Examiners' Report/
Principal Examiner Feedback

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GCE Mechanics M1 (6677) Paper 01

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Introduction

The paper seemed to be of a suitable length for the vast majority with very few candidates unable to attempt all the questions. Overall the paper seemed to be very accessible and there were several very straightforward questions. Good sources of marks were questions 2 and 4. The questions which caused difficulties were 1(b) (sign of impulse), 5(c) (sign errors, resisted motion under gravity), 6(d)(relative position vectors) and 7(c)(e)(tension and thrust). Some candidates always seem to struggle with the interpretation of vector questions and in fully understanding the motion of connected bodies.

Overall, candidates who used large and clearly labelled diagrams and who employed clear and concise methods were the most successful. It should also be emphasised that candidates should "show sufficient working to make your methods clear to the Examiner" as stated on the front page and usually, correct answers only, with no working, will gain no marks. Moreover, if there is a printed answer to show then there is an even bigger onus on candidates to show all the steps in their working.
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, including fractions, will be penalised.

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 equation for 'conservation of linear momentum' in part (a) and proceeded to calculate the required speed. Although there were occasional sign errors, numerical slips or miscopying errors, these were fairly rare and most candidates achieved the correct answer. Equating equal but opposite impulses was an alternative valid approach but was seldom seen. In part (b), most knew a correct formula for 'impulse' in terms of change in momentum on one particle, but often the direction was not properly accounted for; this often led to a negative value for 'm' (with the minus sign just being dropped 'because mass has to be positive'). If the impulse on particle B was used, a correct value for the velocity from part (a) was required to be eligible for accuracy marks. Sometimes, a correct formula was quoted but 'm' (rather than the relevant '$2m$' or '$5m$') was used as the mass. Occasionally 'mg' was quoted in the momentum expressions; this was not penalised in part (a) if the 'g' cancelled throughout, but it was treated as a method error in part (b).

Question 2

In part (a) the majority of candidates used the most direct method of resolving forces to find the reaction at *Q*. Usually the information was interpreted correctly with the reaction at *P* being twice that at *Q*; however, occasionally they were reversed which led to the loss of two accuracy marks for the whole question if the rest of the working was consistent and accurate. Virtually all candidates correctly included '*g*' in the weight term. A small number attempted moments equations but, since this required the solution of two simultaneous equations, errors were more prevalent. Those who only produced one equation and assumed *G* was at the midpoint achieved no credit. Part (b) did require a moments equation (about any point, but '*A*' or '*P*' were the most usual). Sometimes working was not clear and a relevant unknown distance not defined. This led to some candidates giving their final answer as '0.533..' which was in fact *PG*. Since *AG* was specifically asked for in the question, a statement of 'x = 1.33..' was not considered sufficient for the final mark unless 'x' had been defined previously or clearly shown on a diagram. At least 2 significant figure accuracy was acceptable including exact fractions (since 'g' cancelled). Generally this question was done well and full marks were often seen.

Question 3

This was a well-answered question. The majority of candidates obtained the correct number of terms in the resolutions and were able to resolve properly, with most candidates making sensible choices of the methods to use. Common errors were due to wrong signs, specifically with the 20 component, or missing *g*. There were also a few instances of division by sin or cos or the use of tan. A few candidates also neglected the weight in their resolving. The vast majority of candidates opted to resolve perpendicular and parallel to the plane. Of the few who chose to resolve horizontally and vertically most were successful but a few left out a component. There were surprisingly many candidates who lost the final A mark through over accuracy.

Virtually all candidates gained the mark for the use of $F=\mu R$. A significant number did not realise that friction acted up the plane and the ensuing negative value for μ was then conveniently lost. It seemed that fewer candidates than in previous years made the mistake of using $g = 9.81$.
There was evidence of a few candidates having their calculators set in radians rather than in degrees.

Question 4

The graph was usually correct in part (a) but some candidates included an initial period of acceleration from rest or an extra constant speed section at the end whilst others missed out one of the required figures. The majority of candidate scored both marks in the second part but it was quite common to see a sign error (in the acceleration) leading to t = -30, with the (-) sign being then conveniently dropped. Some candidates obtained t = 30 but then subtracted 25 and said it decelerated for 5 seconds, whilst others found the elapsed time at the end of the deceleration (T = 55) and forgot to subtract 30.

Methods attempted in part (c) were mostly correct with a variety of ways used to find the total area under the graph. A few treated the graph for the first 55s as a single trapezium. There was also some confusion as to whether it was the final time that was needed or the time for the final acceleration and several stopped, having calculated t = 40 or added 115 having calculated T = 155. Some used *suvat* equations for each section of the graph, usually successfully, but there were instances of a single equation being used for the whole time period!

