Hooke's Law 2

Q1.

One end of a light elastic string of natural length 0.6 m and modulus of elasticity 24 N is attached to a fixed point O. The other end of the string is attached to a particle P of mass 0.4 kg which hangs in equilibrium vertically below O.

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

P is projected vertically downwards from the equilibrium position with speed 5 m s^{-1}.

(ii) Calculate the distance P travels before it is first at instantaneous rest. [4]

When P is first at instantaneous rest a stationary particle of mass 0.4 kg becomes attached to P.

(iii) Find the greatest speed of the combined particle in the subsequent motion. [4]

Q2.

A particle of mass 0.3 kg is attached to one end of a light elastic string of natural length 0.8 m and modulus of elasticity 6 N. The other end of the string is attached to a fixed point O. The particle is projected vertically downwards from O with initial speed 2 m s^{-1}.

(i) Calculate the greatest speed of the particle during its descent. [5]

(ii) Find the greatest distance of the particle below O. [3]

Q3.

One end of a light elastic string of natural length 0.8 m and modulus of elasticity 24 N is attached to a fixed point O. The other end of the string is attached to a particle P of mass 0.3 kg. P is projected vertically upwards with speed 4 m s^{-1} from a position 1.2 m vertically below O.

(i) Calculate the speed of the particle at the position where it is moving with zero acceleration. [5]

(ii) Show that the particle moves 1.2 m while moving upwards with constant deceleration. [3]

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Q4.

A small ball B is connected to one end of a light elastic string of natural length 0.4 m and modulus of elasticity 12 N. The other end of the string is attached to a fixed point A. The ball is projected with speed 1 m s^{-1} vertically downwards from a position 0.4 m vertically below A, and reaches its greatest speed at the point 0.7 m below A.

(i) Show that the mass of B is 0.9 kg. [2]

(ii) Calculate the greatest speed of B. [4]

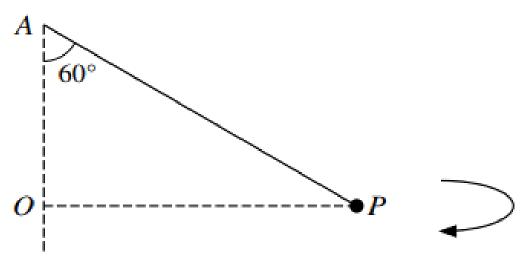
Q5.

A particle P of mass 0.7 kg is attached by a light elastic string to a fixed point O on a smooth plane inclined at an angle of 30° to the horizontal. The natural length of the string is 0.5 m and the modulus of elasticity is 20 N. The particle P is projected up the line of greatest slope through O from a point A below the level of O. The initial kinetic energy of P is 1.8 J and the initial elastic potential energy in the string is also 1.8 J.

(i) Find the distance OA. [2]

(ii) Find the greatest speed of P in the motion. [6]

Q6.



A particle P of mass 0.3 kg is attached to a fixed point A by a light elastic string of natural length 0.8 m and modulus of elasticity 16 N. The particle P moves in a horizontal circle which has centre O. It is given that AO is vertical and that angle OAP is 60° (see diagram). Calculate the speed of P. [6]

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Q7.

A particle P of mass 0.4 kg is attached to one end of a light elastic string of natural length 0.5 m and modulus of elasticity 6 N. The other end of the string is attached to a fixed point O. The particle P is released from rest at the point $(0.5 + x)$ m vertically below O. The particle P comes to instantaneous rest at O.

(i) Find x. [3]

(ii) Find the greatest speed of P. [5]

Q8.

One end of a light elastic string, of natural length a and modulus of elasticity k, is attached to a particle P of mass m. The other end of the string is attached to a fixed point Q. The particle P is projected vertically upwards from Q. When P is moving upwards and at a distance $\frac{4}{3}a$ directly above Q, it has a speed $\sqrt{2ga}$. At this point, its acceleration is $\frac{7}{3}g$ downwards.

Show that $k = 4mg$ and find in terms of a the greatest height above Q reached by P. [8]

Q9.

One end of a light elastic string, of natural length a and modulus of elasticity kmg, is attached to a fixed point A. The other end of the string is attached to a particle P of mass $4m$. The particle P hangs in equilibrium a distance x vertically below A.

(a) Show that $k = \dfrac{4a}{x-a}$. [1]

An additional particle, of mass $2m$, is now attached to P and the combined particle is released from rest at the original equilibrium position of P. When the combined particle has descended a distance $\frac{1}{3}a$, its speed is $\frac{1}{3}\sqrt{ga}$.

(b) Find x in terms of a. [6]
