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

Monday 23 June 2014 – 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	
8	
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} and give your answer to either two significant figures or three significant figures.
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 8 questions in this question paper. The total mark for this paper is 75.
There are 28 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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PEARSON

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1. Three particles of mass $3m$, $2m$ and km are placed at the points whose coordinates are $(1, 5)$, $(6, 4)$ and $(a, 1)$ respectively. The centre of mass of the three particles is at the point with coordinates $(3, 3)$.

Find

(a) the value of k,

(3)

(b) the value of a.

(3)

Leave blank

Question 1 continued

Q1

(Total 6 marks)

Leave blank

2. At time t seconds, where $t \geqslant 0$, a particle P is moving on a horizontal plane with acceleration $[(3t^2 - 4t)\mathbf{i} + (6t - 5)\mathbf{j}]$ m s^{-2}.

When $t = 3$ the velocity of P is $(11\mathbf{i} + 10\mathbf{j})$ m s^{-1}.

Find

(a) the velocity of P at time t seconds,

(5)

(b) the speed of P when it is moving parallel to the vector $\mathbf{i}$.

(4)

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Question 2 continued

Q2

(Total 9 marks)

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3.

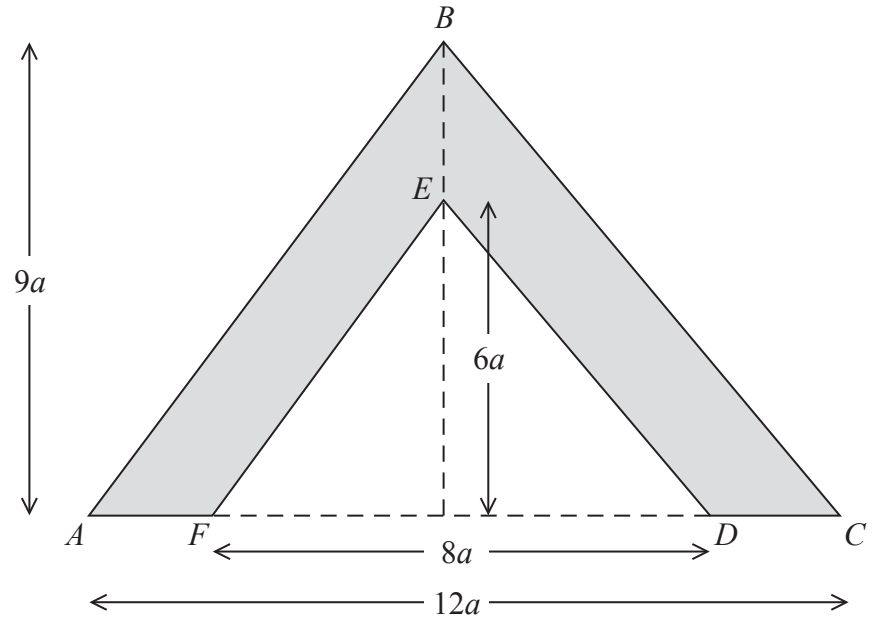

Figure 1

The uniform lamina $ABCDEF$, shown shaded in Figure 1, is symmetrical about the line through B and E. It is formed by removing the isosceles triangle FED, of height $6a$ and base $8a$, from the isosceles triangle ABC of height $9a$ and base $12a$.

(a) Find, in terms of a, the distance of the centre of mass of the lamina from AC.

(5)

The lamina is freely suspended from A and hangs in equilibrium.

(b) Find, to the nearest degree, the size of the angle between AB and the downward vertical.

(4)

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Question 3 continued

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Question 3 continued

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Question 3 continued

Q3

(Total 9 marks)

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4. A truck of mass 1800 kg is towing a trailer of mass 800 kg up a straight road which is inclined to the horizontal at an angle α, where $\sin \alpha = \frac{1}{20}$. The truck is connected to the trailer by a light inextensible rope which is parallel to the direction of motion of the truck. The resistances to motion of the truck and the trailer from non-gravitational forces are modelled as constant forces of magnitudes 300 N and 200 N respectively. The truck is moving at constant speed v m s^{-1} and the engine of the truck is working at a rate of 40 kW.

(a) Find the value of v.

(5)

As the truck is moving up the road the rope breaks.

(b) Find the acceleration of the truck immediately after the rope breaks.

(4)

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Question 4 continued

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Question 4 continued

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Question 4 continued

Q4

(Total 9 marks)

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5. A particle of mass m kg lies on a smooth horizontal surface. Initially the particle is at rest at a point O midway between a pair of fixed parallel vertical walls. The walls are 2 m apart. At time $t = 0$ the particle is projected from O with speed u m s^{-1} in a direction perpendicular to the walls. The coefficient of restitution between the particle and each wall is $\frac{2}{3}$. The magnitude of the impulse on the particle due to the first impact with a wall is λmu N s.

