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Pearson Edexcel
International
Advanced Level

Centre Number | | | | | |

Candidate Number | | | | |

Mechanics M1

Advanced/Advanced Subsidiary

Wednesday 3 June 2015 – Morning
Time: 1 hour 30 minutes

Paper Reference
WME01/01

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.

Turn over ▶

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1. Three forces $\mathbf{F}_1$, $\mathbf{F}_2$ and $\mathbf{F}_3$ act on a particle P.

$\mathbf{F}_1 = (2\mathbf{i} + 3a\mathbf{j})$ N; $\mathbf{F}_2 = (2a\mathbf{i} + b\mathbf{j})$ N; $\mathbf{F}_3 = (b\mathbf{i} + 4\mathbf{j})$ N.

The particle P is in equilibrium under the action of these forces.

Find the value of a and the value of b.

(6)

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2. Particle A of mass $2m$ and particle B of mass km, where k is a positive constant, are moving towards each other in opposite directions along the same straight line on a smooth horizontal plane. The particles collide directly. Immediately before the collision the speed of A is u and the speed of B is $3u$. The direction of motion of each particle is reversed by the collision. Immediately after the collision the speed of A is $\frac{1}{2}u$.

(a) Show that $k < 1$

(6)

(b) Find, in terms of m and u, the magnitude of the impulse exerted on B by A in the collision.

(3)

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Question 2 continued

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3.

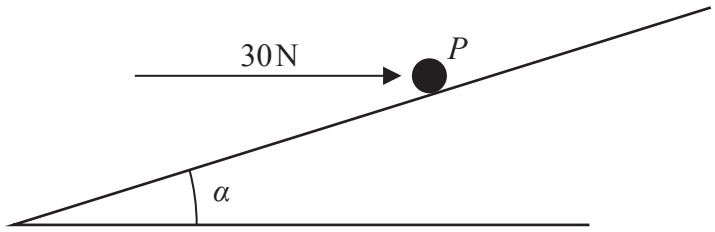

Figure 1

A particle P of mass 2 kg is pushed by a constant horizontal force of magnitude 30 N up a line of greatest slope of a rough plane. The plane is inclined to the horizontal at an angle α, where $\tan \alpha = \frac{3}{4}$, as shown in Figure 1. The line of action of the force lies in the vertical plane containing P and the line of greatest slope of the plane. The particle P starts from rest. The coefficient of friction between P and the plane is μ. After 2 seconds, P has travelled a distance of 5.5 m up the plane.

(a) Find the acceleration of P up the plane.

(2)

(b) Find the value of μ.

(8)

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Question 3 continued

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4. A small stone is released from rest from a point A which is at height h metres above horizontal ground. Exactly one second later another small stone is projected with speed 19.6 m s^{-1} vertically downwards from a point B, which is also at height h metres above the horizontal ground. The motion of each stone is modelled as that of a particle moving freely under gravity. The two stones hit the ground at the same time.

Find the value of h.

(7)

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5. A car travelling along a straight horizontal road takes 170 s to travel between two sets of traffic lights at A and B which are 2125 m apart. The car starts from rest at A and moves with constant acceleration until it reaches a speed of 17 m s^{-1}. The car then maintains this speed before moving with constant deceleration, coming to rest at B. The magnitude of the deceleration is twice the magnitude of the acceleration.

(a) Sketch, in the space below, a speed-time graph for the motion of the car between A and B.

(3)

(b) Find the deceleration of the car.

(7)

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Question 5 continued

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6.

