Paper Reference(s)

6679

Edexcel GCE

Mechanics M3
(New Syllabus)
Advanced/Advanced Subsidiary

Monday 14 January 2002 – Afternoon

Time: 1 hour 30 minutes

Materials required for examination	Items included with question papers
Answer Book (AB16)	Nil
Graph Paper (ASG2)	
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 $g = 9.8$ 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. Pages 7 and 8 are blank.

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.

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1. A particle P of mass 0.2 kg moves away from the origin along the positive x-axis. It moves under the action of a force directed away from the origin O, of magnitude $\frac{5}{x+1}$ N, where $OP = x$ metres. Given that the speed of P is 5 m s^{-1} when $x = 0$, find the value of x, to 3 significant figures, when the speed of P is 15 m s^{-1}.

(8)

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2. One end of a light elastic string, of natural length 2 m and modulus of elasticity 19.6 N, is attached to a fixed point A. A small ball B of mass 0.5 kg is attached to the other end of the string. The ball is released from rest at A and first comes to instantaneous rest at the point C, vertically below A.

(*a*) Find the distance AC.

(6)

(*b*) Find the instantaneous acceleration of B at C.

(3)

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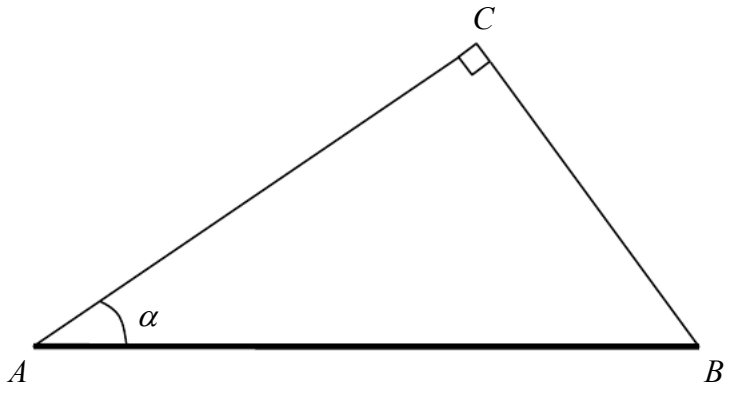
3. **Figure 1**



A rod AB, of mass $2m$ and length $2a$, is suspended from a fixed point C by two light strings AC and BC. The rod rests horizontally in equilibrium with AC making an angle α with the rod, where $\tan \alpha = \frac{3}{4}$, and with AC perpendicular to BC, as shown in Fig. 1.

(a) Give a reason why the rod cannot be uniform.

(1)

(b) Show that the tension in BC is $\frac{8}{5}mg$ and find the tension in AC.

(5)

The string BC is elastic, with natural length a and modulus of elasticity kmg, where k is constant.

(c) Find the value of k.

(4)

4.

Figure 2

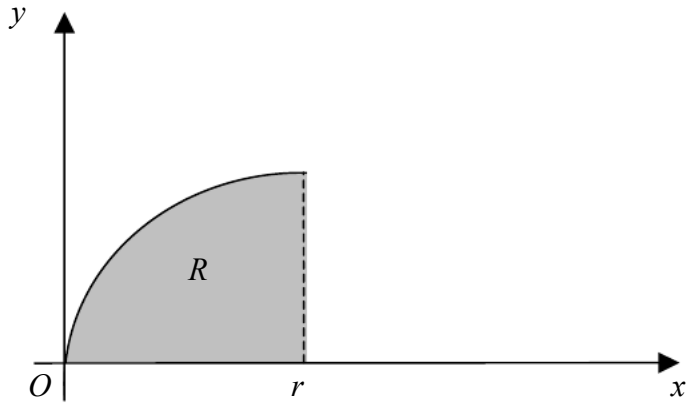


Figure 2 shows the region R bounded by the curve with equation $y^2 = rx$, where r is a positive constant, the x-axis and the line $x = r$. A uniform solid of revolution S is formed by rotating R through one complete revolution about the x-axis.

(a) Show that the distance of the centre of mass of S from O is $\frac{2}{3}r$.

(6)

The solid is placed with its plane face on a plane which is inclined at an angle α to the horizontal. The plane is sufficiently rough to prevent S from sliding. Given that S does not topple,

(b) find, to the nearest degree, the maximum value of α.

(4)

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5. A cyclist is travelling around a circular track which is banked at 25° to the horizontal. The coefficient of friction between the cycle's tyres and the track is 0.6. The cyclist moves with constant speed in a horizontal circle of radius 40 m, without the tyres slipping.

Find the maximum speed of the cyclist.

(10)

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6. The points O, A, B and C lie in a straight line, in that order, where $OA = 0.6$ m, $OB = 0.8$ m and $OC = 1.2$ m. A particle P, moving along this straight line, has a speed of $\left(\frac{3}{10}\sqrt{3}\right)$ m s^{-1} at A, $\left(\frac{1}{5}\sqrt{5}\right)$ m s^{-1} at B and is instantaneously at rest at C.

(*a*) Show that this information is consistent with P performing simple harmonic motion with centre O.

(5)

Given that P is performing simple harmonic motion with centre O,

(*b*) show that the speed of P at O is 0.6 m s^{-1},

(2)

(*c*) find the magnitude of the acceleration of P as it passes A,

(2)

(*d*) find, to 3 significant figures, the time taken for P to move directly from A to B.

(4)

7. **Figure 3**

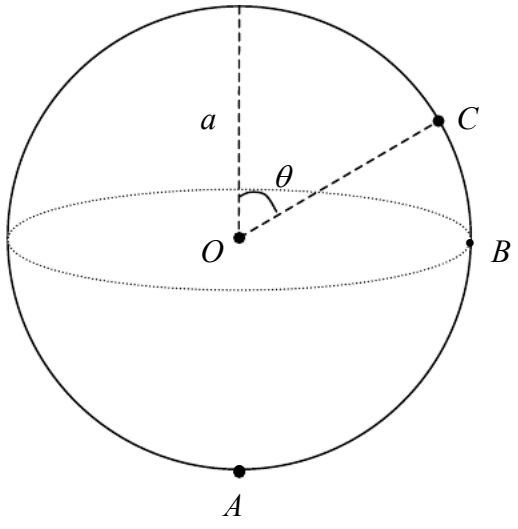

Figure 3 shows a fixed hollow sphere of internal radius a and centre O. A particle P of mass m is projected horizontally from the lowest point A of a sphere with speed $\sqrt{\left(\frac{7}{2}ag\right)}$. It moves in a vertical circle, centre O, on the smooth inner surface of the sphere. The particle passes through the point B, which is in the same horizontal plane as O. It leaves the surface of the sphere at the point C, where OC makes an angle θ with the upward vertical.

(a) Find, in terms of m and g, the normal reaction between P and the surface of the sphere at B.

(4)

(b) Show that $\theta = 60°$.

(7)

After leaving the surface of the sphere, P meets it again at the point A.

(c) Find, in terms of a and g, the time P takes to travel from C to A.

(4)

END