Pearson Edexcel

Examiners' Report
Principal Examiner Feedback

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In Mathematics (9MA0)
Paper 32 Mechanics

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General

The paper seemed to work particularly well with the majority of candidates able to make attempts at all six questions, although there was some evidence of time issues for weaker candidates. The first three questions provided the opportunity for candidates to settle into the paper and score some easy marks. The remaining questions ramped nicely in their accessibility. There were some excellent scripts but there were also some where there were issues with the standard of presentation. This, in some cases, made it difficult for examiners to follow the working. Candidates should try to spread their work out as this will make it easier to read.

Question 1 was the best answered question, followed by questions 2 to 5.

The most challenging question was question 6. Questions 4, 5 and 6 produced a similar pattern of responses, with a small proportion unable to make any progress at all but large numbers scoring all or almost all of the marks.

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.

There were a number of printed answers to show on this paper, and candidates *must* 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. There were many cases where it was similar (e.g. $S = \frac{1}{2}\cot\theta Mg$ in 6(b)) but not *exactly* as printed. Candidates run the risk of losing a mark in such cases.

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 very friendly starter. In part (a), almost all of the candidates were able to score the mark. In some rare instances it was lost for incorrect subsequent working such as $\sqrt{16} = 4$. In the second part, the vast majority used a correct method with most using $s = ut + \frac{1}{2}at^2$ but other *suvat* formulae were seen. Area under a *v*-*t* graph and integration were employed very occasionally but usually with success. The most common mistake was to assume constant velocity and a few made an error with the arithmetic and lost the final mark. A surprising number wrote 3.2 for acceleration but used 3.5 in their calculation. Candidates would be well advised to state the formula being used before doing their calculation, so that method marks can still be awarded in the event of an arithmetical slip.

Question 2

The vast majority were able to score the mark in part (a), with answers of 5g or 49 being the most common. A few candidates used g = 9.81 but were not penalised here. There were very many correct answers for the second part also, but some ignored the 28N force completely and gave $5 \times 1.4 = 7$, as their answer or made a sign error and ended up with F = 35. In the final part, $F = \mu R$ was very well known, and this was a follow through mark on their answers to (a) and (b). However, some left their answer as a fraction or didn't give it to 2 sf and lost the mark anyway.

Question 3

Part (a) was generally a well answered question. Some found the velocity vector at t = 0 and went no further, either forgetting, or not being aware that they needed to use Pythagoras' Theorem to find the speed. A small number of candidates scored the M mark only, if they had an incorrect velocity vector but used Pythagoras' Theorem correctly. The majority of candidates who attempted the second part used a correct method, setting the **i** and **j** components of the velocity equal to each other or both equal to a constant which was then eliminated. A few also successfully used trial and error. However, a significant number set both **i** and **j** coefficients equal to 1, solved one or two separate equations and scored nothing.

Question 4

The first part was usually well attempted with most candidates scoring all four marks. The vast majority used **v** = **u** + **a***t* to find the velocity but a few lost the second two marks by not going on to find the magnitude of their velocity vector. Parts (b) and (c), however, proved to be significantly more challenging. A few candidates wrote down a correct vector equation but were unable to make any further progress without focussing on separate components. Those who used integration to find **r** were often more successful, because the initial position of A was the integration constant. Of those who used

$\mathbf{r} = \mathbf{u}t + 0.5\mathbf{a}t^2$, many forgot to include the initial position of A and/or made a sign error and lost marks in both (b) and (c). In part (b), occasionally the quadratic equation was solved correctly but the wrong value of T was selected and in part (c) there was often a sign error on the 30 term. It was very rare to see candidates working with B as their initial position.

