Examiners' Report

January 2015

Pearson Edexcel International Advanced Level in Mechanics Mathematics M3 (WME03/01)

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General

There was plenty of work on this paper for candidates of all abilities and most seemed to be able to complete all they were able to do within the time available.

Candidates need to be wary of omitting steps in their working in any question which includes a given answer, such as questions 6(a) and 7(a). Examiners do check each stage of the work and errors will be found and penalised even if the "answer" at the end is "correct". Also correct answers which are not given in the question and follow incorrect (or sometimes no) working suggest malpractice.

Presentation continues to be a problem in some cases – illegible handwriting, an answer that has been changed by writing on top of the original so that, even by enlarging it, it is impossible to read, trying to fit the solution into the smallest possible space. Marks are given for the complete solution, not just for the final answer and without legible complete working, candidates may lose marks.

Use of calculators to do the integration in question 2 lost almost all the marks. The instruction to "use algebraic integration" means that the algebra must be shown. Calculators that are capable of performing algebraic integration are not allowed in the examination; the calculators that are allowed can, at the most, only do numerical integration and so produce approximations.

Question 1

Most candidates were familiar with this type of differential equation. There was occasional use of $\frac{\mathrm{d}v}{\mathrm{d}t}$ but the majority managed the integration successfully. Less successful was the calculation of the constant – some omitted it completely, some used $x = 0$ when $v = 0$ and others used $x = 0$ when $v = 32$. A few used Work = Change in KE; this led to a longer but successful solution which involved finding the initial speed first.

Question 2

This was generally answered very well and the vast majority of candidates knew in essence how to approach the question. Only a few did not work with areas and most gave fully correct answers to part (a). Part (b) was a little less successful, with some attempts to integrate with respect to y. The majority, however, did attempt to integrate y^2, usually with the half. Many candidates did not evaluate the integrals separately, but wrote as a fraction. Whilst this was fine in the main, some did cancel 3 before integrating and this occasionally caused problems in (b) where they carried forward $\frac{2}{3}$ for their denominator.

Question 3
This question was answered astonishingly well, with most candidates gaining full marks. There was a wide range of orders to the working, with some keeping two tensions for a long time, whilst some went to a single T straight away, which gave a more efficient solution. Some of the working got very complicated, depending upon exactly when variables were eliminated, r substituted and a numerical value used for the trigonometrical ratios, but, in spite of some very messy looking sets of equations, candidates nearly always got through to the correct solution without any fudging. Some even managed to avoid ever using a value for their trigonometrical ratios as everything cancelled, leading to a very elegant solution. The most common error seen was to take the vertical components of the tensions both to be acting upwards.

Question 4
Part (a) was generally answered very well, with most correctly identifying the required lengths and most candidates finding the tension in the half string. When going on to resolve most made an acceptable attempt at resolving and it was generally only strange slips in copying across tensions that lead to trouble. Most actually identified their answer as weight, although some did only label it mg. The commonest problems encountered in this part of the question involved mixing up numbers for the string with those for the complete string. There was also some confusion about the natural length of the string; some candidates appeared to think this was 6 m whist some were inconsistent and sometimes used 5 m and other times used 6 m.

Part (b) certainly caused more problems and for candidates with full marks in (a) it tended to be 0 or 5. Almost all realised that they had to use energy and gave a KE, GPE and EPE term, but a large number failed to include an initial EPE. Where all four terms were present, the correct answer was generally reached, unless they were carrying forward an incorrect weight from (a). Any candidate who made any sensible attempt (even if missing an EPE term) did go on to correctly use their mass from (a).

Question 5
Part (a) was generally answered reasonably well, albeit very messily. The majority measured their distances from O although a few forgot that one of their values should then be negative. Many candidates used the full mass expressions in their equations, making for unnecessarily complicated lines of working, but almost all managed to do so without dropping powers. It was often hard to distinguish k and 4 their equations, which did not help with allocating part marks. The most common mistake, however, was to leave fractions in their fraction for the final answer. This is not acceptable from Further Mathematics students.

