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Examiners' Report
Principal Examiner Feedback

Summer 2017

Pearson Edexcel International Mechanics A-Level
(WME03)

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IAL Mathematics Unit Mechanics 3

Specification WME03/01

General Introduction

This was a well balanced paper which tested all areas of the specification and gave all students the opportunity to show what they knew. Most students made good attempts at all the questions. There was no indication that time was short and there were many high scoring papers marked.

Students should be reminded that it can be to their benefit to quote equations in their general form before substituting the numbers specific to the question being solved. This not only helps examiners follow the methods being applied but also makes the method secure in cases where substitution errors have been made. There is no need to squash work into small spaces; most questions have ample space provided for the solution to be written in a manner that allows examiners to see the work without enlarging it.

Answers which depend on a numerical value for g having been used should always be given to 2 or 3 significant figures. Any other answers which required rounding may also be given to the same degree of accuracy unless the question specifies otherwise.

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Reports on Individual Questions

Question 1

This proved to be a very straightforward question, with nearly all students scoring full marks. A small number treated the shape as a lamina, but these were very rare. All students who worked with a solid went on to show algebraic integration. Those who worked with a lamina lost all the marks and those who used a lamina formula for one integral and a solid for the other only gained the marks for the correct part. Another error was forgetting to square y when they substituted into their integral. The limits were almost invariably correct and there were few processing errors.

Question2

Part (a) was answered very well, with most students arriving at the correct answer by the mark scheme method. Some students measured their distances from the top of the cone, but they generally did go on to find the required distance. The most likely source of error was to forget/make a slip adding on h to the distance for the top cone. This often resulted in a centre of mass outside the object; surprisingly this didn't seem to alert them to a problem.
Part (b) caused more problems, although a pleasingly large number did work out the correct angle. Most students realised that they needed to use r –... for the numerator and used $3r$ for the denominator. Many stopped there, although most who continued found the correct angle, although this was often given as 8.09^{o} rather than 8.10^{o}.

Question 3

Part (a) was not answered as well as should have been expected. Many were not able to translate the four oscillations per second into the correct period and the failure to find led to all marks being lost in (a). A disappointing number also used an incorrect amplitude.

Part (b) was generally better answered (at least for the first few marks), with most students correctly finding the new velocity, following through their amplitude and ω and most realising what was required to find an impulse. However, even students who got (a) correct often made a sign error in the impulse-momentum equation, leading to an answer of $\frac{\pi}{2}$

In both parts, nearly all gave positive answers in order to obtain the magnitude.

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Question 4

Part (a) tended to be all or nothing. If students realised that they needed to use energy, they generally formed a correct quadratic, and solved for the correct answer. The most popular approach was the main mark scheme method, with virtually all students remembering to add 0.4 at the end. Those who used just x in both the PE and EPE terms could not obtain a 3 term quadratic and lost the last three marks. Of those who did obtain a quadratic, some used the formula and showed their working and others just wrote down a calculator answer. When this answer was wrong, they lost the last two marks. The answer had to be to 2 or 3 significant figures because a numerical value of g had been used but some students had not read the rubric Very few used SUVAT to find the speed when the string became taut, but they generally got to the correct answer. A large number of students unfortunately found the distance at equilibrium, rather than rest, scoring no marks.

Most students recovered in (b), with the majority knowing to use energy and many getting the correct answer. Here it was more common to consider two stages, using energy to find the speed as the string became slack and then using SUVAT to complete.

In both parts of the question there were examples of the EPE formula not being used correctly – missing the 2 in the denominator or using the total length of the string instead of the extension. Another error was to put the GPE on the wrong side of the energy equation.

However, many completely correct solutions were seen.

Question 5

In part (a) almost all could set up a correct equation of motion and write this in the required form prior to integration. A significant number of students would first quote $\frac{1}{2}v^2 = \int a \, \mathrm{d}x$ or $\frac{\mathrm{d}}{\mathrm{d}x}\left(\frac{1}{2}v^2\right) = a$ with only some using KE = work done. Integration was almost always successful, the majority using indefinite integration and a handful using limits. Some students did make careless computational errors in calculating the constants but most had no problems. By far the most common error was to omit the minus sign from the equation of motion at the start resulting in a loss of 3 out of the 9 marks available. A few students missed out the mass in the initial equation of motion.

Part (b) was very well answered with students able to use $v = 0$ in their equation. Marks lost here were usually as a result of errors in part (a). It was common for both constants to be found in part (a) and then transferred to this part.

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Question 6

There were many fully correct answers to this question but there were a significant number of poor answers which proved costly.

Part (a) was answered well by many, who obtained two correct equations which almost always led to the correct answer. However there were some poor solutions with, for example, $R = mg\cos\theta$ from an attempt to resolve perpendicular to the plane. One single equation $mg\sin\theta\cos\theta = \frac{mv^2}{50}$ was sometimes seen but the most common error was to assume the force down the slope caused the circular motion: $mg\sin\theta = \frac{mv^2}{50}$. A handful of incorrect solutions resolved the radius using $r = 50\cos\theta$ instead of 50.

Part (b) caused more problems than part (a) although was still answered well by many. Almost all attempted horizontal and vertical equations rather than attempting equations parallel and perpendicular to the slope. The most common error was in the calculation of *R*. It was often assumed that *R* was the same as it was in part (a) or that the motorcycle was in equilibrium perpendicular to the plane with $R = mg\cos\theta$ used. This error was often seen accompanied by a full correct horizontal equation of motion, but not always. There was the occasional missing term or an attempt to apply $F = ma$ down the slope without resolving the component of $\frac{mv^2}{r}$ into $\frac{mv^2}{r}\cos\theta$. Another common error was to have the friction force going the wrong way or to have a single sign error in the equations. Sine/cosine confusion was rarely seen. A few very poor answers did not explicitly state what the expression for *R* was and so it was also unclear that $F = \frac{1}{4}R$ had been used. It is worth advising students to write down all relevant equations before combining them to avoid losing more marks.

Again a significant number of students lost one mark through over-specifying their answers following the use of $g = 9.8\text{ m s}^{-2}$.

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Question7

Part (a) was the least well answered part of the paper. The responses were generally very poorly presented and it was often extremely hard to work out what the students were actually doing. Whilst most got as far as finding the velocity at B before striking the plane, most did not go on to find the velocity in terms of e. Where they did go on to find a second energy equation this was often labelled in an unclear way. The need to find tension at the top was missed by many students. Many did quote a learnt result about the velocity at the top for a complete circle, but many inserted an inequality into their energy equation. Having said that, a significant number did give a clear derivation of the result, either by the mark scheme method, or by finding an inequality for the velocity on leaving B and then introducing e.

Part (b) was not well presented, but many students managed to gain method marks even if their accuracy went astray. Many failed to use the restitution in the energy equation, but were still able to gain marks for finding components of their velocity at C and using these to find an angle. Very few realised that the speed of the particle just before reaching C was the same as the speed as it left B. In fact, it was surprising how comfortable the students were with the projectile part of the question, even if they could not cope with the preceding restitution/circular motion work. Again, it would have helped if they had written/labelled their working more clearly.

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