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Examiners' Report / Principal Examiner Feedback

Summer 2010

GCE

Mechanics M5 (6681)

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Specification 6681

Introduction

The paper proved to be demanding for many of the candidates but most were able to complete it in the time allowed. Much of the work produced was clearly and logically presented but some candidates need to be reminded to write their solutions clearly and include full explanations of methods used. A number of solutions were difficult to read and difficult to follow. Candidates also need to read questions carefully and ensure that they answer the question asked. Errors arising from failure to do this were quite common. The questions which caused the most difficulty were again those on the moments of inertia and rotation sections of the specification.

Report on individual questions

Question 1

This question was very well answered. Most candidates scored full marks. Those who lost marks generally had no idea how to start and failed to use a correct method in their attempt to solve the differential equation. Just occasionally candidates attempted to use the initial conditions before attempting to solve the differential equation. There were very few algebraic errors and almost all remembered to include the constant of integration.

Question 2

In part (a) many correct solutions were seen. Errors arose in the use of the parallel axes rule. Despite distances being quite clearly given and marked on the diagram some candidates attempted to use $3a$, perhaps misreading the question. A few failed to use the parallel axes rule at all. It was surprising to see such basic errors in what was a fairly standard problem involving a change of axis for a moment of inertia.

In part (b) most candidates realised that an energy equation was required. A surprisingly large number, however, failed to realise that the position of the centre of mass for the lamina was required in the calculation of Potential Energy. Another common error was to use $4mg$ rather than $3mg$ for the weight of the lamina. It was surprising to see a number misquoting the expression for Kinetic Energy – sometimes omitting the 1/2 or failing to square the Ω.

Question 3

This question proved to be too difficult for many. Few completely correct solutions were seen.

Part (a) was very poorly answered. In order to find the mass of a strip, the ratio of base to height of the triangle was required. The height was easily found using a 3,4,5 triangle yet a number of candidates made errors here with 3/5 rather than 4/3 seen quite often. Many candidates were unable to use appropriate methods for calculating the moment of inertia of a strip about the required axis through *A*. Many tried to use an axis through *BC* instead. A number used an incorrect density, failing to understand that *m* was the mass for the **whole** triangle and not half of it. Methods used were often very difficult to follow. There was often little indication of what the candidate was trying to do.

For part (b), very many thought that $8/3\,ma^2$ was the moment of inertia required in their solution. Very few realised that they needed to use this, together with the answer from part (a), and the perpendicular axes rule. Of those who did, few appreciated that they also needed to use the parallel axes rule, in order to find the moment of inertia about the axis required. Using their moment of inertia, in an equation of motion, to find the angular acceleration also proved to be a stumbling block for many, with 2*a* rather than *a* often seen. A significant number chose, instead, to differentiate an energy equation and both methods were generally used correctly by those who got this far.

In part (c) many candidates failed to write down the actual SHM equation for $\ddot{\theta}$ in terms of θ before writing down the periodic time, thereby losing all the marks.

Question 4

Candidates had more success with this question and many good attempts were seen. A few candidates seemed to have little knowledge of vectors and failed to score any marks apart from the marks for (a)(i) where very few errors were seen.

Most candidates were able to answer (a)(ii) successfully. It was pleasing to see few arithmetical errors in vector products and all but a few used their vector products consistently. Problems occasionally arose in attempts to find **a.** Some candidates were attempting to solve their equations to find a *unique* solution for the components of **a** when one did not exist. Some candidates simply found the intersection of the lines of the action of the two forces to obtain **a.**

Part (b) proved more difficult and quite a few candidates failed to read the question properly and hence failed to include the vector moment of the single force they found in (a)(i) or indeed failed to include the moments of the other two forces in their equation to find **G**. Many failed to realise that if they had used the vector product method in (a)(ii) they already had the answer to the moments of the other two forces. A significant number failed to find the *magnitude* of **G** as required in the question.

Question 5

Many candidates knew exactly what to do here and there were a good number of fully correct solutions.

Part (a) required a standard technique which most candidates followed successfully to the given answer. It was pleasing to see the steps required were clearly set out. A few were unable to make a correct start and then attempted to fudge the given answer.

Many completely correct solutions to part (b) were seen. Most were able to find the correct Integrating Factor, solve the differential equation correctly, remember the constant and use initial conditions to find v correctly. Some candidates attempted to put in the initial conditions at the start before attempting to solve their differential equation, a costly error, as this lost them all of the marks in this part of the question.

Question 6

A fairly high number of good attempts to this question were seen.

In part (a) most candidates used the correct moment of inertia for an axis tangential to the disc and some did then use the perpendicular axes rule followed by the parallel axes rule. Only a few, erroneously, used an axis perpendicular to the disc. Most of the errors in this part then resulted from trying to use energy conservation for an inelastic impact where energy was *not* conserved**.** Conservation of angular momentum was required here and those who used this were generally successful in scoring most of the available marks.

Very few completely correct solutions were seen to part (b). Some attempted to use energy conservation again. Of those who correctly realised that equations of motion were required, there were very many incomplete solutions with only a very small number correctly justifying the fact that the horizontal component of the force required was zero. Of those who correctly followed through a vertical equation of motion, quite a number failed to include the mass of the particle to make the total mass $2m$.

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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