(a) Find the value of λ.

(3)

The particle returns to O, having bounced off each wall once, at time $t = 3$ seconds.

(b) Find the value of u.

(6)

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Question 5 continued

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Question 5 continued

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Question 5 continued

Q5

(Total 9 marks)

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6.

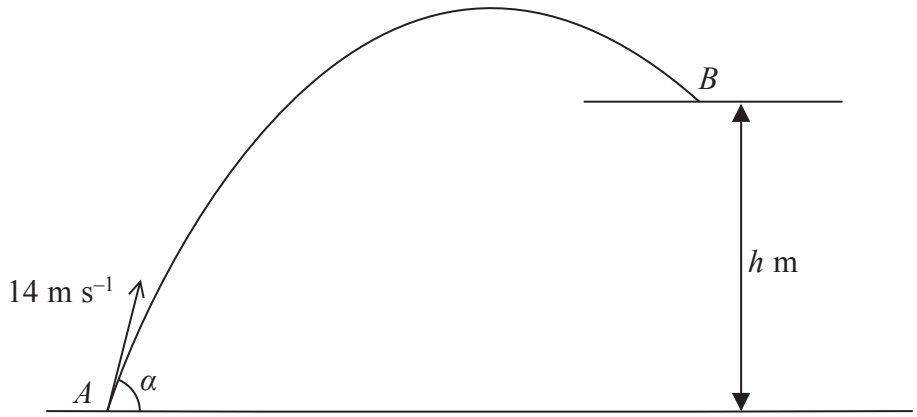

Figure 2

A small ball is projected with speed 14 m s^{-1} from a point A on horizontal ground. The angle of projection is α above the horizontal. A horizontal platform is at height h metres above the ground. The ball moves freely under gravity until it hits the platform at the point B, as shown in Figure 2. The speed of the ball immediately before it hits the platform at B is 10 m s^{-1}.

(a) Find the value of h.

(4)

Given that $\sin \alpha = 0.85$,

(b) find the horizontal distance from A to B.

(8)

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Question 6 continued

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Question 6 continued

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Question 6 continued

Q6

(Total 12 marks)

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7.

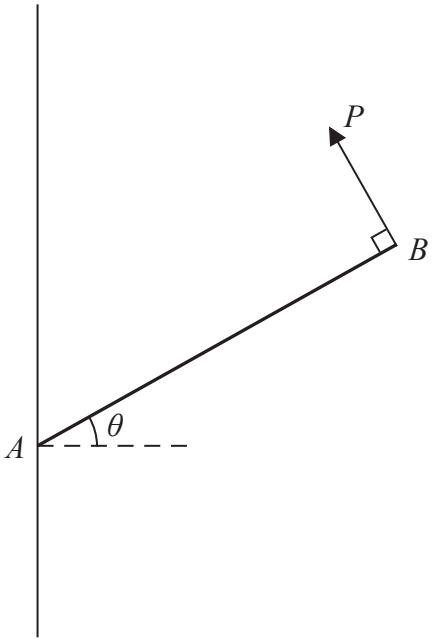

Figure 3

A uniform rod AB of weight W has its end A freely hinged to a point on a fixed vertical wall. The rod is held in equilibrium, at angle θ to the horizontal, by a force of magnitude P. The force acts perpendicular to the rod at B and in the same vertical plane as the rod, as shown in Figure 3. The rod is in a vertical plane perpendicular to the wall. The magnitude of the vertical component of the force exerted on the rod by the wall at A is Y.

(a) Show that $Y = \frac{W}{2}(2 - \cos^2\theta)$.

(6)

Given that $\theta = 45°$

(b) find the magnitude of the force exerted on the rod by the wall at A, giving your answer in terms of W.

(6)

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Question 7 continued

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Question 7 continued

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Question 7 continued

Q7

(Total 12 marks)

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8. The points A and B are 10 m apart on a line of greatest slope of a fixed rough inclined plane, with A above B. The plane is inclined at 25° to the horizontal. A particle P of mass 5 kg is released from rest at A and slides down the slope. As P passes B, it is moving with speed 7 m s^{-1}.

(a) Find, using the work-energy principle, the work done against friction as P moves from A to B.

(4)

(b) Find the coefficient of friction between the particle and the plane.

(5)

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Question 8 continued

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Question 8 continued

Q8

(Total 9 marks)

TOTAL FOR PAPER: 75 MARKS

END