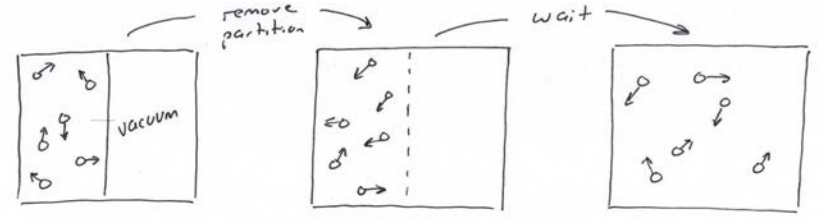
3.020 Lecture 1

Prof. Rafael Jaramillo

1 Non-interacting gas molecules in a box

following Fennie p. 1-10



- Volume spontaneously adjusts within its new limits (the walls of the box) to increase the amount of disorder.

Why ???

Because the more disordered state is more likely.

then Fennie p. 11-24

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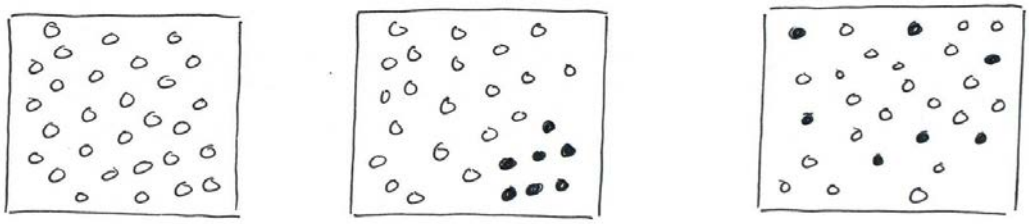
2 Solutions

- Case of non-interacting molecules

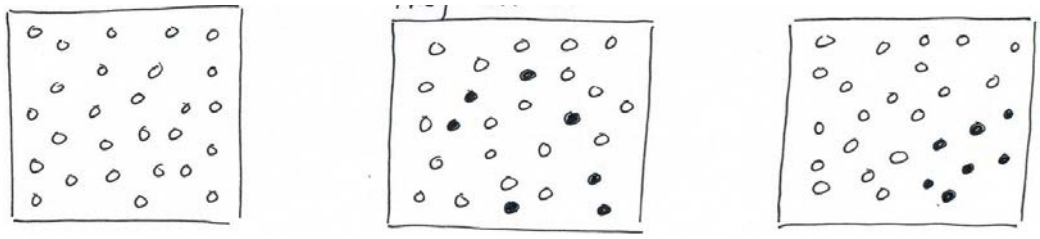
Start: Uniform material $\longrightarrow$ Label certain molecules $\longrightarrow$ Wait



- Diffusion spontaneously mixes the labeled molecules

- Case of interacting molecules

Start: Uniform material $\longrightarrow$ Label certain molecules so that they attract $\longrightarrow$ Wait



- Inter-atomic/molecular interactions cause spontaneous un-mixing
- Also consider case of labeled molecules that repel

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3 Endothermic process

e.g. ammonium nitrate dissolving in water

$$\underbrace{nNH_4NO_3}_{\text{pure ammonium nitrate,solid}} + \underbrace{mH_2O}_{\text{pure water, liquid}} \xrightarrow{Q} \underbrace{(NH_4NO_3)_n(H_2O)_m}_{\text{liquid solution}}$$

- Process absorbs heat energy Q from surroundings
- Energy and entropy of the system both increase

heat of solution

gain in entropy drives the reaction

molecules interact while they mix, breaking old bonds and forming new ones

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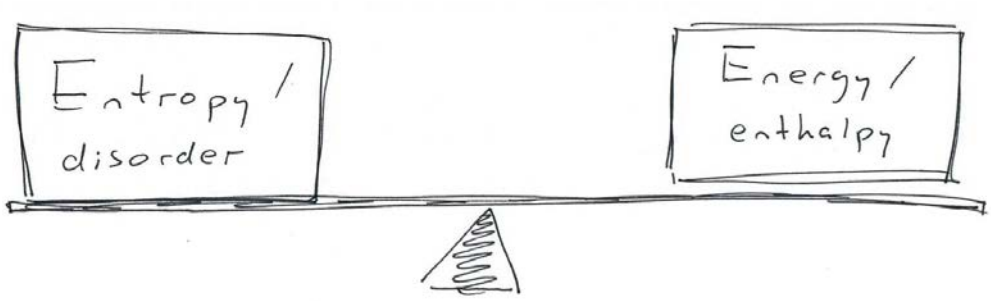
4 Exothermic process

e.g. Crystallization of sodium acetate from solution

$$\underbrace{(CH_3COONa)_x(H_2O)_z}_{\text{liquid solution, supersaturated}} \xrightarrow{Q} \underbrace{(CH_3COONa)_y}_{\text{pure solid}} + \underbrace{(CH_3COONa)_{x-y}(H_2O)_z}_{\text{liquid solution, saturated}}$$

- Process releases heat energy Q to surroundings
- Energy and entropy of the system <u>both</u> decrease

lowering energy drives the reaction



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3.020 Thermodynamics of Materials

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