Examiners' Report
Principal Examiner Feedback

Summer 2025

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

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General Comments

The paper proved to be very accessible with the majority of learners able to make good attempts at all six questions. Generally, time was not an apparent issue but there were a few who did not attempt the last part of the last question, possibly because they didn't know how to attempt it. The first few questions provided the opportunity for learners to settle into the paper. There were some excellent responses seen but there were also some where there are opportunities for improvement in the clarity and overall presentation. This, in some cases, made it difficult for examiners to follow the working. Learners should try to make use of all the available space on the answer pages, spreading their working out, as this will make it easier to read.

Question 1 was the best answered question, providing an accessible start to the paper, whilst question 6 proved to be the most challenging for learners. The final part of question 4 also proved to be a good discriminator.

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 not be awarded marks, including fractions, however exact multiples of g are usually accepted.

There were a number of printed answers to 'show' on this paper (in 2(a), 6(b) and 6(d)), and learners 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, with no errors in the working. It is evident that many understand these requirements, clearly establishing necessary equations, including at least one line of working and re-arranging their final answer, when necessary, to match the printed answer. However, there were a number of cases where it was similar but not exactly as printed. Learners run the risk of not being awarded a mark in such cases.

In all cases, as stated on the front of the question paper, learners 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 learner runs out of space in which to give their answer than they are advised to use a supplementary sheet. If learners do their working within another part of the question paper, it is crucial for the learner to say whereabouts in the question the extra working is going to be completed. In both cases learners must ensure that any additional work is clearly labelled.

Question 1

Part (a) proved to be a friendly starter and the vast majority of responses successfully quoted and used the correct *suvat* equation for final velocity. Arithmetic slips, such as $2 \times 4 = 6$, were the main cause of any marks not being awarded. Very few responses did not gain marks by assuming $u = 0$.

In part (b), most responses scored both marks by correctly finding the value of the driving force of the engine. Many started by quoting $F = ma$ and working with a complete equation. These responses were generally successful, although some made an arithmetic slip when rearranging their formula to make D the subject. Others did not start by formally stating the equation but approached it in a fragmented manner. These responses were far more likely to demonstrate the common error of subtracting the 400 N force from their 'ma' term instead of adding it, leading to an incorrect answer of 1200 N. A few responses included g with the mass of 800 in their calculations possibly due to confusion of mass and weight.

Question 2

Part (a) was generally well done with some making good use of the diagram. After identifying the three forces, successful responses resolved vertically to form an equation with the vertical component of 5 N clearly found. This was a 'Show that…' question and so those who just wrote '3' down, with no supporting evidence of how it had been obtained, received no reward. Very occasionally cosine was used instead of sine and a few learners used the value of g as 9.81, which meant that the accuracy mark was not awarded.

In part (b), most responses gave a good description of the motion 'as decelerating to a stop or slowing down'. However, a significant number thought that the box would stop immediately or continue at a constant speed.

Part (c) was well answered and the correct result of $2g$ or 19.6 (N) was stated for the magnitude of the reaction once the force of 5 N had been removed. Common incorrect answers were 2 or 16.6.

In part (d), learners needed to plan their method carefully. Most responses gained the mark for finding the value of the friction as $F_{max} = \mu R = 0.2 \times 19.6$. Successful responses then applied Newton's 2nd law, $\pm F = ma = 2a$ and then used a *suvat* approach to arrive at the distance as 4.1 or 4.08(m) to 2 or 3 s.f. Leaving the final answer to more than 3 s.f resulted in the final mark not being awarded. Errors were mainly in the $F = ma$ equation when the force was incorrectly formed. Use of $a = 0.4g$ or $a = -\mu$ were common mistakes. Fractional answers, after the use of $g = 9.8$, were not acceptable.

In part (e), a variety of acceptable limitations to the model were given. Learners were required to refer to the model, as stated in the question, and most referred to the box being modelled as a particle or that it had size or dimensions. Others correctly said that the coefficient of friction may vary as the box continues in its motion or that the friction may vary. Common incorrect answers were: use a more accurate value of g, the plane might not be horizontal or a reference to the mass of the box. None of these are mentioned in the model in the question and so gained no credit. Note that if more than one answer is given, any incorrect answer in the list will mean the mark is not awarded.

Question 3

In part (a) most responses scored the first mark by using $\mathbf{F} = m\mathbf{a}$ with the given mass and acceleration vector. A few responses omitted the mass. The question stipulated that the answer should be given in terms of **i**'s and **j**'s and most learners did so correctly.

In part (b) most responses scored both marks by quoting and correctly using $\mathbf{v} = \mathbf{u} + \mathbf{a}t$ with their vector quantities. A few used their **F** for **a**. Arithmetical slips were occasionally seen. It was relatively rare to see the method of integration deployed. This was more mixed in terms of levels of success with some not considering the constant of integration. Others made arithmetical slips, the longer method providing more opportunity to make an error. Many responses demonstrated a preference for column vectors and used them in this part.

Finding the bearing of the direction of motion in part (c) proved more challenging for many learners. A good number were able to find an acute angle relating to their velocity vector. Use of basic trigonometry or the properties of a right-angled isosceles triangle were seen in roughly equal measure, but gaining the final mark for a correct bearing was often not achieved. Unrepresentative diagrams and a misunderstanding of bearings appeared to be the cause of this. A significant number did not need to use trigonometry, realising that the components indicated a north west direction and writing down 315° directly. A few learners first worked out the displacement vector and attempted to find the bearing of the position of the particle. This was not what the question had asked for and gained no credit.

