

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

Paper Reference(s)

**6678/01R**

Examiner's use only

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## **Edexcel GCE**

### **Mechanics M2**

### **Advanced/Advanced Subsidiary**

Thursday 6 June 2013 – Morning

Time: 1 hour 30 minutes

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  $g = 9.8 \text{ m s}^{-2}$ .

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 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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**P42830A**

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**Turn over**

**PEARSON**

1. A caravan of mass 600 kg is towed by a car of mass 900 kg along a straight horizontal road. The towbar joining the car to the caravan is modelled as a light rod parallel to the road. The total resistance to motion of the car is modelled as having magnitude 300 N. The total resistance to motion of the caravan is modelled as having magnitude 150 N. At a given instant the car and the caravan are moving with speed  $20 \text{ m s}^{-1}$  and acceleration  $0.2 \text{ m s}^{-2}$ .

(a) Find the power being developed by the car's engine at this instant.

(5)

(b) Find the tension in the towbar at this instant.

(2)

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### **Question 1 continued**

Q1

(Total 7 marks)



P 4 2 8 3 0 A 0 3 2 8

2. A ball of mass 0.2 kg is projected vertically upwards from a point  $O$  with speed  $20 \text{ m s}^{-1}$ . The non-gravitational resistance acting on the ball is modelled as a force of constant magnitude 1.24 N and the ball is modelled as a particle. Find, using the work-energy principle, the speed of the ball when it first reaches the point which is 8 m vertically above  $O$ .

(6)

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## **Question 2 continued**

Q2

(Total 6 marks)



P 4 2 8 3 0 A 0 5 2 8

3. A particle  $P$  moves along a straight line in such a way that at time  $t$  seconds its velocity  $v$  m s $^{-1}$  is given by

$$v = \frac{1}{2}t^2 - 3t + 4$$

Find

- (a) the times when  $P$  is at rest, (4)

(b) the total distance travelled by  $P$  between  $t = 0$  and  $t = 4$ . (5)



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### **Question 3 continued**



P 4 2 8 3 0 A 0 7 2 8

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**Question 3 continued**

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### **Question 3 continued**

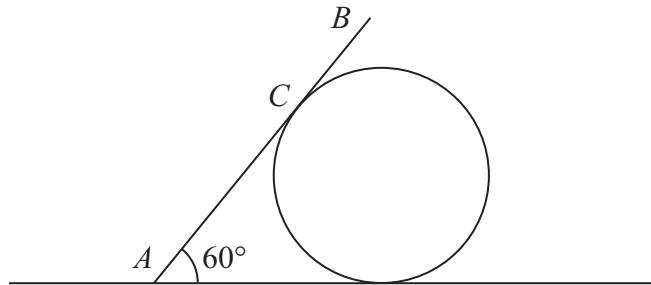
Q3

(Total 9 marks)



P 4 2 8 3 0 A 0 9 2 8

4. A rough circular cylinder of radius  $4a$  is fixed to a rough horizontal plane with its axis horizontal. A uniform rod  $AB$ , of weight  $W$  and length  $6a\sqrt{3}$ , rests with its lower end  $A$  on the plane and a point  $C$  of the rod against the cylinder. The vertical plane through the rod is perpendicular to the axis of the cylinder. The rod is inclined at  $60^\circ$  to the horizontal, as shown in Figure 1.



**Figure 1**

- (a) Show that  $AC = 4a\sqrt{3}$

(2)

The coefficient of friction between the rod and the cylinder is  $\frac{\sqrt{3}}{3}$  and the coefficient of friction between the rod and the plane is  $\mu$ . Given that friction is limiting at both  $A$  and  $C$ ,

- (b) find the value of  $\mu$ .

(9)



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### **Question 4 continued**



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## **Question 4 continued**



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### **Question 4 continued**

Q4

(Total 11 marks)



5. Two particles  $P$  and  $Q$ , of masses  $2m$  and  $m$  respectively, are on a smooth horizontal table. Particle  $Q$  is at rest and particle  $P$  collides directly with it when moving with speed  $u$ . After the collision the total kinetic energy of the two particles is  $\frac{3}{4}mu^2$ . Find

(a) the speed of  $Q$  immediately after the collision,

(10)

(b) the coefficient of restitution between the particles.

