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

Paper Reference(s)

6678/01R

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	
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 7 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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1. A van of mass 600 kg is moving up a straight road inclined at an angle θ to the horizontal, where $\sin\theta = \frac{1}{16}$. The resistance to motion of the van from non-gravitational forces has constant magnitude R newtons. When the van is moving at a constant speed of 20 m s^{-1}, the van's engine is working at a constant rate of 25 kW.

(a) Find the value of R.

(4)

The power developed by the van's engine is now increased to 30 kW. The resistance to motion from non-gravitational forces is unchanged. At the instant when the van is moving up the road at 20 m s^{-1}, the acceleration of the van is a m s^{-2}.

(b) Find the value of a.

(4)

P 4 3 1 7 4 A 0 2 2 8

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Question 1 continued

Leave blank

Question 1 continued

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Question 1 continued

Q1

(Total 8 marks)

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2. A ball of mass 0.4 kg is moving in a horizontal plane when it is struck by a bat. The bat exerts an impulse $(-5\mathbf{i} + 3\mathbf{j})$ N s on the ball. Immediately after receiving the impulse the ball has velocity $(12\mathbf{i} + 15\mathbf{j})$ m s^{-1}.

Find

(a) the speed of the ball immediately before the impact,

(4)

(b) the size of the angle through which the direction of motion of the ball is deflected by the impact.

(3)

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Question 2 continued

Q2

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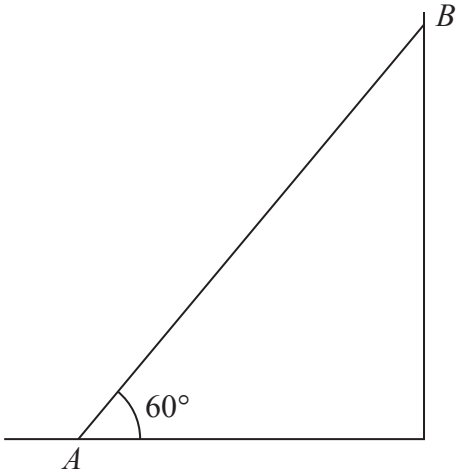

Figure 1

A non-uniform rod, AB, of mass m and length $2l$, rests in equilibrium with one end A on a rough horizontal floor and the other end B against a rough vertical wall. The rod is in a vertical plane perpendicular to the wall and makes an angle of 60° with the floor as shown in Figure 1. The coefficient of friction between the rod and the floor is $\frac{1}{4}$ and the coefficient of friction between the rod and the wall is $\frac{2}{3}$. The rod is on the point of slipping at both ends.

(a) Find the magnitude of the vertical component of the force exerted on the rod by the floor.

(5)

The centre of mass of the rod is at G.

(b) Find the distance AG.

(5)

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Question 3 continued

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Question 3 continued

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Q3

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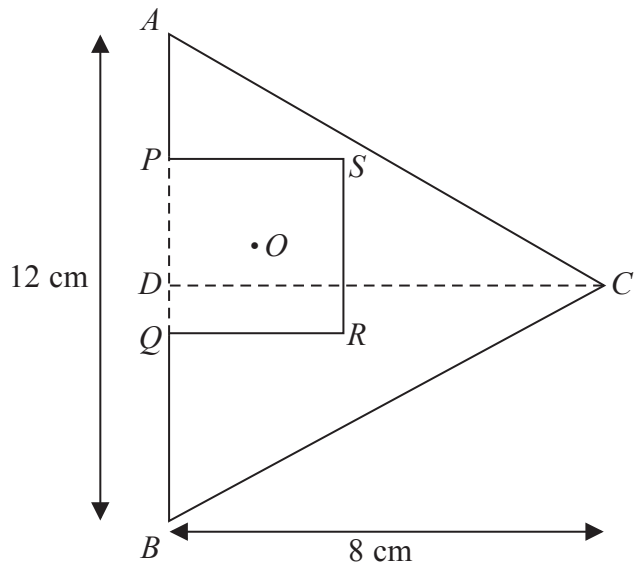

Figure 2

Figure 2 shows a lamina L. It is formed by removing a square $PQRS$ from a uniform triangle ABC. The triangle ABC is isosceles with $AC = BC$ and $AB = 12$ cm. The midpoint of AB is D and $DC = 8$ cm. The vertices P and Q of the square lie on AB and $PQ = 4$ cm. The centre of the square is O. The centre of mass of L is at G.

(a) Find the distance of G from AB.

(4)

When L is freely suspended from A and hangs in equilibrium, the line AB is inclined at 25° to the vertical.

(b) Find the distance of O from DC.

