



Uva Wellassa University, Sri Lanka
B.Tech. Degree Program - 2006/07



End Semester Examination- Semester 2
(Closed books & notes Examination)

June -2008

CHE 282-1 – Thermodynamics

Answer any two questions

Time: one hour

Always assume ideal conditions unless otherwise specified. The symbols carry standard meanings.

$$R = 8.31 \text{ JK}^{-1}\text{mol}^{-1}$$

1. (a) Prove that for adiabatic expansion of a mole of ideal gas $w = \Delta U = C_v \Delta T$ and $\Delta H = C_p \Delta T$.
[20 marks]
- (b) A sample consisting of 2.00 mol He is expanded isothermally at 22°C from 22.8 dm³ to 31.7 dm³ (a) reversibly, (b) against a constant external pressure equal to the final pressure of the gas, and (c) freely (against zero external pressure). For the three processes calculate q , w , ΔU , and ΔH .
[30 marks]
2. (a) Prove that in a reversible closed process, the net total entropy for the system and surroundings is zero.
[20 marks]
- (b) A sample of nitrogen of mass 3.12 g at 23 °C is allowed to expand reversibly and adiabatically from 400 cm³ to 2.00 dm³. Write an equation for reversible work? What is the work done by the gas? $C_{V,m} = 29.50 \text{ JK}^{-1}\text{mol}^{-1}$, $T_f V_f^{1/c} = T_i V_i^{1/c}$ and $c = C_{V,m}/R$.
[30 marks]
3. (a) For a closed system with no composition change, prove that following fundamental equations
[25 marks]
 - (i). $dU = TdS - PdV$ (ii). $dH = TdS + VdP$
 - (iii). $dA = -SdT - PdV$ (iv). $dG = -SdT + VdP$

Modify the fundamental equation (iv) for a two component open system.

(b) Prove following relationships

[25 marks]

$$(i). S = -\left(\frac{\partial G}{\partial T}\right)_P \quad (ii). V = \left(\frac{\partial G}{\partial P}\right)_T \quad (iii). H = G - T\left(\frac{\partial G}{\partial T}\right)_P$$

$$(iv). A = G - P\left(\frac{\partial G}{\partial P}\right)_T$$

4. (a) State Carnot theorem. How can the efficiency of heat engine is increased?

[25 marks]

(b) State third law of thermodynamics. Shown below is a carbon monoxide (CO) crystal at 0 K. State why the absolute entropy of this crystal is not zero at 0 K.

[10 marks]

C O C O C O C O C O C O C O
C O C O C O C O C O O C C O
C O C O C O O C C O C O C O
C O C O C O C O C O C O C O

Consider the following sequence of processes for the substance A:

$$A(s, 0 \text{ K}, 1 \text{ bar}) = A(s, T_m, 1 \text{ bar}) = A(l, T_m, 1 \text{ bar}) = A(l, T_b, 1 \text{ bar}) = A(g, T_b, 1 \text{ bar}) =$$

$A(g, T, 1 \text{ bar})$. Write an expression to calculate entropy of A at 0 K, 1 bar.

[15 marks]