Hooke's law and elastic strings

Further Mechanics 1 | Edexcel 9FM0 | 12 questions, 75 marks

Further Maths topic practice

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Name: _____ **Date:** _____ **Score:** _____ **/ 75**

1 A light elastic string has natural length 0.8 m and modulus of elasticity 24 N. A light spring has natural length 0.5 m and modulus of elasticity 40 N.

a. Find the tension in the string when it is stretched to a length of 1.1 m.

b. Find the thrust in the spring when it is compressed to a length of 0.35 m.

(3 marks)

Answer _____

2 A particle P of mass 1.5 kg is attached to one end of a light elastic string of natural length 0.6 m and modulus of elasticity 45 N. The other end of the string is attached to a fixed point O. The particle hangs in equilibrium vertically below O.

Find the length OP.

(3 marks)

Answer _____

3 A light elastic string has one end attached to a fixed point. When a particle of mass 2 kg hangs in equilibrium on the other end, the length of the string is 1.2 m. When the 2 kg particle is replaced by a particle of mass 3 kg, the length of the string in equilibrium is 1.35 m.

Find the natural length and the modulus of elasticity of the string.

(5 marks)

Answer _____

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4 A light spring has natural length 0.4 m and modulus of elasticity 49 N. The spring stands vertically with its lower end fixed to a horizontal floor. A particle P of mass m kg rests in equilibrium on the top of the spring, and the length of the spring is 0.3 m, as shown in the diagram.

a. Find the value of m.

A vertical force of magnitude F newtons is now applied to P, pushing it downwards, so that P rests in equilibrium with the length of the spring equal to 0.22 m.

b. Find the value of F.

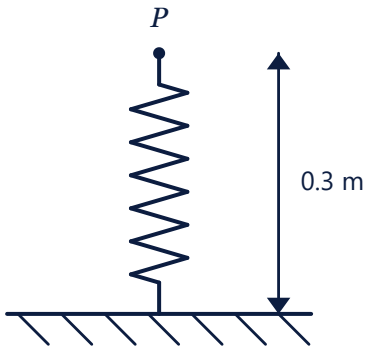


Diagram NOT accurately drawn

(5 marks)

Answer

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5 A particle P of mass 2 kg is attached to one end of a light elastic string of natural length 1.2 m and modulus of elasticity 30 N. The other end of the string is attached to a fixed point A on a smooth plane inclined at an angle α to the horizontal, where $\tan \alpha = \frac{3}{4}$

P rests in equilibrium on the plane below A, with the string lying along a line of greatest slope, as shown in the diagram.

a. Find the length AP.

P is now pulled down the line of greatest slope and held in equilibrium with AP = 2 m by a force acting parallel to the plane.

b. Find the magnitude of this force.

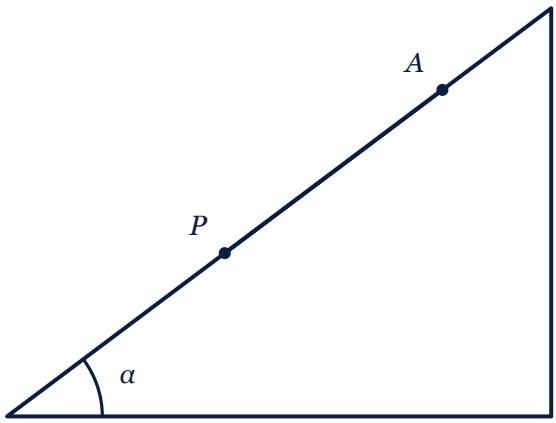


Diagram NOT accurately drawn

(6 marks)

Answer

6 Two points A and B on a smooth horizontal floor are 1.8 m apart. A light spring of natural length 0.8 m and modulus of elasticity 20 N joins A to a particle P. A second light spring of natural length 1.2 m and modulus of elasticity 30 N joins P to B. The springs lie along the straight line AB and P rests in equilibrium, as shown in the diagram.

a. Find the distance AP.

b. Find the thrust in each spring.

c. Explain why P would not have a single equilibrium position if the two springs were replaced by light elastic strings with the same natural lengths and moduli.