(3)



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**Question 5 continued**

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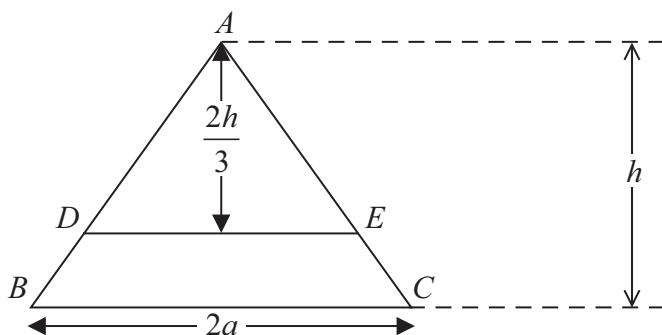
### **Question 5 continued**

Q5

(Total 13 marks)



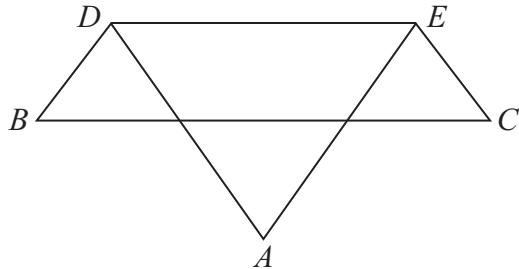
6.

**Figure 2**

A uniform triangular lamina  $ABC$  of mass  $M$  is such that  $AB = AC$ ,  $BC = 2a$  and the distance of  $A$  from  $BC$  is  $h$ . A line, parallel to  $BC$  and at a distance  $\frac{2h}{3}$  from  $A$ , cuts  $AB$  at  $D$  and cuts  $AC$  at  $E$ , as shown in Figure 2.

It is given that the mass of the trapezium  $BCED$  is  $\frac{5M}{9}$ .

- (a) Show that the centre of mass of the trapezium  $BCED$  is  $\frac{7h}{45}$  from  $BC$ . (5)

**Figure 3**

The portion  $ADE$  of the lamina is folded through  $180^\circ$  about  $DE$  to form the folded lamina shown in Figure 3.

- (b) Find the distance of the centre of mass of the folded lamina from  $BC$ . (4)

The folded lamina is freely suspended from  $D$  and hangs in equilibrium. The angle between  $DE$  and the downward vertical is  $\alpha$ .

- (c) Find  $\tan \alpha$  in terms of  $a$  and  $h$ . (4)



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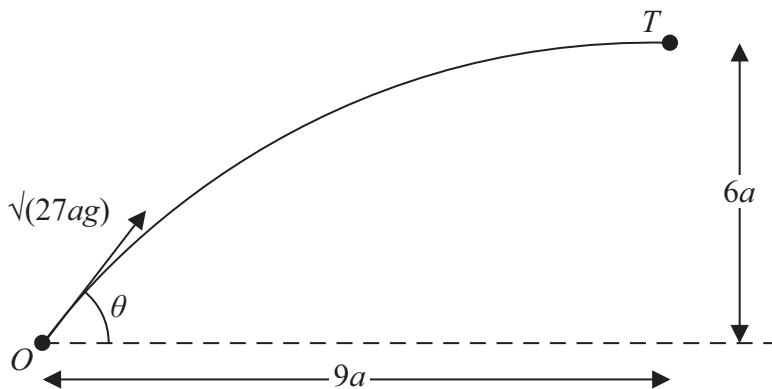
**Q6**

**(Total 13 marks)**



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

7.

**Figure 4**

A small ball is projected from a fixed point  $O$  so as to hit a target  $T$  which is at a horizontal distance  $9a$  from  $O$  and at a height  $6a$  above the level of  $O$ . The ball is projected with speed  $\sqrt{(27ag)}$  at an angle  $\theta$  to the horizontal, as shown in Figure 4. The ball is modelled as a particle moving freely under gravity.

- (a) Show that  $\tan^2 \theta - 6 \tan \theta + 5 = 0$

(7)

The two possible angles of projection are  $\theta_1$  and  $\theta_2$ , where  $\theta_1 > \theta_2$ .

- (b) Find  $\tan \theta_1$  and  $\tan \theta_2$ .

(3)

The particle is projected at the larger angle  $\theta_1$ .

- (c) Show that the time of flight from  $O$  to  $T$  is  $\sqrt{\left(\frac{78a}{g}\right)}$ .

(3)

- (d) Find the speed of the particle immediately before it hits  $T$ .

(3)



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**Q7**

**(Total 16 marks)**

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**TOTAL FOR PAPER: 75 MARKS**

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