26.20

The proper length of the rocket is $L_S = 1.00\,\text{m}$. As it is fired past an observer at a relativ speed v, the observer measures the length of the rocket to be $L_M = 0.500\,\text{m}$. Since $L_M = L_S\sqrt{1 - v^2/c^2}$, the speed v of the rocket relative to the observer is

$$v = c\sqrt{1 - \left(\frac{L_M}{L_S}\right)^2} = c\sqrt{1 - \left(\frac{0.500\,\text{m}}{1.00\,\text{m}}\right)^2} = 0.866c\,.$$

26.27

The 1.000-m length of the bar is its proper length L_S. As the bar moves by the telescope at a speed v relative to the scope, its moving length L_M measured by the observer through the scope is $L_M = L_S\sqrt{1 - v^2/c^2}$. At $v = 0.600c$, the time t it takes for the entire length of the bar to fly past the cross hairs of the telescope is therefore

$$t = \frac{L_M}{v} = \frac{L_S\sqrt{1 - v^2/c^2}}{v} = \frac{(1.000\,\text{m})\sqrt{1 - (0.600c/c)^2}}{0.600(2.998 \times 10^8\,\text{m/s})} = 4.45 \times 10^{-9}\,\text{s} = 4.45\,\text{ns}\,.$$

26.37

According to the Second Postulate of Special Relativity, the speed of either pulse of light is always c, regardless of the reference frame in which it is measured. To verify this with Eq. (26.7), call one of the pulses O and the other P, and denote the sender of the pulses as O′. Then v_{PO} is the speed of the pulse P relative to the other one, O. Since $v_{PO'} = c$ and $v_{O'O} = -v_{OO'} = -(-c) = c$ (where we noted that $v_{PO'}$ and $v_{OO'}$ have opposite signs since the two pulses, P and O, are sent in opposite directions by O′), according to Eq. (26.7)

$$v_{PO} = \frac{v_{PO'} + v_{O'O}}{1 + \frac{v_{PO'}v_{O'O}}{c^2}} = \frac{c + c}{1 + \frac{(c)(c)}{c^2}} = \frac{2c}{2} = c\,,$$

as expected. Classically, we would expect $v_{PO} = v_{PO'} + v_{O'O} = c + c = 2c$, which would have exceeded c.

26.46

In this case $m = m_e = 9.109 \times 10^{-31}$ kg and $v = 0.866c$, so the momentum of the electron is

$$p = \frac{m_e v}{\sqrt{1 - v^2/c^2}} = \frac{(9.109 \times 10^{-31}\,\text{kg})(0.866 \times 2.998 \times 10^8\,\text{m/s})}{\sqrt{1 - (0.866c/c)^2}} = 4.73 \times 10^{-22}\,\text{kg·m/s}\,.$$