Please check the examination details below before entering your candidate information

Candidate surname	Other names

Pearson Edexcel Level 3 GCE

Centre Number	Candidate Number

Mock Paper – Set 2

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 $g = 9.8$ 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 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

Pearson

1. At time t seconds ($t \geqslant 0$), a particle P is modelled as having velocity $\mathbf{v}\,\text{m s}^{-1}$, where

$$\mathbf{v} = (3t^2 - 12t)\mathbf{i} + (9t^2 - 3t)\mathbf{j}$$

and having acceleration $\mathbf{a}\,\text{m s}^{-2}$

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

(2)

When $t = 0$, P is at the origin O.

At time t seconds ($t \geqslant 0$), P has position vector $\mathbf{r}$ metres relative to O.

(b) Find $\mathbf{r}$ in terms of $\mathbf{i}$, $\mathbf{j}$ and t.

(2)

At the instant when $\mathbf{a} = \lambda\mathbf{j}$, where λ is a constant, P is at the point A.

(c) Find the position vector of A relative to O.

(4)

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S 6 7 8 0 3 A 0 2 2 0

Question 1 continued

(Total for Question 1 is 8 marks)

2.

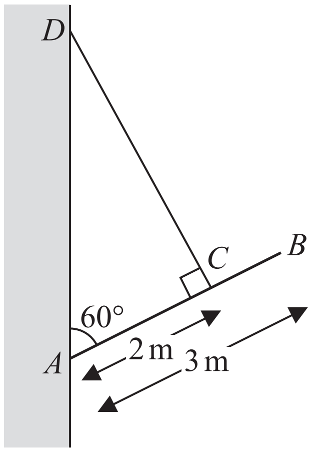

Figure 1

A beam AB has weight 40 N and length 3 m.
The beam is freely hinged at the end A to a vertical wall.
The beam is held in equilibrium at an angle of 60° to the wall by a rope.

One end of the rope is attached to the point C on the beam, where $AC = 2$ m.
The other end of the rope is attached to a point D on the wall, where D is vertically above A.
The rope is perpendicular to the beam, as shown in Figure 1.
The rope and the beam lie in a vertical plane that is perpendicular to the wall.

The beam is modelled as a uniform rod and the rope as a light inextensible string.

Using the model, find

(a) the tension in the rope,

(3)

(b) the magnitude of the resultant force acting on the beam at A.

(6)

If the rope was not modelled as being light,

(c) state how this would affect the tension along the rope, explaining your answer.

(2)

Question 2 continued

Question 2 continued

Question 2 continued

(Total for Question 2 is 11 marks)

3.

