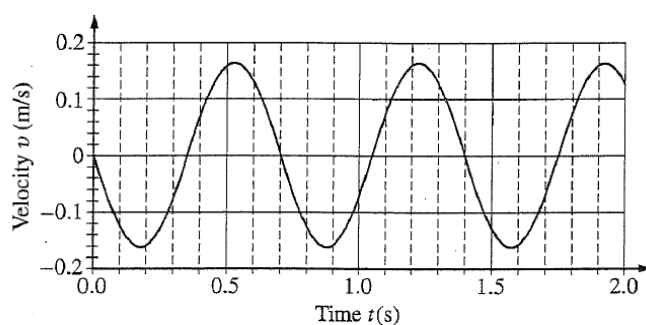


Experiment 1. A block of mass 0.30 kg is placed on a frictionless table and is attached to one end of a horizontal spring of spring constant k , as shown above. The other end of the spring is attached to a fixed wall. The block is set into oscillatory motion by stretching the spring and releasing the block from rest at time $t=0$. A motion detector is used to record the position of the block as it oscillates. The resulting graph of velocity v versus time t is shown below. The positive direction for all quantities is to the right.



a) Determine the equation for $v(t)$, including numerical values for all constants.

$$v(t) = -v_{\max} \sin(\omega t) \quad \text{1 pt for correct trig eqn with (-) sign}$$

$$\omega = 2\pi f \therefore \omega = \frac{2\pi}{T} \quad \text{1 pt. for using eqn. to solve for omega}$$

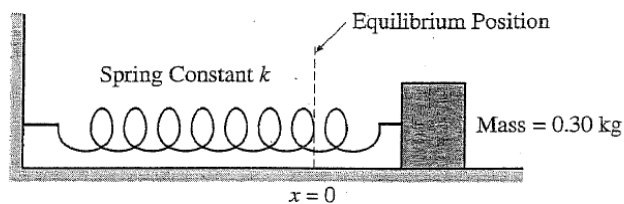
$$\omega = \frac{2\pi}{0.70\text{s}} = 9.0 \frac{\text{rad}}{\text{s}} \quad \text{1 pt for correct period of 0.70 s}$$

$$v(t) = -\left(0.16 \frac{\text{m}}{\text{s}}\right) \sin\left(9.0 \frac{\text{rad}}{\text{s}}\right) t \quad \text{1 pt for correct vmax}$$

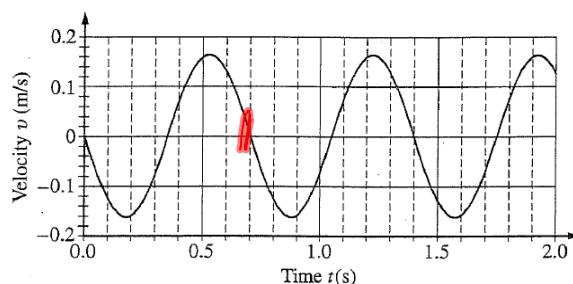
Note:

-acceptable answers for v_{\max} are 0.15 to 0.17 m/s

-Full credit is awarded for a correct answer with no work shown



Experiment 1. A block of mass 0.30 kg is placed on a frictionless table and is attached to one end of a horizontal spring of spring constant k , as shown above. The other end of the spring is attached to a fixed wall. The block is set into oscillatory motion by stretching the spring and releasing the block from rest at time $t=0$. A motion detector is used to record the position of the block as it oscillates. The resulting graph of velocity v versus time t is shown below. The positive direction for all quantities is to the right.



b) Given that the equilibrium position is at $x=0$, determine the equation for $x(t)$, including numerical values for all constants

$$v(t) = -\left(0.16 \frac{\text{m}}{\text{s}}\right) \sin\left(9.0 \frac{\text{rad}}{\text{s}} t\right) \quad \text{from part a}$$

$$x(t) = \int v(t) dt$$

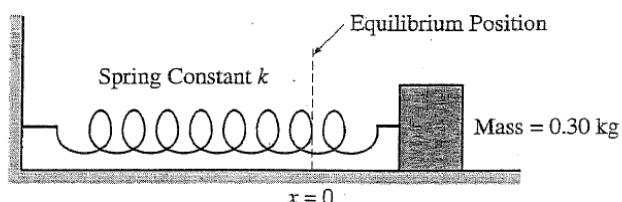
$$x(t) = \int -\left(0.16 \frac{\text{m}}{\text{s}}\right) \sin\left(9.0 \frac{\text{rad}}{\text{s}} t\right) dt$$

$$x_{\text{max}} = (0.16 \frac{\text{m}}{\text{s}}) / (9.0 \frac{\text{rad}}{\text{s}}) = 0.018 \text{ m}$$

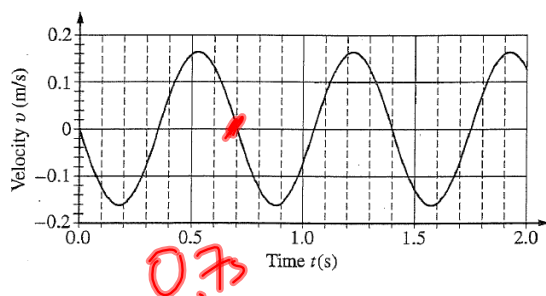
$$x(t) = (0.018) \cos(9.0t)$$

Note:

