Write your name here

Surname	Other names

Pearson Edexcel
International
Advanced Level

Centre Number

Candidate Number

Mechanics M2

Advanced/Advanced Subsidiary

Friday 16 June 2017 – Afternoon
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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Pearson

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1. A particle of mass 4 kg is moving with velocity $(2\mathbf{i} + 3\mathbf{j})\,\text{m s}^{-1}$ when it receives an impulse of $(7\mathbf{i} - 5\mathbf{j})$ N s.

Find the speed of the particle immediately after receiving the impulse.

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Question 1 continued

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Q1

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2. A cyclist and his bicycle have a total mass of 75 kg. The cyclist is moving up a straight road inclined at an angle θ to the horizontal, where $\sin\theta = \frac{1}{21}$. The non-gravitational resistance to motion is modelled as a constant force of magnitude R newtons. The cyclist is working at a constant rate of 280 W and moving at a constant speed of $2\,\mathrm{m\,s^{-1}}$.

(a) Find the value of R.

(4)

Later the cyclist cycles down the same road on the same bicycle. He is again working at a constant rate of 280 W and the resistance to motion is now modelled as a constant force of magnitude 60 N.

(b) Find the acceleration of the cyclist at the instant when his speed is $3.5\,\mathrm{m\,s^{-1}}$.

(4)

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Question 2 continued

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Question 2 continued

Q2

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3. A particle P moves along the x-axis. At time $t = 0$, P passes through the origin with speed $6\,\mathrm{m\,s^{-1}}$ in the positive x direction. The acceleration of P at time t seconds, where $t \geqslant 0$, is $(4t - 8)\,\mathrm{m\,s^{-2}}$ in the positive x direction.

(a) (i) Show that P is instantaneously at rest when $t = 1$

(ii) Find the other value of t for which P is instantaneously at rest.

(5)

(b) Find the total distance travelled by P in the interval $1 \leqslant t \leqslant 4$

(4)

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Question 3 continued

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Question 3 continued

Q3

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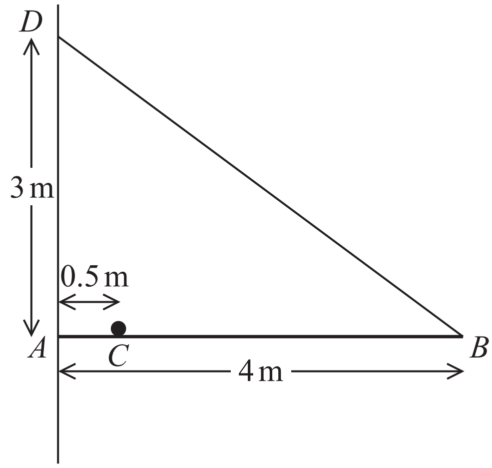

Figure 1

A uniform rod AB has mass 5 kg and length 4 m. The rod is held in a horizontal position by a light inextensible string. The end A of the rod rests against a rough vertical wall. One end of the string is attached to the rod at B and the other end is attached to the wall at a point D. The point D is vertically above A, with $AD = 3$ m. A particle of mass 2 kg is attached to the rod at C, where $AC = 0.5$ m, as shown in Figure 1. The rod is in equilibrium in a vertical plane perpendicular to the wall. The coefficient of friction between the rod and the wall is μ.

Find

(a) the tension in the string,

(4)

(b) the magnitude of the force exerted by the wall on the rod at A,

(5)

(c) the range of possible values of μ.

(2)

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Q4

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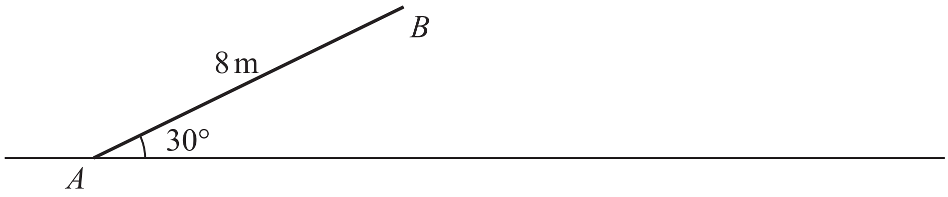

Figure 2

A smooth straight ramp is fixed to horizontal ground. The ramp has length 8 m and is inclined at 30° to the ground, as shown in Figure 2. A particle P of mass 0.7 kg is projected from a point A at the bottom of the ramp, up a line of greatest slope of the ramp, with speed $u\,\text{m s}^{-1}$. As P reaches the point B at the top of the ramp, P has speed $4.2\,\text{m s}^{-1}$.

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

(4)

After leaving the ramp at B, the particle P moves freely under gravity until it hits the ground at a point C. Immediately before hitting the ground at C, particle P is moving at $\theta°$ below the horizontal with speed $w\,\text{m s}^{-1}$.

Find

(b) (i) the value of w,

(ii) the value of θ,

(4)

(c) the horizontal distance from B to C.

(5)

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Q5

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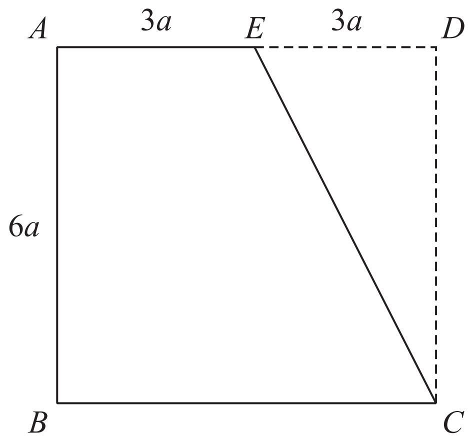

Figure 3

The uniform lamina $ABCD$ is a square with sides of length $6a$. The point E is the midpoint of side AD. The triangle CDE is removed from the square to form the uniform lamina L, shown in Figure 3. The centre of mass of L is at the point G.

(a) Show that the distance of G from the side AB is $\frac{7}{3}a$.

(5)

(b) Find the distance of G from the side AE.

(3)

The mass of L is M. A particle of mass kM is attached to L at the point E. The lamina, with the particle attached, is freely suspended from A and hangs in equilibrium with the diagonal AC vertical.

(c) Find the value of k.

(5)

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Q6

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7. Three particles A, B and C lie at rest in a straight line on a smooth horizontal surface, with B between A and C. The particles A, B and C have mass $6m$, $4m$ and m respectively. Particle A is projected towards B with speed $3u$ and A collides directly with B. Immediately after this collision, the speed of B is w. The coefficient of restitution between A and B is $\frac{1}{6}$.

(a) Show that $w = \frac{21}{10}u$.

(6)

(b) Express the total kinetic energy of A and B lost in the collision as a fraction of the total kinetic energy of A and B immediately before the collision.

(5)

After being struck by A, the particle B collides directly with C. The coefficient of restitution between B and C is e. After the collision between B and C, there are no further collisions between the particles.

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

(5)

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Q7

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TOTAL FOR PAPER: 75 MARKS

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