(6)

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Q4

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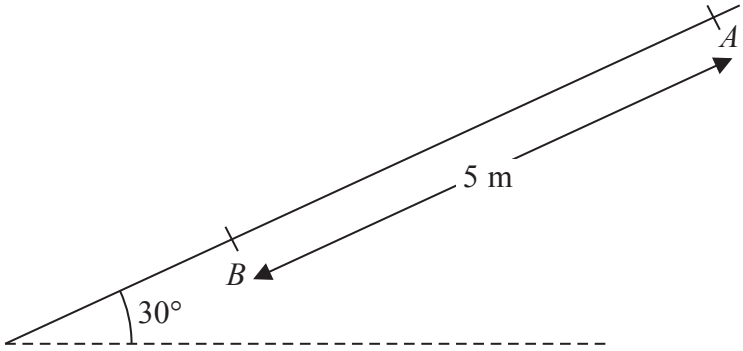

Figure 3

A particle P of mass 2 kg is released from rest at a point A on a rough inclined plane and slides down a line of greatest slope. The plane is inclined at 30° to the horizontal. The point B is 5 m from A on the line of greatest slope through A, as shown in Figure 3.

(a) Find the potential energy lost by P as it moves from A to B.

(2)

The speed of P as it reaches B is 4 m s^{-1}.

(b) (i) Use the work-energy principle to find the magnitude of the constant frictional force acting on P as it moves from A to B.

(ii) Find the coefficient of friction between P and the plane.

(7)

The particle P is now placed at A and projected down the plane towards B with speed 3 m s^{-1}. Given that the frictional force remains constant,

(c) find the speed of P as it reaches B.

(4)

P 4 3 1 7 4 A 0 1 6 2 8

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Q5

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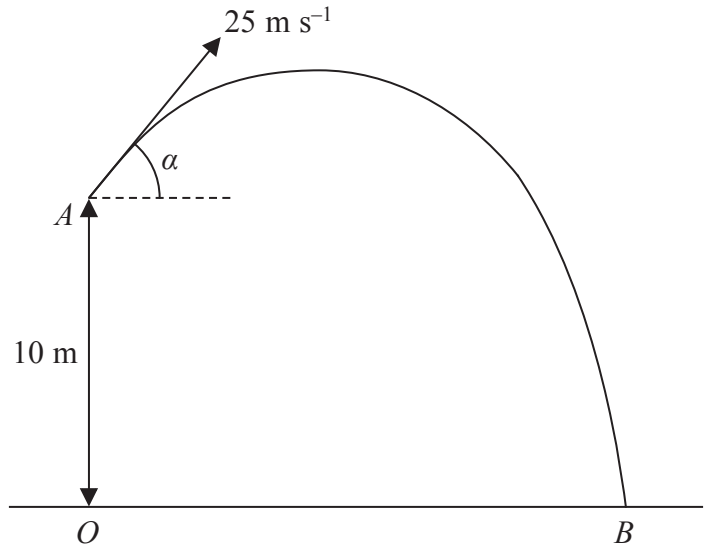

Figure 4

A particle P is projected from a point A with speed 25 m s^{-1} at an angle of elevation α, where $\sin\alpha = \frac{4}{5}$. The point A is 10 m vertically above the point O which is on horizontal ground, as shown in Figure 4. The particle P moves freely under gravity and reaches the ground at the point B.

Calculate

(a) the greatest height above the ground of P, as it moves from A to B,

(3)

(b) the distance OB.

(6)

The point C lies on the path of P. The direction of motion of P at C is perpendicular to the direction of motion of P at A.

(c) Find the time taken by P to move from A to C.

(4)

P 4 3 1 7 4 A 0 2 0 2 8

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Question 6 continued

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Question 6 continued

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Question 6 continued

Q6

(Total 13 marks)

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7. A particle P of mass $2m$ is moving in a straight line with speed $3u$ on a smooth horizontal table. A second particle Q of mass $3m$ is moving in the opposite direction to P along the same straight line with speed u. The particle P collides directly with Q. The direction of motion of P is reversed by the collision. The coefficient of restitution between P and Q is e.

(a) Show that the speed of Q immediately after the collision is $\frac{u}{5}(8e + 3)$

(6)

(b) Find the range of possible values of e.

(4)

The total kinetic energy of the particles before the collision is T. The total kinetic energy of the particles after the collision is kT. Given that $e = \frac{1}{2}$

(c) find the value of k.

(4)

P 4 3 1 7 4 A 0 2 4 2 8

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Question 7 continued

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Question 7 continued

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Question 7 continued

Q7

(Total 14 marks)

TOTAL FOR PAPER: 75 MARKS

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P 4 3 1 7 4 A 0 2 8 2 8