

mass	m	mass	m
temperature	T_1	temperature	T_2

adiabatic: $dQ=0$

pressure constant: $dP=0$

$$h = u + Pv$$

$$dh = du + d(Pv)$$

$$dh = Tds - Pdv + Pdv + v dP$$

$$dh = c_p dT$$

$$= Tds + v dP$$

$$= Tds$$



$$c_p dT = Tds$$

$$ds = \frac{c_p}{T} dT$$

$$\Delta S = c_p \ln\left(\frac{T_f}{T_i}\right)$$

$$\Delta S = m c_p \ln\left(\frac{T_f}{T_i}\right)$$

$$dQ_1 + dQ_2 = 0$$

$$m c_p (T_f - T_1) + m c_p (T_f - T_2) = 0$$

$$T_f = \frac{T_1 + T_2}{2}$$

$$\Delta S_{universe} = \Delta S_1 + \Delta S_2$$

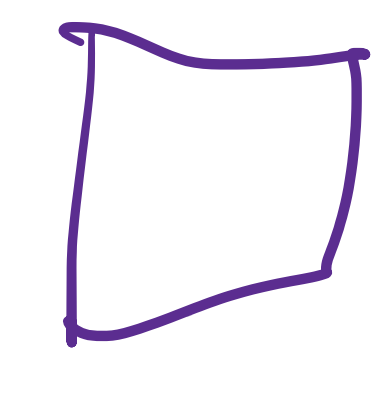
$T_f = \frac{T_1 + T_2}{2}$, as the amount of mass is equal for quantity 1 and quantity 2

$$\Delta S_{universe} = m c_p \left(\ln\left(\frac{T_1 + T_2}{2} \cdot \frac{1}{T_1}\right) + \ln\left(\frac{T_1 + T_2}{2} \cdot \frac{1}{T_2}\right) \right)$$

$$= m c_p \ln\left(\frac{(T_1 + T_2)^2}{4 T_1 T_2}\right)$$

$$= m c_p \ln\left(\left(\frac{T_1 + T_2}{2\sqrt{T_1 T_2}}\right)^2\right)$$

$$= 2 m c_p \ln\left(\frac{T_1 + T_2}{2\sqrt{T_1 T_2}}\right)$$



$$\ln\left(\frac{T_1 + T_2}{2\sqrt{T_1 T_2}}\right) > 0$$

$$\frac{T_1 + T_2}{2\sqrt{T_1 T_2}} > 1$$

$$T_1 + T_2 > 2\sqrt{T_1 T_2}$$

$$T_1^2 + T_2^2 + 2T_1 T_2 > 4T_1 T_2$$

$$T_1^2 + T_2^2 > 2T_1 T_2$$

$$T_1^2 + T_2^2 - 2T_1 T_2 > 0$$

$$(T_1 - T_2)^2 > 0$$

which holds as long as $T_1 \neq T_2$