Thermal Physics (PH2202) Mid Sem Exam

time 1hr

1.a) Among the following thermodynamic variables write down extensive and intensive variables, write conjugate pairs of generalised displacement and generalised force.

P(pressure), A(area), σ(surface tension), M(magnetization), V(volume), B(magnetic field). (2+2).

b)Entropy of a system is given by $S = N[\log(V) + a\log(N)]$, where V and N are volume and number of particles. Find out the value of a so that S is extensive. (1).

c)Show that the differential work done $\bar{d}W$ by the force $\vec{F} = y\hat{x} - x\hat{y}$ is inexact. Find out the integrating factor $f(x)f(y)$ so that $f(x)f(y)\bar{d}W$ is exact. (2+2)

d)Calculate the work done in expansion of a gas at constant temperature from volume V_1 to V_2. Equation of state of the gas is $P(V - b) = NK_BT$, where b is a constant and other variables have usual meaning. (3)

2. Internal energy $E(T, V)$ of a gas is function of temperature and volume. Starting from the first law show that the heat capacity at constant pressure and constant volume are given by:

$C_p = (\frac{\partial E}{\partial T})_V + [(\frac{\partial E}{\partial V})_T + P](\frac{\partial V}{\partial T})_P$

$C_V = (\frac{\partial E}{\partial T})_V$ (3+1).

3. Consider one non-Carnot (NC) engine and a Carnot engine (C) are operating between two reservoirs at temperature T_H(higher T) and T_c (colder). Efficiency of the non Carnot engine is 10% of the Carnot engine. Heat intake (from reservoir at T_H) of NC and C are Q_{nc} and Q_c respectively. Find out the efficiency of the combined engine as a function of $y = Q_c/Q_{nc}$. For $y \geq 0$, find out maximum and minimum efficiency. Show that $T_C \to 0$ leads to the violation of Kelvin's statement. (2+1+1)