Examiners' Report/ Principal Examiner Feedback

January 2013

GCE Mechanics M1 (6677) Paper 01

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General Introduction

Candidates found this paper accessible .By far the best sources of marks were questions 4, 5, 2 and 1, in that order. The final parts of the last two questions provided good 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.

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.

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

Question 1

The vast majority of candidates wrote down an appropriate ‘conservation of linear momentum’ equation for part (a). There were occasional sign errors and the few who tried to equate impulses often did not take account of directions. Most reached the required positive value for speed ($5u$) but, those who took the opposite direction as positive, sometimes left their answer as $-5u$ and lost a mark. It was important that the subsequent direction of motion of Q was described in the context of the problem (such as ‘direction reversed’ or ‘opposite direction’) and not relative to the candidate’s diagram (such as ‘to the right’ or by drawing an arrow). In the second part almost all quoted and used a correct impulse formula, applying it to either the motion of P or Q. The relevant velocities for P were given in the question, so there were no follow through accuracy marks for those who chose to use the impulse on Q with a wrong value from part (a). Sometimes direction was not properly accounted for leading to a sign error. Since the magnitude of the impulse was asked for, the positive value ‘$10mu$’ was required for the final mark. Following correct working, some candidates wrongly stated the magnitude as ‘10’. Nevertheless, there were many entirely correct solutions seen.

Question 2

There were many excellent solutions with the better candidates clearly stating the points about which they were taking moments. Very few candidates produced dimensionally incorrect equations or left out g's but a significant majority lost an accuracy mark in either (a) or (b). In part (a) the majority chose to take moments about *D* so finding the reaction in one step. It was helpful to the candidates that, if marks were lost in part (a), this did not prevent them from picking up all of the remaining marks since part (b) led into part (c) and most found part (b) straightforward. Very few fell into the trap of using data from (a) in the ensuing solution and very few had rounding errors in their final answer. Part (c) was surprisingly completely correct in some cases after poor performance in parts (a) and/or (b). Apart from really poor solutions, most marks were lost through using incorrect distances when taking moments. However there were some good accurate alternative solutions to part (c) showing competent use of algebra, with candidates choosing to take taking moments about a variety of points, with *B* and *C* being the most popular.

Question 3

The vertical and horizontal resolution option was by far the most popular method of solution but some candidates were unable to solve the resulting simultaneous equations. The alternative method, used by more astute candidates, produced a considerable number of very succinct 'two lined" solutions, gaining them seven quick marks. However, after such good solutions a surprising number lost the last accuracy mark. Solutions using a triangle of forces or Lami's Theorem were not uncommon. A significant minority of candidates added a force *R* vertically which led to a great deal of confusion.

Question 4

Candidates seemed to like this question and there were many correct solutions. Most candidates found the acceleration successfully using *suvat* but some treated the whole question as a statics problem. Others omitted the weight component when resolving along the plane and a few used 30° instead of 15°. Occasionally sine and cosine were mixed up when resolving but for the most part the candidates produced convincing solutions.

Question 5

In part (a) the vast majority were able to obtain the acceleration, either directly or else by finding the time first. The easiest way of finding T in the second part was to find the distance 360 and then use $30T = 840$, but finding $t = 24$ for the final stage was a common first step. In part (c), many lost two marks by not drawing the triangle onto the trapezium and those who redrew only drew a triangle, hence still losing both marks. It was rare to see a completely redrawn whole diagram. In addition, many failed to mark V on their diagram. In the final part there were many who got the first three marks by getting an overall time of 72. There were a good number of candidates who used the area of the whole triangle but it certainly wasn't obvious to all and, as a result, there were some more complicated but accurate solutions. Where errors occurred it often came from students wanting to apply *suvat* to the whole distance, or getting bogged down trying to use *suvat* with unknown values of V and t, while others were successful in using an isosceles triangle. A few candidates producing correct working lost the final mark through recording 41.6.

Question 6

Apart from the final two available marks, this vector question was generally well answered. In part (a) most candidates could derive the relevant velocity from the given position vectors and time. However, some failed to realise that ‘speed’ required evaluation of the magnitude of their vector. In the second part the required expression for the general position vector was given, and so it was essential that the derivation was clear and entirely correct, including “$\mathbf{r}$ = ”. An incorrect velocity vector from part (a) correctly used here earned one of the two available marks. However, if the working was not consistent with that in part (a), both marks were lost unless there was clear evidence of the velocity being re-calculated. In part (c) many candidates substituted the relevant values of t (1 and 1.5) into the given expression to find the position vectors at these times. However, only a minority used these properly to solve the problem. Some realised that the $\mathbf{j}$-component of the position vector of L was zero, but deduced that the $\mathbf{i}$-component was $-8\mathbf{i}$ or $-7\mathbf{i}$ rather than the correct value $-9\mathbf{i}$. A clear diagram would have helped many to fully appreciate the situation.

Question 7

The relevant modelling assumption that leads to the accelerations of both particles being the same is that the string is inextensible. If additional but not relevant reasons were stated in part (a), the mark for this was withheld. Not all candidates realised, in the second part, that 'equation of motion' refers to Newton's Second Law ('$F = ma$'), and some attempts at constant acceleration equations, or just combining forces, were seen. However, often these candidates proceeded to produce the correct equations in part (c) in order to calculate the acceleration; they were awarded marks retrospectively. Occasionally the weight was omitted from the resolution parallel to the plane but generally the friction term (including the normal reaction) was handled correctly. Correct trigonometric ratios were mostly identified and used appropriately. Generally the motion of connected particles seemed well understood although numerical slips, including sign errors when solving the simultaneous equations, sometimes led to a wrong final value for the acceleration. The final part proved to be much more of a challenge. Some realised that it was necessary to calculate the speed (in terms of h) when one of the particles hits the ground, but then made little further progress. Those who realised that a new acceleration was required by applying Newton's Second Law parallel to the plane, sometimes made a sign error or omitted the weight component. A significant minority did complete their solutions, but with numerical or algebraic errors which led to a wrong answer. Having obtained $v^2 = 0.8gh$ many then went on to write $v = 2.8h$ (or similar) producing an h^2 in the final equation. Nevertheless, there were some clear, entirely correct solutions seen.

Grade Boundaries

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