Elastic potential energy

Further Mechanics 1 | Edexcel 9FM0 | 12 questions, 89 marks

Further Maths topic practice

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Name: _____ **Date:** _____ **Score:** _____ **/ 89**

1 A light elastic string has natural length 1.2 m and modulus of elasticity 30 N.

a. Find the elastic potential energy stored in the string when its extension is 0.4 m.

b. Find the work done in stretching the string from an extension of 0.4 m to an extension of 0.6 m.

(4 marks)

Answer _____

2 A light spring of natural length 0.5 m and modulus of elasticity 80 N lies on a smooth horizontal surface with one end fixed to a vertical wall. A particle of mass 0.4 kg is held against the free end of the spring so that the spring is compressed to a length of 0.35 m. The particle is released from rest.

a. Find the elastic potential energy stored in the spring before the particle is released.

b. Find the speed of the particle when it leaves the spring.

(4 marks)

Answer _____

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3 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 20 N. The other end of the string is attached to a fixed point O on a smooth horizontal table. P moves on the table directly away from O, and when the string becomes taut P has speed 3 m s^{-1}.

a. Find the greatest extension of the string in the motion that follows.

b. Find the greatest tension in the string.

(5 marks)

Answer

4 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 19.6 N. The other end of the string is attached to a fixed point O.

a. Find the extension of the string when P hangs in equilibrium vertically below O.

P is pulled vertically down until OP = 1.3 m and is released from rest.

b. Find the speed of P as it passes through its equilibrium position.

c. Find the speed of P at the instant the string becomes slack.

(8 marks)

Answer

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5 A particle P of mass 0.4 kg is attached to one end of a light elastic string of natural length 1.5 m and modulus of elasticity 29.4 N. The other end of the string is attached to a fixed point O. The particle is held at O and released from rest, and falls vertically.

a. Show that the greatest extension of the string is 1 m.

b. Find the greatest speed of P during its fall.

(8 marks)

Answer

6 A light spring of natural length 0.6 m and modulus of elasticity 48 N lies on a rough horizontal floor with one end fixed to a vertical wall. A particle P of mass 0.8 kg is placed against the free end of the spring, and is held at rest with the spring compressed by 0.2 m, as shown in the diagram. The coefficient of friction between P and the floor is 0.25. The particle is not attached to the spring.

P is released from rest.

a. Find the speed of P at the instant it leaves the spring.

b. Find the total distance that P moves before it comes to rest.

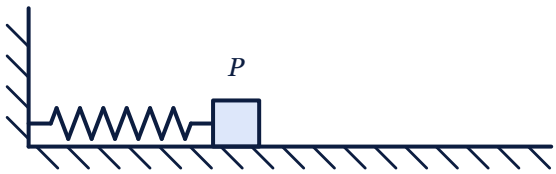


Diagram NOT accurately drawn

(7 marks)

Answer

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7 A particle P of mass 0.5 kg is attached to one end of a light elastic string of natural length 1 m and modulus of elasticity 9.8 N. The other end of the string is attached to a fixed point A on a smooth plane inclined at 30° to the horizontal. P is held at A and released from rest. It slides down a line of greatest slope and first comes to instantaneous rest at the point B, as shown in the diagram.

a. Find the distance AB.

b. Find the magnitude and direction of the acceleration of P at B.

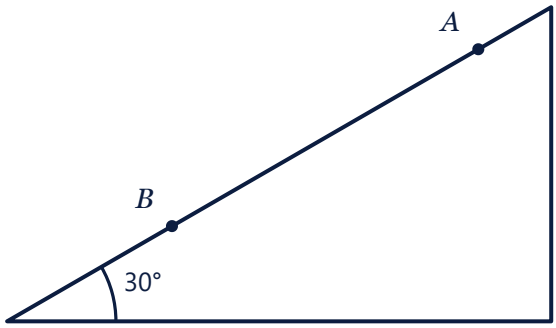


Diagram NOT accurately drawn

(7 marks)

Answer

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8 A rough plane is inclined at an angle α to the horizontal, where $\tan \alpha = \frac{3}{4}$. A particle P of mass 2 kg is attached to one end of a light elastic string of natural length 1.5 m and modulus of elasticity 120 N. The other end of the string is attached to a fixed point O on the plane. The coefficient of friction between P and the plane is 0.25.

P is held at rest at the point B on the plane, where B is below O on a line of greatest slope and OB = 2.1 m, as shown in the diagram. P is released and moves up the plane.

a. Find the speed of P at the instant the string becomes slack.

b. Find the further distance that P moves up the plane before it comes to instantaneous rest.

c. Determine whether P remains at rest at this point, giving a reason.

