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Examiners' Report

Summer 2015

Pearson Edexcel International Advanced Level in Mechanics M2 (WME02/01)

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Summer 2015
Publications Code IA042165

Mathematics Unit Mechanics 2
Specification WME02/01

General Introduction

The vast majority of students seemed to find the paper to be of a suitable length, but some students failed to complete the last question and it wasn't always clear whether they were running out of time or running out of ideas. Students found some aspects of the paper very challenging, in particular, questions 3 and 7 and to a lesser extent, question 6(c). The best source of marks was question 1. The paper discriminated well at all levels including at the top end, and there were some impressive, fully correct solutions seen to all questions. Generally, students who used large and clearly labelled diagrams and who employed clear, systematic and concise methods were the most successful.

As clearly stated on the front of the question paper, in calculations the numerical value of g which should be used is 9.8 and 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 students 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, students should show sufficient working to make their methods clear to the Examiner.

If a student 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 student to say whereabouts in the script the extra working is going to be done.

Report on Individual Questions

Questions 1

This question was generally answered well, with almost all students knowing what was required to find the final velocity. The only common error was to write the momenta the wrong way round, but apart from that most students were able to correctly find the new velocity. Similarly most knew what to do to find the change in KE. This part was not always set out in an easy to follow manner and some students lost the final 3 marks by working in vectors, although most who started in this way managed to correct themselves and produce an appropriate solution.

Question 2

Students were generally successful on this question, with many getting full marks in part (b).Nearly all knew that they needed to differentiate/integrate, although there was sometimes confusion about which was required and many ended up doing part (b) first (correctly labelled).The differentiation and integration were generally correct, but in part (a) the majority did not seem to know how to use the information to find the correct time. Realising that they needed a time, they generally went for 0, 1 or 3. Frustratingly, a fair number did find a (possibly correct) acceleration, but did not go on to find the magnitude, losing 2 marks.

Part (b) was generally better than part (a), with nearly all students attempting to find **c** and then find the position when t = 3. This was done surprisingly accurately, given the numbers and fractions involved.

Question 3

This question, rather surprisingly, proved to be a challenge. The combination of both a wire frame and particles being attached proved far too much for most to cope with. The most common mistakes were to either assume that the centre of mass of the frame was at the centroid, or to miss out the particles altogether. Those students that set out a table with all five elements actually found the question fairly straightforward, but these tended to be few and far between. Instead, students often decided to find the centre of mass of the frame and then attempt to find the centre of mass of the whole system, (some even found the centre of mass of just the particles and then found the centre of mass of the whole system).Whilst some were successful with these approaches, the additional complexity often caused things to go wrong. Some students also got into a terrible mess by failing to appreciate the geometry of the triangle and it was not always easy to see exactly which axes were being used.

Once a centre of mass had been found, most actually knew how to find the required angle, (although again unusual choices of axes sometimes made this tricky to follow) and many gained the M1A1 marks.

Question 4

This question that was well answered on the whole. Almost all students resolved to find the reaction and used friction correctly. The majority set up valid work-energy equations although some missed terms and then clearly fudged the final answer. Whilst most gave sufficient working to convincingly show the given result, there is still a tendency for some to leap to the printed answer. A few did all the work correctly and then failed to actually give the 2 s.f. answer. Some students ignored the instruction to use a work/energy method, giving a perfect solution that sadly only gained the first two marks. Part (b) was again generally answered well, at least in method, but there was a good deal of premature approximation which often led to students losing the final mark. This was generally due to using d=2.7, even when they had correctly arrived at the "exact" value of d in part (a).Very few students actually gave the answers 2.0 or 2.00, which they strictly ought to have done, since g was used and never cancelled.

Question 5

Part (a) was generally done quite well. Most students wrote down the two required equations correctly and went on to solve for one of the two velocities, usually that of particle *B*, and then found the impulse as the change in its momentum. Some did this using the velocity of particle *A* which was slightly harder as a difference was required, rather than a change from zero. The most common error in part (a) was to make a sign error in applying the impact law, which cost three A marks usually, so it was an expensive mistake. It was noticeable that many students use $v_1 - v_2 = -e(u_1 - u_2)$ for the impact law rather than 'separation speed = e x approach speed', leading to an equation with lots of minus signs, and some made processing errors from their correct equations leading to two lost marks. There was less success in part (b). Those writing good solutions used the given kinetic energy for particle *C* to establish its velocity first; then an application of CLM and NEL led in a straightforward manner to a value for e. The main error here was to not use $5m$ and so an incorrect velocity for particle *C* was obtained, losing two marks. Those who used the CLM and NEL equations first to find the velocity of *C* and the used the given kinetic energy found they had a quadratic in e to solve; some did so correctly but very often processing errors led to an incorrect answer. A substantial minority made little or no progress in part (b) despite having done the first part correctly.

Question 6

Correct answers to the first part of this question were very rare. However, part (b) proved to be successful for many students, although the derivation of the given answer was often done inefficiently. Sometimes several approaches were made until moments about *A* was tried and seen to yield the required reaction force at C directly. The third part proved to be more problematic. Students attempting this part usually resolved forces horizontally and vertically, writing down correct equations and combined with $F = 0.75\,R$ to obtain the first five marks easily. Most did not consider the inequality until obtaining their value for k and this lost the final mark. Some took moments about *C*, again usually correctly, but were more likely to make errors in deriving expressions for the forces, although this was penalised in the final A mark only, as long as an equation in k was obtained which was usually the case. Most completely correct solutions found the friction and normal reaction at A, and then substituted into $F \leq \mu R$. A significant number of students, having obtained a correct solution for part (b), seemed unable to continue correctly. A very few tried resolving forces along and perpendicular to the rod and left out forces, and again a very few introduced a reaction force on the rod at B on the rod and this led to no marks being scored.

Question 7

The first part was usually answered correctly. A few students gave an over-specified answer and fewer decided to calculate the initial speed of the particle as root $\sqrt{97}$ and use this instead of the vertical speed of 9. Some students found the height not the time and did not seem to appreciate that they had not answered the question. There was much less success on part (b), however, with many students seemingly having no idea how to proceed. Those that did start with a correct method usually found k correctly to 3sf (rather than leaving as 40/g). The third part, which was related to part (b), was not done well, even by those who had answered part (b) correctly. Most used a vertical distance equation with $s = k$ to find t and hence found the required position vector, but often it was left as numeric and this lost the final A mark. Some did attempt to use the symmetry of the parabola to derive the second position, using the methods outlined in the scheme or by using the range of the projectile rather than the highest point. Part (d) was done poorly with only a minority able to obtain the correct answer. A common error was to look for $v = {}^{16}/_{9}$ losing two marks, although some did arrive at $v = {}^{16}/_{9}$ but then realised the projectile was travelling downwards and so added the minus sign. Some simply found the time when the particle landed losing all the marks. Some applied a correct perpendicular rule, using either ${}^{-1}/_{m}$ or setting a dot product equal to zero, but failed to realise that the horizontal speed was still 4 and thus made no progress towards a solution.

There were many blank or virtually blank responses to this question, perhaps because time was short but perhaps also because, other than part (a), students were thrown by the problem-solving aspect and did not know how to start.

Grade Boundaries

Grade boundaries for this, and all other papers, can be found on the website on this link:
http://www.edexcel.com/iwantto/Pages/grade-boundaries.aspx

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