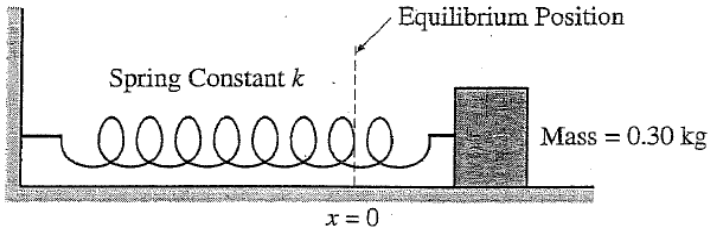
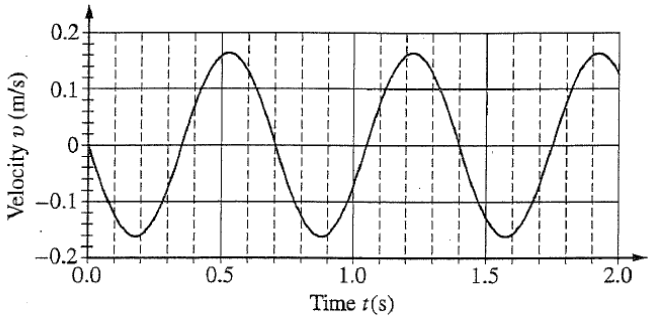


Experiment 1. A block of mass 0.30 kg is placed on a frictionless table and is attached to one end of a horizontal spring of spring constant k, as shown above. The other end of the spring is attached to a fixed wall. The block is set into oscillatory motion by stretching the spring and releasing the 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.

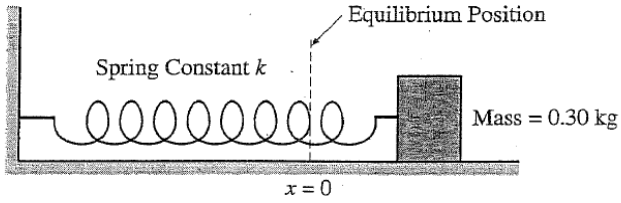
$$v(t) = -v_{max}\sin(\omega t)$$ 1 pt for correct trig eqn with (-) sign

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

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

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

Note:
-acceptable answers for vmax are 0.15 to 0.17 m/s
-Full credit is awarded for a correct answer with no work shown



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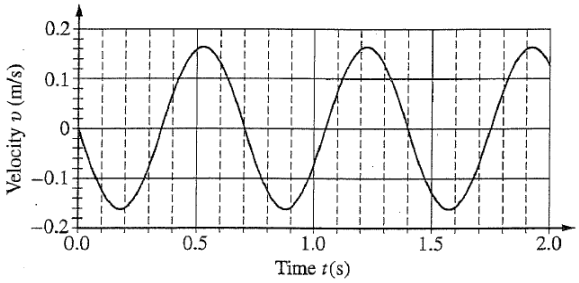


b) Given that the equilibrium position is at x=0, determine the equation for x(t), including numerical values for all constants

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

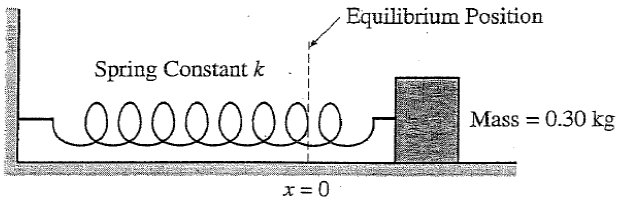
$$x(t) = \int v(t)\,dt$$

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

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

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

Note:
-1 pt for a correct trigonometric expression sinsistent with tnetgrating the answer from part a
-1 pt for a correct xmax consistent with the integrating the answer from part a
-Full credit is awarded for a correct answer with no work shown



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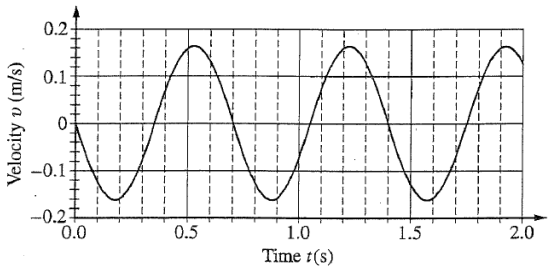


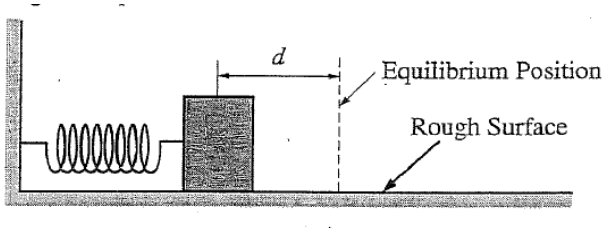
c) Calculate the value of k

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

1 pt for a correct relationship btwn. period and k

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.



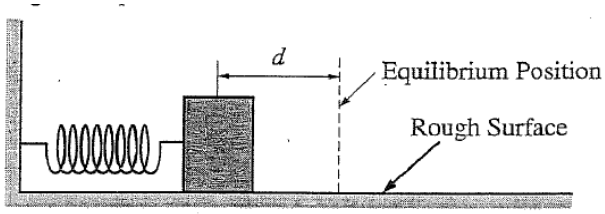
d) On the dots below that represent the block, draw and label the forces (not components) that act on the block when the spring is compressed a distance x=d/2 and the block is moving in the direction indicated below each dot

Toward
the equilibrium position

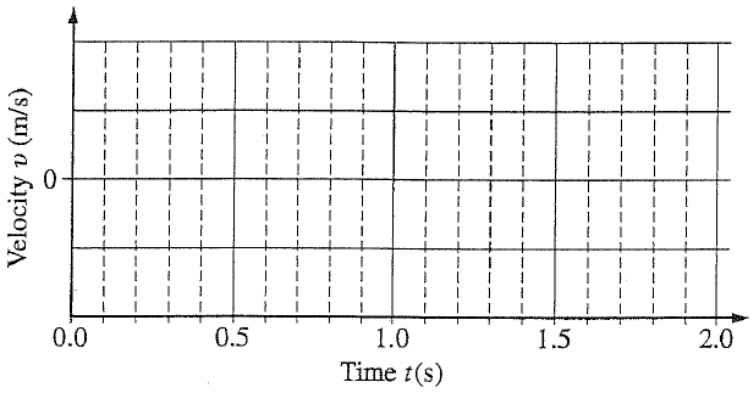
Away from
the equilibrium position

note:
-1 pt for drawing and labeling Fn 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