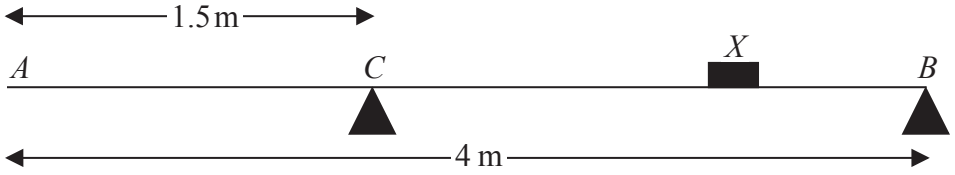

Figure 2

A plank AB has length 4 m and mass 6 kg. The plank rests in a horizontal position on two supports, one at B and one at C, where $AC = 1.5$ m. A load of mass 15 kg is placed on the plank at the point X, as shown in Figure 2, and the plank remains horizontal and in equilibrium. The plank is modelled as a uniform rod and the load is modelled as a particle. The magnitude of the reaction on the plank at C is twice the magnitude of the reaction on the plank at B.

(a) Find the magnitude of the reaction on the plank at C.

(3)

(b) Find the distance AX.

(5)

The load is now moved along the plank to a point Y, between A and C. Given that the plank is on the point of tipping about C,

(c) find the distance AY.

(4)

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Question 6 continued

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7. A particle P moves from point A to point B with constant acceleration $(c\mathbf{i} + d\mathbf{j})$ m s^{-2}, where c and d are positive constants. The velocity of P at A is $(-3\mathbf{i} - 3\mathbf{j})$ m s^{-1} and the velocity of P at B is $(2\mathbf{i} + 9\mathbf{j})$ m s^{-1}. The magnitude of the acceleration of P is 2.6 m s^{-2}.

Find the value of c and the value of d.

(5)

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8.

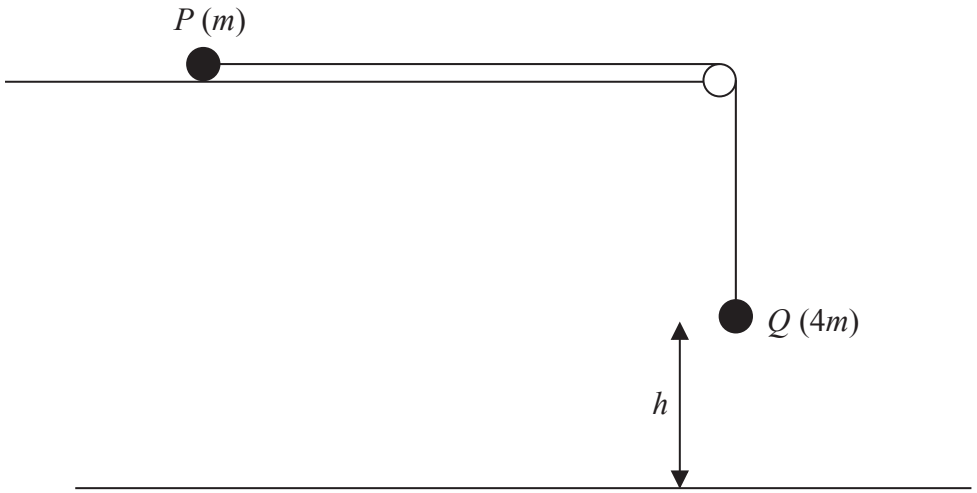

Figure 3

Two particles P and Q have masses m and $4m$ respectively. The particles are attached to the ends of a light inextensible string. Particle P is held at rest on a rough horizontal table. The string lies along the table and passes over a small smooth light pulley which is fixed at the edge of the table. Particle Q hangs at rest vertically below the pulley, at a height h above a horizontal plane, as shown in Figure 3. The coefficient of friction between P and the table is 0.5. Particle P is released from rest with the string taut and slides along the table.

(a) Find, in terms of mg, the tension in the string while both particles are moving.

(8)

The particle P does not reach the pulley before Q hits the plane.

(b) Show that the speed of Q immediately before it hits the plane is $\sqrt{1.4gh}$

(2)

When Q hits the plane, Q does not rebound and P continues to slide along the table. Given that P comes to rest before it reaches the pulley,

(c) show that the total length of the string must be greater than $2.4h$

(6)

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Question 8 continued