HOOKE'S LAW

When necessary take g as 9.8 ms^{-2}

1. a) A light elastic string of length 4 m is stretched to a length of 5 m. The modulus of elasticity of the string is 2N. Find the tension in the string

[2]

b) The string is now stretched a further amount y m. The tension in the string is now 2N. Find y.

[3]

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2. Two light elastic strings AB and BC each of natural length L m and modulus of elasticity 2mg N are fastened together at B. Their other ends A and C are fixed to two pegs. C is vertically above A and CA = 4Lm. A particle of mass m kg is attached at B.

a) Given that the system is in equilibrium, find the height of the particle above A.

[7]

The particle is pulled down so that it is a distance $\frac{3L}{2}$ m from A and then released.

b) Find its speed when it first passes through the equilibrium position.

[10]

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3. A light elastic string of length 6 m is stretched between two points A and B, on the same horizontal level where AB = 8 m. A particle of weight 5 N is attached to the midpoint M of the string. In equilibrium AM makes an angle of 30^0 with the horizontal.

Find the modulus of elasticity of the string, giving your answer to 3 significant figures.

[9]

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4. Two light elastic strings AB and BC of natural lengths Lm and 2Lm respectively and moduli of elasticity mg N and 2mg N respectively are joined at B. A particle of mass m kg is attached at B Find the distance BC if

a) the strings and particle are on a smooth horizontal table and A and C are fastened so that AC = 5L.

[7]

b) A and C are fixed to two points a distance 5L apart with A vertically above C.

[6]

HOOKE'S LAW

5. A light elastic string AB of natural length L and modulus of elasticity 2mg has a particle of mass m kg attached at B. The end A is attached to a fixed peg. Initially B is vertically below A.

a) Find the extension of the string when B is vertically below A.

[4]

A force is then applied to B so that it is on the same horizontal level as previously but AB makes an angle of θ where $\cos\theta = \frac{4}{5}$ with the vertical.

b) Find the extension of the string in its new position.

[3]

c) Find the work done in moving the particle to its new position.

[8]

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6. One end, A, of a light elastic string of length Lm is attached to a peg which is at a height of 3L m above a point B on a horizontal floor. The modulus of elasticity of the string is 2mg N.
A particle of mass m kg is attached to the other end of the string. The particle is held at A and then released.

a) Show that the particle will not reach the floor.

[10]

b) If, instead of being held initially at A, the particle is released from the point B, find the maximum height reached by the particle

[6]

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7. Inside the barrel of a toy gun there is a light spring of natural length 8 cm. A pellet is placed inside the barrel and by means of an external trigger the spring is compressed to a length of 2 cm. The trigger is then released, firing the pellet from the gun. The pellet is of mass 1 gramme and the modulus of elasticity of the spring is 0.6N.

a) Assuming that the pellet is lying against the spring when the trigger is released, find the speed of the pellet when it leaves the barrel.

[8]

b) The gun is 1 m above the ground. Find the velocity of the pellet when it reaches the ground if, when the bullet is fired, the barrel is pointing:
i) vertically upwards

[5]

ii) horizontally

[7]

c) State two assumptions you have made in your calculations.

[2]

HOOKE'S LAW

8. The buffer at the end of a railway line is comprised of 6 identical light metal springs each of natural length 0.5 m. An engine, of mass 40 tonnes, whose brakes have failed, approaches the buffer at a speed of 60 kmh^{-1}. When the buffer stops the engine, the springs have been compressed to one tenth of their original length. Find the modulus of elasticity of the springs.
(You may assume that the rails on which the engine is travelling are smooth)

[12]

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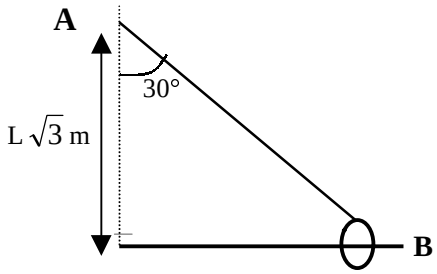
9. The diagram shows a light elastic string AB of natural length L m. The end A is attached to a fixed peg; the end B is attached to a small ring of weight 2 N which is free to slide on a rough horizontal rod. A is $L\sqrt{3}$ metres vertically above the rod and in limiting equilibrium, AB makes an angle of 30° with the vertical.



The coefficient of friction between the ring and the rod is $\frac{1}{4}$. Find the modulus of elasticity of the string, giving your answer in surd (ie. square root) form.

[11]

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10. A trapeze artist, of mass 70 kg, is on a high wire 30 m above the ground. He has a safety harness attached, which enables him, if he falls, to land in a standing position. The harness consists of a light fine elastic rope of length 10 m and modulus of elasticity 900 N.

If when performing on the rope he slips and falls find, using an appropriate mathematical model:

a) his speed when he hits the ground.

[10]

b) the impulsive force with which he hits the ground.

[3]

c) State three assumptions you have made in your modelling.

[3]

HOOKE'S LAW

11. An elastic string of natural length 3m is fixed at one end and a particle of mass 2kg is attached to the other end. The modulus of elasticity of the string is 6g N.

a) Find the extension of the string when it is hanging in equilibrium.

[4]

A force of magnitude P newtons is applied to the particle in a direction perpendicular to the string. The system is in equilibrium with the string making an angle of 30^0 with the vertical.

b) Find the value of P and the extension of the string.

[7]

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12. A uniform rod AB of length 4L and weight W has its end A on a smooth horizontal plane. It is held in equilibrium with AB making an angle of 30^o with the horizontal by means of a light elastic spring of natural length L. The spring is vertical, and has one end on the plane and the other on the rod at a distance L from A. Find, in terms of W and L,

a) the thrust in the spring.

[3]

b) the modulus of elasticity of the spring.

[5]

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13. In a children's game of "jumping frogs", a "frog" consists of a plastic model of a frog of mass 5 grammes attached to an light elastic spring of natural length 5cm.

a) Shamila pushes a "frog" down so that the spring is compressed to a length of 2cm. When it is released, the "frog" jumps up a distance of 8cm. Find the modulus of elasticity of the spring.

[9]

b) Find the average force that Shamila had to exert to compress the spring.

[4]
