b)

connects bypass stream to rocket engine via a

$$\tau_\lambda = \frac{T_{t3}}{T_0} \quad + \quad \tau_{\lambda R} = \frac{T_{tR}}{T_0}$$

recall that energy conservation eqn for mixer (i.e. total enthalpy balance) gives

$$\frac{T_{t7}}{T_{t5}} = \frac{1 + \alpha \, T_{t3}/T_{t5}}{1 + \alpha} \qquad (5.97)$$

in notation for this problem

$$\frac{T_{t4}}{T_{tR}} = \frac{1 + \alpha \, T_{t3}/T_{tR}}{1 + \alpha}$$

but

$$\alpha = \frac{1}{\beta}$$

$$\frac{T_{t4}}{T_{tR}} = \frac{T_{t4}}{T_{t3}} \frac{T_{t3}}{T_0} \frac{T_0}{T_{tR}} = \tau_m \tau_\lambda \frac{1}{\tau_{\lambda R}}$$