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

Paper Reference(s)

**6678/01**

# Edexcel GCE

## Mechanics M2

## Advanced/Advanced Subsidiary

Tuesday 9 June 2015 – Morning

Time: 1 hour 30 minutes

Examiner's use only

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Team Leader's use only

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| Question Number | Leave Blank |
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**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 32 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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P 4 4 8 3 7 A 0 1 3 2

*Turn over*

PEARSON

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**1.** A van of mass 900 kg is moving down a straight road that is inclined at an angle $\theta$ to the horizontal, where $\sin\theta = \frac{1}{30}$. The resistance to motion of the van has constant magnitude 570 N. The engine of the van is working at a constant rate of 12.5 kW.

At the instant when the van is moving down the road at 5 m s$^{-1}$, the acceleration of the van is $a$ m s$^{-2}$.

Find the value of $a$.

**(5)**

Leave blank

**Question 1 continued**

**Q1**

**(Total 5 marks)**

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**2.**

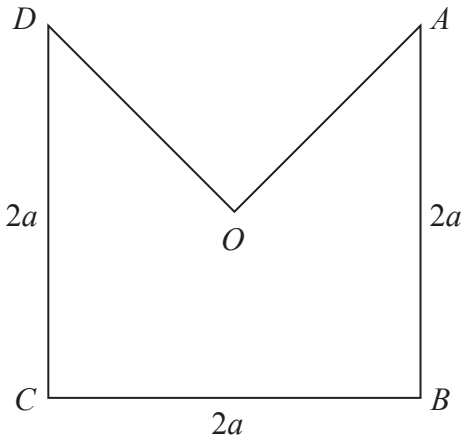



**Figure 1**

The uniform lamina $OABCD$, shown in Figure 1, is formed by removing the triangle $OAD$ from the square $ABCD$ with centre $O$. The square has sides of length $2a$.

(a) Show that the centre of mass of $OABCD$ is $\frac{2}{9}a$ from $O$.

**(4)**

The mass of the lamina is $M$. A particle of mass $kM$ is attached to the lamina at $D$ to form the system $S$. The system $S$ is freely suspended from $A$ and hangs in equilibrium with $AO$ vertical.

(b) Find the value of $k$.

**(4)**

Leave blank

**Question 2 continued**

Leave blank

**Question 2 continued**

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**Question 2 continued**

**Q2**

**(Total 8 marks)**

Leave blank

**3.** A particle $P$ of mass 0.75 kg is moving with velocity $4\mathbf{i}$ m s$^{-1}$ when it receives an impulse $(6\mathbf{i} + 6\mathbf{j})$ N s. The angle between the velocity of $P$ before the impulse and the velocity of $P$ after the impulse is $\theta°$.

Find

(a) the value of $\theta$,

**(5)**

(b) the kinetic energy gained by $P$ as a result of the impulse.

**(3)**

Leave blank

**Question 3 continued**

Leave blank

**Question 3 continued**

Leave blank

**Question 3 continued**

**Q3**

**(Total 8 marks)**

Leave blank

**4.** A ladder $AB$, of weight $W$ and length $2l$, has one end $A$ resting on rough horizontal ground. The other end $B$ rests against a rough vertical wall. The coefficient of friction between the ladder and the wall is $\frac{1}{3}$. The coefficient of friction between the ladder and the ground is $\mu$. Friction is limiting at both $A$ and $B$. The ladder is at an angle $\theta$ to the ground, where $\tan\theta = \frac{5}{3}$. The ladder is modelled as a uniform rod which lies in a vertical plane perpendicular to the wall.

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 9 marks)**

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**5.**

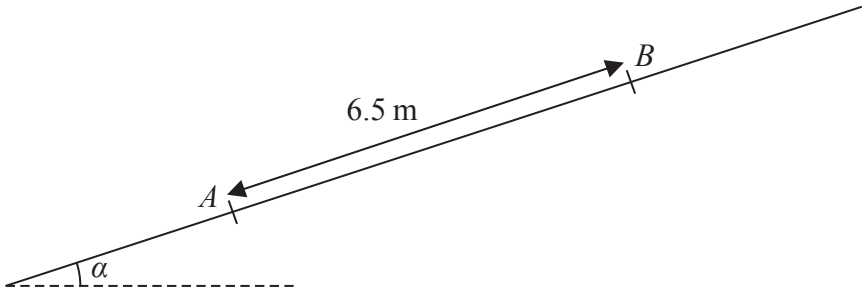



**Figure 2**

A particle $P$ of mass 10 kg is projected from a point $A$ up a line of greatest slope $AB$ of a fixed rough plane. The plane is inclined at angle $\alpha$ to the horizontal, where $\tan\alpha = \frac{5}{12}$ and $AB = 6.5$ m, as shown in Figure 2. The coefficient of friction between $P$ and the plane is $\mu$. The work done against friction as $P$ moves from $A$ to $B$ is 245 J.

