2. Using Hooke's law, the following proportion is obtained.

UNIT 1 Physics 101

$$k=\frac{F_1}{x_1}=\frac{F_2}{x_2}$$

Solve for x_2.

$$x_2=\frac{F_2}{F_1}x_1=\frac{7.0\text{ N}}{5.0\text{ N}}(3.5\text{ cm})=\boxed{4.9\text{ cm}}$$

Substitute known values for F_1 and x_1 to find k.

$$k=\frac{F_1}{x_1}=\frac{5.0\text{ N}}{3.5\text{ cm}}=\boxed{1.4\text{ N/cm}}$$

66. **(a)**
$$\begin{aligned}
v_y^2-v_{0y}^2&=-2g\Delta y\\
0-v_{0y}^2&=-2g\Delta y\\
v_{0y}&=\sqrt{2g\Delta y}\\
&=\sqrt{2\left(9.8\frac{\text{m}}{\text{s}^2}\right)(0.30\text{ m})}\\
&=\boxed{2.4\text{ m/s}}
\end{aligned}$$

(b)
$$\begin{aligned}
v^2-v_0^2&=2a\Delta r\\
a&=\frac{v^2-v_0^2}{2\Delta r}\\
&=\frac{\left(1.4\sqrt{2g\Delta y}\right)^2-0}{2\Delta r}\\
&=\frac{1.4^2(2g\Delta y)}{2\Delta r}\\
&=\frac{1.4^2 g\Delta y}{\Delta r}\\
&=\frac{1.4^2\left(9.8\frac{\text{m}}{\text{s}^2}\right)(0.30\text{ m})}{0.040\text{ m}}\\
&=140\text{ m/s}^2
\end{aligned}$$

So, $\vec{\mathbf{a}}=\boxed{140\text{ m/s}^2\text{ at }55^\circ\text{ above the horizontal}}$.

(c) Use Newton's second law.

$$\vec{\mathbf{F}}=m\vec{\mathbf{a}}=(0.0020\text{ kg})\left(144\frac{\text{m}}{\text{s}^2}\text{ at }55^\circ\text{ to the horizontal}\right)=\boxed{0.29\text{ N at }55^\circ\text{ above the horizontal}}$$

$$\frac{F}{W}=\frac{F}{mg}=\frac{0.29\text{ N}}{(0.0020\text{ kg})\left(9.8\frac{\text{N}}{\text{kg}}\right)}=15$$

It was okay to ignore the weight of the locust since the force was 15 times that of the weight, which makes only a small change to the net force on the locust.

71. **(a)** $a_x < 0$ when the engine is moving in the $+x$-direction and slowing down and when it is moving in the $-x$-direction and speeding up. So, at $\boxed{t_3 \text{ and } t_4}$ $a_x < 0$.

(b) $a_x = 0$ when the engine's speed is constant or zero. So, at $\boxed{t_0,\ t_2,\ t_5, \text{ and } t_7}$ $a_x = 0$.

(c) $a_x > 0$ when the engine is moving in the $+x$-direction and speeding up and when it is moving in the $-x$-direction and slowing down. So, at $\boxed{t_1 \text{ and } t_6}$ $a_x > 0$.

(d) $v_x = 0$ when the slope of the graph is zero. So, at $\boxed{t_0,\ t_3, \text{ and } t_7}$ $v_x = 0$.

(e) The speed is decreasing when a_x and v_x have opposite directions. So, at $\boxed{t_6}$ the speed is decreasing.

72. **(a)** The area under the curve represents the change in velocity. Assume each tick mark along the t-axis represents 1 s; for example, $t_1 = 3$ s.

$$A_1 = \frac{1}{2}bh = \frac{1}{2}(4\text{ s})\left(\frac{1\text{ m}}{4\text{ s}^2}\right) = \frac{1}{2}\text{ m/s}$$

The elevator accelerates $(a_y > 0)$ to $1/2$ m/s during the first 4 s. Then, the elevator travels at $1/2$ m/s $(a_y = 0)$ for the next 4 s.

$$A_2 = \frac{1}{2}bh = \frac{1}{2}(2\text{ s})\left(-\frac{1\text{ m}}{2\text{ s}^2}\right) = -\frac{1}{2}\text{ m/s}$$

The elevator slows down $(a_y < 0)$ until it comes to rest. Then, it sits for the next 2 s. So, the passenger has gone to a $\boxed{\text{higher}}$ floor.

74. **(a)** The ball reaches its maximum height the first time $v_y = 0$, or at $t = \boxed{0.3\text{ s}}$.

(b) The time it takes for the ball to make the transition from its negative-most velocity to its positive-most velocity is the time that the ball is in contact with the floor.

$0.65\text{ s} - 0.60\text{ s} = \boxed{0.05\text{ s}}$

(c) $$\Delta y = v_{0y}t + \frac{1}{2}at^2 = v_{0y}t + \frac{\Delta v_y}{2\Delta t}t^2 = \left(3.0\frac{\text{m}}{\text{s}}\right)(0.30\text{ s}) + \frac{0 - 3.0\,\frac{\text{m}}{\text{s}}}{2(0.30\text{ s})}(0.30\text{ s})^2 = \boxed{0.45\text{ m}}$$

(d) $$a_y = \frac{\Delta v_y}{\Delta t} = \frac{0 - 3.0\,\frac{\text{m}}{\text{s}}}{0.30\text{ s}} = \boxed{-10\text{ m/s}^2}$$

(e) $$a_{av} = \frac{\Delta v}{\Delta t} = \frac{3.0\,\frac{\text{m}}{\text{s}} - \left(-3.0\,\frac{\text{m}}{\text{s}}\right)}{0.05\text{ s}} = \boxed{120\text{ m/s}^2}$$