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Principal Examiner Feedback

Summer 2013

GCE Mechanics M3 (6679)
Paper 01R

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Mechanics M3 (6679R)

Introduction

Candidates in general found this to be a difficult paper. There were many candidates who gained few or no marks on each of questions 5, 6 and 7. Some failed to attempt some or all of these questions. The paper provided many opportunities for grade discrimination.

The standard of presentation seems to get worse with every session. While many set out their work neatly and include adequate or, in some cases, extremely detailed, explanations of their reasoning, others completely ignore the importance of this aspect of the work. It is not unusual to see solutions which look like more like rough jottings than an attempt to impress in an A level examination: no formulae or equations are written, numbers are randomly placed, the lines on the paper are often ignored and the only thing which appears to matter is the final answer. If the answer is right, these candidates usually get full marks provided the question does not say "show that". Also, it is not unusual for candidates to misread their own badly written numbers. Some candidates insisted on writing in a very small font; centres need to advise candidates that if their work is difficult to read it could lead to a loss of marks due to illegible writing.

In calculations the numerical value of g which should be used is 9.8, as advised on the front of the question paper. In this paper there was evidence that $g = 9.81$ is still being used by some centres. 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 candidates 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, candidates should show sufficient working to make their methods clear to the Examiner.

If a candidate runs out of space in which to give his/her answer then he/she is 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

A question in which the vast majority of students were able to make a start and score marks. Most successful students resolved vertically and horizontally using acceleration as $\frac{v^2}{r}$ with the correct $r = \frac{1}{3}a$. A significant minority went straight to a $\tan\alpha$ = ... statement. Common errors included not using $r = \frac{1}{3}a$ and interchanging their $\sin\alpha$ and $\cos\alpha$. The discipline of using notation properly led to some losing the final mark when the square root sign did not include the *hg* and the 3. Other errors included a wrongly placed reaction force (i.e. vertical). Some students wrongly applied energy methods as if the question were a vertical circular motion question. With the answer given some students used their creative mathematics which suddenly (wrongly) changed incorrect working into the given answer. A number of candidates opted to do this by using the centrepetal force method, usually with little success. The standard approach was very well done and there were (of course) many correct solutions.

Question 2

Another question in which the majority gained some marks. Most candidates used $a = \frac{\mathrm{d}v}{\mathrm{d}t}$, integrated successfully and then included a calculation for the unknown constant. However a significant number confused integration with differentiation. Some students also tried to use constant acceleration formulae. The majority of students reached a successful velocity equation. However the calculation for work done seems to have challenged many. Correct solutions came from change in KE using velocities at $t = 0$ and $t = 4$. Others chose to employ a more complicated method of using $\int F\,\mathrm{d}x$ which required careful use of algebra. Common errors came from using work done = Fs. Many, wrongly, attempted to find the total distance and multiply it by the final force. A few left their final answer as -90 which was incorrect.

Question 3

Students should be encouraged to make greater use of diagrams as a good diagram would have been very helpful in this and other questions.

In part (a) Hooke's law was generally applied together with a weight component in Newton's second law. However many students reversed the sign of the thrust arriving at $a = 10.2$ rather than 29.8. In part (b) many students were penalised as they failed to deal with change in EPE in the energy equation. In future students would be advised to quote formulae such as $\text{EPE} = \dfrac{\lambda x^2}{2l}$ as some students confused λ and l when substituting values. Successful attempts either defined $h = BC$ or $BC = h + 1$ with a correct interpretation of BC in last line. A significant number of students did not progress beyond part (a). A small minority assumed this was a question on SHM and rarely made any progress.

Question 4

Many candidates made a good attempt at part (a) using $F = ma$ and integrating. There were some candidates who differentiated rather than integrated to find their t expression. Most who showed evidence of integration did show that $c = 0$. Solving the quadratic equation was often shown either using the formula or completing the square. However too many students just produce answers without working, probably by using a calculator; if the answers given are not fully correct no method marks can be awarded. Part (b) caused problems as many failed to use $v\dfrac{\mathrm{d}v}{\mathrm{d}x}$ as their acceleration or employ the $\dfrac{1}{2}v^2$ method. Some thought that acceleration $= \dfrac{\mathrm{d}v}{\mathrm{d}x}$. Of those candidates who reached a correct answer for the acceleration many failed to answer the question set and left the magnitude of acceleration as negative despite describing the direction correctly. Quite often the derivative of v was seen as $\ln(x + 2)$ which resulted in a significant loss of marks.

Question 5

In part (a) the answer was given so examiners checked carefully that full methods were used accurately. Many candidates applied energy with correct trigonometric values used. Some needlessly lost the last mark with poor notation in the use of square root sign. Part (b), however, challenged many candidates. The most common method was to use projectile solution by applying *suvat* equations vertically and horizontally. Many of the attempted solutions established a quadratic equation which had sign errors in it or incorrect trigonometric values used. The method of solution of this equation was not always easy to follow; inclusion of more method could have helped many candidates. This then led to a horizontal equation with many forgetting to include $\frac{3}{5}\times 0.4$. Others attempted to use energy. Errors here included not finding the vertical component of final velocity successfully. Others noted that the final speed would be $\sqrt{gr}$ but showed little progress beyond this. Students who formed a linear equation in t were generally more successful than those who used a quadratic equation. Again the use of diagrams in these type of questions should be encouraged.

Question 6

A significant number of candidates did not follow the language of the question and tried to do part (a) by non-integration methods. When candidates ignore the instructions to follow a particular method they cannot be awarded many, if any, marks.

For the relatively few successful candidates on part (a), finding the y coordinate seemed to be more accessible. Many quoted correct formulae but had problems integrating $xy\,\mathrm{d}x$ if using that method. With the answer given there were examples of incorrect creative mathematics. To gain the final mark some students failed to spot the symmetry of the situation and it was not unusual for a candidate to attempt integration methods on both x and y coordinates. Other candidates only gave one coordinate.

When it came to part (b) many candidates failed to make further progress. The most successful candidates used sections *ABDF*, *BDC* and then added *FDGE* and subtracted *EDG* in a moments equation. Algebraic errors were common. Other successful candidates provided a separate calculation to find position of the centre of mass of section *EFD* which they then applied in a moments equation for the whole shape. This latter method often led to errors in finding position of the centre of mass of *EFD.* Some found the mathematics so complicated when finding the centre of mass of *EFD* that they gave up. A few reached the correct answer.

Of those who attempted part (c) many gained 2 out of 3 marks with the use of follow through in a valid moments equation.

Students should be encouraged to make greater use of diagrams and tables in this type of question so they can keep track of their work more easily.

Question 7

In part (a) Hooke's law was generally applied to both strings with a range of interpretations on lengths being considered but there were a number of candidates who misinterpreted the question and thought that the mass pulled the strings downwards and got absolutely nowhere.

In part (b) many students failed to make significant progress. Successful students used the difference in tensions correctly in an $F = ma$ statement. However some over complicated their work by introducing e and x in their equation where e was equilibrium position. Use of e and x correctly led to a complete solution. Sign errors did hamper progress. Regrettably some students completed all the hard work and failed to supply a conclusion that SHM had been shown or decided to leave the acceleration as a rather than $\ddot{x}$.

Part (c) did gain marks for those who attempted it with most using $v = a\omega$. However some students used a variety of SHM formulae incorrectly without $a = 0.4$ or used a wrong value of their x. Part (d) was only attempted by a minority of candidates. Successful candidates followed the scheme method. Knowledge of the SHM formulae was weak.

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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