

Please check the examination details below before entering your candidate information

Candidate surname

Other names

Pearson Edexcel
International
Advanced Level

Centre Number

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Candidate Number

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Tuesday 19 January 2021

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 (Blue), 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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1. A small stone is projected vertically upwards with speed 20 m s^{-1} from a point O which is 5 m above horizontal ground. The stone is modelled as a particle moving freely under gravity.

Find

- (a) the speed of the stone at the instant when it is 2 m above the ground, (2)

(b) the total time between the instant when the stone is projected from O and the instant when it first strikes the ground. (4)



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Question 1 continued

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Q1

(Total 6 marks)



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2. Two particles, P and Q , have masses $2m$ and m respectively. The particles 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 P is $3u$ and the speed of Q is $2u$.

The magnitude of the impulse exerted on Q by P in the collision is $5mu$.

Find

- (a) the speed of P immediately after the collision, (3)
 (b) the speed of Q immediately after the collision. (3)



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Question 2 continued

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Q2

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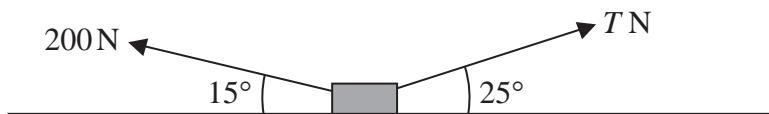


Figure 1

A parcel of mass 20kg is at rest on a rough horizontal floor. The coefficient of friction between the parcel and the floor is 0.3

Two forces, both acting in the same vertical plane, of magnitudes 200N and T N are applied to the parcel. The line of action of the 200N force makes an angle of 15° with the horizontal and the line of action of the T N force makes an angle of 25° with the horizontal, as shown in Figure 1. The parcel is modelled as a particle P .

Find the smallest value of T for which P remains in equilibrium.

(9)

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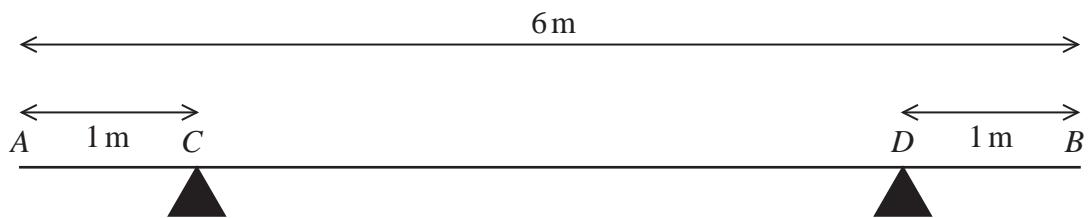


Figure 2

A metal girder AB has weight W newtons and length 6m. The girder rests in a horizontal position on two supports C and D where $AC = DB = 1$ m, as shown in Figure 2.

When a force of magnitude 900N is applied vertically upwards to the girder at A, the girder is about to tilt about D.

When a force of magnitude 1500N is applied vertically upwards to the girder at *B*, the girder is about to tilt about *C*.

The girder is modelled as a non-uniform rod whose centre of mass is a distance x metres from A.

Find the value of x .

(6)

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Q4

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5. A particle is acted upon by two forces \mathbf{F} and \mathbf{G} . The force \mathbf{F} has magnitude 8N and acts in a direction with a bearing of 240° . The force \mathbf{G} has magnitude 10N and acts due South.

Given that $\mathbf{R} = \mathbf{F} + \mathbf{G}$, find

- (i) the magnitude of \mathbf{R} ,
 - (ii) the direction of \mathbf{R} , giving your answer as a bearing to the nearest degree.

(7)

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Q5

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6. Two girls, Agatha and Brionie, are roller skating inside a large empty building. The girls are modelled as particles.

