Hooke's Law

Question Paper 1

Level	International A Level
Subject	Maths
Exam Board	CIE
Topic	Hooke's Law
Sub Topic	
Booklet	Question Paper 1

Time Allowed: **58 minutes**

Score: **/48**

Percentage: **/100**

Grade Boundaries:

A*	A	B	C	D	E	U
>85%	'77.5%	70%	62.5%	57.5%	45%	<45%

1 One end of a light elastic string of natural length 0.7 m is attached to a fixed point A on a smooth horizontal surface. The other end of the string is attached to a particle P of mass 0.3 kg which is held at a point B on the horizontal surface, where $AB = 1.2$ m. It is given that P is released from rest at B and that when $AP = 0.9$ m, the particle has speed $4\,\text{m}\,\text{s}^{-1}$. Calculate the modulus of elasticity of the string. [3]

2 A particle P of mass 0.3 kg is attached to one end of a light elastic string of natural length 0.9 m and modulus of elasticity 18 N. The other end of the string is attached to a fixed point O which is 3 m above the ground.

(i) Find the extension of the string when P is in the equilibrium position. [2]

P is projected vertically downwards from the equilibrium position with initial speed $6\,\text{m}\,\text{s}^{-1}$. At the instant when the tension in the string is 12 N the string breaks. P continues to descend vertically.

(ii) (a) Calculate the height of P above the ground at the instant when the string breaks. [2]

(b) Find the speed of P immediately before it strikes the ground. [4]

3 One end of a light elastic string of natural length 0.5 m and modulus of elasticity 30 N is attached to a fixed point O. The other end of the string is attached to a particle P which hangs in equilibrium vertically below O, with $OP = 0.8$ m.

(i) Show that the mass of P is 1.8 kg. [2]

The particle is pulled vertically downwards and released from rest from the point where $OP = 1.2$ m.

(ii) Find the speed of P at the instant when the string first becomes slack. [3]

4 One end of a light elastic string of natural length 0.4 m and modulus of elasticity 20 N is attached to a fixed point A on a smooth plane inclined at 30° to the horizontal. The other end of the string is attached to a particle P of mass 0.5 kg which rests in equilibrium on the plane.

(i) Calculate the extension of the string. [2]

P is projected down the plane from the equilibrium position with speed $5\,\text{m s}^{-1}$. The extension of the string is e m when the speed of the particle is $2\,\text{m s}^{-1}$ for the first time.

(ii) Find e. [4]

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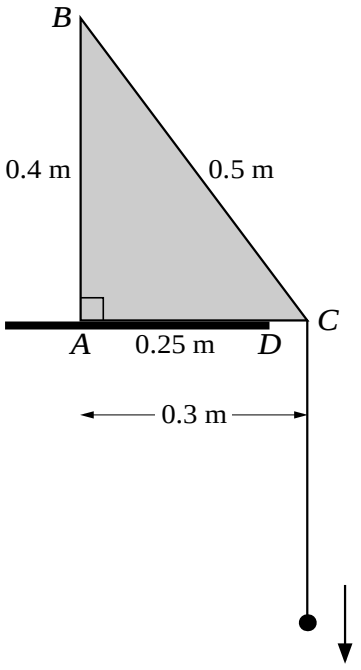

A uniform triangular prism of weight 20 N rests on a horizontal table. ABC is the cross-section through the centre of mass of the prism, where $BC = 0.5$ m, $AB = 0.4$ m, $AC = 0.3$ m and angle $BAC = 90°$. The vertical plane ABC is perpendicular to the edge of the table. The point D on AC is at the edge of the table, and $AD = 0.25$ m. One end of a light elastic string of natural length 0.6 m and modulus of elasticity 48 N is attached to C and a particle of mass 2.5 kg is attached to the other end of the string. The particle is released from rest at C and falls vertically (see diagram).

(i) Show that the tension in the string is 60 N at the instant when the prism topples. [3]

(ii) Calculate the speed of the particle at the instant when the prism topples. [5]

6 One end of a light elastic string of natural length 1.6 m and modulus of elasticity 28 N is attached to a fixed point O. The other end of the string is attached to a particle P of mass 0.35 kg which hangs in equilibrium vertically below O. The particle P is projected vertically upwards from the equilibrium position with speed 1.8 m s^{-1}. Calculate the speed of P at the instant the string first becomes slack. [5]

7 A particle P of mass 0.2 kg is attached to one end of a light elastic string of natural length 0.8 m and modulus of elasticity 64 N. The other end of the string is attached to a fixed point A on a smooth horizontal surface. P is placed on the surface at a point 0.8 m from A. The particle P is then projected with speed 10 m s^{-1} directly away from A.

(i) Calculate the distance AP when P is at instantaneous rest. [3]

(ii) Calculate the speed of P when it is 1.0 m from A. [3]

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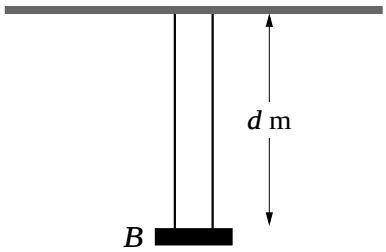

Two light elastic strings each have one end attached to a fixed horizontal beam. One string has natural length 0.6 m and modulus of elasticity 12 N; the other string has natural length 0.7 m and modulus of elasticity 21 N. The other ends of the strings are attached to a small block B of weight W N. The block hangs in equilibrium d m below the beam, with both strings vertical (see diagram).

(i) Given that the tensions in the strings are equal, find d and W. [4]

The small block is now raised vertically to the point 0.7 m below the beam, and then released from rest.

(ii) Find the greatest speed of the block in its subsequent motion. [4]