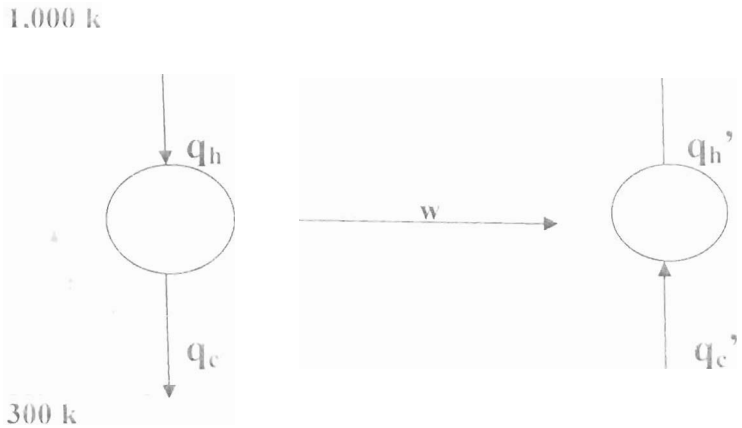
Rain Semester 2010/2011 Session Examination

CHM 304 – Chemical Thermodynamics

Instruction: Answer all questions **Time Allowed:** 2 Hours

SECTION A

1(a). Name three fundamental thermodynamic variables.
(b). What happens to the variables in **1(a)** above at a quasi-static conditions?
(c). Calculate the work done in joules on a 2000 kg car that accelerates from rest to a speed of 100 km hr^{-1}, assuming that friction is negligible.
2(a). Give the mathematical expression of the Cyclic Rule.
(b). Show from the equation. Cp − Cv = [P + (dt/dv)](dt/dv)$_p$ that Cp − Cv = R for one mole of an ideal gas
(c). Suppose that a piece of metal with a volume of 100 cm^3 at 1.013×10^5 Nm^{-2} is compress adiabatically by a shock wave of 1.013×10^{11} Nm^{-2} to a volume of 90 cm cm^3. Calculate ΔE and ΔH in joules for the metal assuming that the compression occurs at a constant pressure of 1.013×10 Nm^{-2}
3(a). What is an inversion temperature?
(b). State **(i)** the efficiency of the Cannot regrigerator in terms of the temperatures of the heat reservoirs **(ii)** the master thermodynamic equation applicable to a closed system at constant volume and temperature.
(c). The diagram below shows a Cannot engine driving a cannot regrigerator. **CR**



Determine **(i)** efficiency of **CE** **(ii)** efficiency of **CR** **(iii)** **w** and q_c'

Section B

4(a) i. State the third law of thermodynamics 2 marks

ii. From the Debye Third Power law, show that the absolute entropy is one third of C_v at a given temperature (**T**) 3 marks

(b) Write the expression for the estimation of the entropy change that accompanies the transformation of a solid substance at 0°C to its vapour at the boiling point of 393°C 5 marks

(c) 2.0 mol of liquid water was reversibly heated from 0.0°C to100.0°C at a constant pressure of 1.00 atm. (C_p of water is 4.18JK $^{-1}$g^{-1} and Molecular mass is 18g mol^{-1})

Calculate **i.** ΔS for the process 3 marks

ii. ΔS of the surrounding 2 marks

5(a)i. What is the degree of freedom of a system? 2 mark

ii. Estimate the degree of freedom for a two component single phase system. 1 marks

(b) A solution was prepared by mixing 1.20 mol of benzene and 1.30 mol of toluene at 20.0°C. Assume the solution to be ideal, estimate (i) the Gibbs energy change, (ii) the entropy change, (iii) the enthalpy change and (iv) the volume change for the mixing 1 marks

(c) State the Raoult's law 2 marks

(d) Define azeotropes 1 mark

(e) An insoluble organic compound A was steam distilled, the atmospheric pressure being 760 mmHg. Of the 69 ml of water, 60 ml was water and the mixture boils at 99.3°C at which the vapour pressure of water is 740 mmHg. If the density of water is 1g cm $^{-3}$and that of A is 1.22 g cm^{-3}. Calculate the molecular weight of A. 5 marks