 4

In part (a), most started by resolving vertically and then used a moments equation, although a significant number used two moments equations. There were missing g's, sign errors and errors in the calculation of lengths used in the moments equations and some failed to solve the simultaneous equations they had correctly set up because the algebra became too complicated. A few fell at the last hurdle for not giving an exact answer but there were many correct solutions. The second part was sometimes omitted but most realised that the tension at D was zero and got to the right answer quite easily by taking moments about C. Some used two equations and attempted to eliminate the tension at C, although these were generally less successful. Again, some lost the final mark because they rounded the answer to 0.67. The final part was reasonably well answered. Common incorrect answers were: remains straight, does not bend, equal tensions, mass/weight acts at single point but did not state that it was the centre of the beam.

Question 5

Part (a) was usually done well although several candidates wrote the given answer after incorrect working. Using a trapezium, or a triangle and rectangle were the most successful methods. In the second part, the shape was usually well drawn but the most common error was having 40 and 50 on the axis, rather than 50 and 60, and this adversely affected the response to part (d). Many did not understand how to answer part (c) and did not make use of the fact that the car and motorbike had the same accelerations. Some omitted this part but then used the given answer in (d). There were some 'fudged' solutions using the given answer, but also many correct ones using the correct acceleration. The final part was well answered if students had successfully answered part (b). There were more successful solutions than in the past for this type of question. Candidates' work was usually clear and easy to follow. All benefitted from the given answer in (a) and most scored the M1 for setting the expression equal to the expression for the distance travelled by the car. The common method was to obtain the triangle, rectangle and trapezium areas under the motorbike graph and then equate this to the area under the car graph although there were a few clever solutions obtained by equating the parallelogram and trapezium areas lying outside the respective graphs. The most common error was to omit the rectangle for the last part of the journey under the car graph, using $\left(\frac{4V}{3} - V\right)$ rather than the correct $\left(\frac{4V}{3} + V\right)$. Some used $\frac{4V}{3}$ instead of $\left(\frac{4V}{3} + V\right)$ and so treated this as a triangle rather than a trapezium. Very few omitted ½ from one of their expressions. A few used wrong times, i.e., 50 instead of 60 and/or 40 instead of 50.

Question 6

Most candidates attempted to resolve forces vertically and horizontally with a fair degree of success. The weight was given as W newtons, but some chose to treat this as a mass and use Wg in their equation. Occasionally sin/cos confusion was evident although such cases were rare. More common was a sign error in the vertical resolution where it was assumed the component of P was acting upwards rather than downwards. The question required a derivation of the inequality $P \leqslant \frac{5W}{8}$ which depended on the application of $F \leqslant \frac{1}{4}R$. Many candidates assumed the limiting case of maximum friction throughout, reaching the equation $P = \frac{5W}{8}$. In these cases, all the marks were available except the final one; this required fully correct working which led directly to the inequality. Those who just inserted the inequality on the final line with or without a word explanation did not achieve the mark. There were some excellent concise solutions seen but also some attempts which showed a lack of understanding of resolving with some only managing to achieve the B mark for $F_{MAX} = \frac{1}{4}R$ seen or implied.

Question 7

In part (a), some candidates wrote down an equation of motion for the combined car and trailer by equating all the relevant forces acting parallel to the slope to the (total mass × acceleration). They then went on to show sufficient correct working to derive the given answer for R. Those who tried to form equations for the car and the trailer separately tended to be less successful with confusion about which terms belonged to which equation. In this case, to achieve the method mark, it was also necessary to eliminate the tension term to obtain an equation in R only and so there was greater opportunity for error. A minority omitted the *ma* term completely and treated it as an equilibrium problem whilst others neglected to resolve the weights in the direction parallel to the slope. A few even introduced an extra friction term.

In the second part, many of those who had achieved all the marks in part (a), proceeded with a valid equation of motion for the trailer and calculated $T = 1000$ correctly. Nevertheless, perhaps surprisingly, some now forgot to include the *ma* term. A minority chose to work with the car only, with varying degrees of success. To achieve the method mark it was necessary to include all the relevant terms including the given value of the resistance for either the car or the trailer and the relevant mass in the *ma* term. Often a wrong combination of terms led to no marks being awarded and showed a lack of real understanding of the motion of connected bodies.

Many candidates, in the final part, assumed that, after the tow bar breaks, the trailer would continue to move up the slope with the same acceleration as before (0.75 ms^{-2}) rather than slow down and move with a deceleration that needed to be calculated. Those who did attempt to use $F=ma$ for this situation sometimes omitted R or had the resistance acting up the slope, opposing the weight component. A *suvat* method, generally $v^2 = u^2 + 2as$, could then be used to find the required distance. Since $g = 9.8$ m s^{-2} had been used in the weight component only a correct answer given to 2 or 3 significant figures was acceptable.

Question 8

The method of using $\frac{\text{change in displacement}}{\text{time}}$ was generally well understood by those who attempted the first part of the question, and many went on to write down the position vector in terms of t as required. The question specified that the answer was to be given in terms of **i**, **j** and t; the small number of candidates who gave their answer as a column vector were not awarded the final mark.

In part (b), the most common error in forming the position vector for the second robot was to give it relative to the point at the bottom left-hand corner of the square rather the centre O. This led to an incorrect answer of $(50 - t)\mathbf{i} + (50 - t)\mathbf{j}$ rather than $(25 - t)\mathbf{i} + (25 - t)\mathbf{j}$. A minority assumed the answer was $-t\mathbf{i} - t\mathbf{j}$. Again, the question specified an answer in terms of **i**, **j** and t but use of a column vector was not penalised for a second time.

Part (c) required a given vector to be found for ***SR***. Most used the correct method of subtracting their position vectors and the given answer alerted some to their error in (b). When it is required to show a given result it is important that the final line of working is a statement that matches exactly that printed on the paper. Although some candidates did not attempt part (d) to find the time when the robots were at a minimum distance apart, there were others who earned marks here who had failed to make much progress in previous parts of the question. Most wrote down an expression for the distance apart at time t using the given answer from part (c) and Pythagoras. Some stopped there or else tried to equate it to zero. However, most expanded their expression to give a 3-term quadratic. Then the most popular approach was to differentiate to find the value of t which gave the minimum distance, although completing the square was used successfully on occasion. A calculator method was also acceptable here. Some found the minimum distance in addition but in this instance only the value of t was required.

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