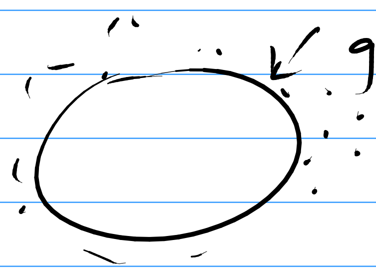
Number of ways ∝ probability of what happens. If you distribute energy ΔE in one atom rather than in all atoms of a gas then the number of ways decreases exponentially:

$$\text{Probability} = \frac{N_{excited}}{N_{total}} = e^{-\Delta E/kT}$$

↑ Boltzmann's constant

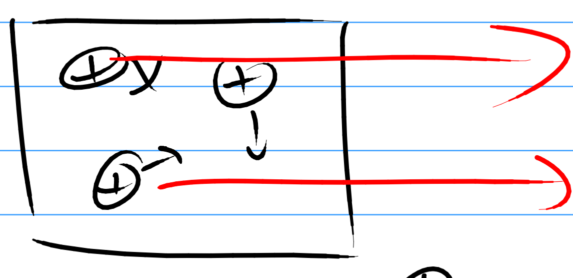
Ex:



$\Delta E = mgh$

$$\text{Prob} = e^{-mgh/kT}$$

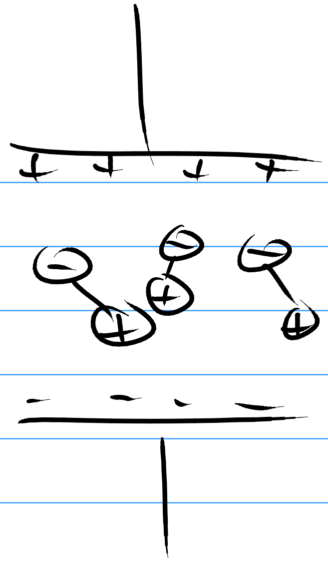
Ex:



this anal. goes to

$$\text{Prob} \propto e^{-qV/kT}$$

Ex:



find $\vec{P} \rightarrow \sigma_b$, ρ_b

gas ← permanent electric dipole mom

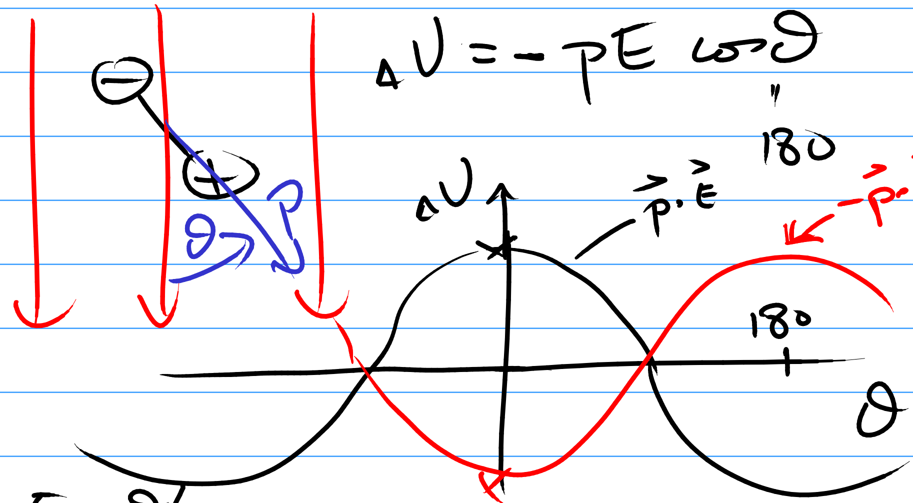
gas of Dihydrogen monoxide

potential energy

$$\text{Prob} = e^{-\Delta E/kT} \qquad \Delta U = -\vec{p}\cdot\vec{E}$$

$$\Delta U = -pE\cos\theta$$

$\theta = 180$



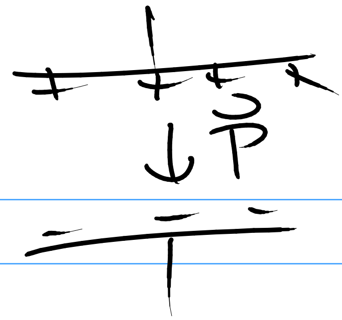
$$\text{Prob} = e^{+pE\cos\theta/kT}$$ of finding a dipole at θ

find $\vec{P}$ for $pE \ll kT$ and for $pE > kT$

for $T = 0$ all H_2O electric dipoles align with E or $\theta = 0$

for $kT > pE\cos(\pi)$ $\quad \text{Prob} = e^{-pE/kT} \simeq 1$ so lots of H_2O dipoles are aligned against E

