This problem consists of two unrelated parts.

**Part I.**

A rocket ship $S'$, of length $l'$ meters in its rest frame, heads toward an observer $O$ at relativistic velocity $v$ as shown in the figure. When the nose of the rocket ship $S'$ reaches $O$, the nose emits a light pulse in all directions.

Express your answers to parts a), b) and c) in terms of $l'$, $v$ and $c$, the speed of light.

a) After what time interval $t'$, according to the rocket ship $S'$, does the pulse reach the tail end of rocket ship?

b) After what time interval $t$, according to observer $O$, does the pulse reach the tail end of rocket ship?

c) Are the two times in parts a) and b) related by time dilation, $t' = t/\sqrt{1-v^2/c^2}$? If not, why not?

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**Part II.**

A photon rocket uses light as a propellant to travel at relativistic speeds. If the initial and final rest masses of the rocket are $M_i$ and $M_f$, respectively, find the final velocity of the rocket, relative to its initial rest frame, in terms of $M_i$, $M_f$ and $c$. 