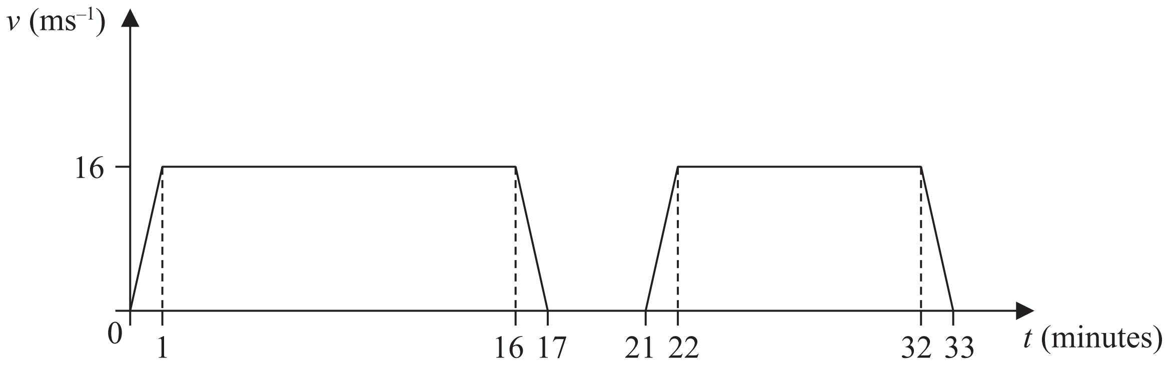

Figure 2

A train X runs on a straight horizontal track that connects stations A and C.
Station B lies between A and C.
Figure 2 shows the graph of the speed, $v\,\text{ms}^{-1}$, of train X against the time, t minutes, after noon.
Train X leaves A at noon and accelerates uniformly from rest until $t = 1$, when it is moving with speed $16\,\text{ms}^{-1}$
Train X then continues to move along the track at constant speed for 15 minutes, before decelerating uniformly and coming to rest at B at time $t = 17$
Train X leaves B at time $t = 21$ and accelerates uniformly for one minute, reaching a speed of $16\,\text{ms}^{-1}$
Train X then moves along the track at a constant speed of $16\,\text{ms}^{-1}$ for 10 minutes, before decelerating uniformly and coming to rest at C at time $t = 33$

(a) Find the distance of C from A, stating the units of your answer.

(3)

A second train, Y, leaves A at T minutes after noon and moves in the same direction as train X on a parallel straight horizontal track.
Train Y accelerates uniformly from rest for 2 minutes, reaching a speed of $24\,\text{ms}^{-1}$
Train Y then moves along the track at a constant speed of $24\,\text{ms}^{-1}$ and passes C at this speed.

Train Y passes C at the instant train X stops at C.

(b) Find the value of T.

(5)

(c) State one assumption made in your working that could affect the accuracy of your answer to part (b).

(1)

Question 3 continued

Question 3 continued

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Question 3 continued

(Total for Question 3 is 9 marks)

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Turn over

4.

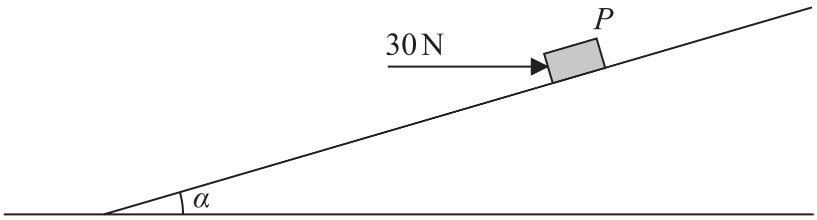

Figure 3

A package P of weight 20 N is moving up an inclined plane under the action of a horizontal force of magnitude 30 N, as shown in Figure 3.
The force is acting in a vertical plane through a line of greatest slope of the plane.
The coefficient of friction between P and the plane is μ

The plane is inclined at angle α to the horizontal, where $\tan\alpha = \frac{5}{12}$

Package P is modelled as a particle.

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

(2)

(b) Find the range of possible values of μ

(4)

The horizontal force is now removed and P continues to slide up the plane until P comes to instantaneous rest.

Package P then slides back down the plane.

Given that $\mu = \frac{1}{3}$

(c) find the acceleration of P as it slides down the plane.

(5)

S 6 7 8 0 3 A 0 1 2 2 0

Question 4 continued

Question 4 continued

Question 4 continued

(Total for Question 4 is 11 marks)

5. A small ball is projected with speed u from a point O on horizontal ground.
The angle of projection is θ to the horizontal, where $0 < \theta < 90°$
The ball hits the ground at the point A.

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

(a) Show that, according to the model, $OA = \dfrac{u^2 \sin 2\theta}{g}$ **(5)**

A golfer hits a golf ball with speed $25\,\text{ms}^{-1}$ from a point X on horizontal ground.
The golf ball hits the ground at the point Y.
The angle of projection is θ to the horizontal, where $0 < \theta < 90°$
The golfer requires the distance XY to be at least 40 m.

The golf ball is modelled as a particle moving freely under gravity.

(b) Find, according to the model, the size of the largest possible angle θ **(2)**

Given that $\theta = 30°$ and that the golf ball is more than 3 m above the ground for T seconds,

(c) find the value of T. **(4)**

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Question 5 continued

Question 5 continued

Question 5 continued

Question 5 continued

(Total for Question 5 is 11 marks)

TOTAL FOR MECHANICS IS 50 MARKS