36.30. **Model:** S is the ground's frame and S′ is the rocket's frame. S′ moves with velocity $v = 0.5c$ relative to S.

Solve: **(a)** We have $\gamma = \left[1-(v/c)^2\right]^{-\frac{1}{2}} = \left[1-(0.50)^2\right]^{-\frac{1}{2}} = 1.155$. Applying the Lorentz transformations to the lightning strike at $x = 0$ m and $t = 10$ μs,

$$x' = \gamma(x - vt) = (1.155)\left[0 \text{ m} - (0.5)\left(3.0\times10^8 \text{ m/s}\right)\left(1\times10^{-5} \text{ s}\right)\right] = -1732 \text{ m}$$

$$t' = \gamma\left(t - \frac{vx}{c^2}\right) = (1.155)\left(1\times10^{-5} \text{ s} - 0 \text{ s}\right) = 11.5 \ \mu\text{s}$$

For the lightning strike at $x = 30$ km and $t = 10$ μs,

$$x' = (1.155)\left[3.0\times10^4 \text{ m} - (0.50)\left(3.0\times10^8 \text{ m/s}\right)\left(1\times10^{-5} \text{ s}\right)\right] = 32.910 \text{ m}$$

$$t' = (1.155)\left[1\times10^{-5} \text{ s} - \frac{(0.50)\left(3.0\times10^8 \text{ m/s}\right)\left(3.0\times10^4 \text{ m}\right)}{\left(3.0\times10^8 \text{ m/s}\right)^2}\right] = -46.2 \ \mu\text{s}$$

(b) The events in the rocket's frame are not simultaneous. The lightning is observed to strike the pole before the tree by $46.2 + 11.5 = 57.7$ μs.