Examiners' Report/ Principal Examiner Feedback

January 2011

GCE

GCE Mechanics M3 (6679) Paper 1

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Introduction

The overall standard seemed very high, even though the paper was not unusually straightforward. Algebraic manipulation was good and there were a great many well-expressed, concise solutions from well-prepared candidates. There were relatively few blank pages or other worthless attempts. The length seemed about right; there were no signs of haste towards the end but neither was there evidence of spare time being used to do questions twice although there were some blank 7(c)s from a few candidates. It was not possible to decide whether these blanks were due to lack of time or an inability to realise where the maximum and minimum tensions occurred.

Some candidates would be well-advised to make more use of the generous space allowed for their solutions. Solutions written in small or poor hand-writing on consecutive lines of the answer booklet can be difficult for examiners to follow and are not easily checked for errors by the candidates either. Well-spaced working tends to contain far fewer mistakes.

Solutions to "show that" questions did not always contain sufficient working to convince the examiner that the candidate would have arrived at the correct answer had it not been given in the question. In some cases it was obvious that the candidate had failed to arrive at the given answer and had either simply introduced extra terms or had tried to correct work but the correction was incomplete.

Report on individual questions

Question 1

As intended, this was a straightforward opening question for most candidates. The majority knew that the $v\frac{\mathrm{d}v}{\mathrm{d}x}$ form of the acceleration was needed and proceeded to a correct integration and then obtained a correct value for the constant. Some candidates integrated $\frac{\mathrm{d}v}{\mathrm{d}x}$, obtaining $v = \ldots$, leading to an incorrect solution. Occasionally $\frac{\mathrm{d}v}{\mathrm{d}t}$ was seen, resulting in a zero score on this question. Virtually all candidates set $v = 0$ and managed to solve the resulting quadratic although some made hard work of solving even the correct quadratic.

Question 2

Part (a) was usually successful. Very few candidates failed to get the masses correct (a very small number considered the volumes of the shapes) but some managed to interchange the distances. Most candidates took moments about the centre of the common face, but some successfully took moments about either end of the toy.

Very poor diagrams did not help with the solution of part (b). Basic geometry/trigonometry let many candidates down as they took the slant edge to be $2r$ and/or put the $30°$ angle in the wrong place. Most attempts tried to set up a moments equation about *B* but few of these led to a correct result. The best students realised that the forces were parallel and so taking moments about *O* or the centre of mass of the combined toy allowed them to use measurements along the axis and thereby avoid complicated trigonometry. These students used surds confidently and quickly arrived at a correct result. The candidates who found the centre of mass of the combined shape and then used that, in conjunction with 30^{o} to work out the value for λ also achieved a higher than average success rate.

Question 3

Part (a) was almost always right, the only occasional errors occurring in integrating e^{2x}. A few failed to realise that $(e^x)^2$ was e^{2x} and similar small numbers missed the $\frac{1}{2}$ when integrating. Some of these "corrected" their error by quoting the volume formula as $\frac{1}{2}\int \pi y^2 dx$ and so lost everything. The method for (b) was also well known but there were quite frequent mistakes. Most errors occurred in the integration by parts, often as a result of trying to substitute the limits and simplify without writing all the detailed steps. There were inevitably some incorrect formulae quoted, the most common of which was for the *x*-coordinate of the centre of mass of an area. Some started with a mixture of formulae such as $\dfrac{\int xy\, dx}{\int y^2 dx}$ but all such errors were in the minority. A few students left answers in terms of e, one or two gave answers to 4sf. A small minority appeared not to have covered the necessary C4 integration as they had no idea of how to integrate by parts.

Question 4

The specification for this unit states that "proof that a particle moves with simple harmonic motion in a given situation may be required (i.e. showing that $\ddot{x} = -\omega^2 x$)". It was clear from many of the attempts seen for part (a) of this question that not all students are aware of this. While many did complete the necessary differentiation and final substitution, although not always correctly, some used v and a instead of $\dot{x}$ and $\ddot{x}$. Full marks could have been gained had *a* been replaced with $\ddot{x}$ for the final statement, but many failed to do this. Part (b) was usually correct, although some who had incorrect final results in (a) used an incorrect ω to obtain the period. Most used $v = a\omega$ and obtained the correct result in part (c). Part (d) also rarely produced problems, the most frequent error being to add the two times instead of subtracting. A few candidates had their calculators in degree mode here.

Question 5

This question was answered well by most candidates. Only in rare cases did candidates fail to recognise that the angle was 45 degrees. Similarly, in only a few cases, some students considered the tensions to be equal. In general, candidates were able to find the equation of motion, vertical resolution and value for *r* correctly. However, some computational errors were made collecting terms which led to a loss of accuracy. In most cases, those who gained the marks for part (a) understood that the tension had to be greater than zero in the lower string and so were able to answer part (b) correctly as well. In some instances, students confused themselves by comparing the two tensions instead.

The students who simplified their equations before trying to eliminate a tension achieved a better rate of success at getting the correct tensions - many quickly spotted the simplified version of the horizontal resolution obtained by cancelling sin (or cos) 45. It was disappointing to see students get all of the mechanics in place and then fall down on processing. A small number of students tried to resolve along the strings but failed to resolve the acceleration. Some did not read the question and left final answers in terms of "*r*" instead of "*l*".

Question 6

Part (a) was answered quite well although in some cases excessively convoluted work was done to produce the correct value of k rather than obtaining the tension using Hooke's Law and separately from resolving vertically and then equating. A very small number treated the problem as a single string of length $2l$, and when they did, they often mixed up the extension for the double string with the natural length of the single one.

In part (b), some candidates had difficulty finding the new initial extension – a few continued to use the $\frac{1}{4}l$ they had found in part (a). A few candidates used the single string approach but too many using two strings failed to double the EPE they had found. Many candidates failed to realise that the mass of the ball was $3m$ resulting in errors in PGE and KE; some candidates even had $3m$ for the mass in one energy term and m for the mass in the other. It was rare to see a candidate attempting to solve this part of the question by any method other than using energy considerations. Those who did quickly ran into problems. A solution by SHM requires SHM to be proved, not just stated as a fact, and use of the equation of motion should include a variable acceleration. Either approach requires much work!

Question 7

Part (a) caused few problems but having the answer given in the question helped a few with convenient changes in signs. Apart from a few who used $v^2 = u^2 + 2as$, it was done very successfully, if not always convincingly. Many students made things more complicated than needed by using various reference lines for the potential energy rather than simply finding the height fallen.

Part (b) was generally answered well but again, having a given answer helped some candidates choose a correct value for $\cos\theta$. Some tried $T > 0$ as the required condition even though they were given that it was a rod. There were some very well explained energy solutions (initial energy > PE needed to reach the top), but the majority of correct solutions were via the main method on the scheme.

Part (c) was a good discriminator. There were a lot of good solutions, and some outstandingly brief ones but also a great many that lost track of what they were trying to do. The most efficient solutions found a general expression for T in the θ position shown in the diagram and then just substituted 1 and –1 for $\cos\theta$. This bypassed a lot of the algebraic manipulation which might go wrong. The majority of correct solutions, though, used the main method on the scheme. The positions of maximum and minimum T were well known, and correct, or almost correct, equations for these positions were written by a majority. There were some very weak attempts, completed very quickly, which assumed the same v in both equations for T. Because this answer was also given, there were the inevitable optimistic fudges from some candidates.

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