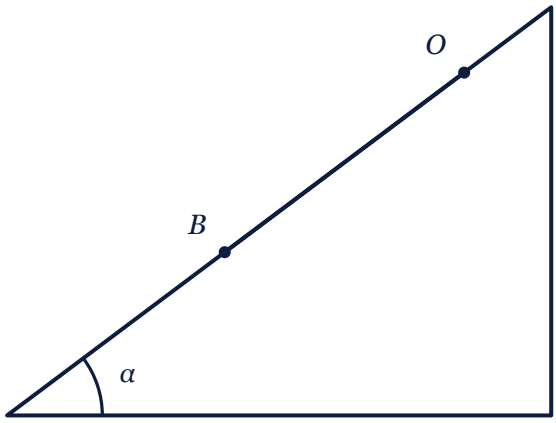


Diagram NOT accurately drawn

(9 marks)

Answer

9 A light spring of natural length 0.5 m and modulus of elasticity 147 N stands vertically with its lower end fixed to a horizontal floor. A particle P of mass 1 kg is held at rest 0.9 m above the floor, directly above the spring, as shown in the diagram. P is released and falls onto the top of the spring.

a. Find the speed of P as it first hits the spring.

b. Find the least height of P above the floor in the motion that follows.

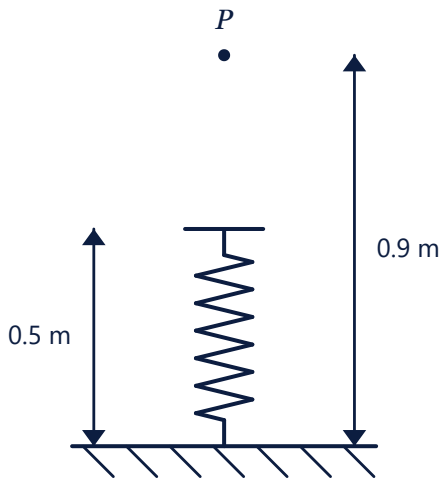


Diagram NOT accurately drawn

(7 marks)

Answer

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10 A particle P of mass 0.5 kg is attached to one end of a light elastic string of natural length 1 m and modulus of elasticity 19.6 N. The other end of the string is attached to a fixed point O on a rough horizontal floor. P is held at rest on the floor with OP = 1.5 m and is then released. P moves in a straight line towards O and comes to rest for the first time at a point 0.25 m from O.

a. Find the coefficient of friction between P and the floor.

b. Find the speed of P at the instant the string becomes slack.

(8 marks)

Answer

11 A bungee jumper of mass 72 kg is attached to one end of a light elastic rope of natural length 16 m. The other end of the rope is fixed to a bridge. The jumper steps off the bridge from rest at the point where the rope is fixed and falls vertically. The jumper first comes to instantaneous rest 40 m below the bridge.

The jumper is modelled as a particle and air resistance is ignored.

a. Show that the modulus of elasticity of the rope is 1568 N.

b. Find the speed of the jumper when they are 30 m below the bridge.

c. Find the greatest speed of the jumper.

d. State one way in which ignoring air resistance affects your answer to part (c).

(10 marks)

Answer

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12 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 29.4 N. The other end of the string is attached to a fixed point O on a rough plane inclined at an angle α to the horizontal, where $\tan \alpha = \frac{3}{4}$

P is held at rest at the point A on the plane, where A is below O on a line of greatest slope and OA = 1.2 m. P is released and slides down the line of greatest slope. It comes to rest for the first time at the point B, where AB = 0.576 m, as shown in the diagram. The coefficient of friction between P and the plane is μ.

a. Show that μ = 0.3

b. Show that P remains at rest at B.

c. Find the greatest speed of P as it moves from A to B.

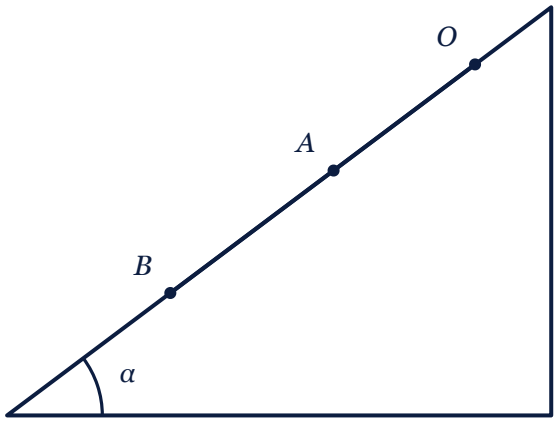


Diagram NOT accurately drawn

(12 marks)

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Answer

End of questions | Total 89 marks

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