Please check the examination details below before entering your candidate information

Candidate surname	Other names

Centre Number | Candidate Number

Pearson Edexcel Level 3 GCE

Thursday 19 June 2025

Afternoon

Paper reference **9MA0/32**

Mathematics

Advanced

PAPER 32: Mechanics

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

Total Marks

Candidates may use any calculator allowed 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.
- Unless otherwise indicated, whenever a 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.
- The total mark for this part of the examination is 50. There are 6 questions.
- 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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Pearson

1. A car moves in a straight line along a horizontal road with constant acceleration $2\,\text{m s}^{-2}$

The car is moving with speed $15\,\text{m s}^{-1}$ in the direction of the acceleration when it passes a signpost on the road.

The car is modelled as a particle.

(a) Use the model to find the speed of the car 4 s after passing the signpost.

(2)

Figure 1 below shows the horizontal forces acting on the car.

Given that

- the car has mass 800 kg
- the driving force of the engine has magnitude D newtons
- the resistance to the motion of the car has magnitude 400 N
- the acceleration of the car is $2\,\text{m s}^{-2}$ in the direction of the driving force

(b) use the model to find the value of D.

(2)

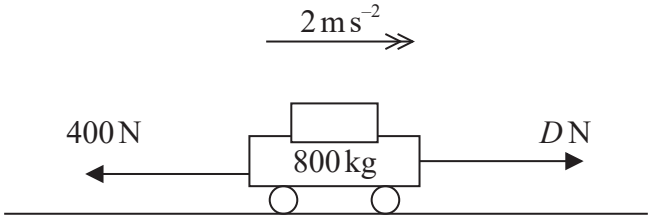

Figure 1

Question 1 continued

(Total for Question 1 is 4 marks)

2.

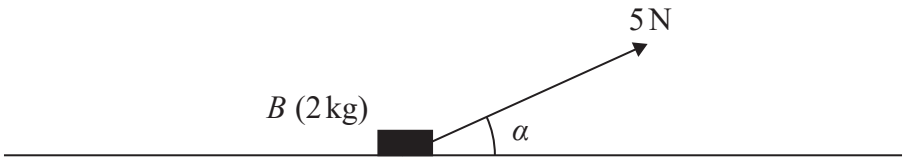

Figure 2

A small box B of mass 2 kg is dragged in a straight line, along a **rough** horizontal plane, at a **constant speed** by a force of magnitude 5 N.

The line of action of the force makes an angle α with the plane, where $\sin\alpha = \frac{3}{5}$, as shown in Figure 2.

(a) Show that the magnitude of the normal reaction of the plane on the box is 16.6 N.

(3)

At the instant when B is at the point O on the plane, the force of magnitude 5 N is removed.

(b) Describe the motion of the box after the force of magnitude 5 N is removed.

(1)

(c) Find the magnitude of the normal reaction of the plane on the box after the force of magnitude 5 N is removed.

(1)

Given that after the force of magnitude 5 N is removed

- the box is modelled as a particle
- air resistance is modelled as being negligible
- the coefficient of friction between the box and the plane is modelled as 0.2
- the speed of the box as it passes through O is $4\,\text{m s}^{-1}$
- the box comes to rest at the point X on the plane

(d) use the model to find the length OX.

(4)

(e) State one limitation of the model, apart from ignoring air resistance, that could affect your answer to part (d).

(1)

Question 2 continued

Question 2 continued

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Question 2 continued

(Total for Question 2 is 10 marks)

3. [*In this question,* **i** *and* **j** *are horizontal unit vectors due east and due north respectively.*]

A particle P of mass 0.5 kg moves with constant acceleration $(2\mathbf{i} - 2.4\mathbf{j})\,\text{m s}^{-2}$ on a smooth horizontal plane under the action of a constant horizontal force $\mathbf{F}$ N.

(a) Find $\mathbf{F}$ in terms of $\mathbf{i}$ and $\mathbf{j}$.

(1)

At time $t = 0$, P is moving with velocity $(-7\mathbf{i} + 7.8\mathbf{j})\,\text{m s}^{-1}$

(b) Find the velocity of P at time $t = 2$ seconds.

(2)

(c) Find the direction of motion of P at time $t = 2$ seconds, giving your answer as a bearing in degrees.

(3)

At time $t = 0$, P passes through the point O.

At time $t = 5$ seconds, P passes through the point A.

(d) Find $\overrightarrow{OA}$ in terms of $\mathbf{i}$ and $\mathbf{j}$.

(2)

Question 3 continued

Question 3 continued

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Question 3 continued

(Total for Question 3 is 8 marks)

4. [*In this question, position vectors are given relative to a fixed origin O.*]

At time t seconds, where $t > 0$, the position vector of a particle P is $\mathbf{r}$ metres where

$$\mathbf{r} = 4t^{\frac{3}{2}}\mathbf{i} - t^2\mathbf{j}$$

(a) Find the position vector of P at $t = 4$

(1)

(b) Find the exact distance of P from O at $t = 4$

(2)

(c) Find an expression for the velocity of P at time t seconds, where $t > 0$, giving your answer in terms of t, $\mathbf{i}$ and $\mathbf{j}$

(2)

At $t = T$, the acceleration of P is in a direction that is perpendicular to the line with equation $y = \frac{1}{3}x$

(d) Find the value of T.

(4)

Question 4 continued

Question 4 continued

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Question 4 continued

(Total for Question 4 is 9 marks)

5.

