Examiners' Report/
Principal Examiner Feedback

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GCE Mechanics M2 (6678)
Paper 01

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General Introduction

The majority of candidates were able to offer solutions to all seven questions on this paper.

The quality of the work seen ranged from clear concise responses, usually accompanied by clearly annotated diagrams, to unclear solutions with little indication of what the candidate was attempting to do. Working to an appropriate level of accuracy is an area in need of some improvement with some candidates not recognising that after using an approximate value for g it is not appropriate to give final answers to more than 3 significant figures.

Another rounding concern is that candidates used rounded values in subsequent parts of a question and obtain inaccurate final answers as a result.

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. Candidates using 9.81 in place of 9.8 should also be aware that this will be penalised.

Candidates should be reminded of the need to show their working. 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 even when using calculator functions to solve equations. This means that if they have a wrong figure in their equation, they could score nothing for solving it if no working has been shown.

If a candidate runs out of space in which to give their answer then they are advised to use a supplementary sheet stating the question that they are attempting on that sheet.

Report on Individual Questions

Question 1

Q1(a) was an accessible question about centre of mass and many correct answers were seen. However, the fact that the ratio of the masses of the two rods was not the same as the ratio of their lengths caused some difficulties and a significant number of candidates did not have the centres of mass of the rods at the centres of the rods.

Some candidates took moments about an axis through *A* parallel to *BC*, but then forgot to find the distance asked for in the question. The question only asked candidates to find the distance of the centre of mass from *BC*, but many candidates also found the distance from *AB*.

In Q1(b) many candidates used the correct triangle and trig ratio to find the angle. Candidates should be reminded that when a value is given in the question they are expected to use it; some candidates who had obtained an answer other than 0.6 for the distance of the centre of mass from *AB* used their own incorrect value. Some candidates found it hard to determine the correct triangle to work with, often as a result of a poor sketch or no sketch at all.

Question 2

In Q2(a) candidates demonstrated a good understanding of the concept of power and many correct solutions were seen, with only a small number of candidates making errors in the equation of motion.

In Q2(b) many correct solutions were seen, but there were some errors in setting up the equation of motion. A few candidates did not include g in their weight component. There were also a significant number who, having correctly found R in Q2(a), then used $R = 720$ in Q2(b). Often it was clear that this was an error and a case of mis-copying from Q2(a).

Question 3

The majority of candidates started this question by resolving vertically and by taking moments about one end of the ladder. Candidates who took moments about *A* tended to be more successful because when taking moments about *B* part of the force acting at *A* was sometimes missing from the equation. A few candidates did not have the reaction at *B* acting perpendicular to the wall, and they were unable to make much progress. Errors in the moment’s equation were usually due to sine/cosine confusion, or to missing a distance in one or more terms. Some candidates ignored the weight of the ladder and/or the woman. The problem can be solved by resolving parallel and perpendicular to the ladder, but candidates who chose this route often went wrong because they left out one or more terms from their equation(s).

Question 4

Q4(a) was usually correct, but a minority of candidates did not realise that if the particle is moving parallel to vector **j** then the **i** component of the velocity must be zero. There were also a number of errors in solving $4t - 5 = 0$.

In Q4(b) some candidates did not attempt to integrate the velocity vector, and some did not have a constant of integration, but there were many correct solutions to this part of the question. Candidates who attempted to use the *suvat* equations usually went wrong because they assumed that the velocity was constant.

Q4(c) proved to be more challenging. There were many neat and concise solutions, but some candidates were not able to use the information given to set up equations to find values for c and d; they did not seem to realise that for the two particles to collide their position vectors needed to be the same.

Question 5

In Q5(a) most candidates found the normal reaction between the particle and the plane correctly and then went on to use the coefficient of friction to find the friction. Many went on to find the work done against friction correctly, but some candidates found the total work done as the particle moved from A to B, not just the work done against friction. A possible contributory factor in this problem could be the indiscriminate use of the symbol F to represent both the force due to the friction and the resultant force.

In Q5(b) almost all candidates followed the request to use the work-energy principle. Many completed the task successfully, but there were sign errors and some sine/cosine confusion.

In Q5(c) most solutions followed the same energy approach as that used in Q5(b) by considering the motion from B back to A but it was pleasing to see some solutions which considered the totality of the motion from A back to A, which simplifies the problem a little. Some candidates preferred to use the equation of motion to find the acceleration of the particle, together with the *suvat* equations to find the speed.

Question 6

Q6(a) was answered well with most candidates showing sufficient working to confirm the given answer. The most common approach was to find values for $u\cos\theta$ and $u\sin\theta$, and then divide to find $\tan\theta$. A few correctly substituted from one equation into the other to find the equation of the trajectory. Some candidates made sign errors in the equation for the vertical component of the motion, yet still claimed to reach tan $\theta =$ 2.2. A small number of candidates did not read the question carefully enough to realise that the ball passed the top of the post when $t = 2$ and were unable to make progress.

In Q6(b) having been given the value for tan θ in Q6(a), most candidates went on to find u correctly, either by using $u\cos\theta$ or $u\sin\theta$ or by using Pythagoras. Most errors were due to incorrect rounding of the final answer to give 9.66 or 9.68.

In Q6(c) those candidates who formed a correct quadratic in T usually went on to find the value of T correctly. There were a few sign errors in the equation, but more commonly candidates were confused between u and $u\sin\theta$ - it was common to see 9.67 used in place of 8.8. Despite the fact that it requires additional work, some candidates prefer to split the task into two parts, finding the time to the maximum height and the time from there to the ground.

Q6(d) proved to be the most challenging part of the question. There were some candidates who did not understand the question and used components of distance rather than velocity here. Almost all good attempts used *suvat* equations, with just a few candidates using an energy method. The use of $v^2 = u^2 + 2as$ proved slightly more successful than use of $v = u + at$, as sign errors or rounding errors were more common in the latter. Over-specified final answers were often an issue here, with several candidates offering four significant figures after using approximate values for u and T.

Question 7

Candidates made errors with inconsistent signs, or signs which did not reflect what they had shown in their diagrams. Several candidates did not start out with the direction of motion of *A* reversed after the collision, and only a few of these went on to give the correct speed of *A* after the collision. There were several algebraic errors in solving the simultaneous equations, often because of a lack of brackets after a minus sign, for example, errors such as $v = eu - \frac{u}{4}(1+e) = eu - \frac{u}{4} + \frac{eu}{4}$.

In Q7(b) many candidates scored the first three marks here for forming correct equations, although there were still errors due to inconsistent signs. Many also went on to solve for the speed of *B* after the second collision, but they often reached the negative of the correct answer because they did not consider the change in the direction of motion. It should be noted that it is much simpler to work through the equations for the second collision using v_B rather than substituting $\frac{u}{4}(1+e)$. Those candidates who had worked through correctly usually concluded that $\frac{3}{8}$ was the lower bound for the set of possible values of *e*, but very few candidates realised that the consequence of the coefficient of restitution between *B* and *C* being 2*e* was that the upper bound would be $\frac{1}{2}$.

In Q7(c) very few candidates offered a complete solution to this part of the question. Of those who attempted it, most appeared to understand the condition for a second collision between *A* and *B* to occur. Some did form a correct inequality in *e*, and a few then went on to consider the critical values of *e*. The majority of candidates made no attempt to use an algebraic approach; they reached their conclusion on the basis of substituting one or more possible values for *e*, and did not consider the full set of possible values.

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