

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 dW by the force $\vec{F} = y\hat{x} - x\hat{y}$ is inexact. Find out the integrating factor $f(x)f(y)$ so that $f(x)f(y)dW$ is exact. (2+2)

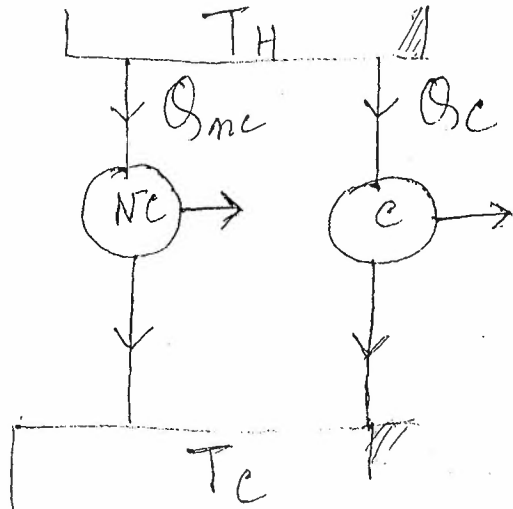
d) Calculate the work done in expansion of a gas at constant temperature from volume V_1 to V_2 . Equation of state of the gas is $P(V - b) = NK_B T$, where b is a constant and other variables have usual meaning. (3)

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:

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

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

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 $T_c \rightarrow 0$ leads to the violation of Kelvin's statement. (2+1+1)



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