Most candidates attempted to equate the area under the graph to 1960 (although there were a few who worked out the various sectional areas, and even added them together, but for whatever reason didn't then equate their sum to 1960). There were many ways of slicing up the area, and examiners had to be careful in counting the errors; since an incorrect answer to part (b) could still produce a correct answer in part (c), examiners took particular care in marking this. Most area errors resulted from wrong timings - for instance a mistake in part (b) or subtracting the 30 in part (b) from 60 so that it travelled at constant speed for only 30s in the third section or from missing out portions of the area or using the wrong formula for the area of a trapezium: it was sometimes impossible to tell which error it was.

Question 5

Part (a) was generally well done with most candidates using the figures 28, 9.8 and 17.5 in a constant acceleration formula to obtain the given 'u = 21'. Occasionally there was a sign error, and although the correct answer was quoted, it did not actually follow from the working. Some considered the motion 'up' and 'down' separately, and used the distances to successfully derive the value of 'u'.

The most common approach in part (b) was to write down a quadratic equation in t, and to solve it using the quadratic formula. Sometimes an inappropriate distance was used such as 1.5 or 36.5 (rather than 19) which showed a lack of understanding of the mechanics of the situation and so achieved no credit. There were occasional sign errors in the equation, and some were either unable to deal with the quadratic at all or misquoted the formula. Nevertheless, a significant number did successfully find the two values of t (accuracy to 2 or 3 significant figures was required following the use of g = 9.8). The alternative approach of 'up' and 'down' separately was seen, but often only one of the times was calculated correctly.

Part (c) proved more of a challenge for many; some omitted it and, although many recognised that it was necessary to calculate a deceleration as the particle moved through the ground, a very common mistake was to consider the resistance only and neglect the weight term. Those candidates could go on to achieve one of the four possible marks by substituting their deceleration into an appropriate constant acceleration formula. Again, accuracy to 2 or 3 significant figures was expected (over-accuracy or use of g=9.81 is penalised by a maximum of one mark per question). A 'work-energy' approach was an alternative valid method but candidates often only considered the change in kinetic energy and not potential energy.

Question 6

In part (a) since only the velocity was stated, virtually all candidates used this vector to identify a relevant angle (generally 32 or 58) using a correct 'arctan'. However, a significant number failed to derive the corresponding bearing (302). In the second part, most stated a correct position vector in terms of *t*, although occasionally the initial position was omitted or the two vectors were reversed. Part (c) required the substitution of t = 3 and the subtraction of the two position vectors. The majority substituted first and generally found a correct vector. However, some did not attempt to find the magnitude of the displacement to calculate the distance between *B* and *S* as required. Although in part (d) many candidates correctly equated **i** components to determine the time when *S* was due North of *B*, some either equated **j** components or, more commonly, equated to zero, the **i** component of the position vector of *S*. Those who reached a value for *t* generally substituted it into the position vector for *S* but sometimes left their final answer as '14.625' rather than subtracting 12.5 as required. Giving the final answer as '2.125**j**' rather than '2.125' was penalised. There were a large number of entirely correct solutions seen, but there were also a fair number of candidates who made little clear progress in part (d).

Question 7

As is usually the case with questions of this type, better candidates who understood the principles scored well and there were a significant number of fully correct answers. Better candidates benefited from appreciating that Newton's Law needed to be applied to either the whole system or to a single particle. The nature of these questions is that errors often involve missing or extra forces and this causes a significant loss of marks. The *suvat* parts were done quite well although a number of candidates tried to use the information about *t* or *T* from parts (b) and (c), in part (d) and this usually caused major difficulties.

The majority of candidates answered part (a) correctly, usually by considering the whole system, but sometimes by considering the particles separately and eliminating T. Candidates who considered just one particle, by omitting T, rarely achieved success in any subsequent part of the question (although they usually picked up the M1 in part (b)). The vast majority answered the second part correctly. In part (c) most candidates were able to produce an equation of motion for one of the particles and those who scored full marks in part (a), generally scored full marks in parts (b) and (c) also. There was a minority, however, who appeared to have no idea how to cope with the particles separately; these candidates might score highly in parts (a), (b), and even in part (d), but they seemed stumped when they couldn't use 0.8 as the relevant mass i.e. in parts (c) and (e). In part (d) a new acceleration was needed and many candidates calculated it correctly then used it appropriately to find the distance travelled. A variety of errors appeared here. Some candidates used the old acceleration, others used g, some used just one particle and left out the thrust while others kept the 4N force. Others didn't think they needed an acceleration because they used $t = 6$ and $s = t(u + v)/2$. _Part (e) caused the most difficulty and a number of candidates were put off by the unfamiliar concept of a thrust.

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