Please check the examination details below before entering your candidate information

Candidate surname	Other names

Centre Number | Candidate Number

Pearson Edexcel International Advanced Level

Tuesday 7 May 2024

Afternoon (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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Pearson

1. Two particles, A and B, have masses m and $3m$ respectively. The particles are connected by a light inextensible string. Initially A and B are at rest on a smooth horizontal plane with the string slack.

Particle A is then projected along the plane away from B with speed U.

Given that the common speed of the particles immediately after the string becomes taut is S

(a) find S in terms of U.

(2)

(b) Find, in terms of m and U, the magnitude of the impulse exerted on A immediately after the string becomes taut.

(3)

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Question 1 continued

(Total for Question 1 is 5 marks)

2. Two forces, **P** and **Q**, act on a particle.

- **P** has magnitude 10 N and acts due west
- **Q** has magnitude 8 N and acts on a bearing of 330°

Given that **F** = **P** + **Q**, find the magnitude of **F**.

(4)

Question 2 continued

(Total for Question 2 is 4 marks)

3.

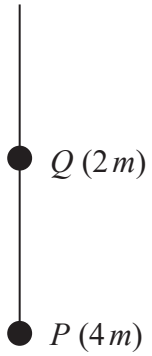

Figure 1

Two particles, P and Q, have masses $4m$ and $2m$ respectively. The particles are connected by a light inextensible string. A second light inextensible string has one end attached to Q. Both strings are taut and vertical, as shown in Figure 1.

The particles are **accelerating** vertically **downwards**.

Given that the tension in the string connecting the two particles is $3mg$, find, in terms of m and g, the tension in the upper string.

(6)

Question 3 continued

(Total for Question 3 is 6 marks)

4.

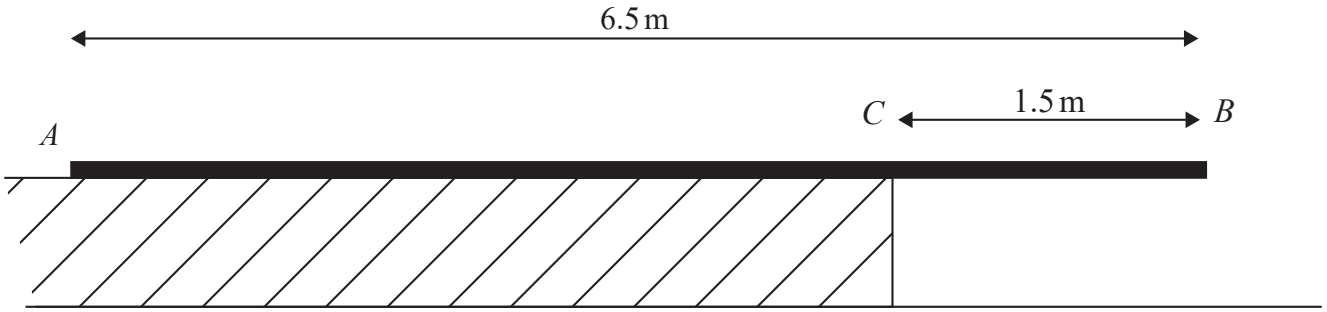

Figure 2

A non-uniform rod AB has length 6.5 m and mass 1.2 kg. The centre of mass of the rod is 3 m from A. The rod rests on a horizontal step and overhangs the end of the step C by 1.5 m, as shown in Figure 2.

The rod is perpendicular to the edge of the step.

A particle of mass 4 kg is placed on the rod at B and another particle, whose mass is M kg, is placed on the rod at D, where $AD = 0.5$ m.

The rod remains in equilibrium in a horizontal position.

(a) Find the smallest possible value of M.

(3)

The particle at B **and** the particle at D are now **removed**.

A new particle is placed on the rod at the point E, where $EB = 0.9$ m.

The rod remains in equilibrium in a horizontal position but is on the point of tilting about C.

(b) Find the magnitude of the force acting on the rod at C.

(3)

Question 4 continued

Question 4 continued

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Question 4 continued

(Total for Question 4 is 6 marks)

5. A parachute is used to deliver a box of supplies. The parachute is attached to the box.

- the parachute and box are dropped from rest from a helicopter that is hovering at a height of 520 m above the ground
- the parachute and box fall vertically and freely under gravity for 5 seconds, then the parachute opens
- from the instant the parachute opens, it provides a resistance to motion of magnitude 3200 N
- the parachute and box continue to fall vertically downwards after the parachute opens
- the parachute and box are modelled throughout the motion as a particle P of mass 250 kg

(a) Find the distance fallen by P in the first 5 seconds.

(2)

(b) Find the speed with which P lands on the ground.

(7)

(c) Find the total time from the instant when P is dropped from the helicopter to the instant when P lands on the ground.

(3)

(d) Sketch a speed-time graph for the motion of P from the instant when P is dropped from the helicopter to the instant when P lands on the ground.

(2)

Question 5 continued

Question 5 continued

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Question 5 continued

(Total for Question 5 is 14 marks)

6.

