Examiners' Report/
Principal Examiner Feedback

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GCE Mechanics M2 (6678) Paper 1

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Specification 6678

Introduction

The candidates found this paper accessible, and the examiners saw a lot of good quality work. The standard of presentation of solutions was generally good, with most candidates giving some commentary with their solutions, however there were some scripts where it was left to the examiner to fill in '=' signs and to guess as to the candidate's intent. The best work was usually accompanied by clearly labelled diagrams.

Candidates should be advised to rewrite work which they wish to alter – it is often not clear what is intended by the overwriting. Poor writing of figures – 4s like 6s or 9s, 5s like 8s, etc. – cause the candidates to make mistakes, frequently misreading their own writing.

Despite comments in all recent reports, there are still many candidates apparently unaware that substituting a value for g has an effect on the accuracy of the final answer. Some candidates are clearly using a calculator for tasks such as solving a quadratic equation. They should be reminded that when an answer is not correct and no method is demonstrated then no marks can be awarded.

Report on individual questions

Question1

Most candidates were confident in completing this question. There were few sign errors in setting up the equations for motion up the inclined road. The errors that were seen usually involved the omission of g, errors in resolving, or confusion over the number of zeros when converting 12 kW to 12000 W.

Many candidates lost the final mark due to giving the final answer to too many significant figures. Answers to questions involving the substitution of a value for g should be given to 2 or at most 3 significant figures
A small number of candidates tried to bring in acceleration, not realising that this would be zero due to the car moving with constant speed.

Question 2

Most candidates understood the principles of conservation of momentum and Newton's Experimental Law. However, many lost a mark here because they did not pay sufficient attention to the direction of motion of the particles after the collision, leading to inconsistent signs between their two equations. Even if they had indicated directions on a diagram, this was not always consistent with their equations. It was also common to see substitution into "template equations " rather than understanding the equations.
Candidates usually went on to eliminate v_p, v_q or u successfully, although some candidates offered no attempt at further work on their simultaneous equations.

The final 2 marks were very often lost because many failed to realise that the final direction of motion of P was the key to a solution. Several candidates did not attempt to obtain the stated result or wrote down the stated result without justification. Those candidates who had obtained an equation involving e but not v_p in the previous part of the question were often unable to make any further progress. For those who did attempt it, it was common for the direction of v_p to be inconsistent with their diagram. This confusion over the direction of the velocities led some candidates to make untrue statements about the value of e and to become very creative in their proofs.
Use of $v_p = 0$ rather than using an inequality was often seen.

Question 3

Many candidates would have gained more marks in this question if they had checked that they had actually found the quantities asked for in the question. Despite some arithmetic errors in dividing by 0.5, many candidates successfully found the velocity after impact but only about half of those went on the find the speed asked for in the question.

In part (b), most candidates managed to find an appropriate angle, although there was some confusion over whether to use the velocity after impact or the impulse. Sometimes the fraction for $\tan\theta$ was the wrong way up, and occasionally sine or cosine were used, but often incorrectly. Those who had sign errors in their **v** often failed to realise that an obtuse angle would then be required.

Finding the change in kinetic energy in part (c)caused difficulties for those candidates who did not realise that energy is a scalar quantity and that the v^2 required was merely the square of the speed found in (a). Some candidates had accuracy errors due to the use of a rounded value for v^2. Some only found the final kinetic energy rather than the change in kinetic energy.

Question 4

Centre of mass is a topic which is well understood by nearly all candidates and this question was a good source of marks for most, with many fully correct responses seen. Many candidates completed part (a) successfully, but it was disappointing to find a number of basic errors made in calculating areas. There was also some confusion over the centre of mass of the triangle; some candidates found the distance from *BD*, but not from *AE*, some knew that they we using $\frac{1}{3}$ of the median, but measured from the vertex rather than from the base, and there were several candidates using $\frac{1}{4}$ rather than $\frac{1}{3}$. Having established their values a moments equation was almost always formed.

Most candidates were able to identify the required angle correctly in part (b) and follow through appropriately on their previous values. It was disappointing to see several candidates needing to work through to find the distance of the centre of mass of the lamina from *AB*, not appreciating the significance of the symmetry of the lamina. Without working, a common error was to use $2a$ rather than a for this distance.

