Pearson Edexcel

Examiners' Report
Principal Examiner Feedback

Summer 2022

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

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The paper seemed to work well with the majority of candidates able to make attempts at all of the questions, although there was some evidence of time issues for weaker candidates. 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. Candidates should try to spread their work out as this will make it easier to read.

Question 1 was the best answered question, with 35% of candidates scoring all 8 marks, and this was the modal mark. On each of the other four questions, the modal mark was zero.

The worst answered question was question 3, where half of the candidates scored 0 or 1. Questions 2 and 4 produced a similar pattern of responses, with large numbers either making little progress or scoring close to full marks.

There were a substantial number of blank responses for question 5, but it wasn't clear whether this was due to time pressure or a lack of ideas.

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. $U^2\cos\alpha\sin\alpha = 588$ in 5(a)) 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 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 correctly substituted $t = 2$ into the expression for the velocity and went on to use Pythagoras correctly to find an exact answer or an answer correct to 2sf or better. Common mistakes were to stop once the velocity had been found, losing the **i** and **j** and then finding $12\text{-}6\sqrt{2}$ rather than apply Pythagoras. A small number subtracted the squared values rather than adding in their Pythagoras. In the second part, most candidates identified that this was variable acceleration and differentiated correctly to find the acceleration vector. Common mistakes were losing either or both **i** and **j** and not recovering, integrating instead of differentiating and, despite the question specifying the answer was to be given in **i** **j** form, final answers given in column vector form were occasionally seen. Many candidates integrated to achieve the first two marks in part (c), but not all used the displacement at $t = 4$ to find the constant of integration. Those that found a vector equation containing a constant of integration **C**, went on to find **C** and then substituted $t = 1$ to reach the correct answer although some responses contained numerical errors involving the negative signs. A common error was to use *suvat* formulae or $\mathbf{r} = \mathbf{r}_0 + \mathbf{v}t$. rather than integrate.

Question 2

Almost a quarter of the candidates scored zero whilst 21% scored full marks on this question. In part (a) the most common approach was to resolve perpendicular and parallel to the plane to first find a value for X (49) before finding a value for the friction. Very few used the most efficient method and resolved vertically. The resolving was generally done well with most candidates resolving all the forces that needed to be resolved and most without sin/cos confusion and sign errors. Many who reached the correct value for friction were able to give the correct direction of the force, including those that had assumed that it acted up the plane and had obtained a negative answer. Not all remembered to give the magnitude of the force and numerical calculation errors were seen in some working. μR was seen in some responses which lost the last mark as friction is not limiting in this part of the question. Part (b) was generally done well, even by those that had struggled with the first part, with many candidates writing down a correct $F = ma$ equation. The most common mistake was to take R as 68.6N, the value given in part (a), and not resolve to find the new value of R. Those that resolved perpendicular to the plane generally went on to use $F = \mu R$ correctly and then accurately calculate the acceleration of the block. A few candidates did not remove the force X. It was noticeable that candidates who produced well labelled diagrams and who presented their solutions in a logical, neat and concise manner often continued to produce a correct solution in both parts.

Question 3

In part (a), the majority of candidates were able to achieve the first mark for adding the two forces and collecting the **i** and **j** components. Many just equated this resultant force to the vector (3**i** + **j**) rather than using (3**i** + **j**) to define the direction. Some set up equations $\lambda + 4 = 3$ and $\mu - 1 = 1$ and proceeded to solve them simultaneously gaining no further credit. Those who did use ratio usually went on to derive the required equation correctly; however, it should be remembered that, if required to derive a given answer, this must be written as a final conclusion in the form *exactly* as stated in the question. Another successful approach was to equate the **i** and **j** coefficients to $3k$ and k and solve as simultaneous equations. A small minority of candidates applied $\mathbf{F} = 4\mathbf{a}$ or used integration to find **v** at this stage and then used ratio appropriately to obtain the required answer. In the second part, many candidates were able to find the resultant force and acceleration vectors. Some candidates found the magnitude of the force or acceleration at this stage and proceeded correctly with *suvat* formulae from there, while others continued with vectors. A number of candidates did not identify the initial velocity as zero, reading back to the information given at the start of the question being important here, so failed to use *suvat* formulae correctly. Use of $\mathbf{u} = 3\mathbf{i} + \mathbf{j}$ was not uncommon. Although most used *suvat* formulae, some successfully integrated the constant acceleration to find the velocity and displacement vectors. The majority of candidates knew how to find the magnitude of a vector using Pythagoras. The most significant errors seen included finding the resultant force but then using it as a displacement or velocity, showing a lack of understanding of the situation. A small number of candidates found an incorrect value for μ when substituting λ and there was occasional use of only one of the forces.

