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Centre No.						Paper Reference							Surname	Initial(s)
Candidate No.						6	6	7	8	/	0	1	Signature	

Paper Reference(s)

6678/01

Edexcel GCE

Mechanics M2

Advanced/Advanced Subsidiary

Thursday 6 June 2013 – Morning

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 (Pink)

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 or symbolic differentiation/integration, or have retrievable mathematical formulae stored in them.

Instructions to Candidates

In the boxes above, write your centre number, candidate number, your surname, initials and signature.
Check that you have the correct question paper.
Answer ALL the questions.
You must write your answer to each question in the space following the question.
Whenever a numerical value of g is required, take $g = 9.8$ 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 must show sufficient working to make your methods clear to the examiner.
Answers without working may not gain full credit.

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1. A particle P of mass 2 kg is moving with velocity $(\mathbf{i} - 4\mathbf{j})$ m s^{-1} when it receives an impulse of $(3\mathbf{i} + 6\mathbf{j})$ N s.

Find the speed of P immediately after the impulse is applied.

(5)

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2. A particle P of mass 3 kg moves from point A to point B up a line of greatest slope of a fixed rough plane. The plane is inclined at 20° to the horizontal. The coefficient of friction between P and the plane is 0.4

Given that $AB = 15$ m and that the speed of P at A is 20 m s^{-1}, find

(a) the work done against friction as P moves from A to B,

(3)

(b) the speed of P at B.

(4)

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3. A particle P moves on the x-axis. At time t seconds the velocity of P is v m s^{-1} in the direction of x increasing, where

$$v = 2t^2 - 14t + 20, \qquad t \geqslant 0$$

Find

(a) the times when P is instantaneously at rest,

(3)

(b) the greatest speed of P in the interval $0 \leqslant t \leqslant 4$

(5)

(c) the total distance travelled by P in the interval $0 \leqslant t \leqslant 4$

(5)

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Question 3 continued

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4.

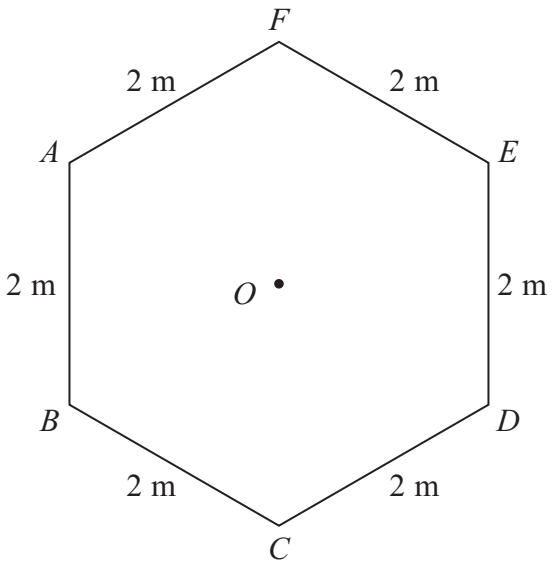

Figure 1

The uniform lamina *ABCDEF* is a regular hexagon with centre *O* and sides of length 2 m, as shown in Figure 1.

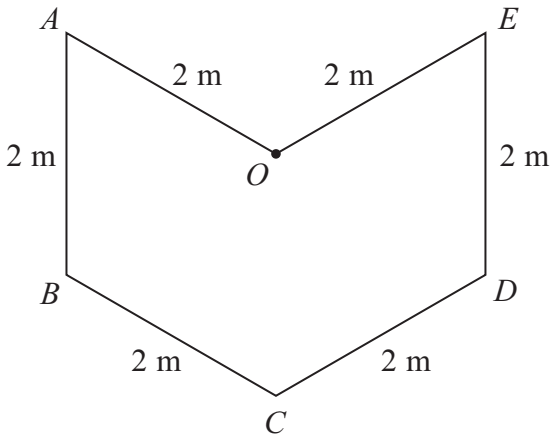

Figure 2

The triangles *OAF* and *OEF* are removed to form the uniform lamina *OABCDE*, shown in Figure 2.

(a) Find the distance of the centre of mass of *OABCDE* from *O*.

(5)

The lamina *OABCDE* is freely suspended from *E* and hangs in equilibrium.

(b) Find the size of the angle between *EO* and the downward vertical.

