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Candidate surname	Other names

Centre Number | Candidate Number

Pearson Edexcel International Advanced Level

Wednesday 17 January 2024

Morning (Time: 1 hour 30 minutes)

Paper reference **WME01/01**

Mathematics

International Advanced Subsidiary/Advanced Level
Mechanics M1

You must have:
Mathematical Formulae and Statistical Tables (Yellow), calculator

Total Marks

Candidates may use any calculator permitted by Pearson regulations. 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).
- **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 $g = 9.8\,\text{m s}^{-2}$, and give your answer to either 2 significant figures or 3 significant figures.

Information

- A booklet 'Mathematical Formulae and Statistical Tables' is provided.
- There are 8 questions in this question paper. 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.
- If you change your mind about an answer, cross it out and put your new answer and any working underneath.

Turn over ▶

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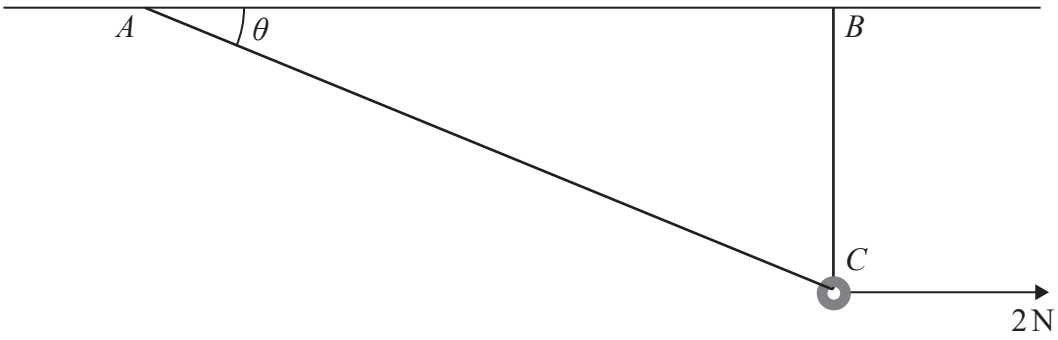

Figure 1

Figure 1 shows a small smooth ring **threaded** onto a light inextensible string.

One end of the string is attached to a fixed point A on a horizontal ceiling and the other end of the string is attached to a fixed point B on the ceiling.

A horizontal force of magnitude 2 N acts on the ring so that the ring rests in equilibrium at a point C, vertically below B, with the string taut.

The line of action of the horizontal force and the string both lie in the same vertical plane.

The angle that the string makes with the ceiling at A is θ, where $\tan\theta = \frac{3}{4}$

The tension in the string is T newtons. The mass of the ring is M kg.

(a) Find the value of T

(3)

(b) Find the value of M

(3)

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Question 1 continued

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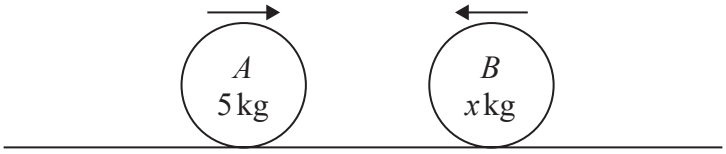

Figure 2

Figure 2 shows two particles, A and B, moving in opposite directions on a smooth horizontal surface. Particle A has mass 5 kg and particle B has mass x kg.

The particles collide directly.

Immediately before the collision, the speed of A is $3\,\text{m s}^{-1}$ and the speed of B is $x\,\text{m s}^{-1}$

Immediately after the collision, the speed of A is $1\,\text{m s}^{-1}$ and its direction of motion is unchanged.

Immediately after the collision, the speed of B is $1.5\,\text{m s}^{-1}$

(a) Find the value of x.

(3)

(b) Find the magnitude of the impulse exerted on A by B in the collision.

(3)

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Question 2 continued

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3. A van travels with constant acceleration along a straight horizontal road.

The van passes a point A with speed $u\,\text{m s}^{-1}$ and 20 seconds later passes a point B with speed $28\,\text{m s}^{-1}$

The distance AB is 400 m.

(a) Show that $u = 12$

(2)

(b) Find the time taken for the van to travel from A to the midpoint of AB.

(5)

The van has mass 1200 kg.

During its motion the van experiences a constant resistive force of magnitude 260 N

(c) Find the magnitude of the driving force exerted by the engine of the van as it travels from A to B.

(3)

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Question 3 continued

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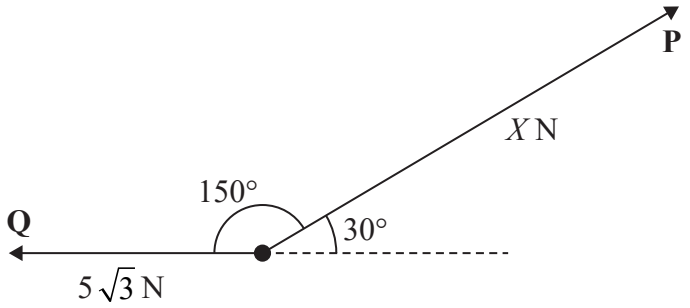

Figure 3

Figure 3 shows two horizontal forces **P** and **Q** acting on a particle.

The angle between the direction of **P** and the direction of **Q** is 150°

Force **P** has magnitude X newtons.

Force **Q** has magnitude $5\sqrt{3}$ N.

The resultant of **P** and **Q** has magnitude $\sqrt{129}$ N.

Find

(i) the value of X.

(ii) the angle between **Q** and the resultant, giving your answer to the nearest degree.

