Unit 5 - Week 3

Assignment 3

The due date for submitting this assignment has passed.
As per our records you have not submitted this assignment.

Due on 2020-10-07, 23:59 IST.

1) Five identifiable particles are distributed in three non-degenerate levels with energies 0, ε and 2ε. If the number of particles occupying the three energy states be N_1, N_2 and N_3, the most probable distribution for a total energy 3ε is — 1 point

- $N_1 = 3$, $N_2 = 1$ and $N_3 = 1$
- $N_1 = 2$, $N_2 = 2$ and $N_3 = 1$
- $N_1 = 4$, $N_2 = 1$ and $N_3 = 0$
- $N_1 = 2$, $N_2 = 1$ and $N_3 = 2$

No, the answer is incorrect.
Score: 0
Accepted Answers:
$N_1 = 3$, $N_2 = 1$ and $N_3 = 1$

2) If there are four energy levels ε, 2ε, 3ε and 4ε, what will be the canonical partition function of a system consisting of two distinguishable particles? — 1 point

(a) $\left(e^{-\beta\varepsilon} + e^{-2\beta\varepsilon} + e^{-3\beta\varepsilon} + e^{-4\beta\varepsilon}\right)^2/2$

(b) $\left(e^{-\beta\varepsilon} + e^{-2\beta\varepsilon} + e^{-3\beta\varepsilon} + e^{-4\beta\varepsilon}\right)/2$

(c) $\left(e^{-2\beta\varepsilon} + e^{-4\beta\varepsilon} + e^{-6\beta\varepsilon} + e^{-8\beta\varepsilon}\right)$

(d) $\left(e^{-\beta\varepsilon} + e^{-2\beta\varepsilon} + e^{-3\beta\varepsilon} + e^{-4\beta\varepsilon}\right)^2$

- a)
- b)
- c)
- d)

No, the answer is incorrect.
Score: 0
Accepted Answers:
d)

3) A system has two energy levels with energies ε and 2ε. The lower energy level is 4-fold degenerate while the upper level is doubly degenerate. If there are N non-interacting classical particles in the system, which is in the thermodynamic equilibrium at temperature T, the fraction of particles in the upper level is — 1 point

(a) $\frac{1}{2e^{-\varepsilon/k_BT} + 4e^{-2\varepsilon/k_BT}}$

(b) $\frac{1}{2e^{\varepsilon/k_BT} - 4e^{2\varepsilon/k_BT}}$

(c) $\frac{1}{2e^{\varepsilon/k_BT} + 1}$

(d) $\frac{1}{1 + e^{-\varepsilon/k_BT}}$

- a)
- b)
- c)
- d)

No, the answer is incorrect.
Score: 0
Accepted Answers:
c)

4) The logarithmic value of partition function for a gas of photons is given as, $\ln Z = \frac{\pi^2}{45}\frac{V(k_BT)^3}{\hbar^3c^3}$, the pressure of the photon gas is — 1 point

(a) $\frac{\pi^2}{45}\frac{(k_BT)^4}{\hbar^3c^3}$

(b) $\frac{\pi^2}{45}\frac{(k_BT)^4}{\hbar^4c^3}$

(c) $\frac{\pi^2}{8}\frac{(k_BT)^4}{\hbar^3c^3}$

(d) $\frac{\pi^2}{15}\frac{(k_BT)^3}{\hbar^3c^3}$

- a)
- b)
- c)
- d)

No, the answer is incorrect.
Score: 0
Accepted Answers:
b)

5) The entropy of a gas containing N particles enclosed in a volume V is given by $S = Nk_B \ln\left(\frac{aVE^{3/2}}{N^{5/2}}\right)$ where E is the total energy, a is a constant and $k_B$is the Boltzmann constant. The chemical potential μof the system at a temperature T is given by — 1 point

(a) $\mu = -k_BT\left[\ln\left(\frac{aVE^{3/2}}{N^{5/2}}\right) - \frac{5}{2}\right]$

(b) $\mu = -k_BT\left[\ln\left(\frac{aVE^{3/2}}{N^{5/2}}\right) - \frac{3}{2}\right]$

(c) $\mu = -k_BT\left[\ln\left(\frac{aVE^{3/2}}{N^{5/2}}\right) - \frac{5}{2}\right]$

(d) $\mu = -k_BT\left[\ln\left(\frac{aVE^{3/2}}{N^{5/2}}\right) - \frac{3}{2}\right]$

- a)
- b)
- c)
- d)

No, the answer is incorrect.
Score: 0
Accepted Answers:
c)

6) For a one-dimensional harmonic oscillator of mass m and frequency ω , the canonical partition is — 1 point

(a) $Q = \frac{k_BT}{\omega}$

(b) $Q = k_BT$

(c) $Q = \frac{T}{\omega}$

(d) $Q = \frac{k_BT}{\hbar\omega}$

- a)
- b)
- c)
- d)

No, the answer is incorrect.
Score: 0
Accepted Answers:
d)

7) The relation between grand canonical and canonical partition function is — 1 point

(a) $\Xi(\mu,V,T) = \sum_{N=1}^{\infty} Q(N,V,T)\exp(-\beta\mu N)$

(b) $\Xi(\mu,V,T) = \sum_{N=1}^{\infty} Q(N,V,T)\exp(\beta\mu N)$

(c) $\Xi(\mu,V,T) = \sum_{N=1}^{\infty} Q(N,V,T)\exp(\beta N)$

(d) $\Xi(\mu,V,T) = \sum_{N=1}^{\infty}\sum_{\varepsilon} Q(N,V,T)\exp(\beta\mu N)$

- a)
- b)
- c)
- d)

No, the answer is incorrect.
Score: 0
Accepted Answers:
b)

8) Which of the following relation is correct? — 1 point

(a) $\frac{PV}{k_BT} = \ln\Xi(\mu,V,T)$

(b) $\frac{P}{k_BT} = \ln\Xi(\mu,V,T)$

(c) $\frac{PV}{k_BT} = -\ln\Xi(\mu,V,T)$

(d) $\frac{1}{k_BT} = \ln\Xi(\mu,V,T)$

- a)
- b)
- c)
- d)

No, the answer is incorrect.
Score: 0
Accepted Answers:
a)

9) Consider a system consisting of a zipper of N links. A link acquires energy ε if it is open and '0' when it is close. Also for the nth link to remain open the previous (n-1) links should be open. The partition function for this system is — 1 point

(a) $\frac{1 - e^{-(N+1)\varepsilon/k_BT}}{1 - e^{-\varepsilon/k_BT}}$

(b) $\frac{1 - e^{-(N-1)\varepsilon/k_BT}}{1 - e^{-\varepsilon/k_BT}}$

(c) $\frac{1 - e^{-(N+1)\varepsilon/k_BT}}{1 + e^{-\varepsilon/k_BT}}$

(d) $\frac{1 - e^{-(N-1)\varepsilon/k_BT}}{1 + e^{-\varepsilon/k_BT}}$

- a)
- b)
- c)
- d)

No, the answer is incorrect.
Score: 0
Accepted Answers:
a)

10) We define a quantity $\xi = \left(\frac{2\pi mk_BT}{h^2}\right)^{\frac{3}{2}} Ve^{\beta\mu}$. In case of N number of ideal gas molecules in grand canonical ensemble the following relation can be shown — 1 point

(a) $\xi = V$

(b) $\xi = \frac{1}{k_BT}$

(c) $\xi = N$

(d) $\xi = m/V$

- a)
- b)
- c)
- d)

No, the answer is incorrect.
Score: 0
Accepted Answers:
c)