Further Maths A-Level Starter Activity

Topic: Hooke's Law (1)

Chapter Reference: Further Mechanics 1, Chapter 3

10 minutes

1. The force required to stretch Hooke's Law spring varies from 0 N to 65 N as we stretch the spring by moving one end 6.3 cm from its unstressed position. Find the force constant of the spring. Answer in units of N/m. **(3)**

2. A string with modulus (of elasticity) 10 N has a natural length of 2m. What is the tension in the strong when its length is 5m. **(2)**

3. A 75 kg person stands on a compression spring with spring constant 5000 N/m and nominal length 0.25m. What is the total length of the loaded spring. **(5)**

Don't know where to start? Draw a daigram

Solutions

1.

6.3 cm = 0.063 m 65 = k x 0.063	**M1**
$k = \frac{65}{0.063}$	**M1**
= 1032 N/m	**A1**

2.

$T = \frac{10 \times 3}{2}$	**M1**
T = 15 N	**A1**

3.

$x = \frac{F}{k} = \frac{mg}{k}$	**M1**
$x = \frac{75 \times 9.81}{5000}$	**M1**
x = 0.15m	**A1**
Therefore, length of loaded spring = Original length – x	**M1**
= 0.1 m	**A1**

Further Maths A-Level Starter Activity

Topic: Dynamics Problems with Hooke's Law (2)

Chapter Reference: Further Mechanics 1, Chapter 3

9 minutes

1. Two light strings, S1 and S2, are joined together at one end only.

One end of the combined string is attached to the ceiling at O, and a mass of 3 kg is attached to the other, and allowed to hang freely in equilibrium.

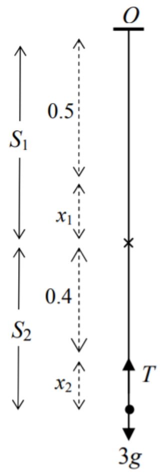
The moduli of S1 and S2 are 75 N and 120 N, and their natural lengths are 50 cm and 40 cm. Find the distance of the 3 kg mass below O.

Don't know where to start? Draw a daigram

Solutions

1.

Strings are light → ignore masses and assume tensions are equal.



Resolving vertically	**M1**
$T = 3g$	**A1**
For S_1: $T = 3g = \frac{\lambda x}{l} = \frac{75x_1}{0.5}$	**M1**
$x_1 = \frac{g}{50}$	**A1**
For S_2: $T = 3g = \frac{\lambda x}{l} = \frac{120x_2}{0.4}$	**M1**
$x_2 = \frac{g}{100}$	**A1**
$x_1 + x_2 = \frac{3g}{100} = 0.295$	**M1**
Distance of 3kg mass below O, is 0.5 + 0.4 + 0.294	**M1**
= 1.194 = 1.2m	**A1**

Topic: Elastic Energy (3)

Chapter Reference: Further Mechanics 1, Chapter 2

9 minutes

1. A light elastic string has natural length 8 m and modulus of elasticity 80 N. The ends of the string are attached to fixed points *P* and *Q* which are on the same horizontal level and 12 m apart. A particle is attached to the mid-point of the string and hangs in equilibrium at a point 4.5 m below *PQ*.

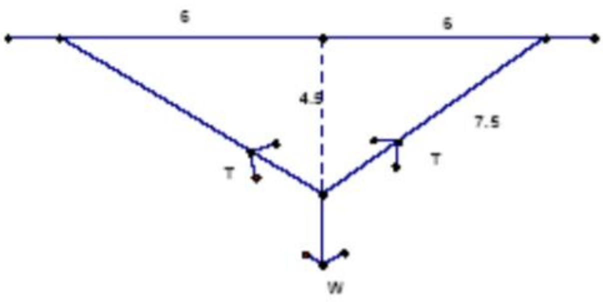
a. Calculate the weight of the particle. **(4)**

b. Calculate the elastic energy in the string when the particle is in this position. **(2)**

Don't know where to start? Draw a diagram!

Solutions

1a.



Resolving vertically	**M1**
$2T\cos\theta = W$	**A1**
Hooke's Law: $T = \frac{80 \times 3.5}{4}$	**M1**
Therefore $W = 84$ N	**A1**

1b.

Elastic Potential Energy = 2 x $\frac{80 \times 3.5^2}{2 \times 4}$	**M1**
$= 245$	**A1**

Further Maths A-Level Starter Activity

Topic: Modulus of Elasticity (4)

Chapter Reference: Further Mechanics 1, Chapter 2

10 minutes

A particle of mass 0.8 kg is attached to one end of a light elastic string of natural length 0.6 m. The other end of the string is attached to a fixed point A. The particle is released from rest at A and comes to instantaneous rest 1.1 m below A.

Find the modulus of elasticity of the string **(4)**

Don't know where to start? Draw a daigram

Solutions

1a.

EPE = $\frac{\lambda \times 0.5^2}{1.2}$	**B1**
GPE lost = EPE gained	**M1**
0.8 x 9.8 x 1.1 = $\frac{\lambda \times 0.5^2}{1.2}$	**A1**
λ = 41.4 N or 41 N	**A1**

Topic: Work-Energy Principle (5)

Chapter Reference: Further Mechanics 1, Chapter 2

10 minutes

1. A particle P of mass m is attached to one end of a light elastic string, of natural length a and modulus of elasticity 3.6mg.
The other end of the string is fixed at a point O on a rough horizontal table.
The particle is projected along the surface of the table from O with speed √(2ag).
At its furthest point from O, the particle is at the point A, where OA = $\frac{4}{3}a$

a. Find, in terms of m, g and a, the elastic energy stored in the string when P is at A **(3)**

b. Using the work-energy principle, or otherwise, find the coefficient of friction between P and the table. **(5)**

Don’t know where to start? Draw a daigram

Solutions

1a.

Elastic Potential Energy = $\frac{1}{2}\frac{3.6mg}{a}x^2 = \frac{1}{2}\frac{3.6mg}{a}\left(\frac{a}{3}\right)^2$	**M1 A1**
= 0.2 mga	**A1**

1b.

Friction = μmg	**M1**
Therefore, work done by friction = μmg ($\frac{4a}{3}$)	**M1**
Work-energy = $\frac{1}{2}m\ 2ga = \ \mu\ mgd + 0.2\ mga$	**M1 M1**
Solving: μ = 0.6	**A1**