Examiners' Report/ Principal Examiner Feedback

Summer 2016

Pearson Edexcel GCE in
Mechanics M1 (6677)
Paper 01

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General

The vast majority of students seemed to find the paper to be of a suitable length, with no evidence of students running out of time. Students found some aspects of the paper very challenging, in particular question 7(a), the second part of question 2 and question 3. However, there were some parts of all questions which were accessible to the majority. Question 5, despite its lack of structure, was particularly well answered with almost 73% of students scoring full marks. A majority achieved full marks on question 4, the speed-time graph question and the first part of question 8 was also particularly well done. Despite being a vectors question, question 1 also proved to be a nice starter with almost half of students scoring all of the marks. Generally the paper discriminated well at all levels including at the top end and there were some impressive, fully correct solutions seen to all questions. Students who used large and clearly labelled diagrams and who employed clear, systematic and concise methods were the most successful.

In calculations the numerical value of g which should be used is 9.8, as advised on the front of the question paper. 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 students 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, students should show sufficient working to make their methods clear to the examiner.

If a student 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 student to say whereabouts in the script the extra working is going to be done.

Question 1

This question was generally well answered by almost all students, particularly parts (a) and (b), where errors were few and far between. Some found the direction of *P* instead of the direction of *Q* and some were unable to convert their angle into a bearing. The final part was more inconsistent with some students getting confused as to which components to equate. A popular alternative approach was to find the vector **PQ** and then equate the **j**-coefficient of this vector to zero. A number of students did not complete part (c), having successfully obtained $t = 32$, they then failed to substitute this back in to find the position vector of *Q* as required.

Question 2

This question, particularly part (b), proved to be a real discriminator with many failing to appreciate how internal and external forces work. In part (a) the majority of students were able to use the whole system to calculate the value of the tension. However there were still some students who confused mass and weight on both sides of the equation. The second part was much more problematic with many students not knowing which forces to include in their equation and of those that did, a significant number lost a mark by giving the final answer to 4 SF.

Question 3

This question involved a particle hitting a wall and rebounding, and then finally coming to rest as a result of friction. A significant minority of responses revealed a lack of understanding of the mechanics of the situation. Although virtually all students realised that a calculation of the frictional force was relevant, some then tried to use this with an extra unknown force in an equation of motion. Another surprisingly common error was to proceed to use the magnitude of the frictional force (0.49) as the deceleration. Others went straight to the use of a *suvat* equation to find the deceleration using the initial velocity as $u=4$ (thereby assuming the particle rebounded from the wall with the same speed as before impact). There was much crossed out working seen as students realised they had equations which either contradicted each other or from which they could make no further progress. Those who developed a clear strategy (finding the deceleration from a valid equation of motion and then using this in an appropriate *suvat* equation to find the velocity immediately after impact) generally applied the formula for impulse successfully although there were occasional sign errors from not taking into account the change in direction of the velocities. A small number tried to use a formula for impulse involving time; this was not relevant here.

Question 4

In part (a) most students were familiar with the shape of the graphs and labelled them correctly although a significant number of students failed to realise that the graphs must cross in order for the distances (areas) to be equal, thereby scoring 3 out of the 4 marks. Some re-drew the graphs after successfully finding the value of T. Students were generally successful on the second part of the question and even those with an incorrect graph were able to gain full marks here and very many did. Those who were familiar with the formula for area of a trapezium tended to produce the most elegant solutions. A few did not proceed to correctly find T after finding $t=15$ or $t=40$. Those who used two unknowns for the motion of M and N and solved simultaneously managed the algebra well. It was rare to see *suvat* being used incorrectly across the whole motion. The few who did use *suvat* did so correctly for that part of the motion, finding the acceleration and then using it to find the time for N.

Question 5

The vast majority of students were able to resolve parallel and perpendicular to the plane to produce two correct equations but sin/cos confusion, sign errors or incorrect angles caused a few to lose marks. Some of the students attempted to resolve vertically and horizontally. The use of $F=\mu R$ was evident in nearly all responses and the mark scheme allowed the last two method marks which was a lifeline to those who had gone wrong yet knew they had to eliminate R and use F/R to obtain the answer. Almost all students rounded their answers correctly.

