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Examiners' Report/
Principal Examiner Feedback

Summer 2013

GCE Mechanics M3 (6679)
Paper 01

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Introduction

Some questions proved very straightforward for the majority but others were answered correctly by only a few. There were a great many very able candidates writing well-reasoned, logical solutions but also a significant number of very poor attempts. The least successful candidates often could not identify which area of the specification was relevant in a particular question; SHM and circular motion are often treated as interchangeable.

The standard of presentation seems to get worse with every session. While many set out their work neatly and include adequate or, in some cases, extremely detailed, explanations of their reasoning, others completely ignore the importance of this aspect of the work. It is not unusual to see solutions which look like more like rough jottings than an attempt to impress in an A Level examination: no formulae or equations are written, numbers are randomly placed, the lines on the paper are often ignored and the only thing which appears to matter is the final answer. If the answer is right, these candidates usually get full marks provided the question does not say "show that". Also, it is not unusual for candidates to misread their own badly written numbers.

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 correct method was identified by all but a very few and there were many fully correct solutions. Many candidates were able to get at least 3 marks by successfully finding an expression for F and applying it to an equation of motion along the radius. The main source of error was in the supposedly straightforward conversion of revs/minute into rads/second (or occasionally m/s). The most common wrong values for ω were 20, 20/60 and $\frac{20}{60} \times 2\pi r$ (the linear speed). Some forgot to square the ω in their calculation but were still able to earn the method mark if they'd written the formula correctly; others lost this mark because the formula either appeared incorrectly $(\mu mg = m\omega r)$ or not at all. A very few of the weakest candidates seem to think that any question containing ω must be to do with SHM; statements such as $\ddot{x} = -\omega^2 x$, $v = a\omega \cos \omega t$ and $T = \frac{2\pi}{\omega}$ were all part of completely failed attempts.

Question 2

In part (a) the majority of candidates used dv/dt for the acceleration and set up a correct equation including the mass. The integration that followed was almost always correct but some candidates wrote $c = 0$ with no justification and so lost a mark. Very few omitted the constant completely.

The first mark of part (b) was gained by integrating their v and only a few integrated $2t + 0.5$ instead. The integration was usually correct but there was the same problem with the lack of justification for a zero constant. The majority set $v = 6$ to obtain a quadratic. Most candidates then factorised obtaining two solutions but there were several instances of $(2t - 3) = 0$ leading to $t = \frac{2}{3}$. Those who used the quadratic formula were generally successful but those who used a calculator and wrote down just one solution lost three marks altogether. Candidates must remember that marks will be lost for not showing sufficient working to make the method clear and a calculator solution must therefore show both solutions to demonstrate the selection of the appropriate one. A small minority omitted to set up a quadratic altogether and took the value of t to be 6 thus losing the last four marks.

Question 3

Part (a) was very straightforward for those who realised that both particles were in equilibrium vertically and that the tension was the same in both portions of the string. However, most did not spot this immediately; they lost their way by writing too many equations and attempting to solve them simultaneously, but without ever realising that $T_1 = T_2$. The invalid combination equation $T + T\cos\theta = 3mg$, which could result from adding the vertical equations for the two particles and hence was correct if these separate equations had been shown first, was seen frequently and the much worse statement $2T = 3mg$ occasionally. Part (b) was often completed successfully even if (a) had not been, as it was possible to do this using only the forces on P. Quite a few, realising from (b) that T must be 2mg, then noticed what they should have spotted in (a) about the equal tensions and went back to do (a) correctly afterwards. It was often difficult to tell whether the reasoning was circular or correct. There were quite a few blank page non-attempts at this question and also a few which, as in question 1, saw the ω and tried to use SHM equations.

Question 4

The vast majority of candidates found λ correctly and then calculated the EPE using the correct formula. They then went on to form an energy equation with the most common error being adding the work done by the friction to the EPE instead of subtracting it. Several lost the last mark by not giving the answer to 2 or 3 significant figures as required when a numerical value of g is used, with 0.8 and 9√5/25 being the most common examples. A few candidates used $\text{EPE} = \dfrac{Tx}{2}$, bypassing the need to find λ and scoring the first 4 marks very easily. Another method was to use N2L – this was more complicated and not often successful. In part (b) there were several methods seen with the mark scheme method being the most straightforward and almost always correct. Another alternative was to use the energy from the string going slack to rest to find a displacement but then 0.3 had to be added to complete the method and this was often forgotten. A third method was to find the acceleration when the string is slack, then to use suvat equations and add 0.3. All three methods were seen being used correctly. An error sometimes seen was the assumption that it was a spring rather than a string so another EPE term was included.

