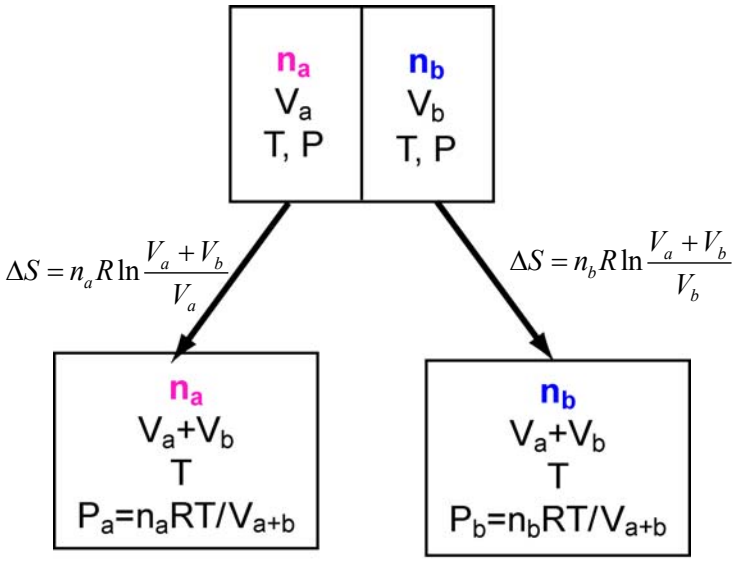
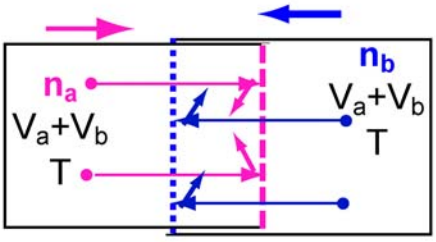
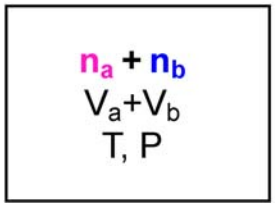
Entropy of Mixing of Differing (Distinguishable) Ideal Gasses





Membrane permeable to
- • • a only
- – – – b only

Reversible combining volumes
Each piston 'sees' P_{ext}=0; w=0; q=0; ΔS=0.



$$\Delta S_{total} = n_a R \ln \frac{V_a + V_b}{V_a} + n_b R \ln \frac{V_a + V_b}{V_b}$$

$$partial\ pressure: P_i = \frac{n_i}{n_{total}} P_{total} \qquad mole\ fraction: X_i = \frac{n_i}{n_{total}}$$

$$ideal\ gas: at\ \ start\ PV_a = n_a RT\ ;\ \ PV_b = n_b RT$$

$$at\ \ end\ \ P(V_a + V_b) = (n_a + n_b)RT \qquad X_a = \frac{n_a}{n_a + n_b} = \frac{V_a}{V_a + V_b} \qquad X_b = \frac{n_b}{n_a + n_b} = \frac{V_b}{V_a + V_b}$$

$$\Delta S = -n_a R \ln X_a \ - n_b R \ln X_b$$

and per mole

$$\frac{\Delta S}{n_{total}} = \Delta \overline{S} = -X_a R \ln X_a - X_b R \ln X_b$$

$$\Delta \overline{S}_{mixing} = -R \sum_i X_i \ln X_i$$

$$\Delta S_{mixing} = -n_{total} R \sum_i X_i \ln X_i$$