Examiners' Report/
Principal Examiner Feedback

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GCE Mechanics M1 (6677) Paper 1

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Introduction

The vast majority of candidates seemed to find the paper to be of a suitable length, with no evidence of candidates running out of time. Overall it also proved to be very accessible. By far the best sources of marks were questions 1, 2 and 6, in that order, with question 4 being the most poorly answered. Both questions on vectors and the final part of the last question provided some discrimination at the top end. Generally, candidates who used large and clearly labelled diagrams and who employed clear 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, once per question.
If there is a printed answer to show then candidates 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, candidates should show sufficient working to make their methods clear to the Examiner.

Report on individual questions

Question 1

This question seemed to pose few problems for the majority of candidates. In part (a) most found the magnitude of the impulse of P on Q with very few giving a negative answer. A few found the magnitude of the impulse on P, giving their answer in terms of m. A fairly common error was to include g in the impulse formula and this received no credit. In the second part, most used conservation of momentum and there were the usual sign errors. A few candidates struggled with re-arranging the equation.

Question 2

In the first part, the majority of candidates wrote down a correct equation of motion for the 'whole system' which they successfully solved to derive the given value for the resistance force on the caravan. Some chose to consider the car and caravan separately, calculating the tension from the car equation and then using this value in the caravan equation, again generally successfully. There were more errors evident in finding the tension in part (b); the mass used in the 'ma' term was not always consistent with the rest of the equation and occasionally the mass of the whole system was used in an equation relating only to one body. Sometimes the two resistances were confused, two tensions were added together in one equation or the 'ma' term was omitted completely, showing a lack of understanding of the motion of connected particles. Less significant errors tended to involve wrong signs. Overall, however, this question was very well done with full marks often awarded.

Question 3

Although many candidates realised, in the first part, that equilibrium implied that both the sum of the i components and the sum of the j components was zero, some equated pi + qj to the sum of the other two vectors, or, more rarely, to their difference. The exact numerical values of the constants were required to be stated explicitly, and statements such as 'pi = −12' or 'p = 12i' were penalised.

In part (b), the majority identified the correct resultant force, but did not always attempt to calculate the magnitude as required for the method mark. Most identified an appropriate 'arctan' in an attempt to find the angle in part (c), but a common mistake was to give the final answer as an angle with the **i** or **-j** directions, rather than 104° with the j direction. Most candidates achieved some marks for this question, but full marks were relatively rare.

Question 4

Part (a) was answered well by the majority, with most taking moments about *D*. Consistent omission of g's was allowed since they cancelled out. A few candidates failed to mention *GD* at all, using an unknown x as the length required, and these were penalised. A few got themselves in a mess by failing to realise that the reaction at *C* was zero, and although it was still possible to solve the problem, few were able to write down two correct equations and then eliminate the reaction at *C* successfully to obtain *GD*. The second part was attempted by almost all candidates with the most common error being the omission of g from one or more terms of their moment's equation. Lengths were generally correct for most of those who attempted this question and it was pleasing to see that nearly all the candidates realised that the rod was non-uniform.

Question 5

In the first part, most candidates derived the value of u in a valid way, either by considering motion to the highest point and using half the given time, or using a displacement of zero with the full $3\frac{4}{7}$ seconds; confusion between the two methods was usually avoided since the answer was given in the question, although occasionally an answer of '35', obtained from using inconsistent values for s and t, was divided by two with no explanation. Finding the greatest height in part (b) was generally well done with the main source of error being in giving an answer to more than 3 significant figures (not justified with g = 9.8).

In part (c) there were many alternative valid approaches to finding the time for which the particle was above the given height. Perhaps the most common of these was to set up a quadratic equation in t. This was generally solved successfully, with occasional sign errors, but the significance of the two solutions was not always recognised; it was necessary to find their difference to reach the final answer. Another common approach was to find the velocity 'v =13.3' at 's = 6.6' and then, either find the time to the highest point (and double), or find the time to return to that level. Alternatively, the time taken to reach 's = 6.6' was calculated, doubled, and subtracted from $3\frac{4}{7}$. Although a wide variety of correct working was seen, some candidates did lose their way and calculated inappropriate values for t. Again, the final answer was required to 2 or 3 significant figures, although over-accuracy is only penalised once per question. The use of g = 9.81 was seen occasionally and led to the loss of one mark for the whole question.

Question 6

In the first part, the majority of candidates found the required time in a valid way, although occasionally substitution into '$v = u + at$' without regard to sign (or interchanging u and v) led to '$t = -6$' and a subsequent change to '$t = 6$' without explanation.

In part (b), the vast majority produced a speed-time graph of the correct shape (a trapezium starting and finishing on the t-axis), but some failed to mark the 'T' correctly (often leading to the interval for the constant speed part of the graph being $\frac{2}{3}T$ rather than T). In the third part, most attempted to equate the area under the graph to the given distance, either using the trapezium formula or splitting into triangles and a rectangle; sometimes, however, there were errors in identifying the relevant lengths in terms of T. Attempts to apply constant acceleration formulae inappropriately to the whole distance were only very rarely seen. Most candidates evaluated the gradient in part (d) to find the acceleration as required, but those who were using an incorrect value for T could only achieve one of the two available marks. The acceleration-time graph in the final part was generally drawn correctly with three separate horizontal sections. Marks lost tended to be from not labelling the known values of the acceleration (or writing '2.5' rather than '−2.5' on the negative acceleration axis) or from using continuous vertical lines to join the sections. Nevertheless, a significant number of full marks were seen with most candidates scoring well.

Question 7

Part (a) was generally correct, although the minus sign was often missing from many solutions. In the second part, most were able to write down a correct expression for p. A large number of candidates, in part (c), incorrectly equated the i-components instead of the j-components and obtained t = 8. For the final part, most of the candidates with an incorrect value of t seemed to be able to substitute their value of t into their p and q expressions yet fewer knew how to subtract one from the other correctly, taking into account any negative signs. Many of those who did try to subtract were unable to maintain accuracy when subtracting a negative term from within a bracket.
Despite the fact that the question said that one boat was due west of the other one, this didn't prompt candidates who obtained a non-zero j-component for PQ to go back and check their value of t.

Question 8

Most candidates, in the first part, made a decent attempt at resolving perpendicular to the plane, although a common error was to give the final answer to too many significant figures. Thus candidates should be reminded that answers that emanate from the use of the numerical value of 'g' should be given to either 2 or 3 s.f. In part (b) the most common error was to get the direction of friction wrong, although this only happened in a minority of responses. Early rounding also led to some candidates being penalised for inaccurate values at the end.

Relatively few candidates identified the change in R for the final part of this question and many of those who did often then used $4g\sin 30 - \mu R = 4a$, losing a mark for the sign error. A large number of candidates showed the original value of F being used in otherwise correct equations, gaining the final two M marks only.

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