Paper Reference(s)

6679

Edexcel GCE

Mechanics M3

Advanced Level

Tuesday 7 June 2005 – Afternoon

Time: 1 hour 30 minutes

Materials required for examination	Items included with question papers
Answer Book (AB16)	Nil
Mathematical Formulae (Lilac)	

Candidates may use any calculator EXCEPT those with the facility for symbolic algebra, differentiation and/or integration. Thus candidates may NOT use calculators such as the Texas Instruments TI 89, TI 92, Casio CFX 9970G, Hewlett Packard HP 48G.

Instructions to Candidates

In the boxes on the answer book, write the name of the examining body (Edexcel), your centre number, candidate number, the unit title (Mechanics M3), the paper reference (6679), your surname, other name and signature.
Whenever a numerical value of g is required, take $g = 9.8 \text{ m s}^{-2}$.
When a calculator is used, the answer should be given to an appropriate degree of accuracy.

Information for Candidates

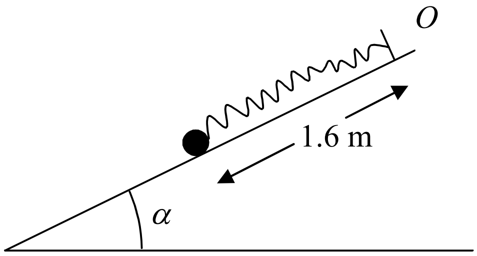
A booklet 'Mathematical Formulae and Statistical Tables' is provided.
Full marks may be obtained for answers to ALL questions.
This paper has seven questions.
The total mark for this paper is 75.

Advice to Candidates

You must ensure that your answers to parts of questions are clearly labelled.
You must show sufficient working to make your methods clear to the Examiner. Answers without working may gain no credit.

N16740A

1. **Figure 1**



A particle of mass 0.8 kg is attached to one end of a light elastic spring, of natural length 2 m and modulus of elasticity 20 N. The other end of the spring is attached to a fixed point O on a smooth plane which is inclined at an angle α to the horizontal, where $\tan \alpha = \frac{3}{4}$. The particle is held on the plane at a point which is 1.6 m down a line of greatest slope of the plane from O, as shown in Figure 1. The particle is then released from rest.

Find the initial acceleration of the particle.

(Total 6 marks)

---

2. A closed container C consists of a thin uniform hollow hemispherical bowl of radius a, together with a lid. The lid is a thin uniform circular disc, also of radius a. The centre O of the disc coincides with the centre of the hemispherical bowl. The bowl and its lid are made of the same material.

(*a*) Show that the centre of mass of C is at a distance $\frac{1}{3}a$ from O.

(4)

The container C has mass M. A particle of mass $\frac{1}{2}M$ is attached to the container at a point P on the circumference of the lid. The container is then placed with a point of its curved surface in contact with a horizontal plane. The container rests in equilibrium with P, O and the point of contact in the same vertical plane.

(*b*) Find, to the nearest degree, the angle made by the line PO with the horizontal.

(5)

(Total 9 marks)

---

3. A light elastic string has natural length $2l$ and modulus of elasticity $4mg$. One end of the string is attached to a fixed point A and the other end to a fixed point B, where A and B lie on a smooth horizontal table, with $AB = 4l$. A particle P of mass m is attached to the mid-point of the string.

The particle is released from rest at the point of the line AB which is $\frac{5l}{3}$ from B. The speed of P at the mid-point of AB is V.

(a) Find V in terms of g and L.

(7)

(b) Explain why V is the maximum speed of P.

(2)

(Total 9 marks)

---

4. A particle P of mass m moves on the smooth inner surface of a spherical bowl of internal radius r. The particle moves with constant angular speed in a horizontal circle, which is at a depth $\frac{1}{2}r$ below the centre of the bowl.

(a) Find the normal reaction of the bowl on P.

(4)

(b) Find the time for P to complete one revolution of its circular path.

(6)

(Total 10 marks)

---

5. A smooth solid sphere, with centre O and radius a, is fixed to the upper surface of a horizontal table. A particle P is placed on the surface of the sphere at a point A, where OA makes an angle α with the upward vertical, and $0 < \alpha < \frac{\pi}{2}$. The particle is released from rest. When OP makes an angle θ with the upward vertical, and P is still on the surface of the sphere, the speed of P is v.

(a) Show that $v^2 = 2ga(\cos\alpha - \cos\theta)$.

(4)

Given that $\cos\alpha = \frac{3}{4}$, find

(b) the value of θ when P loses contact with the sphere,

(5)

(c) the speed of P as it hits the table.

(4)

(Total 13 marks)

---

6. The rise and fall of the water level in a harbour is modelled as simple harmonic motion. On a particular day the maximum and minimum depths of water in the harbour are 10 m and 4 m and these occur at 1100 hours and 1700 hours respectively.

(*a*) Find the speed, in m h^{-1}, at which the water level in the harbour is falling at 1600 hours on this particular day.

(9)

(*b*) Find the total time, between 1100 hours and 2300 hours on this particular day, for which the depth of water in the harbour is less than 5.5 m.

(5)

(Total 14 marks)

---

7. A particle P of mass $\frac{1}{3}$ kg moves along the positive x-axis under the action of a single force. The force is directed towards the origin O and has magnitude $\frac{k}{(x+1)^2}$ N, where $OP = x$ metres and k is a constant. Initially P is moving away from O. At $x = 1$ the speed of P is 4 m s^{-1}, and at $x = 8$ the speed of P is $\sqrt{2}$ m s^{-1}.

(*a*) Find the value of k.

(10)

(*b*) Find the distance of P from O when P first comes to instantaneous rest.

(4)

(Total 14 marks)

TOTAL FOR PAPER: 75 MARKS

END