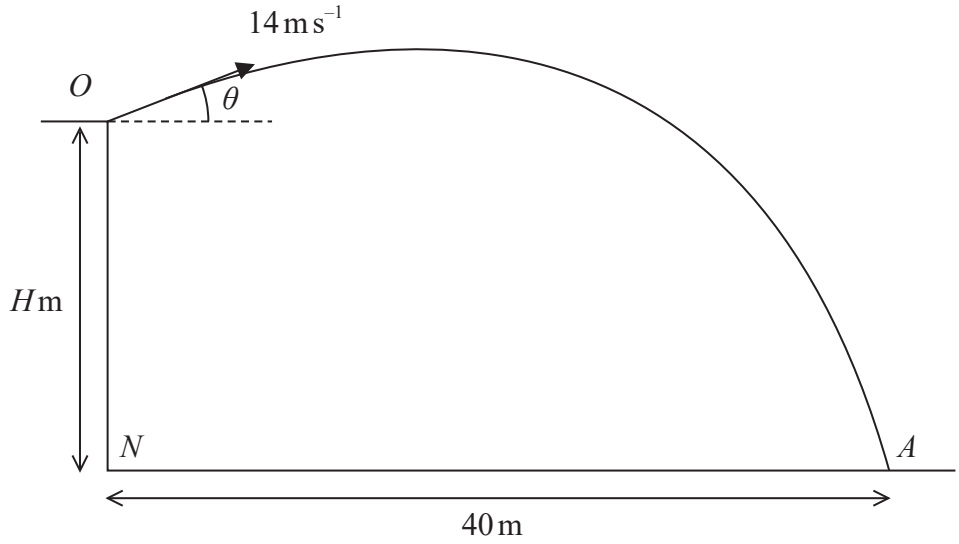

Figure 3

A small stone is projected with speed $14\,\text{m s}^{-1}$ from a point O on the top of a cliff. The point O is H metres vertically above the point N.

Point N is on horizontal ground.

The stone is projected at an angle θ above the horizontal, where $\tan\theta = \frac{1}{2}$

The stone strikes the horizontal ground at the point A, where $NA = 40\,\text{m}$, as shown in Figure 3.

The stone is modelled as a particle moving freely under gravity.

Using this model, find

(a) the value of H

(5)

(b) the maximum height of the stone above the horizontal ground.

(3)

Question 5 continued

Question 5 continued

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Question 5 continued

(Total for Question 5 is 8 marks)

6.

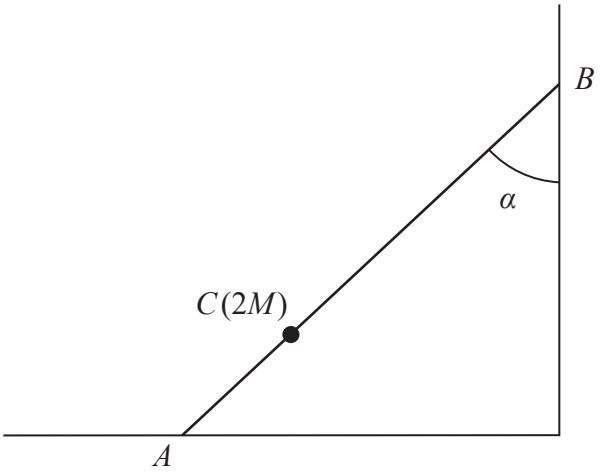

Figure 4

A uniform rod AB has mass M and length $2a$.

A particle of mass $2M$ is attached to the rod at the point C, where $AC = 0.5a$

The rod rests with end A on rough horizontal ground and end B against a vertical wall.

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

The rod is in equilibrium at an angle α to the wall, as shown in Figure 4.

In an initial model

- the vertical wall is modelled as being **smooth**
- the magnitude of the normal reaction of the ground on the rod at A is R
- the magnitude of the force exerted on the rod by the wall at B is S

Using the model,

(a) find R in terms of M and g

(1)

(b) show that $S = Mg \tan\alpha$

(3)

In a refined model

- the vertical wall is modelled as being **rough**
- the magnitude of the normal reaction of the ground on the rod at A is R_1

(c) State which is greater, R or R_1, giving a reason for your answer.

(1)

Question 6 continued

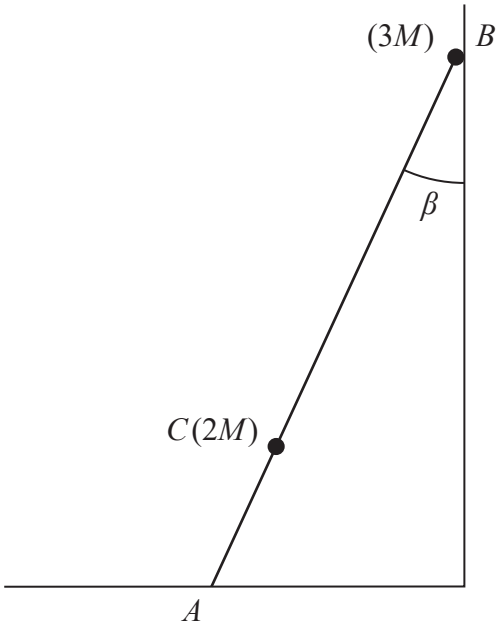

Figure 5

A second particle of mass $3M$ is now attached to the rod at B.

The rod again rests with end A on rough horizontal ground and end B against the vertical wall.

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

The rod is now in limiting equilibrium at an angle β to the wall, as shown in Figure 5.

The vertical wall is again modelled as being **smooth**.

The coefficient of friction between the rod and the ground is μ

Given that $\tan\beta = \frac{1}{2}$

(d) use the model to show that $\mu = \frac{1}{3}$

(6)

Question 6 continued

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Question 6 continued

Question 6 continued

(Total for Question 6 is 11 marks)

TOTAL FOR MECHANICS IS 50 MARKS

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