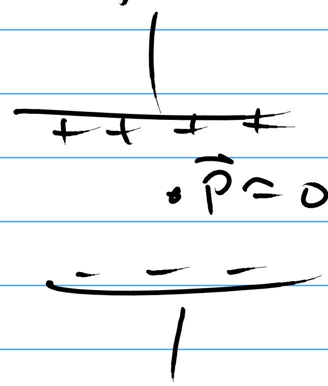
for $kT < |pE\cos(\pi)|$ $\quad \text{Prob} = e^{-pE/kT} \simeq 0$ so very few H_2O dipoles are aligned against E



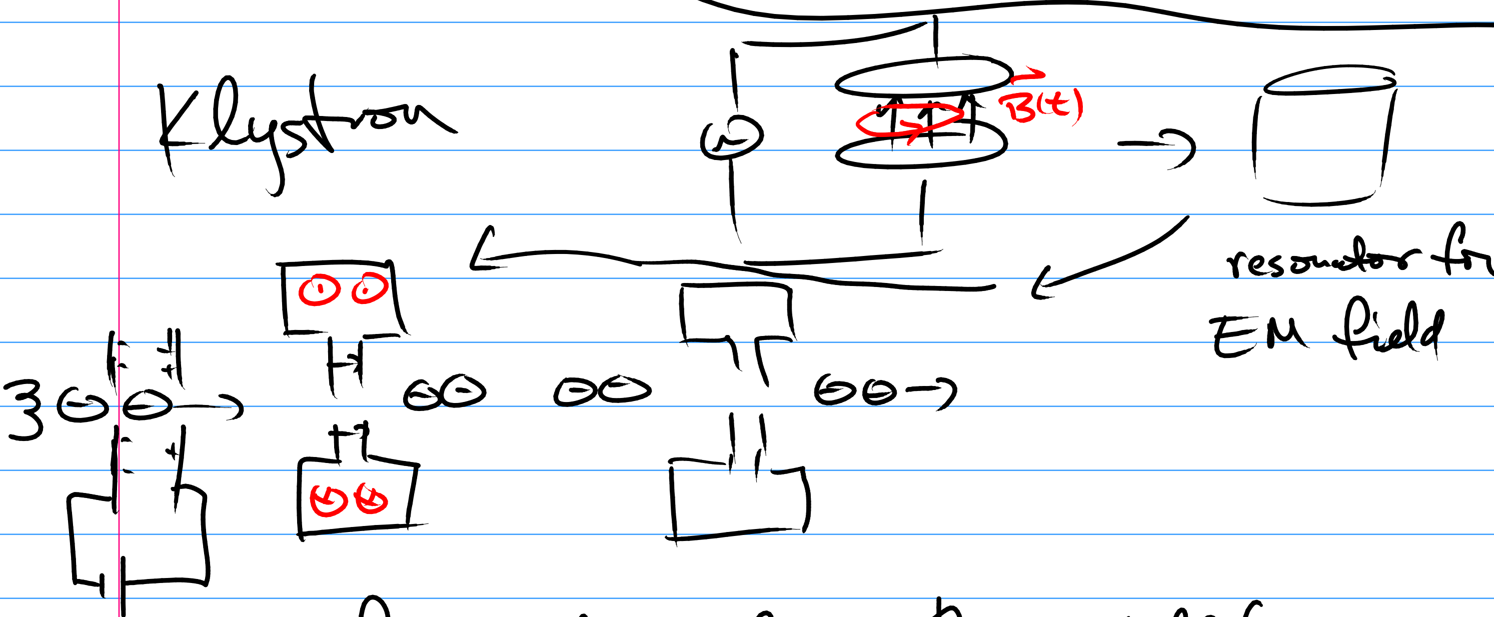
and all dipoles will be a ~ $\theta = 0$

