Pearson Edexcel

Examiners' Report

Principal Examiner Feedback

Summer 2022

Pearson Edexcel GCE

AL Further Mathematics (9FM0)

Paper 3C Further Mechanics 1

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The scripts for this paper covered the full range of ability. There were some clear and confident responses, but many where the candidates showed little understanding of the topics covered.

As usual, the better responses were clearly set out and, when appropriate, accompanied by clearly labelled diagrams. Higher achieving candidates could identify what they needed to do to solve a problem,and produced succinct solutions. At the other extreme there were candidates who needed to take more care in reading the questions, for example associating the correct resistance with each vehicle in question 2. There were also many candidates who need to work on the clarity of their handwriting. If the working in a solution cannot be followed then the final answer is irrelevant.

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.

If there is a printed answer to show, as in 5(a), 7(a), and 7(b)(i), 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. For example, some candidates had memorised a matrix formula for working question 8, but misquoted the formula. With no explanation, this is an incorrect method and scores nothing. By contrast, there were candidates who explained their method step by step. When they made a slip, it was clear that they had a correct approach.

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

Those candidates who drew a clear diagram did well on this question, especially in part (b) when considering the two situations and the change of direction for particle A.

(a) There were many fully correct solutions to this question. The most common errors were due to incorrect pairing of masses and velocities in the impulse equation, and using the incorrect initial direction for particle B.

Some candidates attempted to use CLM in part (a). A few paired this with the impulse-momentum principle for A and solved simultaneous equations to find v.

(b) Those candidates with a clear diagram often scored full marks. Candidates without a clear sense of how the two possible values of k arose usually had a correct method for finding one value but struggled to find a second. A significant minority of candidates worked on the impossible situation with particle B passing through particle A.

Question 2

This proved to be a straightforward question for the majority of candidates with many gaining full marks. Almost all candidates understood the relationship between power, driving force and velocity. There were some sign errors in forming the equations of motion for the vehicles, and some errors in using the correct resistances. Those candidates who used the given diagram or their own copy and marked on all the forces clearly tended to form accurate equations. Several candidates assumed that the vehicles were moving at constant speed, and consequently used an acceleration equal to zero. Many candidates lost the final accuracy mark by giving an over-specified answer following the use of an approximate value for g.

Question 3

This question was accessible to most candidates and many fully correct solutions were seen. The candidates understood that the problem was two-dimensional and made an attempt to resolve either the velocity or the impulse with the former being the most popular and successful method seen. It was common for candidates to work in vector form throughout and this provided a very concise approach. There was occasional confusion between sine and cosine in the components.

The cosine rule method was rarely used and candidates who attempted this tended to be less successful, often starting with an incorrect triangle, either dimensionally incorrect or with the vectors combined incorrectly.

Question 4

This question was accessible to all candidates, with virtually no blank responses. The candidates who were most successful started with a clearly labelled diagram. marking angles appropriately, and in particular assigning directions to velocities. Those who assigned a negative component to the velocity of A parallel to the line of centres after impact were more successful. Realising that the component of velocity perpendicular to the line of centres was unchanged for each mass was key to reaching a successful solution. Many marked this on their diagram. Most candidates understood that Conservation of Momentum parallel to line of centres should be used. There were few sign errors. A few candidates attempted to use the impact law, but that was not needed in this case. Those candidates who used vectors to represent the velocities and used the scalar product usually obtained the correct angle. Candidates who considered the components of the velocity often found a relevant angle, but they did not always use that correctly to find the required angle: the incorrect answer 102.2° was very common. Despite a large number of sign errors, many candidates did obtain the correct exact value for the magnitude of the impulse.

Question 5

(a) This was a familiar task and answered well by the majority of candidates. There were many clearly labelled diagrams defining the direction of motions for P and Q, and this enabled the candidates to form consistent equations for Conservation of Momentum and the Impact Law. A minority of candidates who were unable to reach the given result tried to adjust their working to generate the required result as opposed to identifying errors they had made, or reattempting the question. Candidates should be reminded that fortuitous answers from incorrect working will not gain credit.

(b) This proved to be more challenging, particularly for candidates who did not consider that the direction of motion of P might change in the collision. Although most candidates were able to find expressions for the speed of P and the speed of Q after its collision with the wall, there was often confusion over how to use these values to determine the conditions for a subsequent collision. Those candidates who defined the direction of motion of A following the collision as being away from the wall were more successful as they had already covered the issue of the change in direction. Many candidates did not correctly deduce that the lower bound $e = 0$ did not lead to a subsequent collision as the particles would coalesce and therefore not collide again.

Question 6

(a) There were many correct solutions to this part of the problem. The most common error was not to round the final answer to 2 or 3 significant figures following the use of an approximate value for g. There were also some errors in resolving to find the GPE gained by A.

(b) Most candidates gained marks for finding the work done against friction. Some candidates only found the gain in kinetic energy for one of the blocks. There were some sign errors, but many candidates did consider all the relevant components in forming their work energy equation. A few candidates did not answer part (a) correctly but then used the correct values for the change in GPE of both blocks in part (b).

(c) The most successful approach was to consider the motion from the instant that B hit the ground. When another energy approach was attempted, it often had a term missing and was therefore unsuccessful. The most common error was to use d + 3 in place of d in the term for work done against friction.

A small number of responses obtained correct answers to parts (b) and (c) by using equations of motion. The question directed candidates to use energy and no marks were available for the use of alternative methods.

Question 7

(a) Most candidates scored the first mark for a correct expression for the EPE at A or B. Combining the relevant terms for a correct energy equation was more challenging. Some candidates possibly did not appreciate that they were dealing with a spring and not a string and so two EPE terms were required. Those candidates who did set up the correct equation were able to deduce the given result.

(b) Almost all candidates gained the first two marks by recognising that the package is at its maximum speed when in equilibrium. Several responses then omitted a term when forming their equation for conservation of mechanical energy, or made slips in substituting and simplifying their equations.

(c) Valid responses were rare. The question asks candidates to say how the weight of the spring would affect their energy equation. Only a few responses mentioned the GPE or KE **of the spring** and how it would affect the energy equation. It was more common to read vague statements about there being more energy, the extension changing or the speed changing. These candidates were not referencing the equation or considering how the equation would change.

Question 8

This collision question clearly differentiated between candidates who were familiar with this type of question and had learned a standard method for solving it and those who really had no idea how to approach it.

(a0 Most candidates were able to gain the first two marks, understanding that the parallel component of velocity was unchanged and the perpendicular component was multiplied by e. It was rare to see a totally correct inequality, with many candidates not writing a lower bound for the inequality despite the instruction in the question to find the full range of values for e. Some candidates did not consider that $e = 0$ would not be consistent with the statement in the question that the particle bounced off the wall.

(b) A variety of methods were attempted. The simplest and least prone to errors were methods using scalar products to split the velocities into components parallel and perpendicular to ST. Following this route, the most common error was not to consider the change of direction in the component perpendicular to the wall leading to a velocity that passed through the wall.

Some chose to work with speeds and angles instead of vectors which led to longer more complex solutions. Some eventually found the components of the final velocity parallel and perpendicular to the wall but rarely were able to demonstrate a method to combine these into a vector in terms of **i** and **j**.

Several candidates used matrices to rotate the frame of reference. A few of these clearly understood what they were doing and gave fully explained solutions. Many however, had learned a process without understanding it, often misquoted the process, and consequently scored no marks.