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

Thursday 6 June 2013 – 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	**Items included with question papers**
Mathematical Formulae (Pink)	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 7 questions in this question paper. The total mark for this paper is 75.
There are 24 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.

Printer's Log. No.
P42036A
W850/R6678/57570 5/5/5/5/5/
P 4 2 0 3 6 A 0 1 2 4

Turn over

PEARSON

Leave blank

1. Three particles of masses 2 kg, 3 kg and m kg are positioned at the points with coordinates $(a, 3)$, $(3, -1)$ and $(-2, 4)$ respectively. Given that the centre of mass of the particles is at the point with coordinates $(0, 2)$, find

(a) the value of m,

(4)

(b) the value of a.

(4)

Leave blank

2. A car has mass 1200 kg. The maximum power of the car's engine is 32 kW. The resistance to motion due to non-gravitational forces is modelled as a force of constant magnitude 800 N. When the car is travelling on a horizontal road at constant speed V m s^{-1}, the engine of the car is working at maximum power.

(a) Find the value of V.

(3)

The car now travels downhill on a straight road inclined at an angle θ to the horizontal, where $\sin\theta = \frac{1}{40}$. The resistance to motion due to non-gravitational forces is still modelled as a force of constant magnitude 800 N. Given that the engine of the car is again working at maximum power,

(b) find the acceleration of the car when its speed is 20 m s^{-1}.

(4)

Leave blank

3 A particle P of mass 0.25 kg moves under the action of a single force **F** newtons. At time t seconds, the velocity of P is **v** m s^{-1}, where

$$\mathbf{v} = (2 - 4t)\mathbf{i} + (t^2 + 2t)\mathbf{j}$$

When $t = 0$, P is at the point with position vector $(2\mathbf{i} - 4\mathbf{j})$ m with respect to a fixed origin O. When $t = 3$, P is at the point A. Find

(a) the momentum of P when $t = 3$,

(2)

(b) the magnitude of **F** when $t = 3$,

(6)

(c) the position vector of A.

(5)

Leave blank

4.

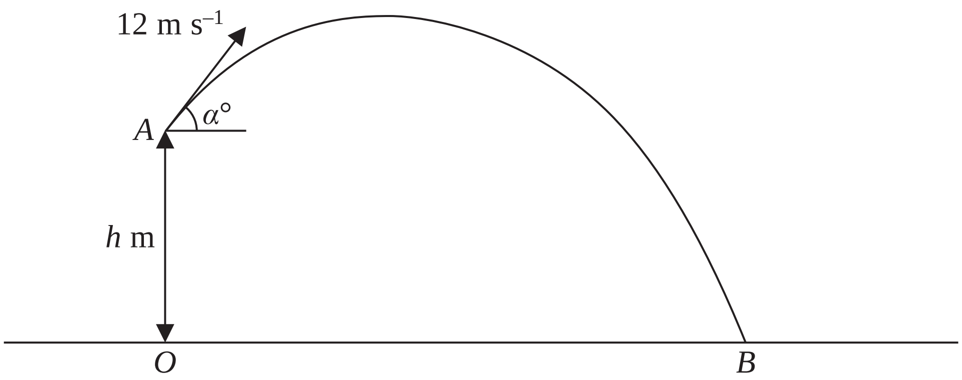

Figure 1

The points O and B are on horizontal ground. The point A is h metres vertically above O. A particle P is projected from A with speed 12 m s^{-1} at an angle $\alpha°$ to the horizontal. The particle moves freely under gravity and hits the ground at B, as shown in Figure 1. The speed of P immediately before it hits the ground is 15 m s^{-1}.

(a) By considering energy, find the value of h.

(4)

Given that 1.5 s after it is projected from A, P is at a point 4 m above the level of A, find

(b) the value of α,

(3)

(c) the direction of motion of P immediately before it reaches B.

(3)

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

5.

