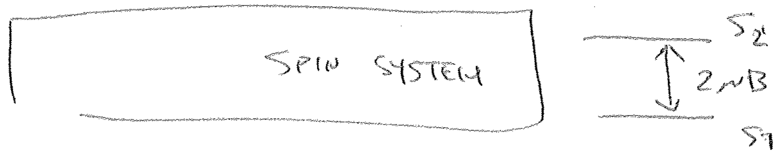
REDUX



$$\frac{P(S_2)}{P(S_1)} = \frac{\Omega(U - \mu B)}{\Omega(U + \mu B)} = \frac{\Omega(-\mu B)}{\Omega(+\mu B)}$$

$$\frac{P(S_2)}{P(S_1)} = \frac{e^{S_-/k}}{e^{S_+/k}} = e^{(S_- - S_+)/k}$$

$$= e^{(E_- - E_+)/kT}$$

$$\frac{P(S_2)}{P(S_1)} = e^{-2\mu B/kT} \quad \checkmark$$

$$U = N\mu B\left(\frac{1 - e^{2\mu B/kT}}{1 + e^{2\mu B/kT}}\right) = (N_\downarrow - N_\uparrow)\mu B$$

$$N\left(\frac{e^{-\mu B/kT} - e^{2\mu B/kT}}{e^{-\mu B/kT} + e^{2\mu B/kT}}\right) = (N_\downarrow - N_\uparrow$$

$$N_{\downarrow} = N \frac{e^{-\mu B/kT}}{\left(e^{-\mu B/kT} + e^{\mu B/kT}\right)}$$

$$N_{\uparrow} = N \frac{e^{+\mu B/kT}}{\left(e^{-\mu B/kT} + e^{\mu B/kT}\right)}$$

$$Z = e^{-E_1/kT} + e^{-E_2/kT} \quad \text{PARTITION FUNCTION}$$

$$Z = \sum_i e^{-E_i/kT} = \sum_i e^{-\beta E_i}$$

THERMAL EXCITATION OF ATOMS

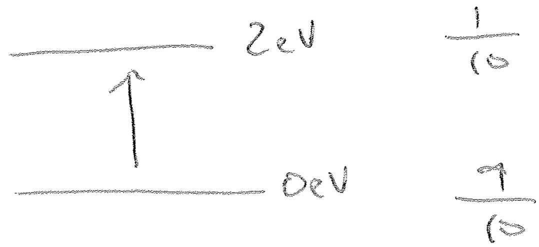
HYDROGEN $E_1 = -13.6\,eV$

$E_2 = -3.4\,eV$

$$\frac{P(2)}{P(1)} = e^{-10.2\,eV/kT}$$

AT $T = 5800K$ $\quad \dfrac{P(2)}{P(1)} = e^{-20.4} \ll 1$

AVERAGE VALUES



THEN

$$\langle U \rangle = 2 \cdot \frac{1}{10} + 0 \cdot \frac{9}{10}$$

$$= \boxed{0.2\,\text{eV}}$$

SIMILARLY

$$\bar{U} = \frac{\sum_i E_i e^{-\beta E_i}}{Z}$$

PARAMAGNET

$$Z = e^{+\beta\mu B} + e^{-\beta\mu B}$$

2

1

$$P_1 = \frac{e^{\beta\mu B}}{e^{\beta\mu B} + e^{-\beta\mu B}}$$

$$P_2 = \frac{e^{-\beta\mu B}}{\quad}$$

A

$$\bar{U} = \mu B \frac{\left(e^{-\beta\mu B} - e^{+\beta\mu B}\right)}{e^{-\beta\mu B} + e^{+\beta\mu B}}$$

$$Z = \sum_i e^{-E_i\beta}$$

$$\frac{\partial Z}{\partial \beta} = \sum_i -E_i\, e^{E_i\beta}$$

$$-\frac{1}{Z}\frac{\partial Z}{\partial \beta} = \frac{\sum_i E_i\, e^{E_i\beta}}{Z} = \underline{\bar{U}}$$

ROTATION OF DIATOMIC MOLECULES

$$E(j) = j(j+1)\varepsilon$$

DEGENERACY $= 2j+1$

$$Z_{ROT} = \sum_{j=0}^{\infty} (2j+1)\, e^{-j(j+1)\varepsilon/kT}$$

CONTINUOUS TREAMENT POSSIBLE IF $kT >> \varepsilon$

$$z_{rot} = \int_0^{\infty} (2j+1)\, e^{-j(j+1)\varepsilon/kT}\, dj = \frac{kT}{\varepsilon} \quad \text{IF } kT >> \varepsilon$$

$$E_{rot} = -\frac{1}{z}\frac{\partial z}{\partial \beta} = kT$$