(6)

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Question 4 continued

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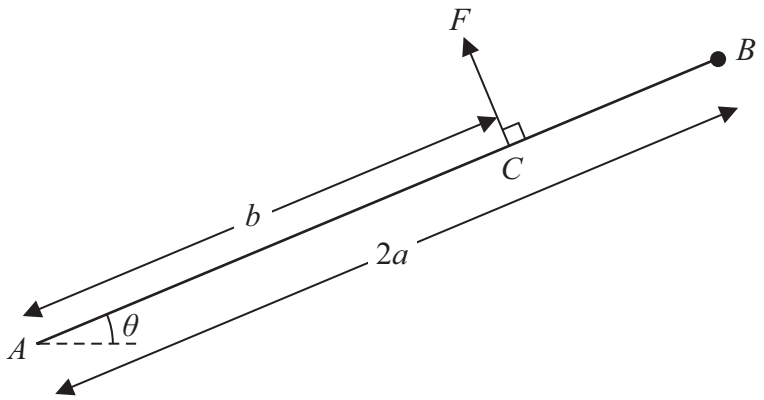

Figure 3

A uniform rod AB, of mass m and length $2a$, is freely hinged to a fixed point A. A particle of mass m is attached to the rod at B. The rod is held in equilibrium at an angle θ to the horizontal by a force of magnitude F acting at the point C on the rod, where $AC = b$, as shown in Figure 3. The force at C acts at right angles to AB and in the vertical plane containing AB.

(a) Show that $F = \dfrac{3amg\cos\theta}{b}$.

(4)

(b) Find, in terms of a, b, g, m and θ,

(i) the horizontal component of the force acting on the rod at A,

(ii) the vertical component of the force acting on the rod at A.

(5)

Given that the force acting on the rod at A acts along the rod,

(c) find the value of $\dfrac{a}{b}$.

(4)

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Question 5 continued

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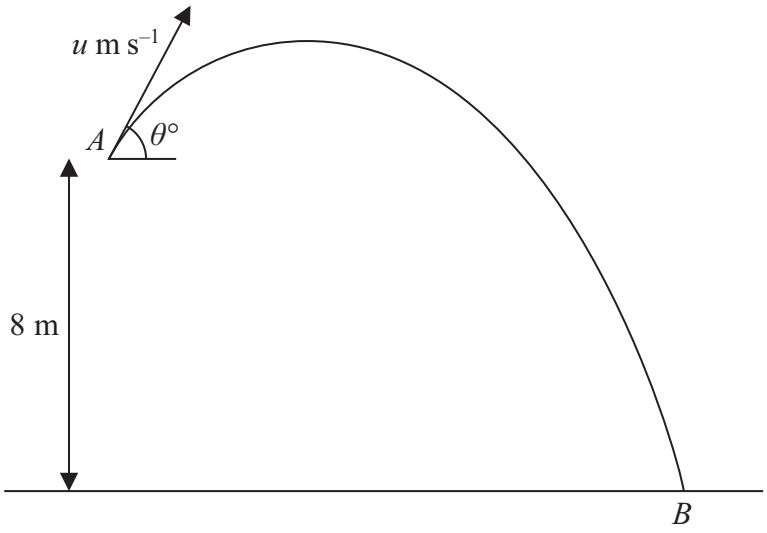

Figure 4

A ball is projected from a point A which is 8 m above horizontal ground as shown in Figure 4. The ball is projected with speed u m s^{-1} at an angle $\theta°$ above the horizontal. The ball moves freely under gravity and hits the ground at the point B. The speed of the ball immediately before it hits the ground is $2u$ m s^{-1}.

(a) By considering energy, find the value of u.

(5)

The time taken for the ball to move from A to B is 2 seconds. Find

(b) the value of θ,

(4)

(c) the minimum speed of the ball on its path from A to B.

(2)

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Question 6 continued

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7. Three particles P, Q and R lie at rest in a straight line on a smooth horizontal table with Q between P and R. The particles P, Q and R have masses $2m$, $3m$ and $4m$ respectively. Particle P is projected towards Q with speed u and collides directly with it. The coefficient of restitution between each pair of particles is e.

(a) Show that the speed of Q immediately after the collision with P is $\frac{2}{5}(1+e)u$.

(6)

After the collision between P and Q there is a direct collision between Q and R.
Given that $e = \frac{3}{4}$, find

(b) (i) the speed of Q after this collision,

(ii) the speed of R after this collision.

(6)

Immediately after the collision between Q and R, the rate of increase of the distance between P and R is V.

(c) Find V in terms of u.

(3)

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Question 7 continued