At time $t = 0$, Agatha is at the point with position vector $(11\mathbf{i} + 11\mathbf{j})\text{ m}$ and Brionie is at the point with position vector $(7\mathbf{i} + 16\mathbf{j})\text{ m}$. The position vectors are given relative to the door, O , and \mathbf{i} and \mathbf{j} are horizontal perpendicular unit vectors.

Agatha skates with constant velocity $(3\mathbf{i} - \mathbf{j})\text{ m s}^{-1}$

Brionie skates with constant velocity $(4\mathbf{i} - 2\mathbf{j})\text{ m s}^{-1}$

- (a) Find the position vector of Agatha at time t seconds.

(2)

At time $t = 6$ seconds, Agatha passes through the point P .

- (b) Show that Brionie also passes through P and find the value of t when this occurs.

(4)

At time t seconds, Agatha is at the point A and Brionie is at the point B .

- (c) Show that $\overrightarrow{AB} = [(t - 4)\mathbf{i} + (5 - t)\mathbf{j}] \text{ m}$

(2)

- (d) Find the distance between the two girls when they are closest together.

(4)

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7. A helicopter is hovering at rest above horizontal ground at the point H . A parachutist steps out of the helicopter and immediately falls vertically and freely under gravity from rest for 2.5 s. His parachute then opens and causes him to immediately decelerate at a constant rate of 3.9 m s^{-2} for T seconds ($T < 6$), until his speed is reduced to $V \text{ m s}^{-1}$. He then moves with this constant speed $V \text{ m s}^{-1}$ until he hits the ground. While he is decelerating, he falls a distance of 73.75 m. The total time between the instant when he leaves H and the instant when he hits the ground is 20 s.

The parachutist is modelled as a particle.

- (a) Find the speed of the parachutist at the instant when his parachute opens. (1)

(b) Sketch a speed-time graph for the motion of the parachutist from the instant when he leaves H to the instant when he hits the ground. (2)

(c) Find the value of T . (5)

(d) Find, to the nearest metre, the height of the point H above the ground. (4)

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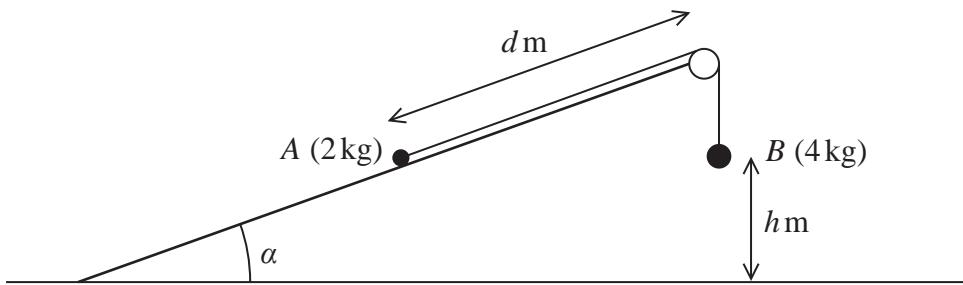


Figure 3

Two particles, A and B , have masses 2 kg and 4 kg respectively. The particles are connected by a light inextensible string. The string passes over a small smooth pulley which is fixed at the top of a rough plane. The plane is inclined to the horizontal ground at an angle α where $\tan \alpha = \frac{3}{4}$. The particle A is held at rest on the plane at a distance d metres from the pulley. The particle B hangs freely at rest, vertically below the pulley, at a distance h metres above the ground, as shown in Figure 3. The part of the string between A and the pulley is parallel to a line of greatest slope of the plane. The coefficient of friction between A and the plane is $\frac{1}{4}$

The system is released from rest with the string taut and B descends.

- (a) Find the tension in the string as B descends.

(9)

On hitting the ground, B immediately comes to rest.

Given that A comes to rest before reaching the pulley,

- (b) find, in terms of h , the range of possible values of d .

(7)

- (c) State one physical factor, other than air resistance, that could be taken into account to make the model described above more realistic.

(1)



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Q8

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TOTAL FOR PAPER: 75 MARKS