- 1 pt for a correct trigonometric expression consistent with integrating the answer from part a
- 1 pt for a correct x_{max} consistent with the integrating the answer from part a
- Full credit is awarded for a correct answer with no work shown



Experiment 1. A block of mass 0.30 kg is placed on a frictionless table and is attached to one end of a horizontal spring of spring constant k , as shown above. The other end of the spring is attached to a fixed wall. The block is set into oscillatory motion by stretching the spring and releasing the block from rest at time $t=0$. A motion detector is used to record the position of the block as it oscillates. The resulting graph of velocity v versus time t is shown below. The positive direction for all quantities is to the right.



c) Calculate the value of k

$$T = 2\pi \sqrt{\frac{m}{k}}$$

1 pt for a correct relationship btwn. period and k

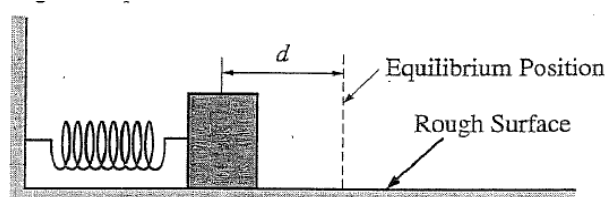
$$\frac{T}{2\pi} = \sqrt{\frac{m}{k}} \Rightarrow \frac{T^2}{4\pi^2} = \frac{m}{k} \rightarrow \frac{4\pi^2}{T^2} = \frac{k}{m}$$

$$k = \frac{4\pi^2 m}{T^2}$$

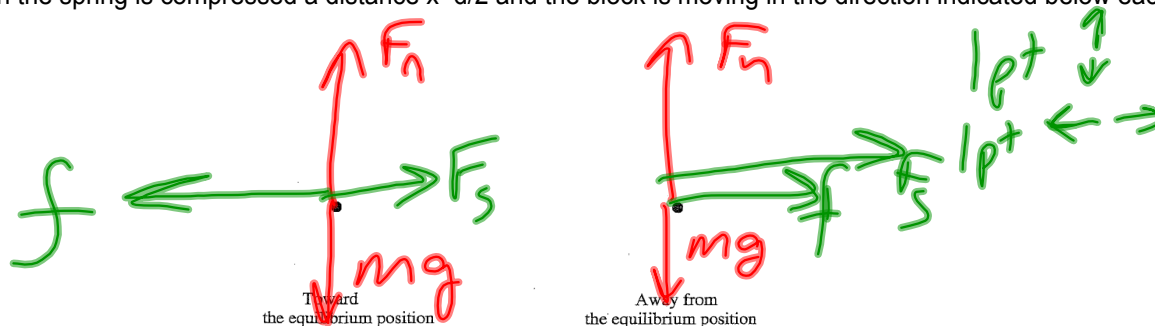
24 N/m

1 pt for substituting correct values

Experiment 2. The block and spring arrangement is now placed on a rough surface as shown below. The block is displaced so that the spring is compressed a distance d and released from rest.



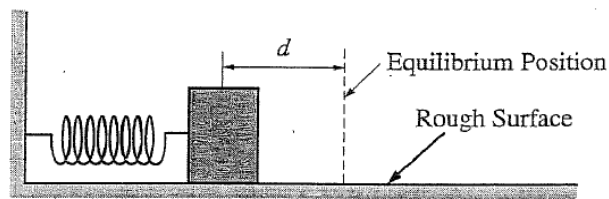
d) On the dots below that represent the block, draw and label the forces (not components) that act on the block when the spring is compressed a distance $x=d/2$ and the block is moving in the direction indicated below each dot



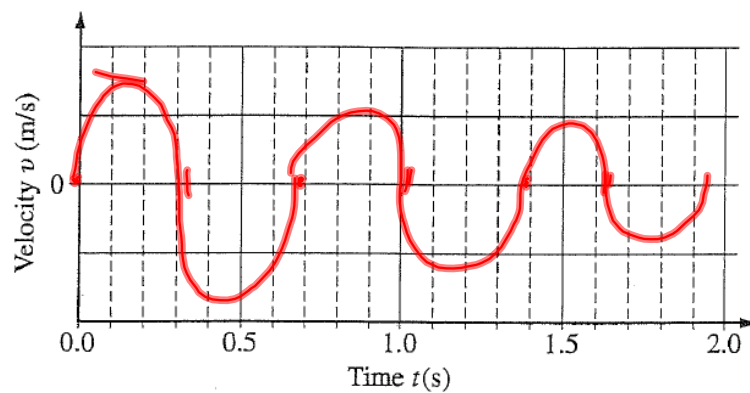
note:

- 1 pt for drawing and labeling F_n and mg correctly on both diagrams
- On the diagram for moving toward the equilibrium position
 - 1 pt for spring force to the right
 - 1 pt for friction force to the left
- On the diagram of the block moving away from the equilibrium position
 - 1 pt for spring force and friction force to the right

Experiment 2. The block and spring arrangement is now placed on a rough surface as shown below. The block is displaced so that the spring is compressed a distance d and released from rest.



e) Draw a sketch of v versus t in this case. Assume that there is a negligible change in the period and that the positive direction is still to the right.



note

- 1 pt for a graph passing through equilibrium at 0.35 s intervals
- 1 pt for a graph displaying damped oscillations
- 1 pt for a graph that starts at zero with an increasing positive velocity

