Version 1.0

**General Certificate of Education (A-level)**
**January 2013**

# Mathematics MM2B

# (Specification 6360)

# Mechanics 2B

# *Report on the Examination*

Set and published by the Assessment and Qualifications Alliance.

The Assessment and Qualifications Alliance (AQA) is a company limited by guarantee registered in England and Wales (company number 3644723) and a registered charity (registered charity number 1073334).
Registered address: AQA, Devas Street, Manchester M15 6EX.

## General

The early questions proved to be a pleasing introduction to the paper with most students achieving good marks for questions 1 to 5. Many students found difficulty with questions which required resolving and as a result questions 6, 7 and 9 were frequently answered less well.

## Question 1

Parts (a) and (b) were usually answered correctly but, in part (c)(i), a number of students added the two energies rather than subtracting them. Part (c)(ii) was usually completed correctly.

## Question 2

This question was also answered well by virtually all students who showed that they were familiar with the techniques involved in answering this question. In part (b) (ii) students sometimes failed to find that the value of $-16\pi\sin\pi\,\mathbf{i}$ was zero; this was usually due to students using the angle in degrees rather than radians. The magnitude of $\mathbf{F}$ was often given as $-216$ rather than $+216$. In part (c) the majority of students integrated to find the position vector but a common error was to use the vector $4\mathbf{i}-2\mathbf{j}$ as the $+\,\mathrm{c}$ term. A considerable number of students found the $+\mathrm{c}$ term correctly but simplified their final $\mathbf{j}$ term to $-\left(3t^3+79\right)\mathbf{j}$ rather than $+\left(79-3t^3\right)\mathbf{j}$.

## Question 3

This question was usually answered well. However some students subtracted their resistance term, $mg\sin\theta$, from $8000$. Others found the angle relating to $\sin^{-1}\frac{1}{25}$ which usually introduced rounding errors and a few used $\sin\frac{1}{25}$ with $\frac{1}{25}$ as the angle. In the final step a few left the power as $189\,000$ watts instead of $189$ kW.

## Question 4

In part (a) a number of students did not state that the reason the centre of mass was $15$ cm from $AH$ was as a result of the lamina being symmetrical. Part (b) of this question was usually answered well. A significant proportion of students, in part (c), did not find the distance of the centre of mass from $HC$. Others found the angle between $HG$ and the vertical rather than the horizontal. A significant proportion of those who did obtain the angle to be $42.39°$ forgot to give the angle to the nearest degree, as required.

## Question 5

This question was usually answered well. However some students forgot the minus sign in the initial equation $12\frac{dv}{dt} = -4v^{\frac{1}{3}}$ whilst others had difficulty with the evaluation of $\int v^{-\frac{1}{3}} dv$ . Most students attempted to find the '+c' term and obtained the printed result. Nearly all students correctly found the time when the particle came to rest.

## Question 6

In part (a) many students resolved vertically to find the angle but in the required equation $T\cos\theta = mg$ a number of students used $\sin\theta$ rather than $\cos\theta$ whilst others used $mg = \frac{T}{\cos\theta}$. Similar errors were seen in part (b). In part (c) many students found $\omega$ and then stopped. The value of $\omega$ was not credited since it was just as simple to find the time from knowing only $v$ as it was from knowing $\omega$.

## Question 7

In part (a) most students used two kinetic energy terms and either one or two potential energy terms. The calculation of the difference in height between the two points $P$ and $A$ caused problems to many students. Some students added the potential energy change from $P$ to $A$ to the kinetic energy at $P$. In part (b) most students tried to include the three terms $T$, $mg\cos 25$ and $\frac{mv^2}{a}$ but $\cos 25$ (or $\sin 25$) was sometimes seen as a factor within the wrong term.

## Question 8

Many students were unable to show convincingly that the work done in stretching the string was $\frac{\lambda e^2}{2l}$ . An integration using a variable, usually $x$ , was required. A number of students were penalised for using either $\int_0^e \frac{\lambda e}{l} de$ or $\int \frac{\lambda x}{l} dx$ (without including limits). Parts (b)(i) and (b)(ii) were usually answered correctly although a minority of students used the incorrect formulae for tension and elastic potential energy. In part (b)(iii), most students included terms in kinetic energy, gravitational potential energy and elastic potential energy but many did not include elastic potential energy at both $A$ and the point when its speed was $0.8 \text{ ms}^{-1}$. Another common error was in using the same variable for the height that the particle moved (in the potential energy gained) and for the extension when the particle's speed was $0.8\text{ms}^{-1}$.

## Question 9

This question was designed to discriminate between grades A and A*. In part (a) many students did not appreciate that the reason the reaction between the rod and the hemisphere acted through $O$ was because the rod and hemisphere were both smooth. This fact was also needed to draw the force diagram in part (b) as at $C$ the reaction was also perpendicular to possible movement. Thus the reaction at $C$ acted perpendicular to the rod. However many students, when drawing the force diagram, did not show the reaction at point $A$ acting through $O$. There was much inventive algebra shown in part (c) to obtain the printed result . Many students attempted to take moments about point $A$ but were unable to find the length of $AC$ in terms of $l$ and $a$. The simplest method to find the length of $AC$ was to draw the line from $O$ to the midpoint of $AC$ giving the length to be $2a\cos\theta$. However many used the cosine rule in triangle OAC and obtained $AC^2 = 2a^2 - 2a^2\cos(180 - 2\theta)$ which was transformed into $AC^2 = 2a^2 + 2a^2\cos 2\theta$. Very few students could transform this into $AC^2 = 4a^2\cos^2\theta$ and hence into $AC = 2a\cos\theta$. As expected only the better students completed this question successfully.

## Mark Ranges and Award of Grades

Grade boundaries and cumulative percentage grades are available on the Results Statistics page of the AQA Website: http://www.aqa.org.uk/over/stat.html

## Converting Marks into UMS marks

Convert raw marks into Uniform Mark Scale (UMS) marks by using the link below.

**UMS conversion calculator** www.aqa.org.uk/umsconversion