Please check the examination details below before entering your candidate information

Candidate surname	Other names

Centre Number | Candidate Number

Pearson Edexcel Level 3 GCE

Friday 23 May 2025

Afternoon

Paper reference **8MA0/22**

Mathematics

Advanced Subsidiary

PAPER 22: 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, wherever 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 30. There are 4 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 ▶

1.

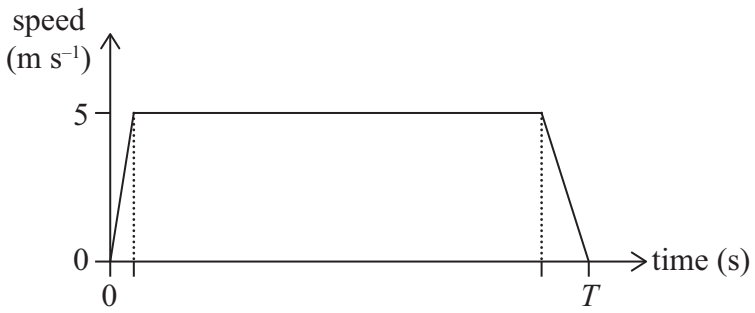

Figure 1

Figure 1 shows a sketch of the speed-time graph for a model of the motion of a runner travelling along a straight horizontal road from a point A to a point B.

The distance from A to B is 400 metres.

In the model of the motion, the runner

- starts from rest at A at time $t = 0$
- then moves with constant acceleration for 5 seconds, reaching a maximum speed of $5\,\text{m s}^{-1}$
- then travels at a constant speed of $5\,\text{m s}^{-1}$
- then moves with constant deceleration for 15 seconds, until coming to rest at B
- travels from A to B in T seconds

(a) Find the value of T.

(3)

(b) State **one** reason why the **actual** time taken to travel from A to B might not be T seconds.

(1)

Question 1 continued

(Total for Question 1 is 4 marks)

2. A particle P has mass 0.25 kg.

The particle moves on a smooth horizontal surface under the action of two horizontal forces $\mathbf{F}_1$ and $\mathbf{F}_2$

Given that $\mathbf{F}_1 = (3\mathbf{i} - 5\mathbf{j})$ N and $\mathbf{F}_2 = (-6\mathbf{i} + 9\mathbf{j})$ N

(a) find, in terms of **i** and **j**, the **resultant force** acting on P,

(1)

(b) find the **magnitude** of the acceleration of P.

(3)

A third horizontal force, $\mathbf{F}_3$, is now applied to P.

Under the action of $\mathbf{F}_1$, $\mathbf{F}_2$ and $\mathbf{F}_3$, the particle moves with **constant velocity**.

(c) Find $\mathbf{F}_3$, giving your answer in terms of **i** and **j**.

(1)

Question 2 continued

(Total for Question 2 is 5 marks)

3. A package P of mass 2 kg is held at rest on a horizontal table.
One end of a thin rope is attached to P.
The rope passes over a pulley that is fixed at the edge of the table.
The other end of the rope is attached to a package Q of mass 3 kg that hangs freely below the pulley.

Package P is 1.2 m from the pulley.
Package Q is 0.4 m above a horizontal floor and the rope is taut, as shown in Figure 2 on page 7.

Package P is released from rest and Q moves downwards.

In an initial model of the motion of P and Q

- the table is modelled as being smooth
- the packages are modelled as particles
- air resistance is modelled as being negligible
- the pulley is modelled as being small and smooth
- the rope is modelled as being light and inextensible

Using this model,

(a) write down an equation of motion for Q as it moves downwards,

(2)

(b) find the acceleration of Q as it moves downwards,

(3)

(c) find the speed of Q at the instant when Q hits the floor.

(2)

Given that K seconds **after** Q hits the floor, P hits the pulley

(d) use the model to find the value of K.

(2)

In a refinement of the model, there is a **resistance** which acts against the motion of P.

This refined model is now used to find the acceleration of Q as it moves downwards.

(e) State, **with a reason**, whether this **new** acceleration will be greater than, equal to, or less than, the acceleration found in part (b).

(1)

(f) Suggest one **further** refinement that could be made to the model, apart from including air resistance, that would make the model more realistic.

(1)

Question 3 continued

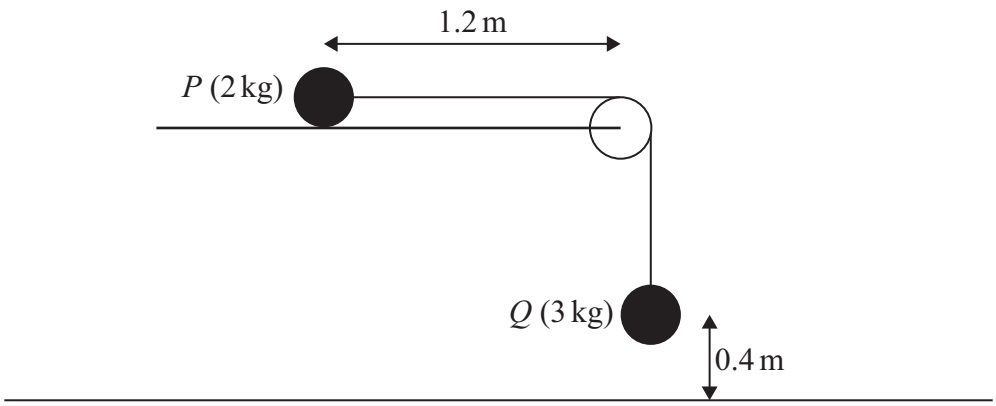

Figure 2

Question 3 continued

Question 3 continued

(Total for Question 3 is 11 marks)

4. **In this question you must show all stages of your working.**
Solutions relying entirely on calculator technology are not acceptable.

A fixed point O lies on a straight line.
A particle P moves along the straight line.

At time t seconds, $t \geqslant 0$, the distance, s metres, of P from O is given by

$$s = 2t^3 - 12t^2 + 18t$$

(a) Find the **values** of t for which P is instantaneously at rest.

(4)

(b) Find the **total** distance travelled by P in the interval $0 \leqslant t \leqslant 4$

(3)

(c) Find the maximum speed of P in the interval $1 \leqslant t \leqslant 3$

(3)

Question 4 continued

Question 4 continued

(Total for Question 4 is 10 marks)

TOTAL FOR MECHANICS IS 30 MARKS