Pearson Edexcel

Examiners' Report
Principal Examiner Feedback

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In Mechanics M2 (WME02) Paper 01

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General

The work on this paper covered the full range of marks available. There were a minority of candidates who showed little understanding of the material examined, but many who demonstrated a good command of the methods required.

Candidates need to be reminded of the properties of vectors and scalars. Many candidates had difficulties in question 3 because they tried to use 7 as a vector. It was common to see dimensionally incorrect equations.

Candidates who use clear diagrams to accompany their solutions tend to have a clearer understanding of directions and relative positions (question 7), and to avoid confusion between forces (question 5) and velocities (question 8).

When checking their solutions, candidates should ensure that they have found what the question asked for: In question 4(a) several candidates found the magnitude of the acceleration. There was no mark penalty for this provided there was a clear statement of the required vector, but they had spent time doing unnecessary work. In question 5(c) some candidates stated a correct value for kW, but not for k. Question 7(a) asked for a speed, so the final answer needs to be positive.

In calculations the numerical value of g which should be used is 9.8. 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. The use of $g = 9.81ms^{-2}$ is marked as an accuracy error.

If there is a printed answer to show, as in 1(a), 5(a), 5(b), 6(a), and 7(a), candidates need to ensure that they show sufficient detail in their working to warrant being awarded all of the marks available and that they end up with *exactly* what is printed on the question paper *with no errors in the working*.

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. Some candidates need to be reminded that the examiner can only mark the work they see.

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.

Report on individual questions

Question 1

Many candidates scored full marks for this question.

(a) The majority of candidates were able to form the relevant equation and derive the required result for the x-coordinate of the centre of mass.

(b) Most candidates obtained the correct expression for the corresponding y-coordinate and then substituted it into the equation of the line to find k. The most common errors were slips in forming and solving the equation in k, particularly if an attempt was made to re-arrange the equation before substitution. A few candidates equated the gradient of the given line to the ratio of the x and y coordinates. A small number of candidates did not attempt to find the y-coordinate of the centre of mass.

Question 2

The majority of candidates scored full marks for this question. The topic was well understood by the candidates, who applied the correct formula for driving force in terms of power and used a valid equation of motion to find the acceleration. The main errors were in signs of terms, usually with the resistance acting in the wrong direction. Several candidates forfeited the final mark because they did not give their final answer to 2 or 3 significant figures following the use of $g = 9.8ms^{-2}$.

Question 3

The responses to this question showed that the vast majority of candidates understand that impulse is change in momentum. Many of them also understand that speed is the magnitude of velocity. Candidates who set up the correct impulse-momentum equation were usually able to complete this question successfully and reach both values of λ. A minority of candidates followed the alternative route and formed an equation in x or y (the components of the velocity). Some of these candidates did not then go on to solve for λ.

The majority of errors in this question arose from treating the speed as a vector. Candidates should be aware that it is not correct to equate a scalar quantity to a vector quantity.

Question 4

This was a well-understood topic and a high scoring question. The majority of candidates showed that they understood that they needed to differentiate the velocity to obtain the acceleration and integrate the velocity to obtain the displacement.

(a) There were many correct answers for the acceleration. Some candidates went on to find the magnitude of the acceleration, which had not been asked for. A minority of candidates set the **i** component of **v** to zero. Some found $\mathbf{a}$ and then attempted to put the $\mathbf{j}$ component of this to zero. Some problems arose from the differentiation—particularly in applying the chain rule to differentiate $\sqrt{5-t}$.

(b) There were many fully correct solutions. The integration of $\sqrt{5-t}$ presented a problem for some candidates. A minority of candidates made sign slips in the integration, and some thought that the **j** component of the position vector would be zero. Some candidates did not attempt to find the constant of integration, either overlooking it or simply adding $-2\boldsymbol{i}+\boldsymbol{j}$ to their answer.

Question 5

(a) Almost all candidates gave a correct explanation of the given answer.