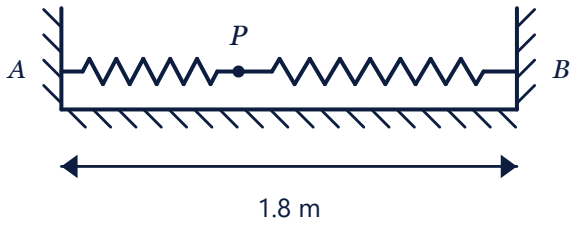


Diagram NOT accurately drawn

(7 marks)

Answer

7 A light elastic string has natural length 1.2 m and modulus of elasticity λ N. Its ends are attached to two fixed points A and B which are 1.6 m apart on the same horizontal level. A particle P of mass 0.8 kg is attached to the midpoint of the string and hangs in equilibrium 0.6 m below the midpoint of AB, as shown in the diagram.

a. Find the tension in the string.

b. Show that λ = 9.8

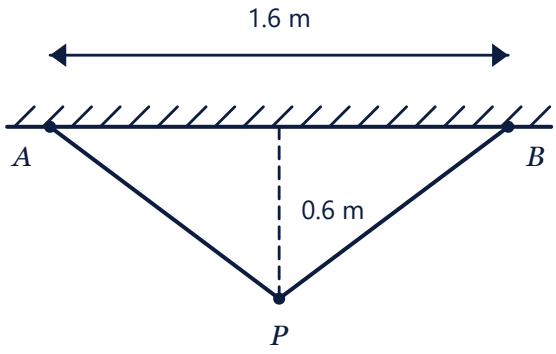


Diagram NOT accurately drawn

(6 marks)

Answer

8 A fixed point A is 3 m vertically above a fixed point B. A particle P of mass 2 kg is attached to one end of each of two light elastic strings. The other end of the first string is attached to A, and the other end of the second string is attached to B.

The string AP has natural length 1 m and modulus of elasticity 49 N. The string PB has natural length 1 m and modulus of elasticity 98 N. The particle rests in equilibrium on the line AB with both strings taut, as shown in the diagram.

a. Find the distance AP.

b. Find the tension in each string.

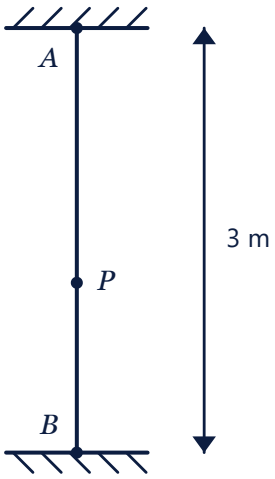


Diagram NOT accurately drawn

(7 marks)

Answer

9 A particle P of mass 0.5 kg is attached to one end of a light elastic string of natural length 0.8 m and modulus of elasticity 12 N. The other end of the string is attached to a fixed point O on a rough plane inclined at 30° to the horizontal. The coefficient of friction between P and the plane is 0.4.

P rests in equilibrium on the plane below O, with the string taut and lying along a line of greatest slope, as shown in the diagram.

Find the range of possible values of the length OP.

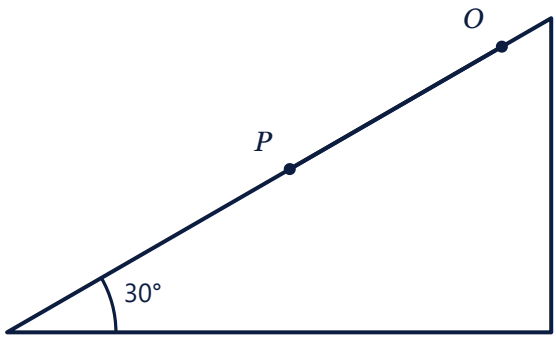


Diagram NOT accurately drawn

(8 marks)

Answer

10 A bird feeder of mass 0.6 kg hangs from a fixed hook O by a light elastic cord of natural length 1.5 m and modulus of elasticity 29.4 N. On a windy day the wind exerts a constant horizontal force of magnitude 4.41 N on the feeder. The feeder hangs in equilibrium with the cord making an angle θ with the downward vertical, as shown in the diagram.