Question 5

It was pleasing to see that an energy approach was the favoured method in part (a), with only a minority opting to use *suvat* equations. Of those using energy, several candidates had the kinetic energies the wrong way round in their equation and appeared not to notice that the velocity of projection at the bottom of the plane was less than the velocity after the particle had risen 2 metres up the plane. Some candidates used the distance along the plane instead of vertical height when calculating the gain in potential energy. Most candidates using *suvat*, correctly deduced that the acceleration was $-\frac{g}{2}$ and proceeded to the correct solution.

In part (b) some candidates ignored the instruction to use the work-energy principle for this part, and lost marks as a result. Many correct solutions were seen. The most common error in the energy equation was to double count the gain in potential energy, treating it as part of the increase in energy and again as a term in work done against 'resistive forces'. Some candidates considered the energy change from *A* to *C* but forgot that the friction only acted over the final 1.5 m, not the full 3.5 m. There was evidence of some confusion between force and energy, with some candidates equating the friction, rather than the work done against the friction, to the change in energy.

Question 6

The candidates appear to have been well prepared for the variable acceleration question with many fully correct answers seen. In part (a), most solutions included the constant of integration which was then successfully found. Any integration errors usually involved omission of the $\frac{1}{2}$ from the t^2 term.

Most candidates realised that they had to solve $v = 0$ but this seemed to take much effort for some in part (b).

In part (c), having doubled their expression for v in solving the quadratic equation in (b), some candidates tried to integrate their doubled equation here. There were many calculation errors in the substitution of the t values and a few candidates were stumped as to what to do with the indeterminable constant of integration. Most candidates realised that the final answer had to be positive. Some candidates tried, inappropriately, to use *suvat* equations to find the distance.

Question 7

This question proved to be more accessible than those of a similar type in recent years, possibly because it was a little more obvious which were the best points about which to take moments and, having given answers, candidates had the opportunity to backtrack if they made a mistake. However candidates should be reminded that when the answer is given, the onus is on them to give a more detailed solution than might otherwise be expected.

It was surprising that some candidates failed to note that *DAB* was a 3, 4, 5 triangle with corresponding simple trig ratios and instead used their calculators to find an angle and, with subsequent rounding, often failed to achieve the required final accuracy.

Many candidates were able to gain full marks in part (a) by taking moments about *A*. Those who did not take moments about *A* usually failed to realise that there were forces at *A* that should be taken into account. A missing g in the moments equation was surprisingly common. A few candidates missed out at least one distance, and some did not consider the angle at all.

Part (b) was usually done well, but some candidates lost marks because they did not show sufficient working to support the given answer or they lost accuracy through using an approximate value for the size of the angle.

Part (c) was often well answered but sometimes an extra vertical force was introduced for the friction at *A* and sometimes unfortunate labelling of the forces at *A* (*F* horizontally and *R* vertically) led to confusion for some candidates when it came to calculating μ.

Question 8

There were some excellent and succinct solutions to this question. However some candidates try to use the same (very long) method for all projectile situations instead of trying to assess the most efficient route to the required answer.

The bookwork required in part (a) was usually completed very confidently, but some candidates clearly had little idea of how to proceed, despite similar questions on recent past papers.

In part (b) many candidates ignored the given equation from (a), instead using the longer route of $s = ut + \frac{1}{2}at^2$ vertically and then horizontally. A few candidates made this even longer by finding the time taken to reach the maximum height and then the time taken to fall to the point 1 m above the beach. Unfortunately, this was a very error prone method, usually accumulating rounding errors.

Choosing the correct value of y proved very problematic. Some of the wrong values chosen lead to a quadratic equation with no real roots although this did not seem to ring alarm bells very often. It is a pity that candidates do not always show their working when solving a quadratic equation and marks were therefore lost here.

Part (c) was answered well by those candidates who realised that the boy was running at a constant speed (and hence had zero acceleration) and that the '0.4 seconds later' meant that the time taken was reduced. A few added the 0.4 instead of subtracting it. Some candidates thought that the boy was starting from rest and accelerating to speed v at the instant when he caught the ball.

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