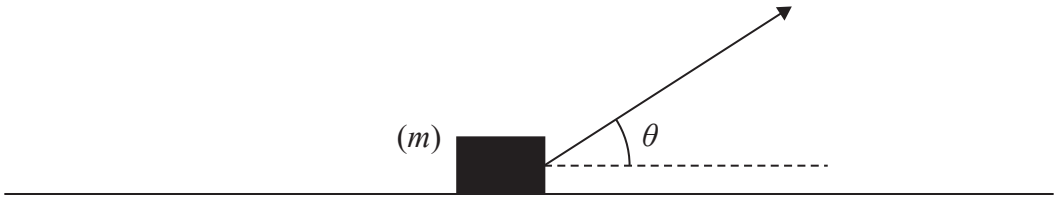

Figure 3

A box of mass m lies on a rough horizontal plane. The box is pulled along the plane in a straight line at **constant speed** by a light rope. The rope is inclined at an angle θ to the plane, as shown in Figure 3.

The coefficient of friction between the box and the plane is $\frac{1}{3}$

The box is modelled as a particle.

Given that $\tan\theta = \frac{3}{4}$

(a) find, in terms of m and g, the tension in the rope.

(7)

The rope is now removed and the box is placed at rest on the plane.
The box is then projected horizontally along the plane with speed u.

The box is again modelled as a particle.

When the box has moved a distance d along the plane, the speed of the box is $\frac{1}{2}u$.

(b) Find d in terms of u and g.

(5)

Question 6 continued

Question 6 continued

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Question 6 continued

(Total for Question 6 is 12 marks)

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

Two speedboats, A and B, are each moving with constant velocity.

- the velocity of A is $40\,\text{km}\,\text{h}^{-1}$ due east
- the velocity of B is $20\,\text{km}\,\text{h}^{-1}$ on a bearing of angle α ($0° < \alpha < 90°$), where $\tan\alpha = \frac{4}{3}$

The boats are modelled as particles.

(a) Find, in terms of **i** and **j**, the velocity of B in $\text{km}\,\text{h}^{-1}$

(2)

At noon

- the position vector of A is $20\mathbf{j}\,\text{km}$
- the position vector of B is $(10\mathbf{i} + 5\mathbf{j})\,\text{km}$

At time t hours after noon

- the position vector of A is $\mathbf{r}\,\text{km}$, where $\mathbf{r} = 20\mathbf{j} + 40t\mathbf{i}$
- the position vector of B is $\mathbf{s}\,\text{km}$

(b) Find an expression for **s** in terms of t, **i** and **j**.

(2)

(c) Show that at time t hours after noon,

$$\overrightarrow{AB} = [(10 - 24t)\mathbf{i} + (12t - 15)\mathbf{j}]\,\text{km}$$

(2)

(d) Show that the boats will never collide.

(3)

(e) Find the distance between the boats when the bearing of B from A is 225°

(4)

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Question 7 continued

Question 7 continued

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Question 7 continued

(Total for Question 7 is 13 marks)

8.

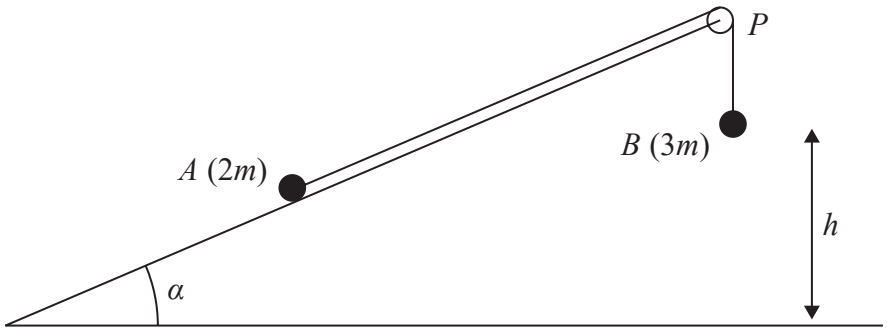

Figure 4

One end of a light inextensible string is attached to a particle A of mass $2m$. The other end of the string is attached to a particle B of mass $3m$. Particle A is held at rest on a rough plane which is inclined to horizontal ground at an angle α, where $\tan\alpha = \frac{5}{12}$

The string passes over a small smooth pulley P which is fixed at the top of the plane. Particle B hangs vertically below P with the string taut, at a height h above the ground, as shown in Figure 4.

The part of the string between A and P lies along a line of greatest slope of the plane. The two particles, the string and the pulley all lie in the same vertical plane.

The coefficient of friction between A and the plane is $\frac{11}{36}$

The particle A is released from rest and begins to move up the plane.

(a) Show that the frictional force acting on A as it moves up the plane is $\frac{22mg}{39}$

(3)

(b) Write down an equation of motion for B.

(2)

(c) Show that the acceleration of A immediately after its release is $\frac{1}{3}g$

(4)

In the subsequent motion, A comes to rest before it reaches the pulley.

(d) Find, in terms of h, the total distance travelled by A from when it was released from rest to when it first comes to rest again.

(6)

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Question 8 continued

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Question 8 continued

Question 8 continued

(Total for Question 8 is 15 marks)

TOTAL FOR PAPER IS 75 MARKS

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