Paper Reference 8FM0/26
Pearson Edexcel
Level 3 GCE

Further Mathematics

Advanced Subsidiary
Further Mathematics options
26: Further Mechanics 2
(Part of option J)

YOU MUST HAVE
Mathematical Formulae and Statistical Tables (Green), calculator

YOU WILL BE GIVEN
Diagram Booklet
Answer Booklet

X72063A

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 Booklet and on the Diagram Booklet, 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 Booklet 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.

Unless otherwise indicated, whenever a value of g is required, take $g = 9{\cdot}8\ \mathrm{m\,s^{-2}}$, 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 40

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.

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1. Refer to the diagram for Question 1 in the Diagram Booklet.

A uniform plane lamina is in the shape of an isosceles trapezium $ABCDEF$, as shown in the diagram in the Diagram Booklet.

- $BCEF$ is a square
- $AB = CD = a$
- $BC = 3a$

(a) Show that the distance of the centre of mass of the lamina from AD is $\frac{11a}{8}$
(5 marks)

(continued on the next page)

1. continued.

The mass of the lamina is M

The lamina is suspended by two light vertical strings, one attached to the lamina at A and the other attached to the lamina at F

The lamina hangs freely in equilibrium, with BF horizontal.

(b) Find, in terms of M and g, the tension in the string attached at A

(2 marks)

(Total for Question 1 is 7 marks)

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

Uniform wire is used to form the framework shown in the diagram in the Diagram Booklet.

In the framework

- **$ABCD$ is a rectangle with $AD = 2a$ and $DC = a$**

- **BEC is a semicircular arc of radius a and centre O, where O lies on BC**

(continued on the next page)

2. continued.

The diameter of the semicircle is BC and the point E is such that OE is perpendicular to BC

The points A, B, C, D and E all lie in the same plane.

(a) Show that the distance of the centre of mass of the framework from BC is

$$\frac{a}{6 + \pi}$$

(5 marks)

The framework is freely suspended from A and hangs in equilibrium with AE at an angle θ° to the downward vertical.

(b) Find the value of θ

(4 marks)

(continued on the next page)

2. continued.

The mass of the framework is M

A particle of mass kM is attached to the framework at B

The centre of mass of the loaded framework lies on OA

(c) Find the value of k

(3 marks)

(Total for Question 2 is 12 marks)

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3. A cyclist is travelling around a circular track which is banked at an angle α to the horizontal, where

$$\tan\alpha = \frac{3}{4}$$

The cyclist moves with constant speed in a horizontal circle of radius r

In an initial model,

- the cyclist and her cycle are modelled as a particle

- the track is modelled as being rough so that there is sideways friction between the tyres of the cycle and the track, with coefficient of friction μ, where $\mu < \frac{4}{3}$

(continued on the next page)

3. continued.

Using this model, the maximum speed that the cyclist can travel around the track in a horizontal circle of radius r, without slipping sideways, is V

(a) Show that

$$V = \sqrt{\frac{(3 + 4\mu)rg}{4 - 3\mu}}$$

(7 marks)

(continued on the next page)

3. continued.

In a new simplified model,

- the cyclist and her cycle are modelled as a particle

- the motion is now modelled so that there is NO sideways friction between the tyres of the cycle and the track

Using this new model, the speed that the cyclist can travel around the track in a horizontal circle of radius r, without slipping sideways, is U

(b) Find U in terms of r and g

(2 marks)

(c) Show that $U < V$

(2 marks)

(Total for Question 3 is 11 marks)

4. A particle P moves on the x–axis.

At time t seconds the velocity of P is v m s^{-1} in the direction of x increasing, where

$$v = \frac{1}{2}(3e^{2t} - 1) \qquad t \geq 0$$

The acceleration of P at time t seconds is a m s^{-2}

(a) Show that $a = 2v + 1$

(2 marks)

(b) Find the acceleration of P when $t = 0$

(1 mark)

(c) Find the exact distance travelled by P in accelerating from a speed of 1 m s^{-1} to a speed of 4 m s^{-1}

(7 marks)

(Total for Question 4 is 10 marks)

TOTAL FOR FURTHER MECHANICS 2 IS 40 MARKS

END OF PAPER