Question 6

There were several possible alternative approaches to solving this moments problem, but those students who failed to realise that 'on the point of tilting' implied that one of the reactions was zero could make no valid progress; they tended to waste time and effort in trying to solve a variety of equations in too many unknowns and much crossed out work was seen. Occasionally the wrong reaction was assumed to be zero, or it was assumed to be zero inconsistently in different equations. Sometimes the sum of the two reactions was equated to the total weight ($30g + Mg$). Clearly labelled separate diagrams of the two scenarios (mass at one end of rod and then at the other) would have helped some students to develop a more systematic approach and avoid such errors. The most straightforward method of solution was, for each case, to take moments about the pivot with the non-zero reaction, leading to simultaneous equations in d (distance) and M (mass). This was often completed successfully although errors in distances (such as $(6 – d)$ rather than $(4 – d)$ in the 'moments about T' equation) were sometimes seen. Another valid approach was to find the reaction (which was the same in both situations) by vertical resolution and then use this in appropriate moments equations; this method was also employed with a fair degree of success although, again, there were occasional errors in relevant distances or in solving the subsequent equations. Inconsistent inclusion of g in the two weight terms was penalised although such instances were rare. There were a fair number of fully correct solutions seen.

Question 7

Many students struggled to produce a clear strategy for solving part (a) of this vector question. Although some correctly wrote down the unknown force in the direction of $(\mathbf{i} + \mathbf{j})$ as $k(\mathbf{i} + \mathbf{j})$ before adding it to $(–\mathbf{i} + 2\mathbf{j})$, many then equated the result to $(\mathbf{i} + 3\mathbf{j})$ rather than a multiple of this vector and so they could make no further progress. Some failed to make any progress at all by being unsure as to how to implement the information about the directions of the forces. By far the most popular and successful method of solution was to add the components of $\mathbf{F}_1$ and $\mathbf{F}_2$ and either equate them to a multiple of $\mathbf{F}_3$ (leading to simultaneous equations) or use the ratio of components as 1:3. Those who adopted either of these approaches tended to reach the correct answer. Another possible strategy was to draw a triangle of forces and use the sine rule to find the required components of $\mathbf{F}_2$; valid attempts were rarely seen and sometimes only the magnitude of $\mathbf{F}_2$ was found. Although full marks were achieved by a number of students in this part of the question, there were also a large number who achieved very few (if any) marks. The second part was completed with a much greater degree of success. Almost all students found the required velocity by using $\mathbf{v} = \mathbf{u} + \mathbf{a}t$ in vector form. Some, however, stopped there rather than proceeding to calculate the magnitude of their vector to give the speed as required.

Question 8

This was an unstructured question but a fairly familiar scenario. Part (a) involved setting up equations of motion (one vertical and one horizontal) for the two particles and then solving them (by eliminating or finding the acceleration) to find the value of the tension. Most students gained two marks for correctly finding the normal reaction and using this to find the frictional force. Those who set up their equations correctly sometimes made numerical or processing slips in solving them, thereby losing the final mark in part (a). Nevertheless, an encouraging number of fully correct solutions were seen, with the final answer being rounded to 2 or 3 significant figures (following the use of $g = 9.8$), or given as $1.2g$. Students generally seemed less familiar with an appropriate method for finding the resultant force exerted on the pulley by the string, as required in part (b). Some omitted it completely, or used forces other than the tensions. The most common successful approach was to resolve the two tension forces in the direction of the resultant which by symmetry is along the angle bisector, giving $2T\cos45^{\circ}$. The last mark was frequently lost as the direction of the resultant was not made clear, whether in words or with a diagram including 45° and an arrow. Bearings and references to south west etc were very common but gained no credit. If an incorrect value for the tension was carried forward from part (a), three out of the possible four marks were available in part (b).

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