PHYSICS 140A : STATISTICAL PHYSICS
HW ASSIGNMENT #1

(1) For each of the following differentials, determine whether it is exact or inexact. If it is exact, find the function whose differential it represents.

(a) $xy^2\,dx + x^2y\,dy$

(b) $z\,dx + x\,dy + y\,dz$

(c) $x^{-2}\,dx - 2x^{-3}\,dy$

(d) $e^x\,dx + \ln(y)\,dy$

2) Consider an engine cycle which follows the thermodynamic path in Fig. 1. The work material is ν moles of a diatomic ideal gas. BC is an isobar ($dp = 0$), CA is an isochore ($dV = 0$), and along AB one has

$$p(V) = p_{\mathsf{B}} + (p_{\mathsf{A}} - p_{\mathsf{B}}) \cdot \sqrt{\frac{V_{\mathsf{B}} - V}{V_{\mathsf{B}} - V_{\mathsf{A}}}}\ .$$

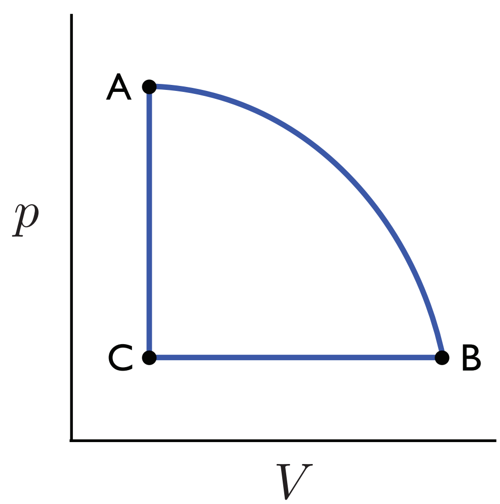

Figure 1: Thermodynamic path for problem 2.

(a) Find the heat acquired Q_{AB} and the work done W_{AB}.

(b) Find the heat acquired Q_{BC} and the work done W_{BC}.

(c) Find the heat acquired Q_{CA} and the work done W_{CA}.

(d) Find the work W done per cycle.

(3) $\nu = 8$ moles of a diatomic ideal gas are subjected to a cyclic quasistatic process, the thermodynamic path for which is an ellipse in the (V, p) plane. The center of the ellipse lies at $(V_0, p_0) = (0.25\,\mathrm{m}^3, 1.0\,\mathrm{bar})$. The semimajor axes of the ellipse are $\Delta V = 0.10\,\mathrm{m}^3$ and $\Delta p = 0.20\,\mathrm{bar}$.

(a) What is the temperature at $(V, p) = (V_0 + \Delta V, p_0)$?

(b) Compute the net work per cycle done by the gas.

(c) Compute the internal energy difference $E(V_0 - \Delta V, p_0) - E(V_0, p_0 - \Delta p)$.

(d) Compute the heat Q absorbed by the gas along the upper half of the cycle.

(4) A gas obeys the thermodynamic relation $E(T, V, N) = aNT$ and the equation of state $p = bN^2T/V^2$ where a and b are constants.

(a) What is the isothermal compressibility $\kappa_T = -V^{-1}(\partial V/\partial p)_{T,N}$?

(b) What is the adiabatic equation of state in terms of T, V, and N?

(c) A container of volume V_0 contains N particles of this gas at an initial temperature T_0. The container is opened and the gas expands adiabatically to a volume $V_1 = 2V_0$. Compute the final temperature T_1.