6679/01

Edexcel GCE

Mechanics

Unit M3 Mock paper

Advanced Subsidiary / Advanced

Time: 1 hour 30 minutes

Materials required for the examination	Items included with these question papers
Answer Book (AB04) Graph Paper (GP02) Mathematical Formulae	Nil

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

Instructions to Candidates

In the boxes on the Answer Book provided, 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 names 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 including Statistical Formulae and Tables' is provided.

Full marks may be obtained for answers to ALL questions.

This paper has 7 questions.

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 will gain no credit

1. A particle P moves on the positive x-axis. When the displacement of P from O is x metres, its acceleration is $(6 - 4x)$ m s^{-2}, measured in the direction of x increasing. Initially P is at O and the velocity of P is 4 m s^{-1} in the direction Ox.

Find the distance of P from O when P is instantaneously at rest. **(6 marks)**

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2. A light elastic string AB has one end A attached to a fixed point on a ceiling. A particle P of mass 0.3 kg is attached to B. When P hangs in equilibrium with AB vertical, AB = 100 cm. The particle P is replaced by another particle Q of mass 0.5 kg. When Q hangs in equilibrium with AB vertical, AB = 110 cm. Find

(a) the natural length of the string, **(5 marks)**

(b) the modulus of elasticity of the string. **(2 marks)**

3.

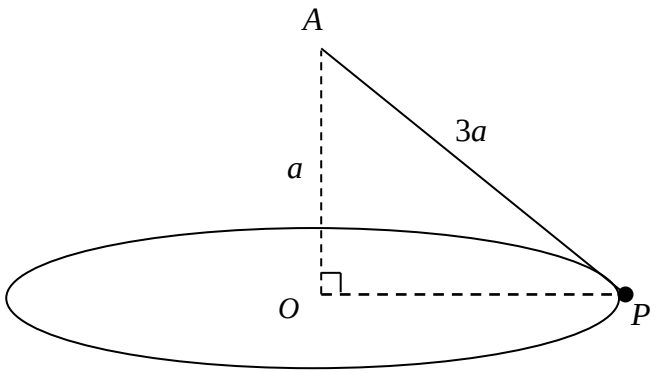

Fig. 1

A particle P of mass m is attached to one end of a light inextensible string of length $3a$. The other end of the string is attached to a fixed point A which is a vertical distance a above a smooth horizontal table. The particle moves on the table in a circle whose centre O is vertically below A, as shown in Fig. 1. The string is taut and the speed of P is $2\sqrt{(ag)}$.

Find

(a) the tension in the string, **(6 marks)**

(b) the normal reaction of the table on P. **(4 marks)**

4.

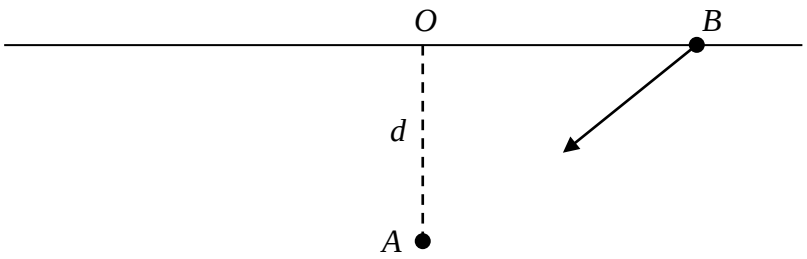

Fig. 2

A small smooth bead B of mass 0.2 kg is threaded on a smooth horizontal wire. The point A is on the same horizontal level as the wire and at a perpendicular distance d from the wire. The point O is the point on the wire nearest to A, as shown in Fig. 2. The bead experiences a force of magnitude $5(AB)$ newtons in the direction BA towards A. Initially B is at rest with $OB = 2$ m.

(a) Prove that B moves with simple harmonic motion about O, with period $\frac{2\pi}{5}$ s. **(5 marks)**

(b) Find the greatest speed of B in the motion. **(2 marks)**

(c) Find the time when B has first moved a distance 3 m from its initial position. **(4 marks)**

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5. In a "test your strength" game at an amusement park, competitors hit one end of a small lever with a hammer, causing the other end of the lever to strike a ball which then moves in a vertical tube whose total height is adjustable. The ball is attached to one end of an elastic spring of natural length 3 m and modulus of elasticity 120 N. The mass of the ball is 2 kg. The other end of the spring is attached to the top of the tube. The ball is modelled as a particle, the spring as light and the tube is assumed to be smooth.

The height of the tube is first set at 3 m. A competitor gives the ball an initial speed of 10 m s^{-1}.