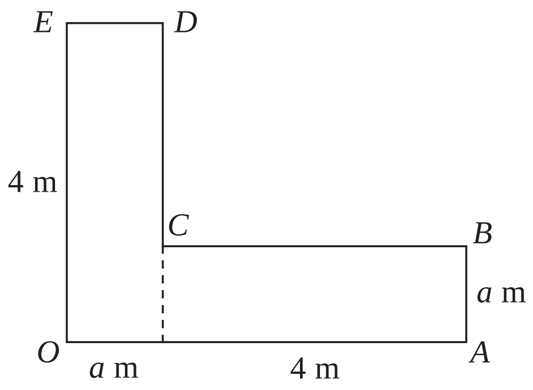

Figure 2

The uniform L-shaped lamina *OABCDE*, shown in Figure 2, is made from two identical rectangles. Each rectangle is 4 metres long and a metres wide. Giving each answer in terms of a, find the distance of the centre of mass of the lamina from

(a) *OE*,

(4)

(b) *OA*.

(4)

The lamina is freely suspended from *O* and hangs in equilibrium with *OE* at an angle θ to the downward vertical through *O*, where $\tan\theta = \frac{4}{3}$.

(c) Find the value of a.

(4)

Leave blank

Leave blank

6.

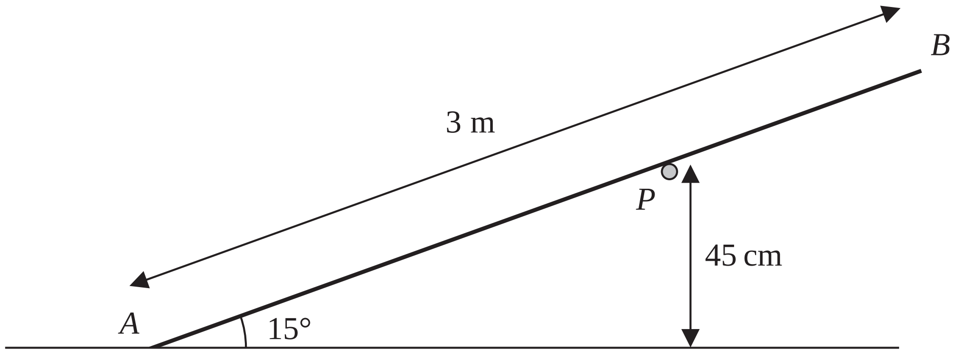

Figure 3

A uniform rod *AB* has weight 30 N and length 3 m. The rod rests in equilibrium on a rough horizontal peg *P* with its end *A* on smooth horizontal ground. The rod is in a vertical plane perpendicular to the peg. The rod is inclined at 15° to the ground and the point of contact between the peg and the rod is 45 cm above the ground, as shown in Figure 3.

(a) Show that the normal reaction at *P* has magnitude 25 N.

(4)

(b) Find the magnitude of the force on the rod at *A*.

(4)

The coefficient of friction between the rod and the peg is μ.

(c) Find the range of possible values of μ.

(4)

Leave blank

7.

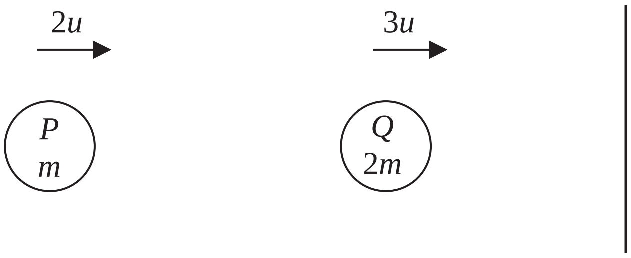

Figure 4

Two smooth particles P and Q have masses m and $2m$ respectively. The particles are moving in the same direction in the same straight line, on a smooth horizontal plane, with Q in front of P. The particles are moving towards a fixed smooth vertical wall which is perpendicular to the direction of motion of the particles, as shown in Figure 4. The speed of P is $2u$ and the speed of Q is $3u$. The coefficient of restitution between Q and the wall is $\frac{1}{3}$. Particle Q strikes the wall, rebounds and then collides directly with P. The direction of motion of each particle is reversed by this collision. Immediately after this collision the speed of P is v and the speed of Q is w.

(a) Show that $v = 2w$.

(5)

The total kinetic energy of P and Q immediately after they collide is half the total kinetic energy of P and Q immediately before they collide.

(b) Find the coefficient of restitution between P and Q.

(8)