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Examiners' Report/ Principal Examiner Feedback

Summer 2010

GCE

Mechanics M3 (6679)

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Introduction

Most candidates were able to tackle all the questions on this paper although their degree of success was varied. There was no evidence that candidates were short of time; on the contrary, many appeared to have had time for detailed checks using alternative methods.

As ever, a significant minority of candidates ignored the advice to "show sufficient working to make your methods clear to the examiner". It is difficult to find method marks when the answer is wrong, the handwriting poor and there is no explanation, even though we may know from experience what was intended. Candidates would do well to remember that examiners mark the solution rather than the answer.

Answers should be given to an appropriate degree of accuracy. Hence, when an exact answer is unattainable, the result should be rounded to at most 3 significant figures; if 9.8 has been used as an approximation for g two significant figures are preferable. There are many situations in mechanics where final answers necessarily include letters (eg Q1(b)); when this happens it is pointless to use a numerical value of g. In the case of surd answers it is not necessary to rationalise the denominator unless specifically demanded by the question.

Report on individual questions

Question 1

For the overwhelming majority this provided a very straightforward introduction leading to full marks. Mistakes made by the weakest students, both here and elsewhere, revealed their lack of understanding of different areas of the syllabus and their reliance on standard equations. In particular, some seemed intent on using SHM wherever they felt a familiar formula seemed applicable.

Question 2

Part (a) should have posed no problems for the majority of candidates as it was a piece of standard bookwork. However, many candidates had little or no idea of how to proceed, but still managed to arrive at the printed result.

In part (b) many forgot the initial minus sign and ended up with a negative u^2 – they did not seem to realise that the most likely error is a missing minus and instead, obtained a real value for the square root of their negative answer. Several tried to use energy with PE as mgh even though the result from part (a) should have told them that the force was variable and so this approach was invalid. There were a few "suvat" equations which again were invalid and a few successful energy attempts using integration. The majority of successful candidates adopted an indefinite integral approach; a few using definite integrals got the limits the wrong way round.

Question 3

This was probably the least well done of all the questions and correct solutions were relatively rare. The most common mistake was the assumption that there was no final EPE but this was often combined with other errors to give a huge variety of different wrong answers. A surprisingly large proportion of candidates treated this as an equilibrium question, either starting with $T = \mu R + mg\sin\theta$ or slipping an EPE term in as well for good measure. Others realised that it was an energy question but forgot to include the work done against friction; these attempts either used only the frictional force in their equation or ignored it completely, offering as their solution "Initial EPE = *mgh*". Another common error was to include the GPE term twice, once as energy and again as part of the "Work done" expression, showing a lack of understanding of the origin of the *mgh* formula. Very many candidates scored only the 3 marks for finding friction, while those who thought that this was a simple conversion of EPE into GPE had no need to find the friction and so didn't even earn these. Some candidates who included all necessary terms fell at the accuracy hurdle. Inexplicably, a final extension/compression of 0.2 was not uncommon and other errors arose from inappropriate use of the various lengths mentioned, 1.5, 0.9 and 0.7. There were also all the usual sign errors generated by mistakes in identifying gains and losses. A few candidates produced a perfect solution but lost the final mark by giving their answer as 12.7008.

Question 4

This was a routine centre of mass problem requiring mass and associated known centre of mass for standard volumes, combined in an appropriate moments equation. A few mistakes occurred when candidates tried to write down their moments equation without detailing each part in a table. However the major difficulty was for those who couldn't produce a correct volume for the cone and occasionally even the cylinder. The cone had multiples of 2/3 and 1/4 used with $\pi r^2 h$ and the cylinder became $2\pi r^2 h$. Some candidates failed to introduce the different value for *r* as *l* and 2*l* before cancelling it hence giving an incorrect mass ratio.

In part (b), the condition for tipping with *G* above the bottom point on the container, was used by all who attempted this part. Recognising the use of 6*l* – (their *x*) was crucial to finding a correct trigonometric ratio, and those that did made few mistakes finding θ correctly. As expected a few used *l* instead of 2*l* in the numerator for their expression for $\tan\theta$.

Question 5

Most candidates were able to make a good start on this question and a considerable number scored highly. Part (a) was done well by the vast majority of students. A few used the bottom of the circle as their reference point for GPE, which did not necessarily produce an incorrect solution, but did require more work. The rare errors were sign errors, using cosine or failing to eliminate the half from the KE correctly. Part (b) was also straightforward for the majority, although some failed to include the component of the weight in their equation of motion and others made sign errors once again. The majority of students realized the use of the result from (b) was required to prove that the particle moved in complete circles and produced a convincing argument, though a few started from scratch. A lot of students thought that having v^2 greater than zero at the top was the required condition and many added this to an already correct solution; perhaps some thought that both $T > 0$ and $v^2 > 0$ were needed. The majority of students realized that $\theta = 90°$ was required, but some students produced convincing arguments based on the range of values for $\sin\theta$. Part (d) was done well by most students Again most used their result from (a), with a few solutions worked out from scratch using energy. The common error was to maximize *v* by simply stating $\theta = 90°$ or $\sin\theta = 0$. This result not only ignores the mechanics but also shows a lack of imagination.

