Write your name here

Surname	Other names

Pearson Edexcel
International
Advanced Level

Centre Number | | | | | |

Candidate Number | | | | |

Mechanics M2

Advanced/Advanced Subsidiary

Wednesday 15 November 2017 – Morning
Time: 1 hour 30 minutes

Paper Reference
WME02/01

You must have:
Mathematical Formulae and Statistical Tables (Blue)

Total Marks

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, differentiation and integration, or have retrievable mathematical formulae stored in them.

Instructions

- Use **black** ink or ball-point pen.
- If pencil is used for diagrams/sketches/graphs it must be dark (HB or B). Coloured pencils and highlighter pens must not be used.
- **Fill in the boxes** at the top of this page with your name, centre number and candidate number.
- Answer **all** questions and ensure that your answers to parts of questions are clearly labelled.
- Answer the questions in the spaces provided
  – *there may be more space than you need.*
- You should show sufficient working to make your methods clear. Answers without working may not gain full credit.
- 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

- The total mark for this paper is 75.
- The marks for **each** question are shown in brackets
  – *use this as a guide as to how much time to spend on each question.*

Advice

- Read each question carefully before you start to answer it.
- Try to answer every question.
- Check your answers if you have time at the end.

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1. A small ball B of mass 0.2 kg is hit by a bat. Immediately before being hit, B has velocity $(10\mathbf{i} - 17\mathbf{j})\,\text{m s}^{-1}$. Immediately after being hit, B has velocity $(5\mathbf{i} + 8\mathbf{j})\,\text{m s}^{-1}$. Find the magnitude of the impulse exerted on B by the bat.

(4)

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Question 1 continued

Q1

(Total 4 marks)

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2. A van of mass 1200 kg is travelling along a straight horizontal road. The resistance to the motion of the van has a constant magnitude of 650 N and the van's engine is working at a rate of 30 kW.

(a) Find the acceleration of the van when its speed is $24\,\text{m s}^{-1}$

(4)

The van now travels up a straight road which is inclined at angle α to the horizontal, where $\sin\alpha = \frac{1}{12}$. The resistance to the motion of the van from non-gravitational forces has a constant magnitude of 650 N. The van moves up the road at a constant speed of $24\,\text{m s}^{-1}$

(b) Find, in kW, the rate at which the van's engine is now working.

(4)

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Question 2 continued

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Question 2 continued

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Question 2 continued

Q2

(Total 8 marks)

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3. A particle P of mass 4 kg moves from point A to point B down a line of greatest slope of a fixed rough plane. The plane is inclined at 40° to the horizontal and $AB = 12$ m. The coefficient of friction between P and the plane is 0.5

(a) Find the work done against friction as P moves from A to B.

(3)

Given that the speed of P at B is 24 m s^{-1}

(b) use the work-energy principle to find the speed of P at A.

(4)

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Question 3 continued

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Question 3 continued

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Question 3 continued

Q3

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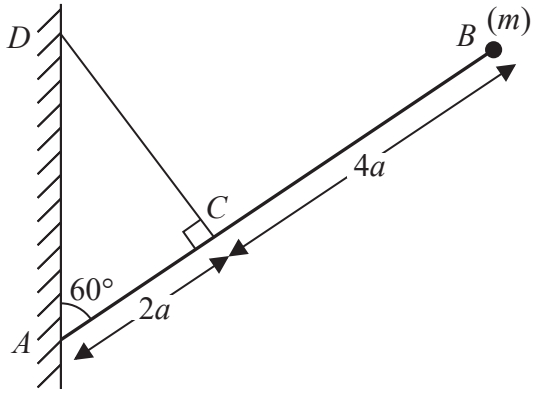

Figure 1

A uniform rod AB has mass m and length $6a$. The end A rests against a rough vertical wall. One end of a light inextensible string is attached to the rod at the point C, where $AC = 2a$. The other end of the string is attached to the wall at the point D, where D is vertically above A, with the string perpendicular to the rod. A particle of mass m is attached to the rod at the end B. The rod is in equilibrium in a vertical plane which is perpendicular to the wall. The rod is inclined at 60° to the wall, as shown in Figure 1.

Find, in terms of m and g,

(a) the tension in the string,

(4)

(b) the magnitude of the horizontal component of the force exerted by the wall on the rod.

(3)

The coefficient of friction between the wall and the rod is μ. Given that the rod is in limiting equilibrium,

(c) find the value of μ.