(a) Find the height to which the ball rises before coming to rest. **(6 marks)**

The tube is now adjusted by reducing its height to 2.5 m. The spring and the ball remain unchanged.

(b) Find the initial speed which the ball must now have if it is to rise by the same distance as in part (a). **(5 marks)**

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6. (*a*) Show, by integration, that the centre of mass of a uniform right cone, of radius *a* and height *h*, is a distance $\frac{3}{4}h$ from the vertex of the cone.

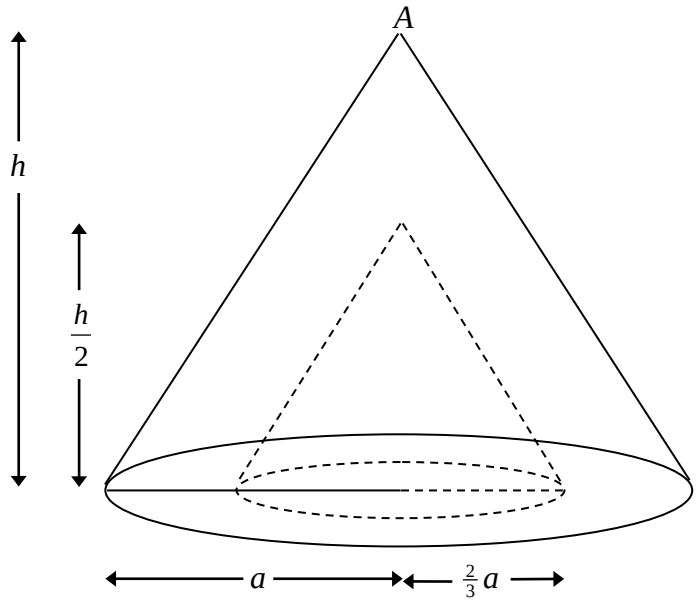

Fig. 3

A uniform right cone *C*, of radius *a* and height *h*, has vertex *A*. A solid *S* is formed by removing from *C* another cone, of radius $\frac{2}{3}a$ and height $\frac{1}{2}h$, with the same axis as *C*. The plane faces of the two cones coincide, as shown in Fig. 3.

(*b*) Find the distance of the centre of mass of *S* from *A*. **(7 marks)**

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7. A smooth solid hemisphere is fixed with its plane face on a horizontal table and its curved surface uppermost. The plane face of the hemisphere has centre *O* and radius *a*. The point *A* is the highest point on the hemisphere. A particle *P* is placed on the hemisphere at *A*. It is then given an initial horizontal speed *u*, where $u^2 = \frac{1}{2}(ag)$. When *OP* makes an angle θ with *OA*, and while *P* remains on the hemisphere, the speed of *P* is *v*.

(*a*) Find an expression for v^2. **(3 marks)**

(*b*) Show that, when $\theta = \arccos 0.9$, *P* is still on the hemisphere. **(5 marks)**

(*c*) Find the value of $\cos\theta$ when *P* leaves the hemisphere. **(2 marks)**

(*d*) Find the value of *v* when *P* leaves the hemisphere. **(2 marks)**

After leaving the hemisphere *P* strikes the table at *B*.

(*e*) Find the speed of *P* at *B*. **(2 marks)**

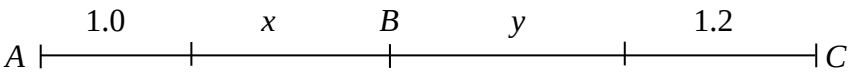
(*f*) Find the angle at which *P* strikes the table. **(3 marks)**

END

Alternative Question 2:

2. Two light elastic strings *AB* and *BC* are joined at *B*. The string *AB* has natural length 1 m and modulus of elasticity 15 N. The string *BC* has natural length 1.2 m and modulus of elasticity 30 N. The ends *A* and *C* are attached to fixed points 3 m apart and the strings rest in equilibrium with *ABC* in a straight line.

Find the tension in the combined string *AC*. **(7 marks)**

Question number	Scheme	Marks
2.		
	Extensions x and y	
	$\frac{15x}{1} = \frac{30y}{1.2}$ Use of Hooke's law correctly once	B1
	Tensions at B same	M1
	$1 + x + 1.2 + y = 3$	
	$\Rightarrow y = 0.8 - x$ y in terms of x	M1
	$\Rightarrow 15x = \frac{30(0.8 - x)}{1.2}$	A1
	$\Rightarrow 18x = 24 - 30x$ solve x	M1
	$\Rightarrow x = 0.5$	A1
	Hence $T = \frac{15 \times 0.5}{1} = 7.5$ N	A1