Paper Reference 8MA0–22
Pearson Edexcel
Level 3 GCE

Mathematics
Advanced Subsidiary
Paper 22: Mechanics

Wednesday 22 May 2019 – Morning

MATERIALS REQUIRED FOR EXAMINATION

Mathematical Formulae and Statistical Tables, calculator

ITEMS INCLUDED WITH QUESTION PAPERS

Diagram Book

Answer Book

Y63361A

Pearson

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

In the boxes on the Answer Book and on the Diagram Book, write 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 Answer Book or on the separate diagrams − there may be more space than you need.

Do NOT write on the Question Paper.

You should show sufficient working to make your methods clear. Answers without working may not gain full credit.

Answers should be given to three significant figures unless otherwise stated.

INFORMATION

A booklet 'Mathematical Formulae and Statistical Tables' is provided.

The total mark for this part of the examination is 30

There are 3 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.

Unless otherwise indicated, wherever a value of g is required, take $g = 9{\cdot}8\ ms^{-2}$ and give your answer to either 2 significant figures or 3 significant figures.

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.

Answer ALL questions.

Write your answers in the Answer Book.

1. At time $t = 0$, a parachutist falls vertically from rest from a helicopter which is hovering at a height of 550 metres above horizontal ground.

The parachutist, who is modelled as a particle, falls for 3 seconds before her parachute opens.

While she is falling, and before her parachute opens, she is modelled as falling freely under gravity.

The acceleration due to gravity is modelled as being $10\,\text{m}\,\text{s}^{-2}$

(continued on the next page)

1. continued.

(a) Using this model, find the speed of the parachutist at the instant her parachute opens.

(1 mark)

(continued on the next page)

1. continued.

When her parachute is open, the parachutist continues to fall vertically.

Immediately after her parachute opens, she decelerates at $12\,\mathrm{m\,s^{-2}}$ for 2 seconds before reaching a constant speed and she reaches the ground with this speed.

The total time taken by the parachutist to fall the 550 metres from the helicopter to the ground is T seconds.

(continued on the next page)

1. continued.

(b) Sketch a speed–time graph for the motion of the parachutist for $0 \leq t \leq T$

(2 marks)

(c) Find, to the nearest whole number, the value of T

(5 marks)

(continued on the next page)

1. continued.

In a refinement of the model of the motion of the parachutist, the effect of air resistance is included before her parachute opens and this refined model is now used to find a new value of T

(d) How would this new value of T compare with the value found, using the initial model, in part (c)?

(1 mark)

(continued on the next page)

1. continued.

(e) Suggest one further refinement to the model, apart from air resistance, to make the model more realistic.

(1 mark)

(Total for Question 1 is 10 marks)

---

2. Refer to the diagram for Question 2 in the Diagram Book.

A small ball, P, of mass 0·8 kg, is held at rest on a smooth horizontal table and is attached to one end of a thin rope.

The rope passes over a pulley that is fixed at the edge of the table.

The other end of the rope is attached to another small ball, Q, of mass 0·6 kg, that hangs freely below the pulley.

(continued on the next page)

2. continued.

Ball P is released from rest, with the rope taut, with P at a distance of $1 \cdot 5$ metres from the pulley and with Q at a height of $0 \cdot 4$ metres above the horizontal floor, as shown in the diagram.

Ball Q descends, hits the floor and does not rebound.

The balls are modelled as particles, the rope as a light and inextensible string and the pulley as small and smooth.

(continued on the next page)

2. continued.

Using this model,

(a) show that the acceleration of Q, as it falls, is $4 \cdot 2 \, m \, s^{-2}$

(5 marks)

(b) find the time taken by P to hit the pulley from the instant when P is released.

(6 marks)

(c) State one limitation of the model that will affect the accuracy of your answer to part (a)

(1 mark)

(Total for Question 2 is 12 marks)

3. A particle, P, moves along a straight line such that at time t seconds, $t \geq 0$, the velocity of P, $v \text{ m s}^{-1}$, is modelled as

$$v = 12 + 4t - t^2$$

Find

(a) the magnitude of the acceleration of P when P is at instantaneous rest,

(5 marks)

(continued on the next page)

3. continued.

(b) the distance travelled by P in the interval $0 \leq t \leq 3$

(3 marks)

(Total for Question 3 is 8 marks)

TOTAL FOR MECHANICS IS 30 MARKS

END OF PAPER