(5)

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Question 4 continued

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Question 4 continued

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Question 4 continued

(Total 12 marks)

Q4

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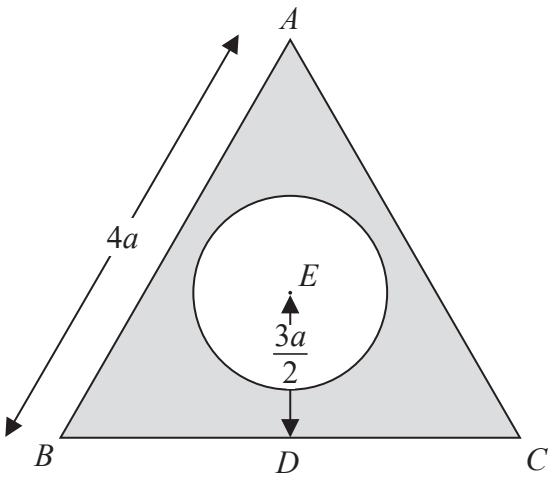

Figure 2

The uniform lamina ABC is in the shape of an equilateral triangle with sides of length $4a$. The midpoint of BC is D. The point E lies on AD with $DE = \frac{3a}{2}$. A circular hole, with centre E and radius a, is made in the lamina ABC to form the lamina L, shown shaded in Figure 2.

(a) Find the distance of the centre of mass of L from D.

(5)

The lamina L is freely suspended from the point B and hangs in equilibrium.

(b) Find, to the nearest degree, the size of the acute angle between AD and the downward vertical.

(3)

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Question 5 continued

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Question 5 continued

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Question 5 continued

Q5

(Total 8 marks)

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6. A particle P moves on the x-axis. At time t seconds, $t \geqslant 0$, the acceleration of P is $(2t - 3)\,\text{m s}^{-2}$ in the positive x direction. At time t seconds, the velocity of P is $v\,\text{m s}^{-1}$ in the positive x direction. When $t = 3$, $v = 2$

(a) Find v in terms of t.

(4)

The particle first comes to instantaneous rest at the point A and then comes to instantaneous rest again at the point B.

(b) Find the distance AB.

(6)

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Question 6 continued

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Question 6 continued

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Question 6 continued

(Total 10 marks)

Q6

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7.

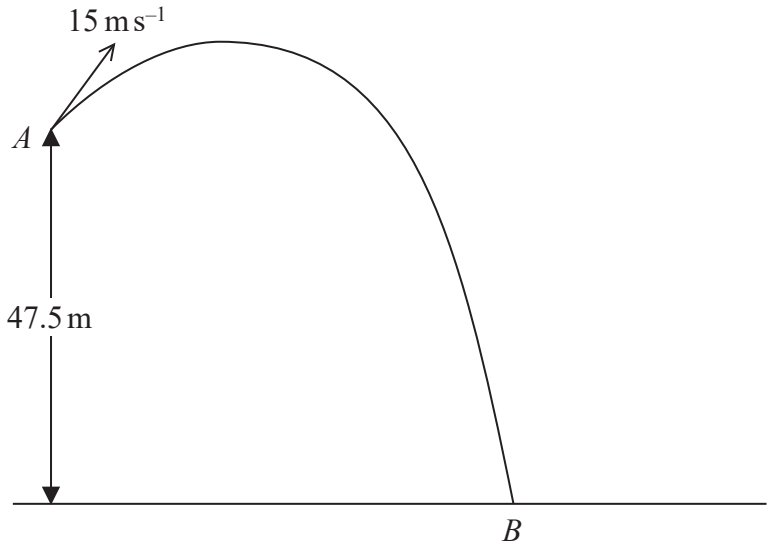

Figure 3

A small ball P is projected with speed 15 m s^{-1} from a point A which is 47.5 m above a horizontal beach. The ball moves freely under gravity and hits the beach at the point B, as shown in Figure 3.

(a) By considering energy, find the speed of P immediately before it hits the beach.

(4)

The ball was projected from A at an angle θ above the horizontal, where $\sin\theta = \frac{3}{5}$

(b) Find the greatest height above the beach of P as it moved from A to B.

(3)

(c) Find the least speed of P as it moved between A and B.

(1)

(d) Find the horizontal distance from A to B.

(6)

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Question 7 continued

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Question 7 continued

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Question 7 continued

(Total 14 marks)

Q7

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8. A particle A of mass $3m$ lies at rest on a smooth horizontal floor. A particle B of mass $2m$ is moving in a straight line on the floor with speed u when it collides directly with A. The coefficient of restitution between A and B is e. As a result of the collision the direction of motion of B is reversed.

(a) Find an expression, in terms of u and e, for

(i) the speed of A immediately after the collision,

(ii) the speed of B immediately after the collision.

(7)

The particle A subsequently strikes a smooth vertical wall. The wall is perpendicular to the direction of motion of A. The coefficient of restitution between A and the wall is $\frac{1}{7}$

There is a second collision between A and B.

(b) Show that $\frac{2}{3} < e < \frac{16}{19}$

(5)

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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 12 marks)

TOTAL FOR PAPER: 75 MARKS

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