Part (b) was one of the worst answered questions on the paper. Many made no attempt and those who did often wrote rubbish. Some attempts became incredibly convoluted, as every conceivable distance was produced algebraically and formed into either similar triangles or Pythagoras. These were generally well labelled, so there was at least a chance of following their reasoning and often the work did lead to the correct answer. The most interesting solution seen found vectors (taking **i** as the axis of symmetry and **j** parallel to the shared face) from V to the pivot and then from the pivot to the centre of mass, finally making the scalar product zero, leading to a very neat solution. In general attempts at (b) were hampered by a failure to simplify their x from (a).

Part (c) was far better with around half the candidates managing to gain the first marks. Where no cancelling had taken place, both (c) and (b) led to quadratics and for the most part no working was shown for their solution, although the correct solution was almost always reached if the correct equation had been found.

Question 6
Being given the answer in part (a) certainly helped a few candidates retrace their working and produce a sound proof. Candidates showed a good understanding of the principles and there were very few uses of uniform acceleration equations rather than energy. The term which caused problems was the PE term where candidates who used $a\cos\theta$, $a(1-\cos\theta)$ and $a(1+\cos\theta)$ all claimed to arrive at the correct final expression.
Part (b) was done well on the whole. Some worked through to find an expression for R and then set it equal to 0 to find an expression for v – there were very few instances of R not being mentioned at all. A small minority did not resolve the weight. The majority used the main method on the scheme but the alternative was also used occasionally. The most common incorrect solution was to claim that the particle leaves the surface when $\cos\theta = 0$ and a few forgot to square root v^2 for their final answer.

Part (c) was a good discriminator with some candidates not attempting it at all. The scheme method was rarely used, with most candidates finding the horizontal and vertical components and then using the tangent. Those who used energy either considered the energy from the top or from where the particle left the sphere. Those who used the alternative in (b) did not all realise that they could find a value for $\cos\theta$ and so had an incomplete method. A few interchanged sine and cosine when trying to resolve the velocity as the particle left the sphere although it was encouraging to see that the majority did actually try to resolve.

The most common errors came from using an incorrect vertical velocity – the velocity from (b), the original given velocity or 0. A small minority thought that the angle could be found using distance rather than velocity. In some cases, potentially good answers were spoiled by poor arithmetic.

Question 7

Part (a) was done correctly by almost all candidates although there were cases where the forces were resolved vertically and horizontally and also some where there was an attempt to use EPE on the particle falling to rest from its natural length.

Part (b) was another good discriminator. It was done perfectly by a very small number – if candidates had not omitted to state that the motion was SHM, there would have been more completely correct solutions. However, the majority had no idea what to do but having been given the period, they worked out ω and tried (unsuccessfully) to contrive a convincing proof. When an attempt at an equation of motion was made, it was not usually at a general point – the most common errors were to use $\frac{a}{5}$ or $\frac{2a}{5}$ with no x or in using an undefined length e which gained no credit at all despite arriving at the correct equation. It was disappointing to see some candidates still using the incorrect form for the acceleration despite repeated reminders in previous reports. Using a for the acceleration is not good in any question as a is non-directional; in this question it could be confused with the a used in the lengths. It is much better to use $\ddot{x}$ from the start, in the direction of increasing x. Also candidates need to be reminded that if they are asked to prove SHM, they must have a conclusion saying that the motion is SHM, and so indicating to the examiner that the proof is complete – the majority of candidates lost this mark.

Part (c) was answered well with some using an equation of motion at the lowest point rather than SHM. A few forgot that the question had asked for the magnitude and gave a negative answer.
Candidates would have benefited from a clearly labelled diagram in part (d) – they knew what they were trying to do but muddled up the different positions of the particle. Very few used the most efficient method, using cosine with $x = -\frac{a}{10}$ to obtain the answer in one step. The most common error was to use cos and then to add $\frac{1}{2}$ or $\frac{1}{4}$ of the period. A small minority solved their equation in degrees instead of radians and the amplitude was often wrong.

Grade Boundaries

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