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Examiners' Report/
Principal Examiner Feedback

Summer 2013

GCE Mechanics M4 (6680)
Paper 01

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Mechanics M4 (6680)

Introduction

The candidate responses to this paper covered the full range of scores. The well prepared candidates found the paper accessible and had plenty of opportunities to demonstrate their knowledge and understanding. However, it was disappointing that the candidates did not do better on the comparatively straight forward relative velocity questions – indeed several made no attempt at the questions on this topic at all.

In calculations the numerical value of g which should be used is 9.8, as advised on the front of the question paper. Final answers should then be given to 2 (or 3) significant figures – more accurate answers will be penalised, including fractions.

In all cases, as stated on the front of the question paper, candidates should show sufficient working to make their methods clear to the Examiner. If there is a printed answer to show then candidates need to ensure that they show sufficient detail in their working to warrant being awarded all of the marks available.

If a candidate runs out of space in which to give their answer than they are advised to use a supplementary sheet – if a centre is reluctant to supply extra paper then it is crucial for the candidate to say whereabouts in the script the extra working is going to be done.

Report on individual questions

Question 1

Part (a) of this question was answered well by the majority of candidates. Virtually all candidates started with a correct equation of motion as a differential equation in terms of v and t. A variety of approaches were used in attempting to solve the differential equation, with the majority opting to separate variables and integrate to obtain a log function. The required answer was given so it was important that sufficient correct working was seen and that the given answer was stated as the conclusion of the work. The most common alternative method was to treat the equation as linear, and to use an integrating factor. This method was usually successful.

In part (b) a substantial number of candidates chose the more difficult route here, using $v\frac{\mathrm{d}v}{\mathrm{d}x}$ rather than $\frac{\mathrm{d}x}{\mathrm{d}t}$ as their starting point. The more difficult method required candidates to re-arrange the expression into a form that could be integrated, and to evaluate the appropriate limit for v, which was not always successful. The most common error in the alternative approach was to omit the constant of integration. If g = 9.8 was substituted, then the final answer was expected to 2 or 3 significant figures, but an exact answer in terms of g and e was also acceptable.

Question 2

This standard relative velocity question should have been straight forward, but many candidates were confused between part (a) and part (c), thinking that the quickest route across the river was also the shortest route across the river. The given diagram did not help them to distinguish the two cases. The answers to parts (a) and (c) were commonly interchanged or identical.

Question 3

A clear diagram showing the components of the velocities of *A* and *B* parallel to the line of centres immediately before the collision was a vital start for most candidates. Choosing simple names for the components parallel to the line of centres after collision rather than introduce two unknown angles led to simpler equations to work with, and usually less confused working. The majority of candidates did try to write down an equation for conservation of linear momentum and to use the impact law parallel to the line of centres, but signs were not always used consistently and there was some confusion with angles. Errors in solving the resulting simultaneous equations were common, often because the candidate's equations were not expressed in the simplest possible form. Most candidates knew the appropriate formula for impulse, but they did not always take account of the change in direction of motion and some candidates used a mixture of speeds and components of velocity.

Question 4

In part (a) the derivation of the expression for potential energy was quite straight forward, with most candidates writing down the correct value for the ring. Many also found the value for the particle by correctly considering the whole length of the string but some just wrote down the given expression without demonstrating a proper understanding of where the square root expression came from.

In part (b) the method of differentiating and setting the derivative equal to zero to find the equilibrium position was well understood, and many found a correct expression for x in terms of d.

In part (c) most candidates attempted to find the second derivative of V, but errors in applying the product or quotient rule were surprisingly common. Most candidates understood the method of considering the sign of the second derivative, but the substitution of $x = \frac{d}{\sqrt{8}}$ often caused difficulties and a clearly positive (or negative) expression for $\frac{d^2V}{dx^2}$ was not always obtained.

Question 5

For part (a) most candidates understood that they needed to consider a right angled triangle, but several identified an incorrect triangle and achieved no credit.

In part (b) the question was usually answered correctly, with only a few candidates confused between the two possible directions for C to follow.

Question 6

Several fully correct solutions to this question were seen, but there were some common errors.

Since the answer was given in part (a), a clear explanation was required to score any marks; the more successful solutions were accompanied by clear diagrams of the string and particle initially and after time t.

In part (b) virtually all candidates used Hooke's Law correctly to derive the expression for the tension in the string, but many candidates did not understand that they needed to start by forming a differential equation for the motion of P and then go on to deduce the equation in x. The subsequent working to reach the given result was often not valid.

In part (c) most candidates realised they had to use initial conditions to find the arbitrary constants, but a few actually solved the differential equation rather than quoting the given solution. The differentiation was usually done correctly but a relatively common error was to assume that $\frac{\mathrm{d}x}{\mathrm{d}t}$ was zero initially (rather than equal to U).

In part (d) the most common error was not to answer the question; the speed of P was asked for so candidates needed to find $\frac{\mathrm{d}y}{\mathrm{d}t}$, not $\frac{\mathrm{d}x}{\mathrm{d}t}$.

Question 7

In part (a) candidates sometimes struggled to give a convincing explanations, involving the use of a scalar product or clearly defined components on a diagram, of why the impulse was in the direction of $-\mathbf{i} + 2\mathbf{j}$.

In part (b) there were two basic approaches to finding the coefficient of restitution in; vectors and scalar products, or resolved components and angles. The second was probably slightly more popular, but there was some confusion with the angles and directions, often through unclear diagrams. In converting from the vector form of the question some candidates took the speed after impact as a rather than $a\sqrt{2}$. Sometimes only the restitution equation was considered which led to a value for e in terms of a and b, rather than an exact numerical value.

In the vector approach some candidates made the working unnecessarily complicated by introducing unit vectors, which simply introduced factors of $\frac{1}{\sqrt{5}}$.

In part (c) many candidates used the correct method for finding the fraction of kinetic energy lost although some candidates only looked for the change in kinetic energy.

Grade Boundaries

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

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