Part (d) was well answered with a **suva***t* equation being the preferred and most successful method for the majority. A few attempted to use integration, and with the constant of integration being the zero vector, this was generally successful albeit a longer method. Almost all responses gave the answer in terms of **i**'s and **j**'s, as required by the question.

Question 4

In part (a) almost all responses substituted $t = 4$ into the given position vector and obtained the correct answer. Occasionally there was a sign error in the **j** term or the answer was not stated in proper vector notation, for example including **i** and **j** in a column vector, but such instances were rare.

In part (b) Pythagoras' Theorem was generally applied correctly to find the magnitude. An exact (surd) answer was required so those who only stated a decimal approximation did not gain the accuracy mark. A few did not account properly for the negative sign and evaluated $\sqrt{32^2 - 16^2}$ thereby not gaining both marks.

In the third part the majority of learners recognised the requirement to differentiate to find the velocity vector and most did so successfully. Occasionally **i** and **j** were omitted entirely resulting in an expression which was no longer a vector and the loss of the method mark. Attempts at *suvat* or integration were seen but only rarely. Virtually all gave their answer in terms of **i**, **j** and t as required.

In part (d) those learners who achieved the marks in part (c) generally achieved the first two here for differentiating to find the acceleration vector. Occasionally the power of $\frac{1}{2}$ was not handled correctly but differentiation skills were mostly sound. The final two marks proved more challenging and many either could not relate the gradient to their coefficients in **i** and **j** or simply stopped after finding the acceleration vector. For those who did attempt a solution, some recognised the need to use the ratio of their **i** and **j** coefficients but the majority did not identify and use the correct perpendicular gradient. Some just equated **i** and **j** coefficients. Other errors seen included ignoring **i** and **j** and setting the expression equal to ± 3 or $\pm\frac{1}{3}$. Of those who achieved the correct equation in T, a few solved it incorrectly as a result of errors in handling $T^{-\frac{1}{2}}$. A very small number of learners used the scalar product successfully.

Question 5

In part (a) there were many excellent responses seen. Most responses gave an expression or an actual value for t by considering the horizontal motion and then substituted it into their equation for vertical motion. Many gained full marks, but some used a heavily rounded value for t and lost accuracy. Others were not clear whether they were taking upwards or downwards as positive in the vertical direction and this led to two common errors. The first was that both terms in their expression for vertical displacement had the same sign. The second was, if they were taking upwards as positive as most did, they replaced 's' with H in their equation and erroneously reached the result $H = -30$ and then just wrote $H = 30$ which resulted in not gained the final accuracy mark. Other errors included poor substitution into formulae, forgetting to resolve the velocity into its components and sin/cos confusion. Quoting and using the equation of the path was rarely seen.

In part (b), finding the maximum height above the ground was done well by nearly all learners, with most using $v^2 = u^2 + 2as$. Common errors seen were to round values prematurely or drop a square from a term after stating a correct initial equation. Those who used two equations were generally less successful. A few others did not gain the final follow through accuracy mark as they did not give their final answer to 2 or 3 significant figures. Some responses erroneously used half of their time from part (a), treating the motion as if it were symmetrical and gained no marks. The energy solution was rarely seen.

Question 6

In part (a) most wrote down the correct answer of $3Mg$ for the reaction force using vertical resolution. The most common error was omitting the weight term for the rod and a few included trigonometric functions in their resolutions.

In part (b) the most popular and simplest approach was to take moments about A to derive the given expression for the normal reaction at B. The angle was given between the vertical and the rod, rather than the possibly more familiar case of between the horizontal plane and the rod. Although this was not a problem for the vast majority, a significant number used $(90^{\circ} - \alpha)$ for their angle which sometimes led to confusion, particularly for those who did not recognise the equivalence with $\sin\alpha/\cos\alpha$ and instead tried to use the addition formula to write this in terms of α only. In addition to sin/cos confusion, errors seen included total omission or inconsistent inclusion of a, slips in copying from one line to the next and occasional omission of the weight of the rod. Since the requirement was to 'show that $S = Mg\tan\alpha$ ' it was essential that working was complete and correct to achieve all the marks. A very small minority attempted to take moments about B but they often did not complete their solution by resolving forces in order to eliminate F and R.

In the third part although many learners recognised that R (with no friction acting at B) was greater than R_1 (with friction acting at B), the explanations were not always clear. Those who used equations generally performed better and gained the mark e.g. $R = 3Mg$ and $R_1 = 3Mg - F$ so R is greater. Some learners thought that the frictional force would act downwards concluding that R_1 was greater whilst others either just stated 'because of friction' or did not state that friction acted upwards (or in the same direction as R_1).

Part (d) was the most challenging part of the question. It was often left blank or multiple half-finished attempts were seen with little clear structure. The most common approach was to take moments about A, to follow from the work in part (b). Responses that did this usually scored some marks for their horizontal and/or vertical resolutions even if their moments equation was incorrect. Occasionally the reaction at the wall was considered to be perpendicular to the rod rather than to the wall which generally resulted in no marks being achieved. Errors in the moments equation included sin/cos confusion, inconsistent inclusion of a and incorrect perpendicular distances. Some omitted the weight of the rod leading to a missing term in both the moments equation and the vertical resolution. Fragmented respondes, simplifying terms before writing down a full moments equation, sometimes made slips in the process. Those who attempted to take moments about B often achieved the mark for their vertical resolution but often did not gain all the marks for their moments equation. Attempts to resolve parallel or perpendicular to the rod were rare and tended to have a term missing. Nevertheless, there were a fair number of entirely correct solutions seen with clear and concise working.

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