Week 5 Assignment 1

The due date for submitting this assignment has passed. Due on 2018-03-14, 23:59 IST.

Submitted assignment

1) Consider a monoatomic ideal gas, made up of N non-interacting distinguishable atoms and has the macroscopic state at equilibrium of T, V, and N. If q is the single particle partition function then what will be the value of total partition function Q?

- (a) $q^N$
- (b) $N!$
- (c) $Nq$
- (d) $\frac{N}{N!}$

No, the answer is incorrect.
Score: 0
Accepted Answers:
(a) $q^N$

2) For a monoatomic ideal gas, if the macroscopic state at equilibrium is T, V and N then the single particle partition function depends on –

- (a) V and N
- (b) T and N
- (c) T and V
- (d) T, V and N

No, the answer is incorrect.
Score: 0
Accepted Answers:
(c) T and V

3) The electronic energy spectrum of a monoatomic ideal gas atom is comprised of two electronic energy levels: $E_1$ and $E_2$. Among those, $E_1$ is the ground electronic energy level and singly degenerate, whereas $E_2$ is upper electronic level and triply degenerate. If the $E_1$ is associated with zero energy, then what is the electronic partition function, $q_{elec}$?

- (a) $1 + 3e^{-E_1}$
- (b) $1 + 3e^{-\beta(E_1 + E_2)}$
- (c) $3 + e^{-\beta E_2}$
- (d) $1 + 3e^{-E_2}$

No, the answer is incorrect.
Score: 0
4) For a hydrogen chloride gas (HCl) molecule under rigid rotor harmonic oscillator approximation, what will be the value of single particle partition function associated with centre of mass ($q_{CM}$) at 300K? (Assume V to be 1 litre and molar mass of HCl = 36.46 gm/mol)

- (a) $1.79 \times 10^{30}$
- (b) $3.0 \times 10^{29}$
- (c) $1.29 \times 10^{28}$
- (d) $2.147 \times 10^{29}$

No, the answer is incorrect.
Score: 0

Accepted Answers:
(d) $2.147 \times 10^{29}$

5) The mean rotational energy ($\langle \varepsilon_{rot} \rangle$) of a heteronuclear diatomic molecule, obtained from rotational partition function $q_{rot}$ is given by –

- (a) $\frac{1}{2} k_B T$
- (b) $\frac{3}{2} k_B T$
- (c) $k_B T$
- (d) $2k_B T$

No, the answer is incorrect.
Score: 0

Accepted Answers:
(c) $k_B T$

6) The length of the bond in Carbon Monoxide is 1.43 Å. What is the rotational partition function for CO molecule at 300K?

- (a) 173.30
- (b) 180.60
- (c) 176.80
- (d) 170.30

No, the answer is incorrect.
Score: 0

Accepted Answers:
(a) 173.30

7) In Sackur-Tetrode equation, the entropy of a monoatomic ideal gas depends on –

- (a) T, V and N
- (b) T, V, N and m
- (c) N and m
- (d) T, V and m

No, the answer is incorrect.
Score: 0

Accepted Answers:
(b) T, V, N and m

8) In microscopic model of a heteronuclear diatomic gas molecule, total energy of the system is the sum of the energy due to the fact that translational motion of the molecule as a whole ($E_{trans}$) and the energy ($E_{int}$) depends on the structure of the molecule. By taking this into consideration, which of the following statement is correct?

- (a) $E_{trans}$ and $E_{int}$ both depend on internal structure of the molecule only.
(b) \( E_{trans} \) and \( E_{int} \) both depend on the centre of mass coordinates only.

(c) \( E_{trans} \) depends only on internal coordinates and \( E_{int} \) depends only on the centre of mass coordinates.

(d) \( E_{trans} \) depends only on the centre of mass coordinates and \( E_{int} \) depends only on internal structure of the molecule i.e. internal coordinates.

No, the answer is incorrect.

Score: 0

Accepted Answers:

(d) \( E_{trans} \) depends only on the centre of mass coordinates and \( E_{int} \) depends only on internal structure of the molecule i.e. internal coordinates.

9) The vibrational frequency of a diatomic gas is \( 1580 \text{ cm}^{-1} \). What is the single particle partition function associated with molecular vibration for that gas at 300K?

(a) 0.781

(b) 0.871

(c) 0.971

(d) 0.718

No, the answer is incorrect.

Score: 0

Accepted Answers:

(a) 0.781

10) For a monoatomic ideal gas, from mean translational energy what is the molar constant volume heat capacity (\( C_V \))?

- \( \frac{5}{2} k_B \)
- \( \frac{3}{2} k_B \)
- \( \frac{1}{2} k_B \)
- \( k_B \)

No, the answer is incorrect.

Score: 0

Accepted Answers:

(b) \( \frac{3}{2} k_B \)