

Please check the examination details below before entering your candidate information

Candidate surname

Other names

Centre Number

Candidate Number

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Pearson Edexcel Level 3 GCE

Tuesday 20 June 2023

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.

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1. A car is initially at rest on a straight horizontal road.

The car then accelerates along the road with a constant acceleration of 3.2 m s^{-2}

Find

(a) the speed of the car after 5 s,

(1)

(b) the distance travelled by the car in the first 5 s.

(2)



Question 1 continued

(Total for Question 1 is 3 marks)



2.



Figure 1

A particle P has mass 5 kg.

The particle is pulled along a rough horizontal plane by a horizontal force of magnitude 28 N.

The only resistance to motion is a frictional force of magnitude F newtons, as shown in Figure 1.

- (a) Find the magnitude of the normal reaction of the plane on P

(1)

The particle is accelerating along the plane at 1.4 m s^{-2}

- (b) Find the value of F

(2)

The coefficient of friction between P and the plane is μ

- (c) Find the value of μ , giving your answer to 2 significant figures.

(1)



Question 2 continued

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(Total for Question 2 is 4 marks)

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

$$\mathbf{v} = (t^2 - 3t + 7)\mathbf{i} + (2t^2 - 3)\mathbf{j}$$

Find

- (a) the speed of P at time $t = 0$ (3)
- (b) the value of t when P is moving parallel to $(\mathbf{i} + \mathbf{j})$ (2)
- (c) the acceleration of P at time t seconds (2)
- (d) the value of t when the direction of the acceleration of P is perpendicular to \mathbf{i} (2)



Question 3 continued

(Total for Question 3 is 9 marks)



4. [In this question, \mathbf{i} and \mathbf{j} are horizontal unit vectors and position vectors are given relative to a fixed origin O]

A particle P is moving on a smooth horizontal plane.

The particle has constant acceleration $(2.4\mathbf{i} + \mathbf{j}) \text{ m s}^{-2}$

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

At time $t = 5 \text{ s}$, P passes through the point B .

The velocity of P as it passes through A is $(-16\mathbf{i} - 3\mathbf{j}) \text{ m s}^{-1}$

(a) Find the speed of P as it passes through B .

(4)

The position vector of A is $(44\mathbf{i} - 10\mathbf{j}) \text{ m}$.

At time $t = T$ seconds, where $T > 5$, P passes through the point C .

The position vector of C is $(4\mathbf{i} + c\mathbf{j}) \text{ m}$.

(b) Find the value of T .

(3)

(c) Find the value of c .

(3)



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Question 4 continued



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Question 4 continued

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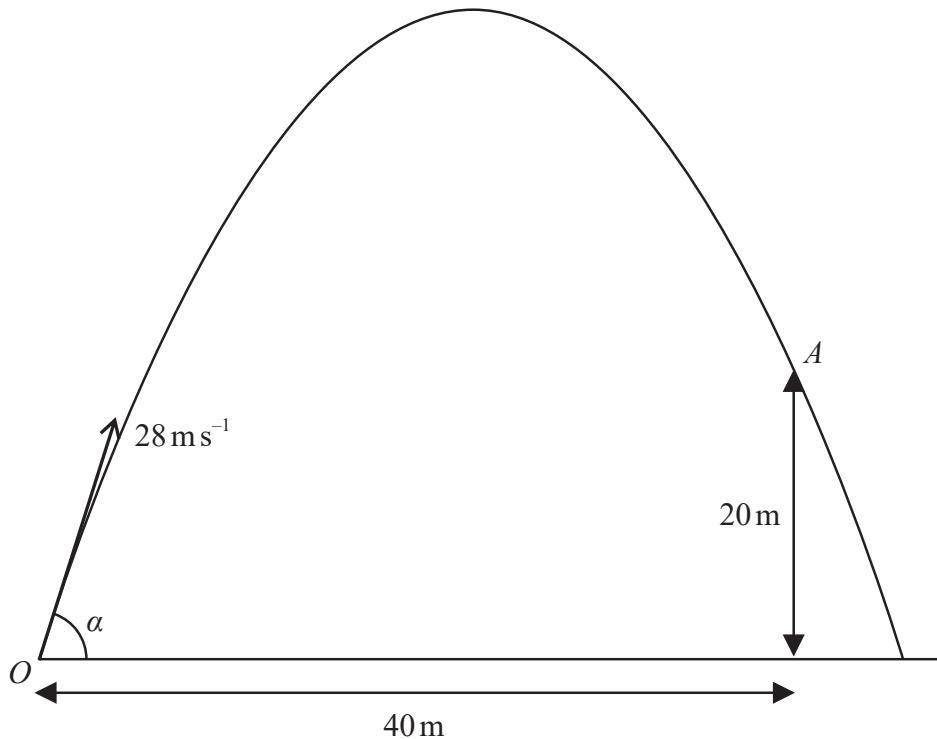


