Please check the examination details below before entering your candidate information

Candidate surname	Other names

Centre Number | Candidate Number

Pearson Edexcel Level 3 GCE

Paper reference **9MA0/32**

Mathematics

Advanced
PAPER 32: Mechanics
Mock Set 4

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 $g = 9.8\,\text{m}\,\text{s}^{-2}$ 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 5 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. [*In this question, position vectors are given relative to a fixed origin.*]

A particle P is moving with constant acceleration $(3\mathbf{i} - 2\mathbf{j})\,\text{m s}^{-2}$

At time $t = 1\,\text{s}$

- P is at the point with position vector $(5\mathbf{i} - 2\mathbf{j})\,\text{m}$
- P is moving with velocity $(-\mathbf{i} + 4\mathbf{j})\,\text{m s}^{-1}$

Find

(a) the exact speed of P at time $t = 4\,\text{s}$

(4)

(b) the position vector of P at time $t = 3\,\text{s}$

(3)

DO NOT WRITE IN THIS AREA

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Question 1 continued

(Total for Question 1 is 7 marks)

2. **In this question, solutions relying on calculator technology are not acceptable.**

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

A particle P is moving in the xy-plane.

At time t seconds, where $t \geqslant 0$, particle P is moving with acceleration $\mathbf{a}\,\text{m s}^{-2}$ where

$$\mathbf{a} = (1 - 3t)\mathbf{i} + (2t^2 - 2t)\mathbf{j}$$

At time $t = 0$

- P passes through the point with position vector $(\mathbf{i} + \mathbf{j})\,\text{m}$
- P is moving with velocity $(3\mathbf{i} - 2\mathbf{j})\,\text{m s}^{-1}$

(a) Find the velocity of P at time t seconds, where $t \geqslant 0$

(3)

(b) Find the position vector of P relative to O, when the acceleration of P is parallel to $(-\mathbf{i} - \mathbf{j})$.

(6)

Question 2 continued

(Total for Question 2 is 9 marks)

3.

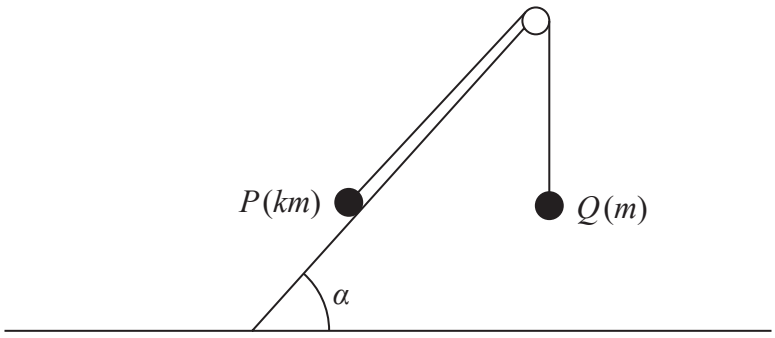

Figure 1

One end of a light inextensible string is attached to a particle P of mass km, where $k > 1.25$
The other end of the string is attached to a particle Q of mass m.
The string passes over a small smooth light pulley that is fixed at the top of a plane.
The plane is inclined to the horizontal at an angle α, where $\tan\alpha = \frac{4}{3}$
Particle P is held at rest on the plane and particle Q hangs at rest with the string taut, as shown in Figure 1.

The part of the string from P to the pulley lies along a line of greatest slope of the plane.
The two particles and the pulley all lie in the same vertical plane.
The particle P is released from rest.

In an initial model,

- the plane is modelled as being smooth
- P slides down the plane with acceleration $\frac{1}{5}g$

Using this model,

(a) write down an equation of motion for P

(2)

(b) find the value of k.

(4)

In a second model,

- the plane is modelled as being rough
- the coefficient of friction between P and the plane is μ
- P remains at rest but is on the point of slipping down the plane

Using this model,

(c) find, in terms of k, m and g, the magnitude of the normal reaction exerted by the plane on P.

(2)

(d) find, in terms of k, the value of μ.

(6)

Question 3 continued

Question 3 continued

Question 3 continued

(Total for Question 3 is 14 marks)

4.

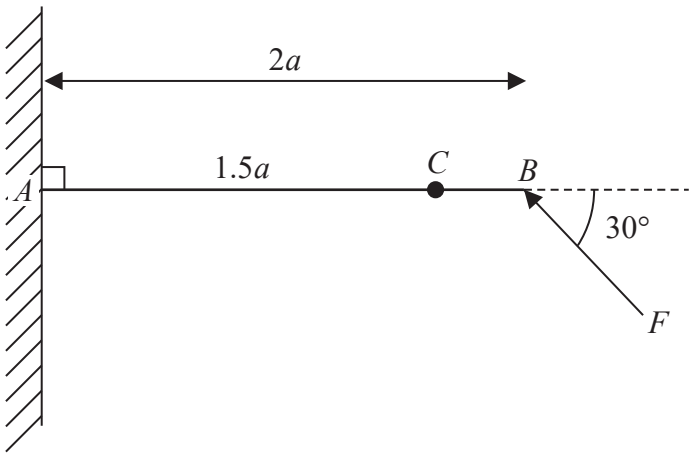

Figure 2

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 $AC = 1.5a$
The rod is freely hinged at its end A to a fixed vertical wall.
The rod is held in equilibrium in a horizontal position by a force applied to its end B.
The force has magnitude F and acts at 30° to the horizontal, as shown in Figure 2.

The line of action of the force and the rod lie in the same vertical plane that is perpendicular to the wall.

(a) Show that $F = 4mg$

(3)

(b) Find the magnitude, in terms of m and g, of the vertical component of the force exerted on the rod by the wall at A.

(2)

The line of action of the force exerted on the rod by the wall at A makes an angle θ with the horizontal.

(c) Find the exact value of $\tan\theta$.

(4)

Question 4 continued

Question 4 continued

Question 4 continued

(Total for Question 4 is 9 marks)

5.

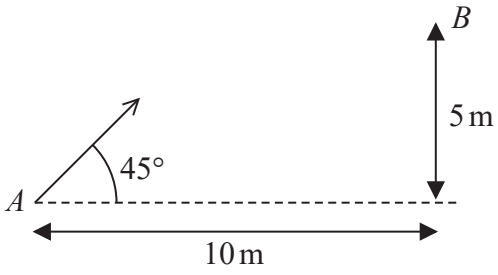

Figure 3

In a game, a small ball is thrown from a point A to a point B.
The ball is thrown at 45° to the horizontal.
The point B is 10 m horizontally from A and 5 m vertically from A, as shown in Figure 3.

In an initial model,

- the ball is modelled as a particle moving freely under gravity
- the initial speed of the ball is $U\,\text{m s}^{-1}$
- $g = 9.8\,\text{m s}^{-2}$

Using this model,

(a) find the value of U.

(6)

(b) find the speed of the ball at B.

(3)

One limitation of this model is that the air resistance on the ball is ignored.

(c) State one other limitation of this model.

(1)

In a refinement of the model,

- the ball is modelled as a particle
- air resistance on the ball is included
- the initial speed of the ball is $V\,\text{m s}^{-1}$
- $g = 9.8\,\text{m s}^{-2}$

(d) State how the value of V compares with the value of U, giving a reason for your answer.

(1)

Question 5 continued

Question 5 continued

(Total for Question 5 is 11 marks)

TOTAL FOR MECHANICS IS 50 MARKS