

Write your name here

| | |
|---------|-------------|
| Surname | Other names |
|---------|-------------|

Pearson Edexcel
Level 3 GCE

Centre Number

| | | | | |
|--|--|--|--|--|
| | | | | |
|--|--|--|--|--|

Candidate Number

| | | | |
|--|--|--|--|
| | | | |
|--|--|--|--|

Further Mathematics

Advanced

Further Mathematics Option 2

Paper 4: Further Mechanics 2

Sample Assessment Material for first teaching September 2017

Time: 1 hour 30 minutes

Paper Reference

9FM0/4F

You must have:

Mathematical Formulae and Statistical Tables, calculator

Total Marks

| |
|--|
| |
|--|

Candidates may use any calculator permitted by Pearson regulations. Calculators must not have the facility for algebraic 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.
- Answers should be given to three significant figures unless otherwise stated.

Information

- A booklet 'Mathematical Formulae and Statistical Tables' is provided.
- There are 7 questions in this question paper. The total mark for this paper is 75.
- 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 ►

S54446A

©2017 Pearson Education Ltd.

1/1/1



Pearson

2.

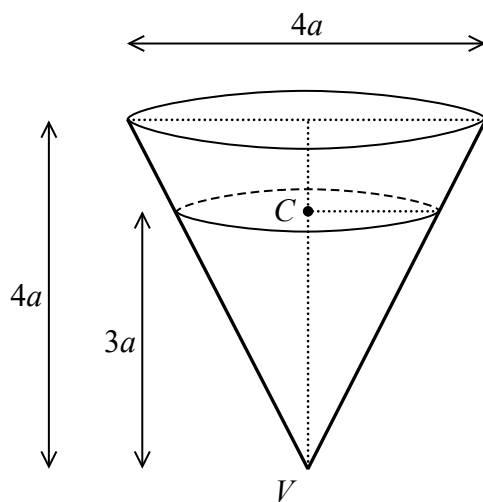


Figure 1

A hollow right circular cone, of base diameter $4a$ and height $4a$ is fixed with its axis vertical and vertex V downwards, as shown in Figure 1.

A particle of mass m moves in a horizontal circle with centre C on the rough inner surface of the cone with constant angular speed ω .

The height of C above V is $3a$.

The coefficient of friction between the particle and the inner surface of the cone is $\frac{1}{4}$.

Find, in terms of a and g , the greatest possible value of ω .

(8)

DO NOT WRITE IN THIS AREA

DO NOT WRITE IN THIS AREA

DO NOT WRITE IN THIS AREA

3.

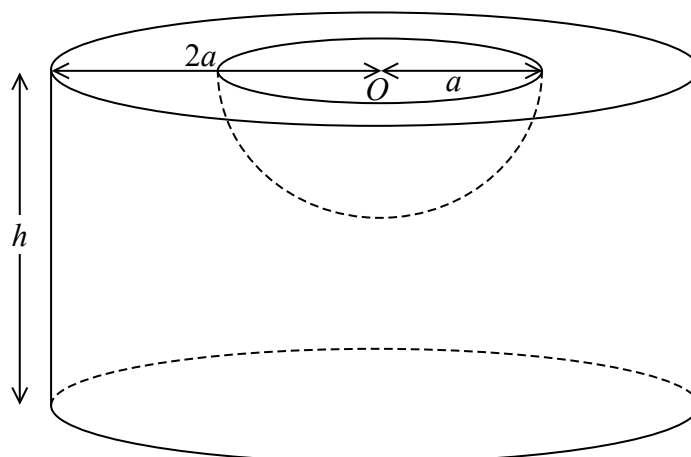


Figure 2

A uniform solid cylinder has radius $2a$ and height h ($h > a$).

A solid hemisphere of radius a is removed from the cylinder to form the vessel V .

The plane face of the hemisphere coincides with the upper plane face of the cylinder.

The centre O of the hemisphere is also the centre of the upper plane face of the cylinder, as shown in Figure 2.

(a) Show that the centre of mass of V is $\frac{3(8h^2 - a^2)}{8(6h - a)}$ from O . (5)

The vessel V is placed on a rough plane which is inclined at an angle ϕ to the horizontal.

The lower plane circular face of V is in contact with the inclined plane.

