

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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Thursday 21 May 2020

Afternoon (Time: 1 hour 30 minutes)

Paper Reference **WME02/01**

Mathematics

International Advanced Subsidiary/Advanced Level
Mechanics M2

You must have:

Mathematical Formulae and Statistical Tables (Blue), calculator

Total Marks

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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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Question 1 continued

Lined writing area for the answer to Question 1.

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Q1

(Total 5 marks)



2. A truck of weight 9000 N is travelling up a hill on a straight road that is inclined at an angle θ to the horizontal, where $\sin \theta = \frac{1}{15}$

When the truck travels up the hill with the engine working at $3P$ watts, the truck is moving at a constant speed of 12 m s^{-1}

Later on, the truck travels down the hill along the same road, with the engine working at P watts. At the instant when the speed of the truck is 12 m s^{-1} , the acceleration of the truck is $\frac{g}{20}$

The resistance to motion of the truck from non-gravitational forces is a constant force of magnitude R newtons in all circumstances.

Find (i) the value of P ,
(ii) the value of R . (9)

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Question 2 continued

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Q2

(Total 9 marks)



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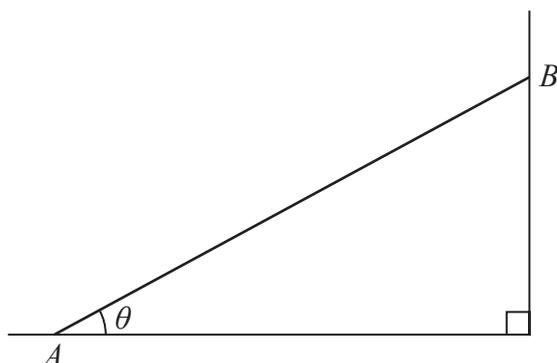


Figure 1

A uniform rod AB , of mass 25 kg and length 3 m , has end A resting on rough horizontal ground. The end B rests against a rough vertical wall.

The rod is in a vertical plane perpendicular to the wall.

The coefficient of friction between the rod and the ground is $\frac{4}{5}$

The coefficient of friction between the rod and the wall is $\frac{3}{5}$

The rod rests in limiting equilibrium.

The rod is at an angle of θ to the ground, as shown in Figure 1.

Find the exact value of $\tan \theta$.

(9)

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Question 3 continued

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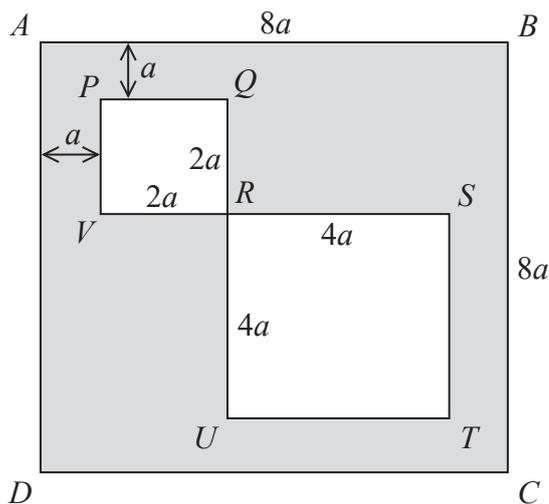


Figure 2

The uniform lamina L , shown shaded in Figure 2, is formed by removing the square $PQRV$, of side $2a$, and the square $RSTU$, of side $4a$, from a uniform square lamina $ABCD$, of side $8a$. The lines QRU and VRS are straight. The side AD is parallel to PV and the side AB is parallel to PQ . The distance between AD and PV is a and the distance between AB and PQ is a . The centre of mass of L is at the point G .

- (a) Show that the distance of G from the side AD is $\frac{42}{11}a$ (5)

The mass of L is M . A particle of mass kM is attached to L at C .

The lamina, with the attached particle, is freely suspended from B and hangs in equilibrium with BC making an angle of 45° with the horizontal.

- (b) Find the value of k . (4)



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Question 4 continued

Lined area for writing the answer to Question 4.

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Q4

(Total 9 marks)



5. At time t seconds ($t \geq 0$), a particle P has velocity $\mathbf{v} \text{ m s}^{-1}$, where

$$\mathbf{v} = (3t^2 - 9t + 6)\mathbf{i} + (t^2 + t - 6)\mathbf{j}$$

(a) Find the acceleration of P when $t = 3$ (3)

When $t = 0$, P is at the fixed point O .

The particle comes to instantaneous rest at the point A .

(b) Find the distance OA . (7)

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Question 5 continued

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Question 6 continued

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7. Particle A of mass $3m$ is moving in a straight line with speed $2u$ on a smooth horizontal surface. Particle A collides directly with particle B of mass m , which is moving along the same straight line and in the same direction as A .

Immediately before the collision, the speed of B is u .

As a result of the collision, the direction of motion of B is unchanged and the kinetic energy gained by B is $\frac{48}{25}mu^2$

- (a) Find the coefficient of restitution between A and B . **(8)**

After the collision, B hits a smooth fixed vertical wall that is perpendicular to the direction of motion of B . The coefficient of restitution between B and the wall is f .

Given that the speed of B immediately after first hitting the wall is equal to the speed of A immediately after its first collision with B ,

- (b) find the value of f . **(2)**



Question 7 continued

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Question 7 continued

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Q7

(Total 10 marks)



8. [In this question, the unit vectors \mathbf{i} and \mathbf{j} are in a vertical plane, with \mathbf{i} being horizontal and \mathbf{j} being vertically upwards.]

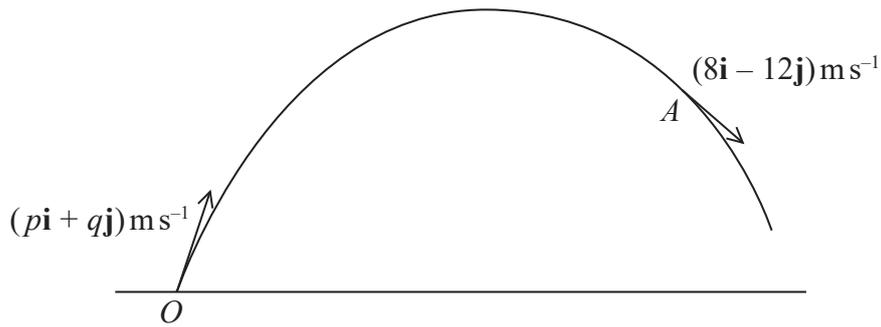


Figure 4

At time $t = 0$, a small ball is projected from a fixed point O on horizontal ground. The ball is projected from O with velocity $(p\mathbf{i} + q\mathbf{j})\text{ m s}^{-1}$, where p and q are positive constants. The ball moves freely under gravity.

At time $t = 3$ seconds, the ball passes through the point A with velocity $(8\mathbf{i} - 12\mathbf{j})\text{ m s}^{-1}$, as shown in Figure 4.

- (a) Find the speed of the ball at the instant it is projected from O . (5)

For an interval of T seconds the speed, $v\text{ m s}^{-1}$, of the ball is such that $v \leq 10$

- (b) Find the value of T . (4)

At the point B on the path of the ball, the direction of motion of the ball is perpendicular to the direction of motion of the ball at A .

- (c) Find the vertical height of B above A . (4)

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