Examiners' Report

Summer 2014

Pearson Edexcel GCE in Mechanics M2
(6678/01)

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Mathematics Unit Mechanics 2

Specification 6678/01

General Introduction

This paper offered all students an opportunity to demonstrate their knowledge and understanding. Much of the work seen was completed to a very good standard, but the standard of presentation varied considerably. There were many well laid-out answers in clear writing, but there were many that were difficult to read - students need to make a clear distinction between the figures 4 and 9, and their characters 3, 5 and 8 are often difficult to distinguish. On some occasions, even the students are confused by their own writing and they miscopy figures from one step to the next. The best solutions were accompanied by clear, accurately labelled, diagrams.

Students need to be reminded to read the rubric and the questions very carefully. In all cases, where a value for g is substituted, the value should be 9.8 m s^{-2}. The use of 9.81 will be penalised as an accuracy error. The rubric on the paper gives students a very clear reminder about the accuracy expected after the use of 9.8, but many students lost marks for giving too many significant figures in their final answers. If the question asks for the magnitude of a quantity, then a positive answer will be expected.

Question 1

The great majority of students found this question accessible and they were quick to analyse the system and create appropriate moments equations. The route of taking moments about the x and y axes was followed by most. Occasionally moments were taken about axes through the centre of mass. Some students worked with a vector equation, but the majority favoured two separate equations.

Most errors were due to errors in the algebra and arithmetic, of which the most common was "$2+3+k=6+k$".

Question 2

This question was answered well with a significant number of students gaining full marks. The majority of students integrated correctly, with only a small number forgetting the "$+C$". Very few students made calculation errors, but there was some transcription errors where an index or sign changed before the final answer was given. Q02(b) most students equated the $\mathbf{j}$ component of the velocity to zero and were able to solve the resulting equation.

The most common error was to give the final answer as a vector when the question asked for the speed.

Question 3

Q03(a) was usually answered well and there were many fully correct answers. Many successful students used a structured layout with the use of a table. Most considered the difference between two triangles, although some students divided their shape into triangles and parallelograms. The latter approach resulted in lengthy working that was rarely successful.

The most common errors involved incorrect mass ratios, and the addition rather than subtraction of the two triangles. Several students did not have the centres of mass of the triangles in the correct place, often because they were working from the base of the triangle rather than from the vertex. Some students incurred accuracy errors because the "a" was in some but not all stages of their working.

In Q03(b) clearly labelled diagrams helped students to identify the required angle, and many did this correctly. Those with an incorrect answer in Q03(a) often earned the method marks here. Some students found the angle between *AC* and the vertical but did not go on to find the angle between *AB* and the vertical. A few assumed that the triangle *ABC* was equilateral, and lost the last two marks.

Students lost time by finding the x coordinate of the centre of mass rather than using the symmetry.

Use of the cosine rule tended to work well but this was not a common method.

Students need to be reminded to read the questions carefully - several lost the final mark in this question because they did not give their answer "to the nearest degree".

Question 4

Many students gave fully correct answers to this question.

In Q04(a) the majority of students treated the truck and trailer as a 'single system' from the start but some considered the equations of motion for the truck and trailer separately and solved their two equations simultaneously to derive the equation of motion for the complete system. They went on to use "$P = Fv$" correctly to find the speed.

A common error was to give the final answer as 22.55 m s^{-1} either forgetting or not realising that having used the approximation $g = 9.8$ a maximum of 3 significant figures would be accepted.

In Q04(b) most students realised that a new equation of motion for the truck was now required. Common errors were to subtract the wrong resistance from the driving force or to omit the weight component. Some students did not realise that the driving force on the truck would be unchanged at this instant and recalculated it, often incorrectly.

Question 5

In Q05(a) many students recognised that the speed of the particle after the first impact would be $\frac{2}{3}u$, but when using this to find the impulse on the particle, the majority of students did not take account of the change in direction and obtained an answer of $\frac{mu}{3}$ rather than $\frac{5mu}{3}$. Some of the students with a correct statement of impulse gave a negative value for λ when the question had asked about the magnitude of the impulse, so a positive answer was expected.

In Q05(b) most students obtained the correct speed, $\frac{4}{9}u$, of the particle for the third stage of the motion. Many students then averaged the velocities, without recognising the different durations of the journeys. Some were under the misconception that there were accelerations rather than instantaneous changes to new constant velocities. Some students appeared to be confused about the relationship between speed, distance and time. For those using the correct method, rearranging the fractions to make u the subject proved challenging, either because they could not simplify $\frac{1}{\frac{4}{9}u}$ or because they made errors in adding their fractions.

Question 6

Q06(a) proved a challenge for many students, which was evident from the number who produced more than one solution. Without a method being suggested in the question, the majority of students opted for a *suvat* approach rather than the energy approach.

Using *suvat* with no specific angle of projection given, many chose to either ignore direction, incorrectly applying $v^2 = u^2 + 2as$ in the form $10^2 = 14^2 - 2gh$, or they used the given value for sin α from Q06(b) and in both cases scored no marks. There were, however, some correct *suvat* solutions where students derived the vertical component of velocity at *B* in terms of $\cos\alpha$, used Pythagoras' theorem, and then applied $v^2 = u^2 + 2as$ to obtain h correctly. These solutions tended to be well thought out and easy to follow.

There were those who separated the motion into two parts, from *A* to highest point then from the highest point to *B*. This rarely succeeded, with the many equations causing confusion.

Having found Q06(a) challenging, some students did not attempt Q06(b). However, many who had not been successful in Q06(a) realised that there was an opportunity to make progress here with a more familiar problem now that the value of $\sin\alpha$ was given. Many worked correctly with the vertical motion to establish a quadratic in the time to reach h and went on to use this time correctly in an expression for the horizontal distance. Students should be reminded that it is sensible to show how they have solved the quadratic equation and not just write down the solutions from a calculator; with incorrect answers and no method shown no credit will be given. In contrast to Q06(a), a few successfully found the time in an over-complicated way, by finding the time taken to get to the highest point and then the time taken to reach B from there. A common error was to assume that the direction of motion of the ball at B was the same as the initial angle of projection.

Question 7

In Q07(a) the more able students identified the two equations independent of the horizontal force at A very quickly, and they had little difficulty in obtaining the required result. A few students chose alternative points to take moments about, although generally these attempts were not successful because they had introduced another variable and could not see how to eliminate it. Another cause of difficulties was the poor use of variables, e.g. using X both as a force and a length, and then confusing the two.

In Q07(b) the first B mark was achieved by the majority of students. A small number of students ignored the $45°$ and assumed that the resultant force at A should act along the rod. In general, students who answered Q07(a) were able to correctly resolve to find X in terms of P. Some students who did not score many marks in Q07(a) nevertheless managed to answer part Q07(b) successfully. Most students who had found the horizontal and vertical components found the resultant correctly.

Question 8

In Q08(a) the vast majority of students followed the instructions and attempted to use the work-energy principle to find the work done against friction. This was a very well answered question. The most common error was leaving the final answer as 84.58 J, which is inappropriate accuracy following the use of $g = 9.8$. Solutions that did not use the work-energy principle received no credit.

In Q08(b) there was no restriction on the method to be used but many students continued to use energy, rather than adopting the alternative *suvat* approach. The vast majority found R, used this to find the maximum friction, equated this to their value for F from Q08(a) and solved for μ. Accuracy marks were sometimes lost in Q08(b) when using rounded answers from Q08(a).

Grade Boundaries

Grade boundaries for this, and all other papers, can be found on the website on this link:

http://www.edexcel.com/iwantto/Pages/grade-boundaries.aspx

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