3.4 Further Mechanics: Elastic Strings, Springs and Elastic Energy: 10-minute Pack

AQA 7367 · Calculator allowed · about 10 minutes

Total Marks

Name: _____ Date: ____ / ____ / _____

Answer ALL questions. Show all your working.

Formulae and modelling assumptions used in this worksheet

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Unless a question states otherwise, take g = 9.8 m s^-2 and model each object as a particle, and each string or spring as light. Hooke's law states that the tension (or thrust) in an elastic string or spring of natural length l and modulus of elasticity lambda, when it is extended (or compressed) by x, has magnitude T = lambda*x/l; an elastic string can only pull (it exerts no force, and is described as slack, whenever its length is less than l), while a spring can both pull and push. The elastic potential energy (EPE) stored in a stretched or compressed string or spring is EPE = lambda*x^2/(2*l). The principle of conservation of mechanical energy states that, provided no energy is lost to resistances such as friction, the sum of the kinetic energy, gravitational potential energy and elastic potential energy of a system remains constant; more generally, the work-energy principle states that the total work done by all the forces acting on a particle (including any work done against resistances) equals its change in kinetic energy.

1 A particle of mass 3 kg hangs in equilibrium at the end of a light elastic string of natural length 0.5 m and modulus of elasticity 60 N, the other end of the string being attached to a fixed point O. Take g = 9.8 m/s^2.

(a) Find the extension of the string in equilibrium, to 3 significant figures. **(2)**

(b) Find the elastic potential energy stored in the string in equilibrium, to 3 significant figures. **(2)**

(c) The particle is pulled a further 0.15 m vertically downwards and released from rest. Use conservation of energy to find the speed of the particle as it passes through the equilibrium position, to 3 significant figures. **(3)**

(Total for Question 1 is 7 marks)

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Mark scheme · 3.4 Further Mechanics: Elastic Strings, Springs and Elastic Energy: 10-minute Pack

Question 1

(a) Hooke's law: $T = \lambda x/l = mg$ **M1**

(a) $x = 3(9.8)(0.5)/60 = 0.245$ m **A1**

(a) Answer: 0.245 m

(b) $EPE = \lambda x^2/(2l)$ **M1**

(b) $60(0.2450)^2/(2 \times 0.5) = 3.60$ J **A1**

(b) Answer: 3.60 J

(c) energy: EPE at the lowest point = EPE at equilibrium + KE + GPE gain **M1**

(c) $(1/2)mv^2 = \lambda[(0.3950)^2 - (0.2450)^2]/(2l) - mg(0.15)$ **M1**

(c) $v = 0.949$ m/s **A1**

(c) Answer: 0.949 m/s

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