1. (20%) Write True (T) or False (F) for the following statements.

(1) Entropy is not conserved.

(2) It is impossible by a cyclic process to remove heat from a hot body and convert it solely into work.

(3) Entropy is a state function

(4) A kilocalorie per degree is called an *entropy unit*, eu.

(5) A pure, perfect crystal at 0 K has 1 microstate, so its entropy is not zero.

(6) The de Broglie wave length of a particle is proportional to its mass. In other word, the heavier the mass, the longer the de Broglie wave length.

(7) The Gibbs free energy has the same units as enthalpy or energy.

(8) Hydrophobic interactions are entropy-driven.

(9) For an average atom, the relation between average translational kinetic energy $\langle U_n \rangle$ and temperature T is $\langle U_n \rangle \propto T^{1/2}$.

(10) A transition that is fully allowed quantum mechanically is said to have an *oscillator strength* of 1.0.

2. (24%)One mole of an ideal gas initially at $P_1 = 2$ atm, T, and V_1 expands to $P_2 = 1$ atm, T, and $2V_1$. Consider two different paths: (a) the expansion occurs irreversibly into a vacuum as shown above, and (b) the expansion is reversible. Calculate $q_{irreversible}$, ΔS(system), and ΔS(surroundings) for (a) and $q_{reversible}$, ΔS(system), and ΔS(surroundings) for (b)

3. (16%)The wavefunction inside a long barrier of height V is $\psi = N\exp(-\kappa x)$. Calculate (a) the probability that the particle is inside the barrier and (b) the average penetration depth of the particle into the barrier.

4. (20%)Prove the Gibbs-Helmholtz equation

$$\left(\frac{\partial}{\partial T}\left(\frac{G}{T}\right)\right)_p = -\frac{H}{T^2}$$

(hint: $S = -(\partial G/\partial T)_p$)

八十八學年度 生命科學系 0803 系(所) 乙、丙 組碩士班研究生招生考試

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5. (20%) Show the rate of change of the expectation value of the observable Ω is

$$\frac{d}{dt}\langle\Omega\rangle = \frac{i}{\hbar}\int \psi^*(H\Omega - \Omega H)\psi dv$$