Paper Reference(s)

6679

Edexcel GCE

Mechanics M3

Advanced/Advanced Subsidiary

Thursday 30 May 2002 – Morning

Time: 1 hour 30 minutes

Materials required for examination
Answer Book (AB16)
Mathematical Formulae (Lilac)
Graph Paper (ASG2)

Items included with question papers
Nil

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.

N10810

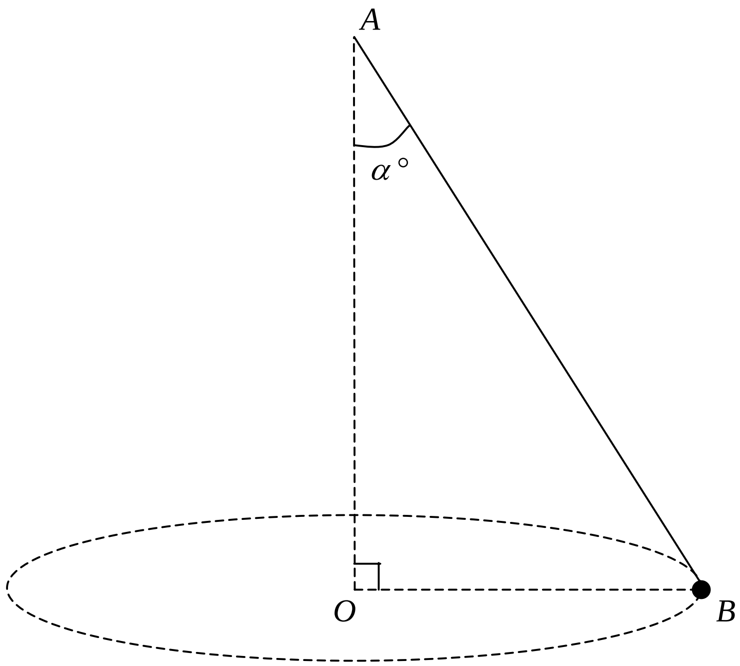
1. A particle P moves in a straight line with simple harmonic motion about a fixed centre O with period 2 s. At time t seconds the speed of P is v m s^{-1}. When $t = 0$, $v = 0$ and P is at a point A where $OA = 0.25$ m.

Find the smallest positive value of t for which $AP = 0.375$ m.

(6)

---

2. **Figure 1**



A metal ball B of mass m is attached to one end of a light inextensible string. The other end of the string is attached to a fixed point A. The ball B moves in a horizontal circle with centre O vertically below A, as shown in Fig. 1. The string makes a constant angle $\alpha°$ with the downward vertical and B moves with constant angular speed $\sqrt{(2gk)}$, where k is a constant. The tension in the string is $3mg$. By modelling B as a particle. find

(a) the value of α,

(4)

(b) the length of the string.

(5)

---

3. A particle P of mass 2.5 kg moves along the positive x-axis. It moves away from a fixed origin O, under the action of a force directed away from O. When $OP = x$ metres the magnitude of the force is $2e^{-0.1x}$ newtons and the speed of P is v m s^{-1}. When $x = 0$, $v = 2$. Find

(*a*) v^2 in terms of x,

(6)

(*b*) the value of x when $v = 4$.

(3)

(*c*) Give a reason why the speed of P does not exceed $\sqrt{20}$ m s^{-1}.

(1)

---

4. A light elastic string AB of natural length 1.5 m has modulus of elasticity 20 N. The end A is fixed to a point on a smooth horizontal table. A small ball S of mass 0.2 kg is attached to the end B. Initially S is at rest on the table with $AB = 1.5$ m. The ball S is then projected horizontally directly away from A with a speed of 5 m s^{-1}. By modelling S as a particle,

(*a*) find the speed of S when $AS = 2$ m.

(5)