(8)

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Question 4 continued

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Question 4 continued

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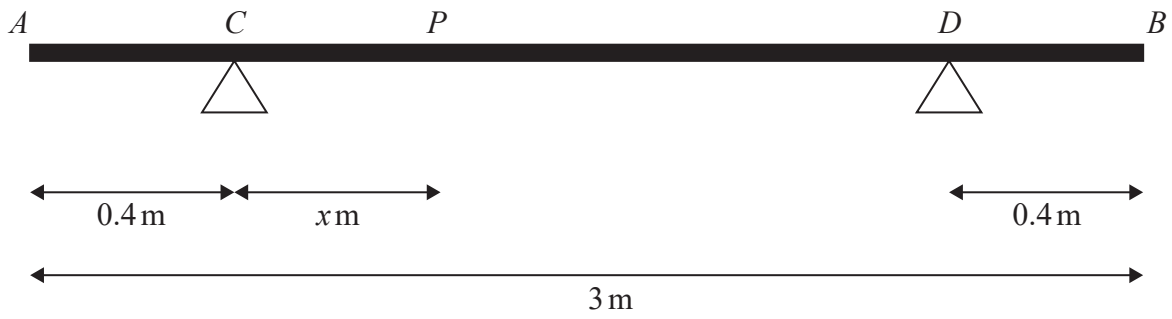

Figure 4

A beam AB has mass 30 kg and length 3 m.

The beam rests on supports at C and D where $AC = 0.4$ m and $DB = 0.4$ m, as shown in Figure 4.

A person of mass 55 kg stands on the beam between C and D.

The person is modelled as a particle at the point P, where $CP = x$ metres and $0 < x < 2.2$

The beam is modelled as a uniform rod resting in equilibrium in a horizontal position.

Using the model,

(a) show that the magnitude of the reaction at C is $(686 - 245x)$ N.

(3)

The magnitude of the reaction at C is **four** times the magnitude of the reaction at D.

Using the model,

(b) find the value of x

(4)

The person steps off the beam and places a package of mass M kg at A.

The package is modelled as a particle at the point A.

The beam is now on the point of tilting about C.

Using the model,

(c) find the value of M

(3)

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Question 5 continued

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Question 5 continued

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6. A particle is projected vertically upwards from a point A with speed $24\,\text{m s}^{-1}$

The point A is 2.5 m vertically above the point B.

Point B lies on horizontal ground.

The particle moves freely under gravity until it hits the ground at B with speed $V\,\text{m s}^{-1}$

After hitting the ground the particle does not rebound.

(a) Find the value of V.

(3)

(b) Find the time taken for the particle to reach B.

(3)

The point C is 10 m vertically above A.

(c) Find the length of time for which the particle is above C.

(4)

(d) Sketch a speed-time graph for the motion of the particle from projection to the instant that it reaches B. (No further calculations are required.)

(2)

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Question 6 continued

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Question 6 continued

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7. [*In this question* **i** *and* **j** *are horizontal unit vectors directed due east and due north respectively and position vectors are given relative to a fixed origin O.*]

At midnight, a ship S is at the point with position vector $(19\mathbf{i} + 22\mathbf{j})$ km

The ship travels with constant velocity $(12\mathbf{i} - 16\mathbf{j})\,\text{km h}^{-1}$

(a) Find the speed of S.

(2)

At time t hours after midnight, the position vector of S is $\mathbf{s}$ km.

(b) Find an expression for $\mathbf{s}$ in terms of $\mathbf{i}$, $\mathbf{j}$ and t.

(2)

A lighthouse stands on a small rocky island. The lighthouse is modelled as being at the point with position vector $(26\mathbf{i} + 15\mathbf{j})$ km.

It is not safe for ships to be within 1.3 km of the lighthouse.

(c) (i) Find the value of t when S is closest to the lighthouse.

(ii) Hence determine whether it is safe for S to continue its course.

(7)

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Question 7 continued

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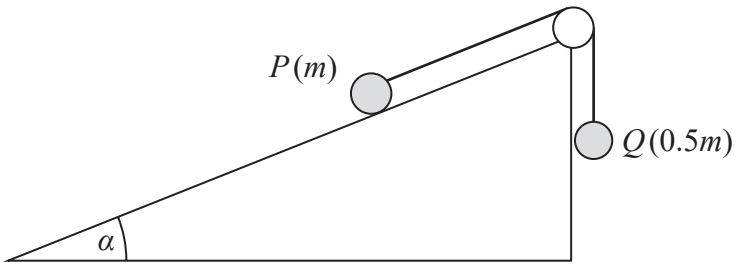

Figure 5

A fixed rough plane is inclined at an angle α to the horizontal, where $\tan\alpha = \frac{5}{12}$

A small smooth pulley is fixed at the top of the plane.

One end of a light inextensible string is attached to a particle P which is at rest on the plane. The string passes over the pulley and the other end of the string is attached to a particle Q which hangs vertically below the pulley, as shown in Figure 5.

Particle P has mass m and particle Q has mass $0.5m$

The string from P to the pulley lies along a line of greatest slope of the plane.

The coefficient of friction between P and the plane is μ.

The system is in **limiting equilibrium** with the string taut and P is on the point of slipping **up** the plane.

(a) Find the value of μ.

(8)

The string breaks and P begins to move down the plane.

When particle P has travelled a distance of 0.8 m down the plane, the speed of P is $V\,\text{m s}^{-1}$

(b) Find the value of V.

(4)

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Question 8 continued

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(Total for Question 8 is 12 marks)

TOTAL FOR PAPER IS 75 MARKS