Question 6

For the majority of candidates, this was a very straightforward and quick question. Unusually, almost all candidates remembered the $+c$ in both parts and found it correctly. The fact that the answer to (a) was given allowed many candidates who would otherwise have missed the required negative in the acceleration to correct their work. However, a substantial minority chose instead to "correct" their work with a further, highly visible deliberate mistake. It is not sensible to choose to do this when they clearly know that what they are writing is wrong. Sign errors are so common in Mechanics that they should have had plenty of experience in finding their source; throwing good marks after bad is never wise. The most common "corrections" were $\int \frac{3}{(t+1)^2}\,\mathrm{d}t = \frac{3}{t+1}$ which was nearly always accompanied by a crossed out minus sign, showing that the correct integration was known but ignored and using $v = -2$ when $t = 0$ to get $v = -\frac{3}{t+1} + 1$ followed by a deliberately fudged rearrangement or a vague comment that "v is in the other direction" to effect the necessary sign change.

One surprising aspect of both parts was that a significant minority needed to use a substitution to integrate, letting $u = t + 1$ to deal with both $\int \frac{3}{(t+1)^2}\,\mathrm{d}t$ and $\int \frac{3}{(t+1)}\,\mathrm{d}t$. Fortunately there was little or no reference to "suvat" equations from candidates in this question. Some did ignore the instruction to give the final answer to 3 significant figures.

Question 7

The majority gained full marks for part (a) but some used m instead of $2m$ for the mass and others forgot to complete the question by adding $3a$ to their extension. However, part (b) was a different story. This was a standard question and should have been routine for most but was very poorly done. Some candidates measured the extension from the natural length, which can produce a correct result provided the appropriate substitution is employed. Probably they were not fully aware of what they were doing and so stopped work when they did not reach the required equation. Many had inconsistent masses, with $2mg$ and $m\ddot{x}$ appearing in the same line of working, although some realised and backtracked successfully. The omission of $2mg$ in the equation of motion led to the correct answer when the extension was incorrectly measured from the natural length so candidates assumed that they had answered correctly. Poor notation was often seen; "acc." or "a" was used for acceleration (as well as its length application) and e was used for the variable extension along with an acceleration $\ddot{x}$. There were many sign errors seen in the equations and although some candidates realised they had made errors and either corrected their work or fiddled the result, others seemed to think that the equation $\ddot{x} = \omega^2 x$ proved S.H.M. Good attempts were presented for parts (c) and (d) although some thought that the amplitude was 3a/4; $\omega = \sqrt{\frac{a}{g}}$ was another common error. Some forgot to complete their work in part (d) by adding $\frac{a}{8}$ and $\frac{3a}{128}$ to obtain the final answer.

Grade Boundary Statistics

The table below give the lowest raw marks for the award of the stated uniform marks (UMS).

Module		Grade	A*	A	B	C	D	E
		Uniform marks	90	80	70	60	50	40
AS	6663 Core Mathematics C1			59	52	45	38	31
AS	6664 Core Mathematics C2			62	54	46	38	30
AS	6667 Further Pure Mathematics FP1			62	55	48	41	34
AS	6677 Mechanics M1			61	53	45	37	29
AS	6683 Statistics S1			55	48	41	35	29
AS	6689 Decision Maths D1			61	55	49	43	38
A2	6665 Core Mathematics C3		68	62	55	48	41	34
A2	6666 Core Mathematics C4		67	60	52	44	37	30
A2	6668 Further Pure Mathematics FP2		67	60	53	46	39	33
A2	6669 Further Pure Mathematics FP3		68	62	55	48	41	34
A2	6678 Mechanics M2		68	61	54	47	40	34
A2	6679 Mechanics M3		69	63	56	50	44	38
A2	6680 Mechanics M4		67	60	52	44	36	29
A2	6681 Mechanics M5		60	52	44	37	30	23
A2	6684 Statistics S2		68	62	54	46	38	31
A2	6691 Statistics S3		68	62	53	44	36	28
A2	6686 Statistics S4		68	62	54	46	38	30
A2	6690 Decision Maths D2		68	61	52	44	36	28

Grade A*

Grade A* is awarded at A level, but not AS to candidates cashing in from this Summer.

- For candidates cashing in for GCE Mathematics (9371), grade A* will be awarded to candidates who obtain an A grade overall (480 UMS or more) *and* 180 UMS or more on the total of their C3 (6665) and C4 (6666) units.
- For candidates cashing in for GCE Further Mathematics (9372), grade A* will be awarded to candidates who obtain an A grade overall (480 UMS or more) *and* 270 UMS or more on the total of their best three A2 units.
- For candidates cashing in for GCE Pure Mathematics (9373), grade A* will be awarded to candidates who obtain an A grade overall (480 UMS or more) *and* 270 UMS or more on the total of their A2 units.
- For candidates cashing in for GCE Further Mathematics (Additional) (9374), grade A* will be awarded to candidates who obtain an A grade overall (480 UMS or more) *and* 270 UMS or more on the total of their best three A2 units.

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