Question 5

In part (a), the vast majority of candidates recognised that the horizontal component of velocity of the particle remained constant throughout the motion; this was then used, together with the horizontal distance, to form an equation in T and α and to derive the given result. The second part, however, provided a greater challenge and, although many realised that they needed to consider the vertical motion, a few did not know how to proceed, with some solving the given quadratic in $\tan\alpha$ rather deriving it. However, many did make progress, using $s = ut + \frac{1}{2}at^2$ with a vertical distance of 20 although there were occasional sign errors. They mostly then substituted the expression for T from part (a) to obtain an equation in α although slips were not uncommon at this stage. Those starting with different *suvat* equations tended to make little significant progress. To achieve the given result it was necessary to use the trig identity $\sec^2\alpha = 1 + \tan^2\alpha$ (or equivalent work) to obtain an unsimplified quadratic equation in $\tan\alpha$ before reaching the given equation. This was the main stumbling block for many and it was not unusual to see candidates make more than one attempt. Since the final equation was given and the demand of the question was "show that", it was essential that all steps in the working were correct and the final answer was stated exactly as printed in order to achieve all the marks. In part (c) most candidates realised they should solve the given quadratic in $\tan\alpha$ to give two possible angles of projection. Consideration of the situation should have indicated that the larger of the two angles would lead to the greatest possible height. Although many recognised that the greatest height is reached when the vertical component of velocity is zero, some chose to use the smaller 45° angle. Some found the greatest heights for both angles but then failed to select the relevant one. Other errors included using the time to greatest height as half the answer in part (a) or choosing $\sin\alpha = 1$ to give the maximum height in an otherwise correct *suvat* equation. Rounding errors were not uncommon leaving the final answer incorrect to 3 significant figures. In the final part, most candidates were able to suggest an acceptable limitation of the model such as it not including spin, dimensions of the ball, effect of wind or a more accurate value for g. The most common incorrect answers were that the model did not include weight/mass of the ball and the ground was not perfectly flat which was not specified as a modelling assumption in the question.

Question 6

In the first part, the majority of candidates stated that the frictional force would act towards the right on the diagram and many gave a satisfactory reason. A minority gave the reason that the friction had to balance the reaction force at the wall which acted to the left. Most mentioned that it prevented the rod from slipping to the left. Those who did not achieve the mark often used language that implied the rod was actually moving. A small number thought that the direction was left or gave no reason at all. In part (b), the question directed the candidates to take moments about A and most were able to do so successfully with many achieving the three available marks. The occasional incorrect response had the distance to the reaction at B unresolved as $2a$. Also a small number had a's missing from both sides of their equation. Since this was a "show that" question it was important that all stages of the solution were shown and were correct. It should be noted that the candidate's final answer had to be written exactly as the printed answer, using the same symbols in the same order, to achieve the final mark. Part (c) required a calculation of the coefficient of friction. There were many fully correct solutions involving vertical and horizontal resolution but many incorrect responses were also seen. The majority who tried other approaches, such as moments about B or resolving parallel and perpendicular to the rod, were usually unsuccessful as they would often miss out a term or there would be a sin/cos error. Some candidates attempted to resolve vertically and horizontally but included an extra force. It was not uncommon for the horizontal resolution $F = S$ to be correct but an extra force would appear in the vertical resolution. Almost all recalled $F = \mu R$ and tried to use it in some way. Part (d) involved finding the magnitude of the resultant force acting at A. It was not always well answered and sometimes omitted entirely. A significant minority of responses were, however, fully correct and there were many who, having made an error in part (c), were still able to apply Pythagoras' theorem correctly with their values of F and S. However, some candidates did not understand what was required with $R = mg$, or an attempt to just combine R and F by adding, seen quite often. A small number failed to deal properly with the square root making an error with the simplification in terms of mg in an otherwise correct solution. In the final part, the majority of candidates were unable to gain the mark often because of lack of precision in the wording of their response. Many stated that S was larger because the weight was closer to B or it exerted more force/pressure at B. Some who did refer to an increased moment about A failed to specify it as the moment of the weight. Some mentioned distance but did not explicitly refer to moments. Candidates who used their moments equation to show that a distance of the weight from A greater than a led to a larger value of S were generally successful. A small number thought S was smaller or did not change.

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