Given that $h = 5a$, the plane is sufficiently rough to prevent V from slipping and V is on the point of toppling,

(b) find, to three significant figures, the size of the angle ϕ . (4)

4. A car of mass 500 kg moves along a straight horizontal road.

The engine of the car produces a constant driving force of 1800 N.

The car accelerates from rest from the fixed point O at time $t = 0$ and at time t seconds the car is x metres from O , moving with speed $v \text{ m s}^{-1}$.

When the speed of the car is $v \text{ m s}^{-1}$, the resistance to the motion of the car has magnitude $2v^2 \text{ N}$.

At time T seconds, the car is at the point A , moving with speed 10 m s^{-1} .

(a) Show that $T = \frac{25}{6} \ln 2$ (6)

(b) Show that the distance from O to A is $125 \ln \frac{9}{8} \text{ m}$. (5)

DO NOT WRITE IN THIS AREA

DO NOT WRITE IN THIS AREA

DO NOT WRITE IN THIS AREA

5.

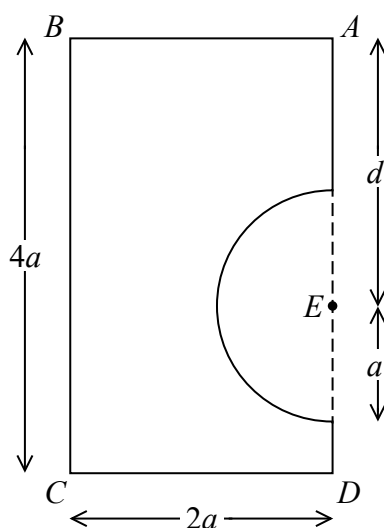


Figure 3

A shop sign is modelled as a uniform rectangular lamina $ABCD$ with a semicircular lamina removed.

The semicircle has radius a , $BC = 4a$ and $CD = 2a$.

The centre of the semicircle is at the point E on AD such that $AE = d$, as shown in Figure 3.

(a) Show that the centre of mass of the sign is $\frac{44a}{3(16 - \pi)}$ from AD . (4)

The sign is suspended using vertical ropes attached to the sign at A and at B and hangs in equilibrium with AB horizontal.

The weight of the sign is W and the ropes are modelled as light inextensible strings.

(b) Find, in terms of W and π , the tension in the rope attached at B . (2)

The rope attached at B breaks and the sign hangs freely in equilibrium suspended from A , with AD at an angle α to the downward vertical.

Given that $\tan \alpha = \frac{11}{18}$

(c) find d in terms of a and π . (6)

6. A small bead B of mass m is threaded on a circular hoop.

The hoop has centre O and radius a and is fixed in a vertical plane.

The bead is projected with speed $\sqrt{\frac{7}{2}}ga$ from the lowest point of the hoop.

The hoop is modelled as being smooth.

When the angle between OB and the downward vertical is θ , the speed of B is v .

- (a) Show that $v^2 = ga\left(\frac{3}{2} + 2\cos\theta\right)$ (3)
- (b) Find the size of θ at the instant when the contact force between B and the hoop is first zero. (5)
- (c) Give a reason why your answer to part (b) is not likely to be the actual value of θ . (1)
- (d) Find the magnitude and direction of the acceleration of B at the instant when B is first at instantaneous rest. (5)

DO NOT WRITE IN THIS AREA

DO NOT WRITE IN THIS AREA

DO NOT WRITE IN THIS AREA

7. Two points A and B are 6 m apart on a smooth horizontal surface.

A light elastic string of natural length 2 m and modulus of elasticity 20 N, has one end attached to the point A .

A second light elastic string of natural length 2 m and modulus of elasticity 50 N, has one end attached to the point B .

A particle P of mass 3.5 kg is attached to the free end of each string.

The particle P is held at the point on AB which is 2 m from B and then released from rest.

In the subsequent motion both strings remain taut.

- (a) Show that P moves with simple harmonic motion about its equilibrium position. (7)
- (b) Find the maximum speed of P . (2)
- (c) Find the length of time within each oscillation for which P is closer to A than to B . (5)

DO NOT WRITE IN THIS AREA

DO NOT WRITE IN THIS AREA

DO NOT WRITE IN THIS AREA