Question 5

In part (a) very few candidates used the formula for a lamina rather than a solid of revolution but unfortunately, several forgot that the $x+1$ had already been squared so that effectively, they integrated y rather than y2. In this case, if they had quoted the required formula correctly, they could score 3/8 but without the formula, only 2/8. It is always worth quoting the formula before embarking on a solution. Many candidates were able to integrate successfully without expanding the brackets but those who chose to expand generally did so correctly. A common error was to assume that the lower limit of 0 resulted in an answer of zero so unless they had actually shown the substitution, they only appeared to be using one limit. There were no problems with π in this part – candidates either left it out altogether or cancelled correctly. Candidates who had forgotten to square y in the part (a) were able to retrieve some follow through marks in part (b). There was now a problem with π – those who had not used it in part (a) often forgot it in (b) when finding the masses. The other common error was to assume that the mass ratio was 1:10:11. There were a few examples of inconsistent distances but candidates were usually able to form a dimensionally correct moments equation and could score 4/5 even if part (a) had been a disaster.

Question 6

There were various approaches to part (a) and with a given answer the working was sometimes manipulated to give the correct answer. Some took AO as the unknown and others had two unknowns in the Hooke's law equations and then used the fact that the extensions added up to 1.5 to provide an additional equation. An alternative was to use a ratio method. The majority of candidates scored full marks in this part. Part (b) was more problematic because candidates were not always clear where the extension should be measured from. Many subtracted the extensions the wrong way round, realised that they needed a minus and put it on the other side of the equation, some did not put in the required minus and a few added the tensions. Those who did not measure the extension from the equilibrium position almost always failed to make an appropriate substitution at the end. Despite the wording in the specification, some candidates continue to use a for acceleration, losing the last two marks. There were also cases of using e for extension, ending up with an equation in two variables. Since this was a proof, a simple conclusion was needed – for example 'so it is SHM'. Some candidates lost the final mark for not stating this and so not indicating that they had completed the work. In part (c) those who had derived an SHM type of equation could find a value for an ω and hence an amplitude and could potentially score the two M marks. Some candidates used $x = a\cos\omega t$ with $x = \pm 0.1$ but those who used sine sometimes forgot to add a quarter of the period so did not have a complete method. Some added $\frac{T}{4}$ after using cosine and a few used $x = 0.3$. Overall, there were some fully correct solutions but there were many poor answers, often losing all the marks in (b) and most of them in (c).

Question 7

Most good candidates knew the correct method for part (a) but many failed to use the mass as 5m in all the necessary terms and so obtained an incorrect answer. There were a variety of reactions to this: some checked carefully, found the mistake and corrected it; others cheated by changing the numbers in either the energy or N2L equation to make it appear "right". A third, thankfully small, group wrote broadly similar rants claiming that their version was definitely the right answer, that it was a disgrace to find errors in examination papers and that they were reluctantly continuing with Edexcel's wrong equation for (b) and (c). Apart from the missing 5s, the most common mistakes among weaker candidates were in using $T = \frac{mv^2}{r}$ without the component of the weight or $T - 5mg\cos\theta = \frac{mu^2}{r}$ with the given initial velocity. A number of solutions used the expression $mga(1-\cos\theta)$ for the GPE in the general position without considering the starting point. Memorised formulae are much less common in vertical circle questions than previously but weak candidates still clearly think that this is a good approach. There were also quite a few non-starters, not just for (a) but for the whole question. Part (b) was generally done well. Even those who could do nothing else at all usually managed to get 1 mark out of 16 by solving $T = 0$ to get either $\cos\theta = -0.6$ or $\theta = 126°$. Many of those who had cheated in (a) now suffered a further, completely unnecessary, mark loss in (b) by using their fiddled expression for v2 instead of the correct one they had originally found. Part (c) was unusual and this put most candidates off. Only a very few managed perfect solutions but there were enough near misses to show that it was a perfectly reasonable question. Very few candidates thought carefully enough about the relationship between the angle found in (b) and that of the projectile with the result that the velocity components were often the wrong way round. When found at all, the initial positions were also often interchanged, but the majority of those who got this far didn't even attempt to include these. Others found these starting positions but then forgot to include them in their final expressions. Another unfortunate error, seen a number of times in otherwise excellent solutions, was to omit the t from the $(v\cos\theta)t$ term in the final expression for x or y. This was obviously a careless slip but a costly one. As well as the significant number of complete blanks, there were a number of very poor attempts by candidates who clearly didn't even recognise the topic. $T = \frac{\lambda x}{l}$ and $F = \frac{GMm}{r^2}$ both appeared in (a), $v = a\omega\cos\omega t$ was written as a method for (b) and several (c) attempts quoted $x = a\sin(\text{or}\cos)\omega t$, where $\omega = \frac{v}{a}$.

Grade Boundaries

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