Write your name here

Surname	Other names

Pearson
Edexcel GCE

Centre Number	Candidate Number

Mechanics M3

Advanced/Advanced Subsidiary

Wednesday 16 May 2018 – Morning
Time: 1 hour 30 minutes

Paper Reference
6679/01

You must have:
Mathematical Formulae and Statistical Tables (Pink)

Total Marks

Candidates may use any calculator allowed by the regulations of the Joint Council for Qualifications. 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). Coloured pencils and highlighter pens must not be used.
- **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.
- Whenever a numerical value of g is required, take $g = 9.8 \text{ m s}^{-2}$, and give your answer to either two significant figures or three significant figures.
- When a calculator is used, the answer should be given to an appropriate degree of accuracy.

Information

- 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.

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1. A rough disc is rotating in a horizontal plane with constant angular speed ω about a vertical axis through the centre of the disc. A particle P is placed on the disc at a distance r from the axis. The coefficient of friction between P and the disc is μ.

Given that P does not slip on the disc, show that

$$\omega \leqslant \sqrt{\frac{\mu g}{r}}$$

(5)

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Question 1 continued

Q1

(Total 5 marks)

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2. A light elastic string has natural length 1.2 m and modulus of elasticity λ newtons. One end of the string is attached to a fixed point O. A particle of mass 0.5 kg is attached to the other end of the string. The particle is moving with constant angular speed ω rad s^{-1} in a horizontal circle with the string stretched. The circle has radius 0.9 m and its centre is vertically below O. The string is inclined at 60° to the horizontal.

Find

(a) the value of λ,

(7)

(b) the value of ω.

(4)

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Question 2 continued

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Question 2 continued

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Question 2 continued

Q2

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3. A particle P of mass m moves in a straight line away from the centre of the Earth. The Earth is modelled as a sphere of radius R. When P is at a distance x, $x \geqslant R$, from the centre of the Earth, the force exerted by the Earth on P is directed towards the centre of the Earth and has magnitude $\frac{mgR^2}{x^2}$. When P is at a distance $2R$ from the surface of the Earth, the speed of P is $\sqrt{\frac{gR}{3}}$.

Assuming that air resistance can be ignored, find the distance of P from the surface of the Earth when the speed of P is $2\sqrt{\frac{gR}{3}}$.

(7)

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Question 3 continued

Q3

(Total 7 marks)

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4. One end of a light elastic string, of modulus of elasticity $2mg$ and natural length l, is fixed to a point O on a rough plane. The plane is inclined at angle α to the horizontal, where $\sin\alpha = \frac{3}{5}$. The other end of the string is attached to a particle P of mass m which is held at rest on the plane at the point O. The coefficient of friction between P and the plane is $\frac{1}{4}$. The particle is released from rest and slides down the plane, coming to instantaneous rest at the point A, where $OA = kl$.

Given that $k > 1$, find, to 3 significant figures, the value of k.

(7)

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Question 4 continued

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Question 4 continued

Q4

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5. A uniform solid hemisphere has radius r. The centre of the plane face of the hemisphere is O.

(a) Use algebraic integration to show that the distance from O to the centre of mass of the hemisphere is $\frac{3}{8}r$.

[*You may assume that the volume of a sphere of radius r is* $\frac{4}{3}\pi r^3$]

(6)

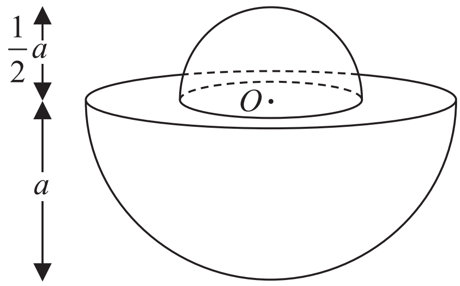

Figure 1

A solid S is formed by joining a uniform solid hemisphere of radius a to a uniform solid hemisphere of radius $\frac{1}{2}a$. The plane faces of the hemispheres are joined together so that their centres coincide at O, as shown in Figure 1. The mass per unit volume of the smaller hemisphere is k times the mass per unit volume of the larger hemisphere.

(b) Find the distance from O to the centre of mass of S.

(5)

When S is placed on a horizontal plane with any point on the curved surface of the larger hemisphere in contact with the plane, S remains in equilibrium.

(c) Find the value of k.

(2)

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Question 5 continued

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Question 5 continued

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Question 5 continued

Q5

(Total 13 marks)

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6.

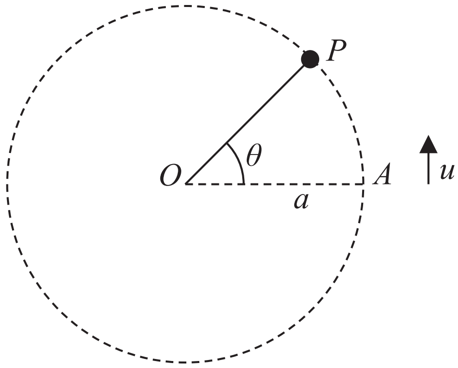

Figure 2

A particle P of mass m is attached to one end of a light inextensible string of length a. The other end of the string is attached to a fixed point O. The particle is held at the point A, where $OA = a$ and OA is horizontal. The particle is projected vertically upwards with speed u, as shown in Figure 2. When the string makes an angle θ with the horizontal through O and the string is still taut, the tension in the string is T.

(a) Show that $T = \dfrac{m}{a}\left(u^2 - 3ag\sin\theta\right)$

(8)

The particle moves in complete circles.

(b) Find, in terms of a and g, the minimum value of u.

(2)

Given that the least tension in the string is S and the greatest tension in the string is $4S$,

(c) find, in terms of a and g, an expression for u.

(5)

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Question 6 continued

Q6

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7. A particle P of mass 0.5 kg is attached to one end of a light elastic string. The string has natural length l metres and modulus of elasticity 29.4 N. The other end of the string is attached to a fixed point A. The particle hangs freely in equilibrium at the point B, where B is vertically below A and $AB = 1.4$ m.

(a) Show that $l = 1.2$

(3)

The point C is vertically below A and $AC = 1.8$ m. The particle is pulled down to C and released from rest.

(b) Show that, while the string is taut, P moves with simple harmonic motion.

(4)

(c) Calculate the speed of P at the instant when the string first becomes slack.

(3)

The particle first comes to instantaneous rest at the point D.

(d) Find the time taken by P to return directly from D to C.

(7)

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Question 7 continued

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Question 7 continued

Q7

(Total 17 marks)

TOTAL FOR PAPER: 75 MARKS

END