Question 4

In part (a), very few candidates gave a *fully* correct reason for why the frictional force must act to the right on the diagram. Many stated that friction must oppose the direction of motion, saying that the rod would otherwise slip to the left. Some did mention it opposing the horizontal component of the tension but then failed to include that friction was the **only** other horizontal force in the system which was a key part of the argument. In the second part, it was required to derive a given expression for T (tension). Although some candidates struggled to make a valid start and basically just wrote down the answer and stated 'by resolving ', it was well done by a fair number who set up a correct equation for moments about A and hence deduced the given result. Alternative approaches by either taking moments about other points or resolving forces were very rare and almost never successful, mostly because of missing terms. A few candidates failed to use perpendicular distances for the moments of the weight terms or failed to include the weight of the rod leading to a missing term. Part (c) was generally well answered by those candidates who resolved vertically, substituted for T and re-arranged to obtain the given answer thereby gaining full marks in a few lines of working. Candidates who used alternative equations as a starting point were generally unsuccessful, usually a result of a missing term in one or both equations used, this often involving friction. In part (d) those candidates who resolved horizontally to give $F = T\sin\Theta$ usually managed to score all four marks for deriving the exact value of the coefficient of friction. There were a variety of equations, resolving or taking moments, which would have led directly to a value for F since the tension and normal reaction were known at that stage; however, these involved more working and therefore greater opportunity for error. Nevertheless, successful solutions by these methods were seen on occasion. Most of those candidates who found an expression for F were able to achieve the independent method mark for the use of $F = \mu R$ even if their method for finding F was incorrect.
Since all the answers were given in this question, candidates needed to ensure that they showed sufficient detail in their working to warrant being awarded all the available marks. In particular, candidates should be encouraged to state their resolved forces and moments as equations, rather than considering them in isolation, and to ensure the substitution stages are shown.

Question 5

In part (a), the majority of candidates found an equation for the horizontal motion in terms of t. Most then used this to substitute $t = 120/U\cos\alpha$ into $0 = U\sin\alpha t - \frac{1}{2}gt^2$, the vertical motion equation for the whole trajectory. This was generally rearranged to give the required answer although cancelling the common factor of t from the quadratic before substitution led to a neater solution. A minority chose to consider just half the motion with $v = u + at$ and $v = 0$ at the greatest height which also led to a neat solution. Some candidates failed to identify that the vertical displacement would be zero over the whole motion, and some were inconsistent in considering the time for the whole or half trajectory. A small but surprising number of answers were seen where 120 m was used as the vertical distance. It should again be emphasised that candidates, when required to derive a given result, should write the final answer in *exactly* the same form as that stated in the question. In the second part, many candidates correctly arrived at an equation in $U\sin\alpha$ using $v^2 = u^2 + 2as$ although a failure to resolve the vertical velocity giving $U^2 = 196$ was not uncommon. Most were unable to progress further and so only gained 2 out of a possible 4 marks. For example, they just left it there or found the "correct" answer without any justification for the value of α. Some did not realise they could use the answer from part (a) and, of those who did, some struggled with the required algebra. Many who correctly identified the value of α as $\tan^{-1}(1/3)$ used the decimal value for the angle in degrees rather than calculating an exact value for sinα with which to substitute, and lost the final mark. A few candidates set up an equation by using $s = ut + ½at^2$ with $s = 10$ and substituting in the time to travel 60 m horizontally, but again had trouble finishing off for the last 2 marks having more difficulty with the slightly more complicated algebra required. Part (c) required a comparison of the initial velocity in the model without air resistance (U) and the initial velocity in a model which took account of air resistance (V). Since the horizontal range and greatest height were fixed, the expected answer was that $V > U$ as air resistance would have to be overcome. However, it was very common to see 'U is greater because air resistance will decrease the velocity' or something similar. A few perhaps confused V with the final speed and so said that U would be greater as air resistance would slow the final speed down. A correct possible refinement was often given in part (d). The most common correct suggestions were to take spin into account, consider the effect of wind or to model the particle as having dimensions. A fair number of candidates incorrectly believed that considering mass or weight was an acceptable answer and that a particle has no mass. Others made suggestions regarding the ground not being level but this, however, was not part of the model as defined in the question.

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