Centre No.						Paper Reference							Surname	Initial(s)
Candidate No.						6	6	7	9	/	0	1	Signature	

Paper Reference(s)

6679/01

Edexcel GCE

Mechanics M3

Advanced/Advanced Subsidiary

Thursday 14 June 2007 – Afternoon

Time: 1 hour 30 minutes

Examiner's use only

Team Leader's use only

Question Number	Leave Blank
1	
2	
3	
4	
5	
6	
7	
Total	

Materials required for examination
Mathematical Formulae (Green)

Items included with question papers
Nil

Candidates may use any calculator allowed by the regulations of the Joint Council for Qualifications. Calculators must not have the facility for symbolic algebra manipulation, differentiation and integration, or have retrievable mathematical formulas stored in them.

Instructions to Candidates

In the boxes above, write your centre number, candidate number, your surname, initial(s) and signature.
Check that you have the correct question paper.
You must write your answer for each question in the space following the question.
Whenever a numerical value of g is required, take $g = 9.8 \text{ m s}^{-2}$.
When a calculator is used, the answer should be given to an appropriate degree of accuracy.

Information for Candidates

A booklet 'Mathematical Formulae and Statistical Tables' is provided.
Full marks may be obtained for answers to ALL questions.
The marks for individual questions and the parts of questions are shown in round brackets: e.g. (**2**).
There are 7 questions in this question paper. The total mark for this paper is 75.
There are 24 pages in this question paper. Any blank pages are indicated.

Advice to Candidates

You must ensure that your answers to parts of questions are clearly labelled.
You should show sufficient working to make your methods clear to the Examiner.
Answers without working may not gain full credit.

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1. The rudder on a ship is modelled as a uniform plane lamina having the same shape as the region R which is enclosed between the curve with equation $y = 2x - x^2$ and the x-axis.

(a) Show that the area of R is $\frac{4}{3}$.

(4)

(b) Find the coordinates of the centre of mass of the lamina.

(5)

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Question 1 continued

(Total 9 marks)

Q1

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2. An open container C is modelled as a thin uniform hollow cylinder of radius h and height h with a base but no lid. The centre of the base is O.

(a) Show that the distance of the centre of mass of C from O is $\frac{1}{3}h$.

(5)

The container is filled with uniform liquid. Given that the mass of the container is M and the mass of the liquid is M,

(b) find the distance of the centre of mass of the filled container from O.

(5)

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Question 2 continued

(Total 10 marks)

Q2

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3. A spacecraft S of mass m moves in a straight line towards the centre of the earth. The earth is modelled as a fixed sphere of radius R. When S is at a distance x from the centre of the earth, the force exerted by the earth on S is directed towards the centre of the earth and has magnitude $\frac{k}{x^2}$, where k is a constant.

(a) Show that $k = mgR^2$.

(2)

Given that S starts from rest when its distance from the centre of the earth is $2R$, and that air resistance can be ignored,

(b) find the speed of S as it crashes into the surface of the earth.

(7)

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Question 3 continued

(Total 9 marks)

Q3

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4. A light inextensible string of length l has one end attached to a fixed point A. The other end is attached to a particle P of mass m. The particle moves with constant speed v in a horizontal circle with the string taut. The centre of the circle is vertically below A and the radius of the circle is r.

Show that

$$gr^2 = v^2\sqrt{(l^2 - r^2)}.$$

(9)

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Question 4 continued

Q4

(Total 9 marks)

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5. A particle P moves on the x-axis with simple harmonic motion about the origin O as centre. When P is a distance 0.04 m from O, its speed is $0.2\ \text{m s}^{-1}$ and the magnitude of its acceleration is $1\ \text{m s}^{-2}$.

(a) Find the period of the motion.

(3)

The amplitude of the motion is a metres.

Find

(b) the value of a,

(3)

(c) the total time, within one complete oscillation, for which the distance OP is greater than $\frac{1}{2}a$ metres.

(5)

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Question 5 continued

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Question 5 continued

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Question 5 continued

(Total 11 marks)

Q5

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6. A particle P is free to move on the smooth inner surface of a fixed thin hollow sphere of internal radius a and centre O. The particle passes through the lowest point of the spherical surface with speed U. The particle loses contact with the surface when OP is inclined at an angle α to the upward vertical.

(a) Show that $$U^2 = ag(2 + 3\cos\alpha).$$

(7)

The particle has speed W as it passes through the level of O. Given that $\cos\alpha = \frac{1}{\sqrt{3}}$,

(b) show that $$W^2 = ag\sqrt{3}.$$

(5)

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Question 6 continued

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Question 6 continued

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Question 6 continued

(Total 12 marks)

Q6

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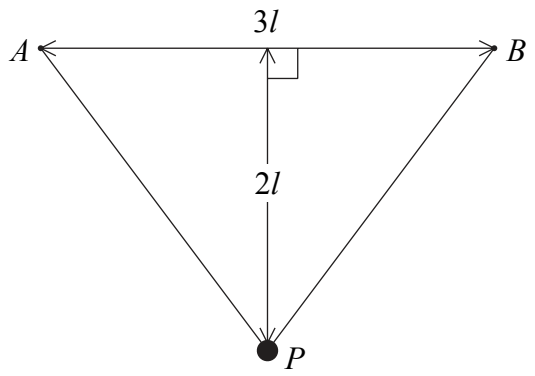
7. **Figure 1**



A light elastic string, of natural length $3l$ and modulus of elasticity λ, has its ends attached to two points A and B, where $AB = 3l$ and AB is horizontal. A particle P of mass m is attached to the mid-point of the string. Given that P rests in equilibrium at a distance $2l$ below AB, as shown in Figure 1,

(a) show that $\lambda = \dfrac{15mg}{16}$.

(9)

The particle is pulled vertically downwards from its equilibrium position until the total length of the elastic string is $7.8l$. The particle is released from rest.

(b) Show that P comes to instantaneous rest on the line AB.

(6)

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Question 7 continued

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Question 7 continued

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Question 7 continued

Q7

(Total 15 marks)

TOTAL FOR PAPER: 75 MARKS

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