'15.1 (a) Taking to the right as positive, the spring force acting on the block at the instant of release is

$$F_s = -kx_i = -(130\ \text{N/m})(+0.13\ \text{m})$$
$$= -17\ \text{N} \quad \text{or} \quad \boxed{17\ \text{N to the left}}$$

(b) At this instant, the acceleration is

$$a = \frac{F_s}{m} = \frac{-17\ \text{N}}{0.60\ \text{kg}} = -28\ \text{m/s}^2$$

or $\boxed{a = 28\ \text{m/s}^2 \text{ to the left}}$

'15.4 (a) The equation for the piston's position is given as

$$x = (5.00\ \text{cm})\cos\left(2t + \frac{\pi}{6}\right)$$

At $t = 0$,

$$x = (5.00\ \text{cm})\cos\left(\frac{\pi}{6}\right) = \boxed{4.33\ \text{cm}}$$

(b) Differentiating the equation for position with respect to time gives us the piston's velocity:

$$v = \frac{dx}{dt} = -(10.0\ \text{cm/s})\sin\left(2t + \frac{\pi}{6}\right)$$

At $t = 0$, $v = \boxed{-5.00\ \text{cm/s}}$

(c) Differentiating again gives its acceleration:

$$a = \frac{dv}{dt} = -(20.0\ \text{cm/s}^2)\cos\left(2t + \frac{\pi}{6}\right)$$

At $t = 0$, $a = \boxed{-17.3\ \text{cm/s}^2}$

(d) The period of motion is

$$T = \frac{2\pi}{\omega} = \frac{2\pi}{2} = \boxed{3.14\ \text{s}}$$

(e) We read the amplitude directly from the equation for x:

$$A = \boxed{5.00\ \text{cm}}$$

'15.5 $x = (4.00\ \text{m})\cos(3.00\pi t + \pi)$; compare this with $x = A\cos(\omega t + \phi)$ to find

(a) $\omega = 2\pi f = 3.00\pi$ or $\boxed{f = 1.50\ \text{Hz}}$

(b) $T = \dfrac{1}{f} = \boxed{0.667\ \text{s}}$

(c) $A = \boxed{4.00\ \text{m}}$

(d) $\phi = \boxed{\pi\ \text{rad}}$

(e) $x(t = 0.250\ \text{s}) = (4.00\ \text{m})\cos(1.75\pi) = \boxed{2.83\ \text{m}}$

15.17 (a) The distance traveled in one cycle is four times the amplitude of motion, or $\boxed{20.0\ \text{cm}}$.

(b) $v_{\max} = \omega A = 2\pi fA = 2\pi(3.00\ \text{Hz})(5.00\ \text{cm}) = \boxed{94.2\ \text{cm/s}}$

This occurs as the particle passes through equilibrium.

(c) $a_{\max} = \omega^2 A = (2\pi f)^2 A = [2\pi(3.00\ \text{Hz})]^2(0.05\ \text{m}) = \boxed{17.8\ \text{m/s}^2}$

This occurs at maximum excursion from equilibrium.

15.19 $\omega = \sqrt{\dfrac{k}{m}} = \sqrt{\dfrac{8.00\ \text{N/m}}{0.500\ \text{kg}}} = 4.00\ \text{s}^{-1}$. Assuming the position of the object is at the origin at $t = 0$, position is given by $x = 10.0\sin(4.00t)$, where x is in cm. From this, we find that $v = 40.0\cos(4.00t)$, where v is in cm/s, and $a = -160\sin(4.00t)$, where a is in cm/s^2.

(a) $v_{\max} = \omega A = (4.00\ \text{rad/s})(10.0\ \text{cm}) = \boxed{40.0\ \text{cm/s}}$

(b) $a_{\max} = \omega^2 A = (4.00\ \text{rad/s})^2(10.0\ \text{cm}) = \boxed{160\ \text{cm/s}^2}$

From our assumed expression for x, we solve for the time t:

$$t = \left(\frac{1}{4.00\text{ Hz}}\right)\sin^{-1}\left(\frac{x}{10.0\text{ cm}}\right)$$

When $x = 6.00$ cm, $t = \left(\frac{1}{4.00\text{ Hz}}\right)\sin^{-1}\left(\frac{6.00\text{ cm}}{10.0\text{ cm}}\right) = 0.161$ s.

We find then that at that time:

(c) $v = (40.0\text{ cm/s})\cos\left[(4.00\text{ Hz})(0.161\text{ s})\right] = \boxed{32.0\text{ cm/s}}$ and

(d) $a = -\left(160\text{ cm/s}^2\right)\sin\left[(4.00\text{ Hz})(0.161\text{ s})\right] = \boxed{-96.0\text{ cm/s}^2}$

(e) Using $t = \left(\frac{1}{4.00\text{ Hz}}\right)\sin^{-1}\left(\frac{x}{10.0\text{ cm}}\right)$ we find that when $x = 0$, $t = 0$, and when $x = 8.00$ cm, $t = 0.232$ s. Therefore, $\Delta t = \boxed{0.232\text{ s}}$.

15.33 (a) $\boxed{\text{The motion is simple harmonic because the tire is rotating with constant angular velocity and you see the projection of the motion of the bump in a plane perpendicular to the tire.}}$

(b) Since the car is moving with speed $v = 3.00$ m/s, and its radius is 0.300 m, we have

$$\omega = \frac{3.00\text{ m/s}}{0.300\text{ m}} = 10.0\text{ rad/s}$$

Therefore, the period of the motion is

$$T = \frac{2\pi}{\omega} = \frac{2\pi}{(10.0\text{ rad/s})} = \boxed{0.628\text{ s}}$$