$\vec{P} = \frac{\text{dipole mom}}{\text{molecule}} \cdot \frac{\#\ \text{molecules}}{\text{vol}}$

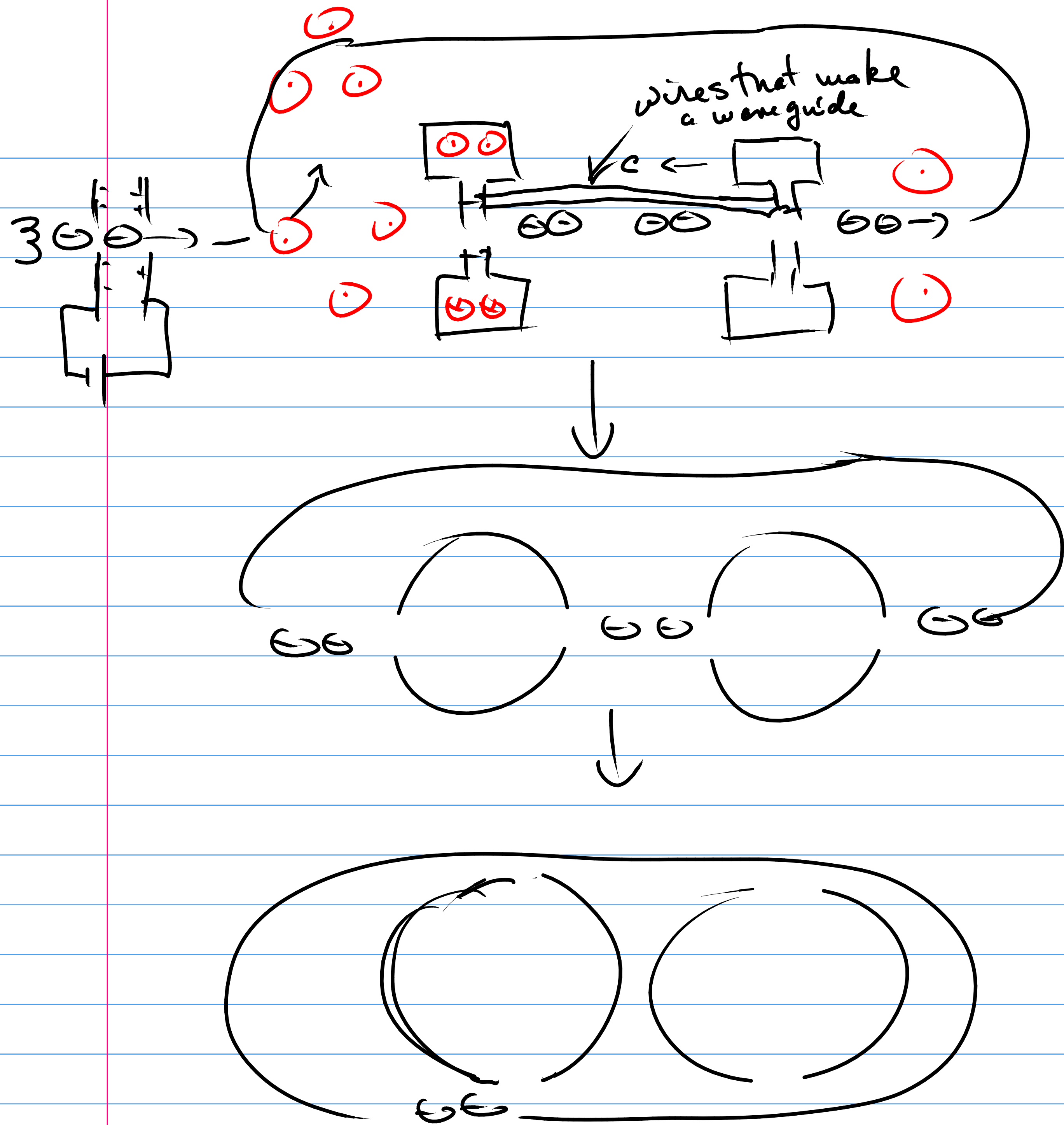
$U \ll kT$ then prob of finding molecule at any angle is large ∴ $\langle \vec{P} \rangle = 0$



Klystron



feedback enhance the oscillation



Magnetron