(b) There were many fully correct solutions. The majority of candidates were able to produce a correct moments equation and substitute the correct value for $cos\,\theta$. However, there were several attempts to fiddle working to reach the given answer. Candidates should be reminded that when an answer is given, they should show sufficient working to support their answer and obtain the answer exactly as given.

(c) There were several possible approaches to this question. Most candidates chose to resolve horizontally and vertically, rather than parallel and perpendicular to the plane and there were a few hybrid versions. Some candidates worked with k and α from the outset, but most started by finding the horizontal and vertical components of the force at *A*. Some difficulties arose due to candidates not labelling diagrams clearly and, therefore, becoming confused about forces and components. Some candidates obtained a correct pair of equations but did not appear to know how to solve them.

Question 6

This question produced a variety of responses and better candidates were often able to score full marks in a succinct and accurate solution.

(a) A key starting point was to choose convenient axes about which to take moments The question hints strongly that *PV* is the most appropriate vertical axis, and this suggestion was taken up by the vast majority of the candidates. A few used *QT* or *RS*: this decision simply led to elements of unnecessary work to achieve the given answer. The shape consists of two rectangles and most candidates used this for the construction of their moments equations. Those who divided up the rectangles or set up the problem using a large rectangle with a section removed were not only making extra work for themselves but also greatly increasing the complexity of the work involved. Most candidates did have a correct method to obtain the given answer.

(b) Those candidates who marked the centre of mass on their diagram and drew the line from *P* usually deduced that the essential vertical distance required was that from the centre of mass to *PR* since this formed part of the given trigonometric ratio. It is, of course, not essential to use *PR* as the axis and there were many candidates who were successful in using *TS*. The main difficulty was caused for those candidates who used *UV* as their horizontal axis; there were many incorrect assumptions about the vertical distances, and only a few used the correct distance of $(a - ka)$ below *UV* for the centre of mass of *QRST*.

The majority of those who found the co-ordinates of the centre of mass correctly were able to construct the resulting equation and find the correct value for *k*.

Question 7

(a) The majority of candidates attempted to set up an equation for conservation of linear momentum and an equation for Newton's Law of impact. Most errors were sign errors rather than method errors. Most then solved their simultaneous equations to derive the given expression for the speed of *B* after impact. Those who had assumed that the direction of motion of *A* was reversed as a result of the collision often did not realise that their final expression for velocity after impact was negative; such cases did not achieve the final mark since the (positive) speed was required.

(b) Several candidates produced succinct correct solutions to this task, but many solutions did not provide evidence of a clear strategy. Most candidates were able to gain the mark for writing down the speed of *B* after the impact with the wall. The mark for the time taken by *B* to reach the wall was awarded less often. Some made little further valid progress either abandoning their working or setting up equations with a variety of unknown times and distances. Some solutions became very complicated because the value of *e* was never substituted, or was substituted after several slips in the algebra.

Question 8

(a) The majority of candidates attempted to find the friction force and multiply it by 15 to calculate the work done. Common errors included sine/cosine confusion, omission of *g* from the reaction force and not giving the answer to 2 or 3 significant figures (following the use of $g = 9.8ms^{-2}$).

(b) The question required a work-energy equation to be set up for the motion of the particle as it moved to the top of the ramp. There many valid attempts seen with the main errors being in the signs of terms. Some candidates omitted either the kinetic energy of P at the top of the ramp or the work done against friction. In a few responses, rounding errors led to an incorrect final answer.

(c) There were several correct solutions. Most candidates attempted to use a correct *suvat* equation, but there were sign errors, errors in the vertical distance, and some confusion between U and the speed of P at the top of the ramp. There was also some confusion between the horizontal and vertical components of the velocity of P.

(d) The stronger candidates adopted a correct strategy to find either the speed of P at the instant it hit the ground, or the vertical component of the velocity. Some candidates were confused between conservation of energy and the use of $v^2 = u^2 + 2as$, attempting to use the latter with $u = 25$ The use of trigonometry was often correct, but there was some confusion between the horizontal and vertical components of the velocity.

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