Thermal Physics (PH2202) End Sem Exam

time 2hr 30min

Write the answers of Q.1 in first page of answer script.

Note: Marks will be deducted for i)unclear writing ii)unclear logical steps iii) writing irrelevant parts which has no connection with question. Extra credit will be given for clear and precise answers.

1. Write down the correct choice/choices (more than one option can be correct). $(5 \times 2 = 10)$

i) Pressure is:

(a) Extensive quantity (b) Intensive quantity (c) Generalized coordinate (d) Generalized force.

ii) In irreversible process:

(a) $dS = 0$ (b) $TdS >$ đQ (c) $TdS <$ đQ (d)$TdS =$ đQ

(S=entropy, T= temperature, Q= heat)

iii)The differential $ye^{ax}dx + xe^{ay}dy$ is exact for:

(a)$a = -1$ (b)$a = 0$ (c) $a = 1$

iv) In a closed system:

(a) $dS = 0$ (b) đQ= 0 (c) $dT = 0$ (d) $dS \geq 0$ (e) $dF < 0$

v) The temperature of a system with heat capacity C is changed from temperature T_i to T_f in a reversible process. Change in entropy:

(a) $C(T_f - T_i)$ (b) $CLog(T_f/T_i)$ (c) $C(T_f/T_i)$

2. State of a gas is changed from (p_1, V_1) to (p_2, V_2) following the adiabatic path $pV^\gamma =$ constant. Find out work done by the system. (3).

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3. For a gas the internal energy is given by:

$E(S,V,N) = a\frac{S^3}{VN}$

(a) Show that the equation of state is given by $T^3/p^2 = 27a\frac{V}{N}$. (5)

(b) Find out heat capacity at constant volume C_V (4).

4. Consider a gas of non-interacting classical partcles with mass m in 3-dimension at a temperature T. (a) Find out average kinetic energy of each particle from the velocity distribution. (6)

(b) Find out most probable value of speed of each particle. (3)

(c) Find out heat capacity at constant volume of the gas with N particles. (2)

5. In 1D a random walker takes a forward step with probability p and backward step with probability $q = 1 - p$.

a)Assuming each step is independent, find out the probability $P_N(m)$ of displacement m in total N steps ($N > m$). (5).

b) Write down the moment generating function. (3)

c) Find out average displacement. (2).

6. (a) Find out entropy of N Bosons distributed in M states. Both $N, M \gg 1$. (4).

(b) A spin with down state has energy 0 and up state has energy ϵ. Find out probability of up state at temperature T. Find out the entropy when $T \to \infty$. (3).

Useful formula: $\int_0^\infty x^t e^{-x} dx = \Gamma[t+1]$

$\Gamma[t+1] = t\Gamma[t]$

$\Gamma[1/2] = \sqrt{\pi}$

$ln(N!) \approx NlnN - N$ for $N >> 1$