Pearson

Examiners' Report

Principal Examiner Feedback

January 2017

Pearson Edexcel International A-Level
Mechanics M3 (WME03)

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The overall standard was high, with algebraic skills and accuracy being particularly evident. The early questions were relatively straightforward but questions 5 to 7 allowed the more able students to demonstrate a greater understanding of the topics being tested. In these harder questions, students often failed to present their solutions logically, making it difficult to decide if they were attempting correct methods. Examiners do not simply mark answers but expect to see clear, well-reasoned solutions, especially in "show that" questions, where every step of the working, however simple, should be written down. The instructions to students advise that “answers without working may not gain full credit”. Many students would also benefit from making more use of the generous space allowed for solutions. There is no sense in squeezing small, easily misread working into one or two lines when two pages are available.

Question 1:
While the majority achieved full marks with little apparent difficulty, some lost all the marks by finding the centre of mass of an area rather than a volume, often appearing to be quoting half-remembered formulae rather than thinking about the mechanics of the situation. This question demanded the use of “algebraic integration” meaning that solutions which bypassed the two integrals but used calculators to find their correct numerical values were worthless. A very significant mistake seen quite a few times was due to carelessness was having initially written the given expression for y^2 correctly, some students squared it again and so attempted integrals involving y^4 instead of y^2.

Question 2:
The majority answered this perfectly but it was noticeable how many students wrote solutions to the quadratic equation in (b) without showing any working. This is acceptable if the answers are correct but no method marks can be given if either the equation or the solutions are wrong. It is therefore advisable to work through the solution fully, showing either factors or formula.
Some major method mistakes among the incorrect solutions were:

- attempting to use $v\frac{\mathrm{d}v}{\mathrm{d}x}$ instead of $\frac{\mathrm{d}v}{\mathrm{d}t}$ for the acceleration in (a)
- using the instantaneous velocity $\frac{10}{3}$ as $\frac{\mathrm{d}x}{\mathrm{d}t}$ in (b) instead of the variable answer from (a).

A number of lesser, but significant, errors seen a number of times were:

- numerical slips when dividing by 3/5 in (a); this led to all the required answers being wrong
- using limits of 0 and 10/3 (the velocity) or –4/3 and 1 instead of 0 and 1 when finding $\int v\,\mathrm{d}t$.

Question 3:
The method required here was well known and most errors were avoidable. The most common of these was giving the final answer as 3.43 instead of 3.43a, or its fraction equivalent. More significant mark losses were incurred by those who either used wrong formulae for the volumes involved or who, unwisely, had maybe just miscalculated from correct formulae that they had not written first. Sign errors were not uncommon; either the volumes or the moments were added rather than subtracted and those who had used negative displacements in their working sometimes incorrectly gave the final answer for the distance as negative.

Field Code Changed

Question 4:
Again, the correct method was very well known, especially in (a) and (b). Most errors arose from wrongly identified values for the trigonometric ratios involved. Some decided that the angles were the same for both strings, others that an angle of 60° must be involved somewhere. In (c), although the majority knew the correct starting point for the inequality, those who did not wasted considerable time exploring a variety of alternatives. It should be noted that a question which asks for a result involving … does not award marks for one using >.

Question 5:
Only a very few scored all four marks for (a). The majority did not give an adequate reason for the inequality and earned only one mark for a question that they probably considered simple. Inequalities in "Show" questions should always be given careful consideration so that the real reason for the inequality is identified. An ideal solution here needed three stages: tension = $\lambda x / l$, tension = friction and friction „ μR. Statements such as $F \ldots T$, supported by vague statements such as "Because it does not move" do not justify the inequality and the often seen statement that $F = \mu R$ is not true unless it is made very clear that this is the maximum possible friction.
Although the underlying principles were well known, many attempts for (b) were not well executed. Most students managed to score two marks by finding correct expressions for the initial EPE and the work done against friction but these were most often then used in equations which contained no other energy terms. Valid equations involved assuming either a final EPE at the point where the particle stopped or some KE when the string reached its natural length. Alternatively, a very neat solution showed by inequality that the initial EPE was insufficient to provide the necessary work for the particle to reach the point where the string became slack.

Question 6:
A few gave themselves difficulties throughout by quoting Hooke's law as $T = kx$ (as used in physics?) and subsequently forgetting that their $k = \lambda / l$. They would do better to accept that there are different versions for the two subjects.
Part (a) was almost always correct although a few forgot to add the extension to $5l$ or added it only
to l.
Unfortunately, most of the potentially perfect proofs in (b) had $m\ddot{x}$ instead of $2m\ddot{x}$ in the Newton's second law equation and so lost some accuracy marks both here and in later parts of the question. As always, there were many failed attempts to prove SHM. Correct use of $\ddot{x}$ for the acceleration has become much more common but significant numbers still lost marks by using a or forgetting to state that they have proved SHM. Some very brief proofs seemed to have been memorised rather than understood and these often did not make sense; either the $2mg$ term did not genuinely cancel out of the equation or they used undefined terms. No credit was given for generalised proofs using e as the equilibrium extension unless $e = l/2$ had been clearly stated either here or in (a).
Parts (c) and (d) presented no problems and many benefited from the follow through marks.
Part (e) was done very well by stronger students but was left out completely by a significant minority. It was well known that a solution could be found using $x = a\cos\omega t$ or $a\sin\omega t$ but there was much confusion over whether this should then be combined with $T/4$ or $T/2$ using addition or subtraction. Some attempts assumed that the time taken from the mid-amplitude point must be $T/8$ and others tried to involve uniform acceleration equations.

Question 7:
For those who knew the relevant theory – a substantial majority - part (a) proved to be very straightforward but some students seemed to have little idea how to get started. Omission of either the energy equation or of the mg term in $R - mg = \frac{mv^2}{r}$ both lost five of the eight marks and were not uncommon.

The most common mark for (b) was 0. The preferred method was to conserve energy from the bottom to the top but overlooking the fact that a KE associated with the horizontal velocity needed to be included at the highest point. An easier, and correct, method used the vertical component of u and *suvat* equations to find the height above the rim, finally adding $3r/2$.

There were some excellent, clearly reasoned solutions for (c) but these were very much in the minority. Most attempts were muddled, poorly explained and often quite wrong. It was not always realised that energy considerations meant that the velocity of the particle when it reached the rim must be U, the same as initially, and quite a few students tried to use the completely irrelevant velocity at the lowest point, found in (a), to investigate the further flight. Others attempted solutions using their greatest height from (b) but, unfortunately, this was usually wrong. There were so many possible methods available here that it was extremely difficult to award method marks to the wrong working unless there was some indication of what had been intended. Horizontal and vertical velocity components and expressions representing times and distances needed to be clearly identified before they could be judged worthy of marks. Quite a few students confused matters further by using

$U = \sqrt{2gr}$ as a given initial velocity. As in question 5, inequalities should always be treated with caution. It was required to show that a velocity **greater** than this resulted in the particle landing outside the bowl. It is very difficult to write a convincing justification of the further distance travelled unless the inequality has been incorporated into the working.

A final point to make was the number of students who made no errors but then claimed to have shown that the particle landed outside the bowl without ever having mentioned the distance across the rim. Finding this distance was an easy trigonometrical calculation and may have been thought obvious but in a question asking for a result to be shown it is essential to state all the necessary information. This omission lost the final 2 marks.

Grade Boundaries

Grade boundaries for this, and all other papers, can be found on the website on this link:

http://qualifications.pearson.com/en/support/support-topics/results-certification/grade-boundaries.html

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