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 13 June 2011 – 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}.
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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1. A car of mass 1000 kg moves with constant speed V m s^{-1} up a straight road inclined at an angle θ to the horizontal, where $\sin\theta = \frac{1}{30}$. The engine of the car is working at a rate of 12 kW. The resistance to motion from non-gravitational forces has magnitude 500 N. Find the value of V.

(5)

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Question 1 continued

Q1

(Total 5 marks)

P 3 8 1 6 2 A 0 3 2 8

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2. A particle P of mass m is moving in a straight line on a smooth horizontal surface with speed $4u$. The particle P collides directly with a particle Q of mass $3m$ which is at rest on the surface. The coefficient of restitution between P and Q is e. The direction of motion of P is reversed by the collision.

Show that $e > \frac{1}{3}$.

(8)

P 3 8 1 6 2 A 0 4 2 8

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Question 2 continued

Q2

(Total 8 marks)

P 3 8 1 6 2 A 0 5 2 8

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3. A ball of mass 0.5 kg is moving with velocity $12\mathbf{i}$ m s^{-1} when it is struck by a bat. The impulse received by the ball is $(-4\mathbf{i}+7\mathbf{j})$ N s. By modelling the ball as a particle, find

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

(4)

(b) the angle, in degrees, between the velocity of the ball immediately after the impact and the vector $\mathbf{i}$,

(2)

(c) the kinetic energy gained by the ball as a result of the impact.

(2)

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Question 3 continued

Q3

(Total 8 marks)

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4.

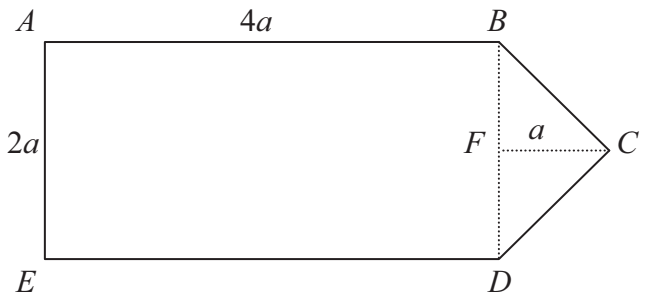

Figure 1

Figure 1 shows a uniform lamina $ABCDE$ such that $ABDE$ is a rectangle, $BC = CD$, $AB = 4a$ and $AE = 2a$. The point F is the midpoint of BD and $FC = a$.

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

(4)

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

(b) Find the angle between AB and the downward vertical.

(3)

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Question 4 continued

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Question 4 continued

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Question 4 continued

Q4

(Total 7 marks)

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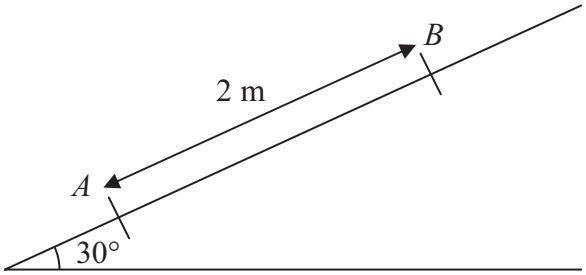

Figure 2

A particle P of mass 0.5 kg is projected from a point A up a line of greatest slope AB of a fixed plane. The plane is inclined at 30° to the horizontal and $AB = 2$ m with B above A, as shown in Figure 2. The particle P passes through B with speed 5 m s^{-1}. The plane is smooth from A to B.

(a) Find the speed of projection.

(4)

The particle P comes to instantaneous rest at the point C on the plane, where C is above B and $BC = 1.5$ m. From B to C the plane is rough and the coefficient of friction between P and the plane is μ.

By using the work-energy principle,

(b) find the value of μ.

(6)

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

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Question 5 continued

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Question 5 continued

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Question 5 continued

(Total 10 marks)

Q5

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6. A particle P moves on the x-axis. The acceleration of P at time t seconds is $(t-4)$ m s^{-2} in the positive x-direction. The velocity of P at time t seconds is v m s^{-1}. When $t = 0$, $v = 6$.

Find

(a) v in terms of t,

(4)

(b) the values of t when P is instantaneously at rest,

(3)

(c) the distance between the two points at which P is instantaneously at rest.

(4)

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Question 6 continued

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Question 6 continued

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Question 6 continued

(Total 11 marks)

Q6

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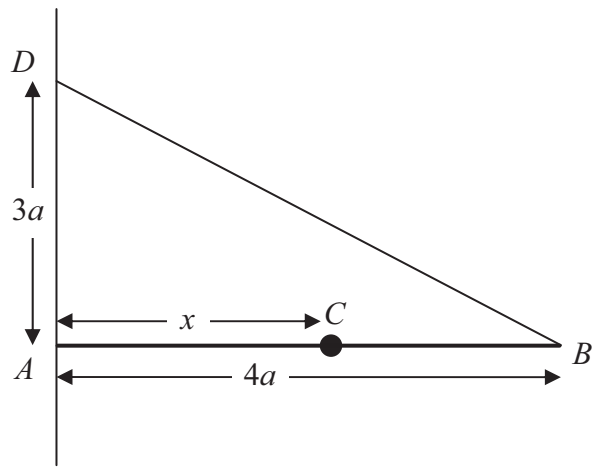

Figure 3

A uniform rod AB, of mass $3m$ and length $4a$, is held in a horizontal position with the end A against a rough vertical wall. One end of a light inextensible string BD is attached to the rod at B and the other end of the string is attached to the wall at the point D vertically above A, where $AD = 3a$. A particle of mass $3m$ is attached to the rod at C, where $AC = x$. The rod is in equilibrium in a vertical plane perpendicular to the wall as shown in Figure 3. The tension in the string is $\frac{25}{4}mg$.

Show that

(a) $x = 3a$,

(5)

(b) the horizontal component of the force exerted by the wall on the rod has magnitude $5mg$.

(3)

The coefficient of friction between the wall and the rod is μ. Given that the rod is about to slip,

(c) find the value of μ.

(5)

P 3 8 1 6 2 A 0 2 0 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 13 marks)

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8. A particle is projected from a point O with speed u at an angle of elevation α above the horizontal and moves freely under gravity. When the particle has moved a horizontal distance x, its height above O is y.

(a) Show that

$$y = x\tan\alpha - \frac{gx^2}{2u^2\cos^2\alpha}$$

(4)

A girl throws a ball from a point A at the top of a cliff. The point A is 8 m above a horizontal beach. The ball is projected with speed $7\ \text{m s}^{-1}$ at an angle of elevation of 45°. By modelling the ball as a particle moving freely under gravity,

(b) find the horizontal distance of the ball from A when the ball is 1 m above the beach.

(5)

A boy is standing on the beach at the point B vertically below A. He starts to run in a straight line with speed $v\ \text{m s}^{-1}$, leaving B 0.4 seconds after the ball is thrown.

He catches the ball when it is 1 m above the beach.

(c) Find the value of v.

(4)

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Question 8 continued

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Question 8 continued

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Question 8 continued

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Question 8 continued

Q8

(Total 13 marks)

TOTAL FOR PAPER 75 MARKS

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