Pts	الجواب (من مطبوعة الدروس و حلول التمارين)	N°
1	مبدأ استبعاد باولي $\Psi(\dots, x_i, \dots, x_j, \dots) = \theta\,\Psi(\dots, x_j, \dots, x_i, \dots) : \theta = \pm 1$ $\theta^2 = 1 \Rightarrow \lvert\Psi(\dots, x_i, \dots, x_j, \dots)\rvert^2 = \lvert\Psi(\dots, x_j, \dots, x_i, \dots)\rvert^2$ لا تتغير كثافة احتمال وجود النظام عندما تتبادل الجسيمات ، **لا يمكن تمييز الجسيمات المتطابقة.**	a
1	$\Psi(\dots, m_i, \dots, m_i, \dots) = -\Psi(\dots, m_i, \dots, m_i, \dots) = 0 : \theta = -1$	b
1	$W_{MB}\{n_m\} = N! \prod_{m=1}^{\infty} \frac{g_m^{n_m}}{n_m!}$, avec $\sum_{m=1}^{\infty} n_m = N$	c1
1	$W_{BE}\{n_m\} = \prod_{m=1}^{\infty} \frac{(n_m + g_m - 1)!}{n_m!(g_m - 1)!}$, avec $\sum_{m=1}^{\infty} n_m = N$	c2
1	$W_{FD}\{n_m\} = \prod_{m=1}^{\infty} \frac{g_m!}{n_m!(g_m - n_m)!}$, avec $\sum_{m=1}^{\infty} n_m = N$	c3
1	$P_m = \begin{cases} \frac{1}{\Omega} & si \;\; E \le E_m \le E + \Delta E \\ 0 & ailleurs \end{cases}$	d1
1	$\Omega(N,V,E;\Delta E) = \sum_{\text{Etats tq } 0 \le E_m \le E} 1 = \frac{1}{N!\,h^{sN}} \int_{EP \text{ tq } 0 \le H(q,p) \le E} d^{sN}q\, d^{sN}p$	d2
1	$P_m = \frac{g_m e^{-\beta E_m}}{Z}$	e1
1	$Z(N, V, \beta) = \sum_m e^{-\beta E_m} \to \frac{1}{N!\,h^{sN}} \int_{EP} d^{sN}q\, d^{sN}p\, e^{-\beta H(q,p)}$	e2
1	$P_{mN} = \frac{g_m e^{-\beta E_{mN} + \beta\mu N}}{\Xi}$	f1
2	$\Xi = \sum_{N=0}^{\infty} \sum_m e^{-\beta E_{mN} + \beta\mu N} = \sum_{N=0}^{\infty} \frac{e^{\beta\mu N}}{N!\,h^{sN}} \int_{EP} d^{sN}q\, d^{sN}p\, e^{-\beta H_N(q,p)}$	f2
1 2	$E = ME = M\varepsilon_0 = (N_+ N)\varepsilon_0$ avec $N = N_+ + N$ $W(E) \equiv W_M = \frac{N!}{N_+!\,N_-!} = \frac{N!}{\left[\frac{1}{2}(N-M)\right]!\left[\frac{1}{2}(N+M)\right]!}$ $S = k_B \log[W_M]$ $= k_B \left\{ N \log N - \left[\frac{1}{2}(N-M)\right] \log\left[\frac{1}{2}(N-M)\right] - \left[\frac{1}{2}(N+M)\right] \log\left[\frac{1}{2}(N+M)\right] \right\}$	1.
2	$\frac{1}{T} = \frac{\partial S}{\partial E} = \frac{\partial S}{\partial M}\frac{\partial M}{\partial E} = \frac{1}{\varepsilon_0}\frac{\partial S}{\partial M} = \frac{1}{2}\frac{k_B}{\varepsilon_0} \log\frac{(N-M)}{(N+M)}$ $E = M\varepsilon_0 = (N_+ - N_-)\varepsilon_0 = -N \tanh\left(\frac{\varepsilon_0}{k_B T}\right)$	2.
2 1	$Z_1 = e^{\beta\varepsilon_0} + e^{-\beta\varepsilon_0}$ et $Z_N = \left[2\cosh\left(\frac{\varepsilon_0}{k_B T}\right)\right]^N$ $F = -k_B T \log(Z_N) = -N k_B T \log\left\{2\cosh\left(\frac{\varepsilon_0}{k_B T}\right)\right\}$	3.