

Please check the examination details below before entering your candidate information

Candidate surname	Other names
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**Pearson Edexcel
Level 3 GCE**

Centre Number

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Candidate Number

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Tuesday 25 June 2019

Morning (Time: 1 hour 30 minutes)	Paper Reference 9FM0/4C
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**Further Mathematics
Advanced
Paper 4C: Further Mechanics 2**

You must have:
Mathematical Formulae and Statistical Tables (Green), calculator

Total Marks

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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.
- Unless otherwise indicated, whenever a numerical 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.
- 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 ►

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Answer ALL questions. Write your answers in the spaces provided.

1.

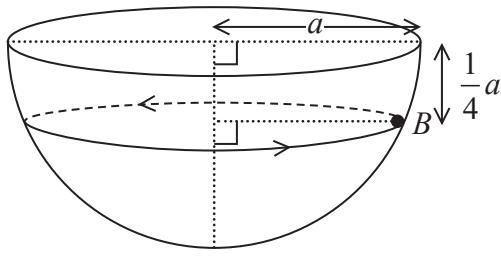


Figure 1

A hemispherical shell of radius a is fixed with its rim uppermost and horizontal. A small bead, B , is moving with constant angular speed, ω , in a horizontal circle on the smooth inner surface of the shell. The centre of the path of B is at a distance $\frac{1}{4}a$ vertically below the level of the rim of the hemisphere, as shown in Figure 1.

Find the magnitude of ω , giving your answer in terms of a and g .

(6)



3. Numerical (calculator) integration is not acceptable in this question.

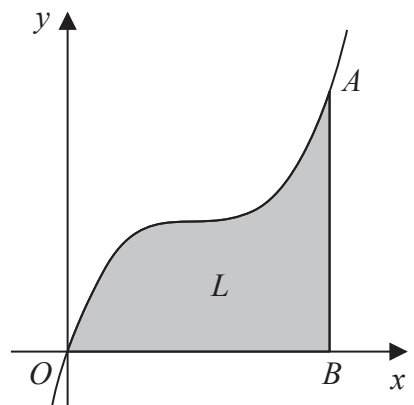


Figure 2

The shaded region OAB in Figure 2 is bounded by the x -axis, the line with equation $x = 4$ and the curve with equation $y = \frac{1}{4}(x - 2)^3 + 2$. The point A has coordinates $(4, 4)$ and the point B has coordinates $(4, 0)$.

A uniform lamina L has the shape of OAB . The unit of length on both axes is one centimetre. The centre of mass of L is at the point with coordinates (\bar{x}, \bar{y}) .

Given that the area of L is 8 cm^2 ,

- (a) show that $\bar{y} = \frac{8}{7}$ (4)

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

- (b) Find the value of θ . (7)



Question 3 continued

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Question 3 continued

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(Total for Question 3 is 11 marks)



4. A flagpole, AB , is 4 m long. The flagpole is modelled as a non-uniform rod so that, at a distance x metres from A , the mass per unit length of the flagpole, $m \text{ kg m}^{-1}$, is given by $m = 18 - 3x$.

(a) Show that the mass of the flagpole is 48 kg.

(3)

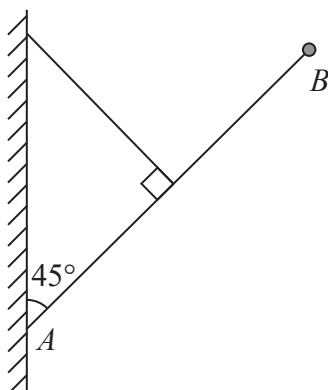


Figure 3

The end A of the flagpole is fixed to a point on a vertical wall. A cable has one end attached to the midpoint of the flagpole and the other end attached to a point on the wall that is vertically above A . The cable is perpendicular to the flagpole. The flagpole and the cable lie in the same vertical plane that is perpendicular to the wall. A small ball of mass 4 kg is attached to the flagpole at B . The cable holds the flagpole and ball in equilibrium, with the flagpole at 45° to the wall, as shown in Figure 3.

The tension in the cable is T newtons.

The cable is modelled as a light inextensible string and the ball is modelled as a particle.

(b) Using the model, find the value of T .

(8)

(c) Give a reason why the answer to part (b) is not likely to be the true value of T .

(1)



Question 4 continued

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5.

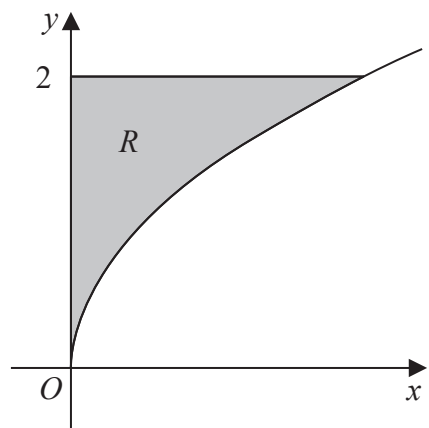


Figure 4

The region R , shown shaded in Figure 4, is bounded by part of the curve with equation $y^2 = 2x$, the line with equation $y = 2$ and the y -axis. The unit of length on both axes is one centimetre. A uniform solid, S , is formed by rotating R through 360° about the y -axis.

Given that the volume of S is $\frac{8}{5}\pi \text{ cm}^3$,

- (a) show that the centre of mass of S is $\frac{1}{3}$ cm from its plane face. (4)

A uniform solid cylinder, C , has base radius 2 cm and height 4 cm. The cylinder C is attached to S so that the plane face of S coincides with a plane face of C , to form the paperweight P , shown in Figure 5. The density of the material used to make S is three times the density of the material used to make C .

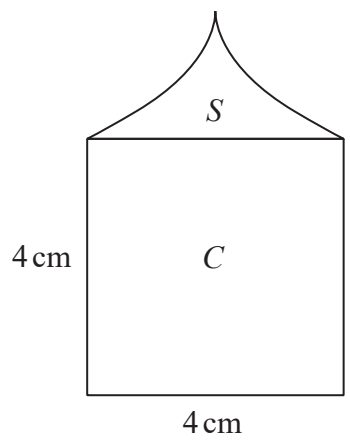


Figure 5

The plane face of P rests in equilibrium on a desk lid that is inclined at an angle θ° to the horizontal. The lid is sufficiently rough to prevent P from slipping. Given that P is on the point of toppling,

- (b) find the value of θ . (7)



Question 5 continued

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Question 5 continued

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Question 5 continued

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(Total for Question 5 is 11 marks)



7. A particle, P , of mass m is attached to one end of a light rod of length L . The other end of the rod is attached to a fixed point O so that the rod is free to rotate in a vertical plane about O . The particle is held with the rod horizontal and is then projected vertically downwards with speed u . The particle first comes to instantaneous rest at the point A .

(a) Explain why the acceleration of P at A is perpendicular to OA . (1)

At the instant when P is at the point A the acceleration of P is in a direction making an angle θ with the horizontal. Given that $u^2 = \frac{2gL}{3}$,

(b) find

(i) the magnitude of the acceleration of P at the point A ,

(ii) the size of θ . (6)

(c) Find, in terms of m and g , the magnitude of the tension in the rod at the instant when P is at its lowest point. (5)



Question 7 continued

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Question 7 continued

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Question 7 continued

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Question 7 continued

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TOTAL FOR PAPER IS 75 MARKS

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