(a) Find the value of $\mu$.

**(5)**

The particle is projected from $A$ with speed 11.5 m s$^{-1}$. By using the work-energy principle,

(b) find the speed of the particle as it passes through $B$.

**(4)**

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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)**

Leave blank

**6.** A particle $P$ moves on the positive $x$-axis. The velocity of $P$ at time $t$ seconds is $(2t^2 - 9t + 4)\ \text{m s}^{-1}$. When $t = 0$, $P$ is 15 m from the origin $O$.

Find

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

**(3)**

(b) the acceleration of $P$ when $t = 5$

**(3)**

(c) the total distance travelled by $P$ in the interval $0 \leqslant t \leqslant 5$

**(5)**

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**Question 6 continued**

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**Question 6 continued**

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**Question 6 continued**

**Q6**

**(Total 11 marks)**

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**7.**

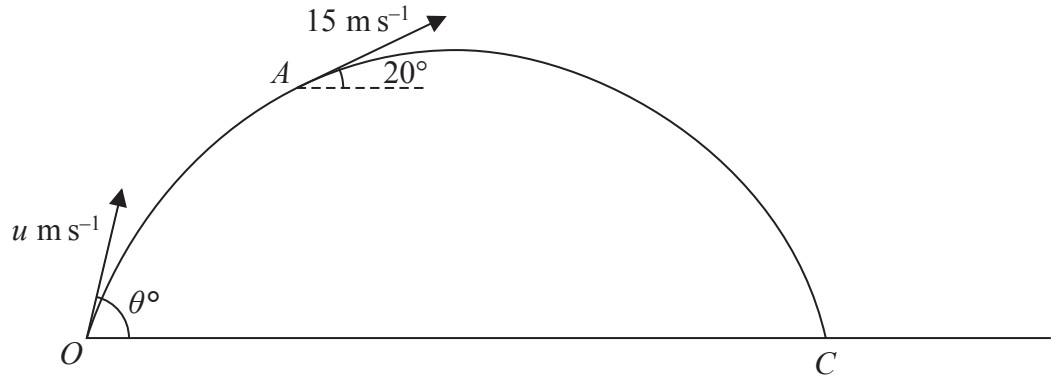



**Figure 3**

At time $t = 0$, a particle is projected from a fixed point $O$ on horizontal ground with speed $u$ m s$^{-1}$ at an angle $\theta°$ to the horizontal. The particle moves freely under gravity and passes through the point $A$ when $t = 4$ s. As it passes through $A$, the particle is moving upwards at 20° to the horizontal with speed 15 m s$^{-1}$, as shown in Figure 3.

(a) Find the value of $u$ and the value of $\theta$.

**(7)**

At the point $B$ on its path the particle is moving downwards at 20° to the horizontal with speed 15 m s$^{-1}$.

(b) Find the time taken for the particle to move from $A$ to $B$.

**(2)**

The particle reaches the ground at the point $C$.

(c) Find the distance $OC$.

**(3)**

Leave blank

**Question 7 continued**

Leave blank

**Question 7 continued**

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**Question 7 continued**

**Q7**

**(Total 12 marks)**

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**8.** Three identical particles $P$, $Q$ and $R$, each of mass $m$, lie in a straight line on a smooth horizontal plane with $Q$ between $P$ and $R$. Particles $P$ and $Q$ are projected directly towards each other with speeds $4u$ and $2u$ respectively, and at the same time particle $R$ is projected along the line away from $Q$ with speed $3u$. The coefficient of restitution between each pair of particles is $e$. After the collision between $P$ and $Q$ there is a collision between $Q$ and $R$.

(a) Show that $e > \frac{2}{3}$

**(7)**

It is given that $e = \frac{3}{4}$

(b) Show that there will not be a further collision between $P$ and $Q$.

**(6)**

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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**

**END**