Problem 1

The time t to compress the spring is just one-fourth of a period: $t = T/4$. But $T = 1/f = 2\pi/\omega$, and $\omega = \sqrt{k/M}$. So:

$$t = \frac{T}{4} = \frac{1}{4}\frac{2\pi}{\omega} = \frac{1}{4}2\pi\sqrt{\frac{M}{k}} = \frac{\pi}{2}\sqrt{\frac{M}{k}} = \underline{\underline{0.1 \text{ s}}}.$$

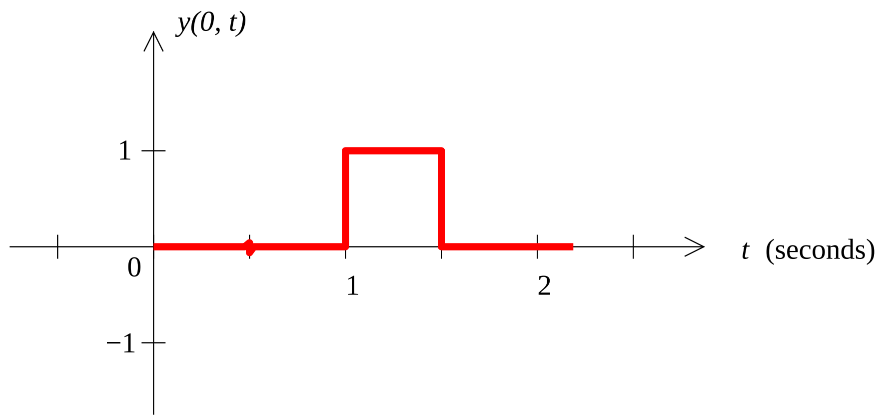
Problem 2

There is half a wavelength in there (since we are driving the fundamental vibration) so $\lambda = 2L = 1.5$ m. The wave speed is just the wavelength divided by the period:

$$v = \frac{\lambda}{T} = \frac{1.5 \text{ m}}{1.5 \text{ s}} = \underline{\underline{1 \text{ m/s}}}$$

Problem 3

Both waves are 0.5 m away and moving at 1 m/s. So, for the first half second, there is nothing going on. Then after a half second, both waves get to $x = 0$. But, they have opposite amplitudes, so they (probably) cancel. After 1 second, the negative wave passes by, but the positive one is still there, so the amplitude goes up to 1. Then after 1.5 seconds, the positive wave passes by and there is nothing left. Putting this in a graph gives:



Problem 4

(a) It says the fundamental standing wave, so we know $\lambda = 2L$. The frequency f is given, so we know the velocity $v = \lambda f = 2Lf$. But, we know the wave velocity is $v = \sqrt{T/\mu}$ and T is given, so this givs us $\mu = T/(4L^2 f^2)$. But the mass is just $M = \mu L$, so we have

$$M = \frac{T}{4Lf^2} = \underline{\underline{0.010 \text{ kg}}}$$

Problem 4, *continued*

(b) Do the same thing as above, except now use $\lambda = L$, and now we know M so we solve for T. We find

$$T = f^2 LM = \underline{\underline{100 \text{ N}}}$$

Problem 5

Just reading off the graph: (a) $\underline{\underline{\lambda = 8 \text{ meters}}}$ and (b) $\underline{\underline{v = 1 \text{ m/s}}}$

(c) We know $v = \lambda f$ so $f = v/\lambda = \underline{\underline{0.125 \text{ m/s}}}$

(d) Now we can write a wave function:

$$y = 1 \sin\left(\frac{2\pi}{\lambda}(x - vt)\right)$$

Putting in $x = 9$, $t = 3$, and $v = 1$ gives $\underline{\underline{y = -1}}$.
Putting in $x = 9$, $t = 3.1$, and $v = 1$ gives $\underline{\underline{y = -0.997}}$.

Problem 6

The pedestrian hears the car coming at a higher frequency. Using the moving source equation we find:

$$f = 100\frac{300}{300 - 30} = 111.1 \text{ Hz}$$

The beat frequency is the difference between this and the frequency that the pedestrian's speaker is making:

$$\Delta f_{\text{ped}} = 111.1 - 100 = \underline{\underline{11.1 \text{ Hz}}}$$

The driver hears the pedestrian coming at a higher frequency. Using the moving observer equation we find:

$$f = 100\frac{300 + 30}{300} = 110.0 \text{ Hz}$$

The beat frequency is the difference between this and the frequency that the pedestrian's speaker is making:

$$\Delta f_{\text{driver}} = 110.0 - 100 = \underline{\underline{10.0 \text{ Hz}}}$$