20.47. Model: The wave pulse is a traveling wave on a stretched string.
Visualize: Please refer to Figure P20.47.
Solve: While the tension T_S is the same in both the strings, the wave speeds in the two strings are not. We have

$$v_1 = \sqrt{\frac{T_S}{\mu_1}} \quad \text{and} \quad v_2 = \sqrt{\frac{T_S}{\mu_2}} \Rightarrow v_1^2\mu_1 = v_2^2\mu_2 = T_S$$

Because $v_1 = L_1/t_1$ and $v_2 = L_2/t_2$, and because the pulses are to reach the ends of the string simultaneously the above equation can be simplified to

$$\frac{L_1^2\mu_1}{t^2} = \frac{L_2^2\mu_2}{t^2} \Rightarrow \frac{L_1}{L_2} = \sqrt{\frac{\mu_2}{\mu_1}} = \sqrt{\frac{4.0 \text{ g/m}}{2.0 \text{ g/m}}} = \sqrt{2} \Rightarrow L_1 = \sqrt{2}L_2$$

Since $L_1 + L_2 = 4$ m,

$$\sqrt{2}L_2 + L_2 = 4 \text{ m} \Rightarrow L_2 = 1.66 \text{ m} \quad \text{and} \quad L_1 = \sqrt{2}(1.66 \text{ m}) = 2.34 \text{ m}$$