QP20

A rope of length $2l$ and uniform density (here: mass per unit length) ρ is hanging over a nail in a wall with a piece of length l on both sides. Friction, the thickness of the nail, and the thickness of the rope are negligible. When one creates a slight length difference between the two sides, a net force will start to act on the rope, and it will slide off the nail, faster and faster.

a) (1 point) When the length on one side is $l + x (0 < x < l)$, what is the net force on the rope?

b) (3 points) Find the velocity as a function of x. Hint: make use of $\frac{dv}{dt} = \frac{dv}{dx}\frac{dx}{dt}$. What is the velocity when the rope completely comes off the nail?