The feeder is modelled as a particle.

a. Find the tension in the cord.

b. Find the value of θ.

c. Find the vertical distance of the feeder below O.

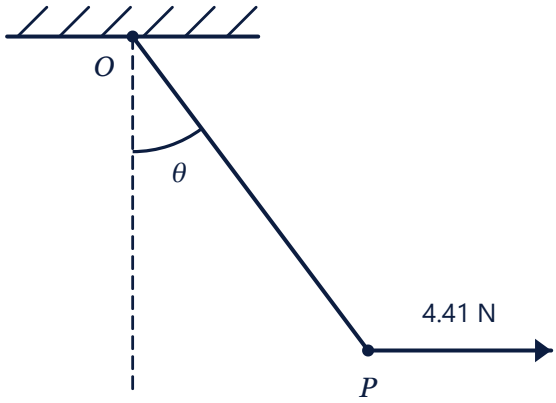


Diagram NOT accurately drawn

(8 marks)

Answer

11 A particle A of mass 3 kg rests on a rough horizontal table. The coefficient of friction between A and the table is 0.5. One end of a light elastic string of natural length 0.9 m and modulus of elasticity 35 N is attached to A. The string passes over a small smooth pulley fixed at the edge of the table, and a particle B hangs freely from the other end, as shown in the diagram. The part of the string between A and the pulley is horizontal.

a. Given that B has mass 1.2 kg and the system is in equilibrium, find the extension of the string.

b. Find the greatest mass that B could have if A is to remain at rest, and the extension of the string in this case.

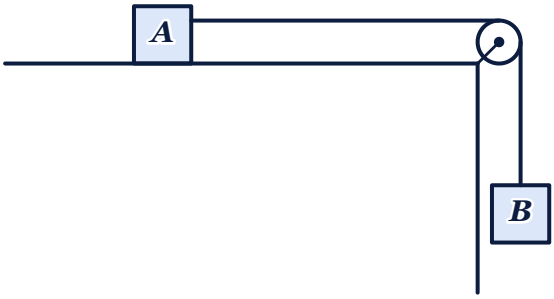


Diagram NOT accurately drawn

(7 marks)

Answer

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12 Two fixed points A and B are 2 m apart on the same horizontal level. A particle P of mass 2.5 kg is attached to A by a light elastic string of natural length 1 m and to B by a light elastic string of natural length 1.2 m. The particle hangs in equilibrium below AB with AP = 1.2 m and BP = 1.6 m, as shown in the diagram.

a. Show that angle APB = 90°.

b. Find the tension in each string.

c. Find the modulus of elasticity of each string.

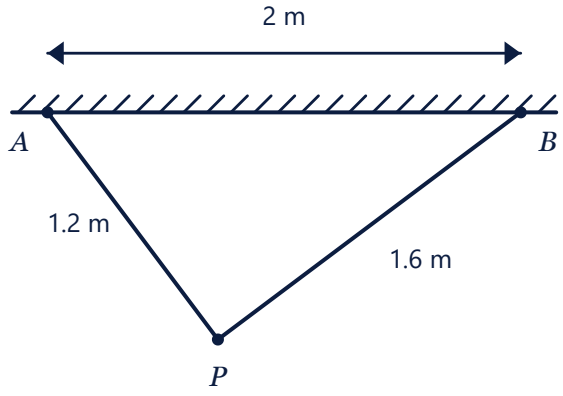


Diagram NOT accurately drawn

(10 marks)

Answer _____

End of questions | Total 75 marks

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