Pearson Edexcel

Examiners' Report
Principal Examiner Feedback

November 2021

Pearson Edexcel GCE
In Mathematics (9MA0)
Paper 32 Mechanics

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Overall the quality of the scripts was very mixed with some clear and fully correct solutions but a substantial number were well below standard, particularly for question 3. There was some evidence of time being a limiting factor as some answers seemed rushed or unfinished, although it is difficult to be sure whether time or ability was the main issue here.

Question 1 proved to be a friendly starter with 75% of candidates able to score at least 2 out of the 4 marks available. Statics, however, continues to be a real problem area for students with 61.5% achieving 0/10 for question 3. Vectors also caused problems, with 48.6% of candidates scoring fewer than 3 marks out of the 14 available for question 5.
In calculations the numerical value of g which should be used is 9.8, unless otherwise stated, as in question 4. 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 printed answer to show then candidates need to ensure that they show sufficient detail in their working to warrant being awarded all of the marks available.
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
Part (a) was well answered with most students making use of $\mathbf{v} = \mathbf{u} + \mathbf{a}t$ to arrive at the correct answer $\mathbf{v} = 8\mathbf{i} - 6\mathbf{j}$. It is important to note that this uses the initial velocity of 4**i**. The alternative method was to use integration, so the equivalent of the first stage was to integrate and use the 4**i** when calculating the constant of integration. A few made careless arithmetic errors and others forgot to use the 4**i** in the integration. A small number either differentiated or made no progress.
Part (b) proved to be more challenging. Although there were many good solutions employing $\mathbf{r} = \mathbf{u}t + \frac{1}{2}\mathbf{a}t^2$ to find the change in displacement from t = 0 to t = 3, earning the method mark, a sizeable number of candidates forgot to add on **i** + **j**. The equivalent to the first stage using integration was $\mathbf{r} = \left[(2\mathbf{i} - 3\mathbf{j})\frac{1}{2}t^2 + 4t\mathbf{i}\right]$. It was essential to include use of the 4**i** to earn the method mark, but the use of **i** + **j** was only required for the A mark. Some students chose to answer the question in stages, working out position vectors at t = 1, 2 and then t = 3. Other errors involved not keeping the question in **i** and **j** or column vector form, which lost the M mark, or incorrectly trying to turn the problem into a scalar problem.

Question 2

Candidates need to make sure that they read and then answer questions carefully. In part (a) an equation of motion for *A* was required. Most realized that this required the use of Newton's second law on the 3*m* mass. However, some ignored this requirement and went straight to a whole system approach to the problem. Errors in part (a) were mainly due to the omission of a relevant force or a misunderstanding of direction. It was essential that the frictional force on *A* and the tension were in the same direction i.e. had the same sign in the equation. In part (b) either an equation of motion for *B* was required or an equation of motion for the whole system. This was generally well answered provided that the reaction force from the plane on *A* had been found and used with $F = \mu R$ to give $F = \frac{1}{6}R$. The question was a "Show that" question so full marks were only awarded if there was a fully correct solution, with all the steps included. Errors involved sin/cos confusion, the omission of *g*, an incorrect direction for the reaction force, omission of a force in an equation of motion or an incorrect reaction such as $R = 3mg$. Some candidates did make algebraic errors in solving their equations. A few candidates assumed that the tension in the string was *mg*. Those candidates who attempted a whole system approach were mostly successful. In part (c), most of the graphs given were correct but there are still candidates who add a solid vertical line at the end of the graph and this lost the mark. However, the second mark here was frequently lost. All that was required was a comment that the acceleration was constant. For the final part, candidates needed to answer the question which asked for " how this would affect the working in part (b)". Those who referred to how it would affect the answer received no credit.

Question 3

Part (a) required candidates " To show that…". Consequently, full marks were only awarded if there was a fully correct solution, with all the steps included. Thus successful candidates needed one moments equation together with a vertical resolution and/or a horizontal resolution, depending on which point they had used for their moments equation. These equations, combined with $F \leq \mu R$, could then lead to full marks being earned. Many candidates assumed that the beam was in limiting equilibrium i.e. that $F = \mu R$, produced an equation and then changed it to the required inequality. These candidates lost the final mark. Other errors included omission of *g*, sin/cos confusion in moments equations and assuming that the reaction at *A* and the reaction at *B* were the same. Candidates tended to be more successful in part (b), where a similar strategy was required, together with $F = \mu R$, since the beam was now in limiting equilibrium. A common error was to have the friction force acting towards the wall. This lead to a *k* value of -0.1 and the negative sign should have flagged up an error to candidates.

Question 4

Candidates were instructed to use g = 10 in this question but were only penalised once if another value was used. In part (a), the majority of successful candidates employed the most efficient method using a single application of $s = ut + \frac{1}{2}at^2$ to find the time to the ground. Other successful methods found the time to the top of the flight and then the time to go from the top to the ground and added. However, sign errors were common resulting in 2/4 marks being scored for this part. A few candidates did not resolve the speed of 65 m s^{-1}. This lost the M mark and consequently they scored zero for part (a). In part (b), candidates who used $v^2 = u^2 + 2as$ to find the vertical component of velocity of the particle at A were generally more successful than those who used the time found in part (a). Many solutions finished here and did not consider the need to look at the horizontal component as well. Those who had both components usually went on to apply Pythagoras theorem and calculate the actual speed of 75 m s^{-1}. For part (c), there were several possible answers, and candidates should always focus their attention on refining the model that has been used, in this case g = 10 and the stone being modelled as a particle i.e. the dimensions of the particle ignored (not the mass of the particle, which was a common wrong answer). Candidates should note that they should concentrate on giving a single correct answer to this type of question as extra incorrect answer(s) will lose the mark. The most common correct answer was 'to use a more accurate value for g'.

Question 5

Part (a) was well answered by most candidates who realised that they needed to differentiate although a few candidates did omit the vector notation and therefore achieved zero marks. Part (b) proved to be the least popular part of this question. Successful candidates employed a ratio method to obtain the equation $3t^{\frac{1}{2}} = 2t$ and then solved it. However, a significant minority of candidates incorrectly equated the **i** and **j** parts and then solved the two equations to obtain the correct answer. Candidates should note that this approach scored no marks. Other errors included using the acceleration vector or the displacement vector rather than the velocity vector when dealing with direction of travel. Part (c) tended to be well answered with a good number of candidates integrating and gaining 2 or 3 marks here. It was disappointing to see a few using constant acceleration formulae. Part (d) allowed those who had made little progress on the first 3 parts, to score some marks as it only required the use of the given velocity vector to get started. For those who attempted it, the use of Pythagoras' theorem on the velocity components was very accessible and a number of candidates solved the quadratic to obtain t = 4. Sign errors here were common, however, with many ending up with a wrong t value. Some candidates then scored a further two M marks for substituting their value of t into their position vector and then applying Pythagoras to find the distance. The question required an exact distance and so only surd answers earned the final mark.

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