9.26. **Model:** Model the rocket as a particle, and use the impulse-momentum theorem. The only force acting on the rocket is due to its own thrust.

**Visualize:** Please refer to Figure P9.26.

**Solve:**

(a) The impulse is

\[ J_x = \int F_x \, dt = \text{area of the } F_x(t) \text{ graph between } t = 0 \text{ s and } t = 30 \text{ s} = \frac{1}{2}(1000 \text{ N})(30 \text{ s}) = 15,000 \text{ N s} \]

(b) From the impulse-momentum theorem, \( p_f = p_i + 15,000 \text{ Ns} \). That is, the momentum or velocity increases as long as \( J_x \) increases. When \( J_x \) increases no more, the speed will be a maximum. This happens at \( t = 30 \text{ s} \). At this time,

\[ mv_f = mv_i + 15,000 \text{ N s} \Rightarrow (425 \text{ kg})v_f = (425 \text{ kg})(75 \text{ m/s}) + 15,000 \text{ N s} \Rightarrow v_f = 110.3 \text{ m/s} \]