Question 4 continued

(Total for Question 4 is 10 marks)



5.

**Figure 2**

A small ball is projected with speed 28 m s^{-1} from a point O on horizontal ground.

After moving for T seconds, the ball passes through the point A .

The point A is 40 m horizontally and 20 m vertically from the point O , as shown in Figure 2.

The motion of the ball from O to A is modelled as that of a particle moving freely under gravity.

Given that the ball is projected at an angle α to the ground, use the model to

(a) show that $T = \frac{10}{7 \cos \alpha}$ (2)

(b) show that $\tan^2 \alpha - 4 \tan \alpha + 3 = 0$ (5)

(c) find the greatest possible height, in metres, of the ball above the ground as the ball moves from O to A . (3)

The model does not include air resistance.

(d) State one other limitation of the model. (1)



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Question 5 continued



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6.

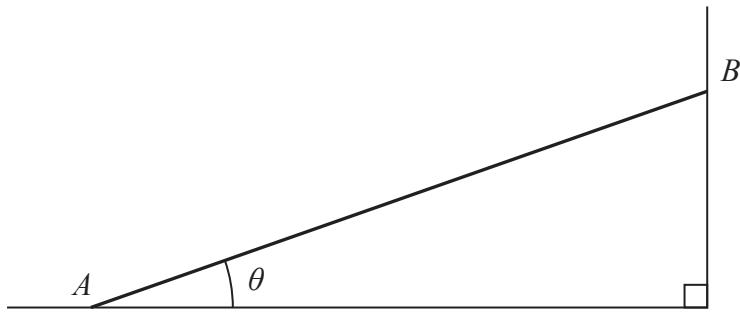


Figure 3

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

The rod has its end A on rough horizontal ground and its end B against a smooth vertical wall.

The rod makes an angle θ with the ground, as shown in Figure 3.

The rod is at rest in limiting equilibrium.

- (a) State the direction (left or right on Figure 3 above) of the frictional force acting on the rod at A . **Give a reason for your answer.**

(1)

The magnitude of the normal reaction of the wall on the rod at B is S .

In an initial model, the rod is modelled as being **uniform**.

Use this initial model to answer parts (b), (c) and (d).

- (b) By taking moments about A , show that

$$S = \frac{1}{2} Mg \cot \theta \quad (3)$$

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

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

- (c) find the value of μ (5)

- (d) find, in terms of M and g , the magnitude of the resultant force acting on the rod at A . (3)

In a new model, the rod is modelled as being **non-uniform**, with its centre of mass closer to B than it is to A .

A new value for S is calculated using this new model, with $\tan \theta = \frac{3}{4}$

- (e) State whether this new value for S is larger, smaller or equal to the value that S would take using the initial model. **Give a reason for your answer.** (1)



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Question 6 continued



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Question 6 continued



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(Total for Question 6 is 13 marks)

TOTAL FOR MECHANICS IS 50 MARKS