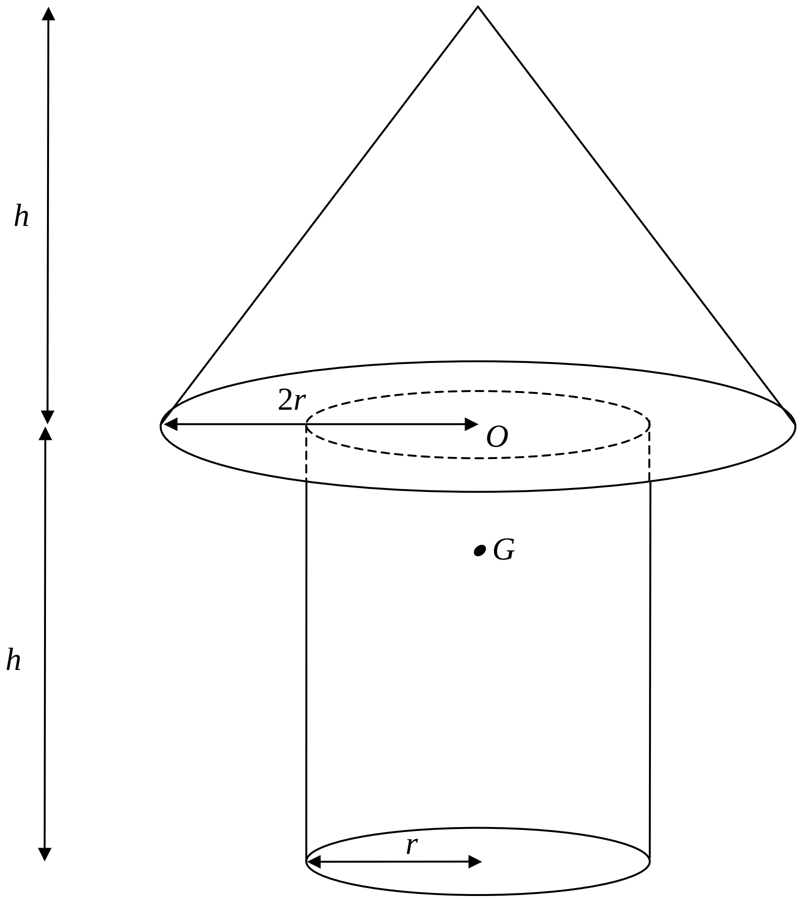
When the speed of S is 1.5 m s^{-1}, the string breaks.

(*b*) Find the tension in the string immediately before the string breaks.

(5)

---

5. **Figure 2**



A model tree is made by joining a uniform solid cylinder to a uniform solid cone made of the same material. The centre O of the base of the cone is also the centre of one end of the cylinder, as shown in Fig. 2. The radius of the cylinder is r and the radius of the base of the cone is $2r$. The height of the cone and the height of the cylinder are each h. The centre of mass of the model is at the point G.

(*a*) Show that $OG = \frac{1}{14}h$.

(8)

The model stands on a desk top with its plane face in contact with the desk top. The desk top is tilted until it makes an angle α with the horizontal, where $\tan \alpha = \frac{7}{26}$. The desk top is rough enough to prevent slipping and the model is about to topple.

(*b*) Find r in terms of h.

(4)

6. A light elastic string, of natural length $4a$ and modulus of elasticity $8mg$, has one end attached to a fixed point A. A particle P of mass m is attached to the other end of the string and hangs in equilibrium at the point O.

(*a*) Find the distance AO.

(2)

The particle is now pulled down to a point C vertically below O, where $OC = d$. It is released from rest. In the subsequent motion the string does not become slack.

(*b*) Show that P moves with simple harmonic motion of period $\pi\sqrt{\left(\frac{2a}{g}\right)}$.

(7)

The greatest speed of P during this motion is $\frac{1}{2}\sqrt{(ga)}$.

(*c*) Find d in terms of a.

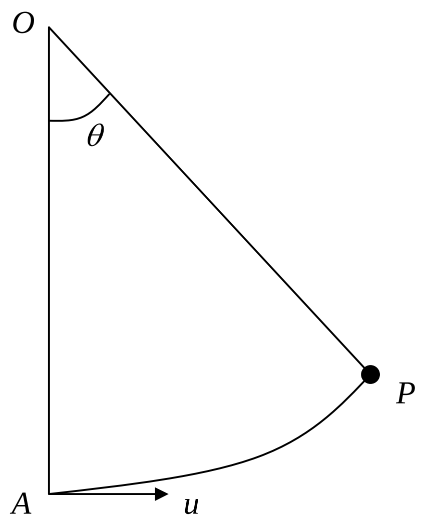
(3)

Instead of being pulled down a distance d, the particle is pulled down a distance a. Without further calculation,

(*d*) describe briefly the subsequent motion of P.

(2)

7. **Figure 3**



A particle of mass m is attached to one end of a light inextensible string of length l. The other end of the string is attached to a fixed point O. The particle is hanging at the point A, which is vertically below O. It is projected horizontally with speed u. When the particle is at the point P, $\angle AOP = \theta$, as shown in Fig. 3. The string oscillates through an angle α on either side of OA where $\cos \alpha = \frac{2}{3}$.

(*a*) Find u in terms of g and l.

(4)

When $\angle AOP = \theta$, the tension in the string is T.

(*b*) Show that $T = \dfrac{mg}{3}(9 \cos \theta - 4)$.

(6)

(*c*) Find the range of values of T.

(4)

END