

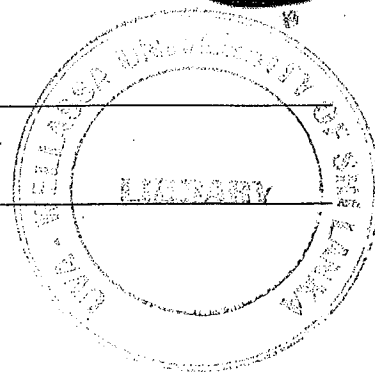
Uva Wellassa University, Sri Lanka  
End Semester Examination – January 2010  
SCT 254-1 Thermodynamics (Repeat)



Time: One (01) hour

Total 05 Questions

Answer four (04) questions only



$$R = 8.31 \text{ J/mol} \cdot \text{K}^{-1}$$
$$1 \text{ atm} = 101,325 \text{ Pa}$$

- 01) I. What do you mean by external work, internal work, equation of state and quasi-static process? (06 marks)
- II. Show that the work done by an ideal gas during the quasi-static, isothermal expansion from an initial pressure  $P_i$  to  $P_f$  is given by

$$W = nRT \ln \frac{P_f}{P_i}$$

(12 marks)

- III. Calculate the work done when the pressure of 1 mol of an ideal gas is decreased quasi-statically from 20 to 1 atm, the temperature remaining at 20 °C. (07 marks)

- 02) I. Explain what is quasi-static adiabatic process. (06 marks)

- II. Derive the following formula for a quasi-static adiabatic process for the ideal gas, assuming  $\gamma$  to be constant :

$$T_f = T_i \left( \frac{P_f}{P_i} \right)^{(\gamma-1)/\gamma}$$

(12 marks)

- III. Helium at 300 K is compressed quasi-statically and adiabatically to one fifth of its initial pressure. Assuming that the helium behaves like the ideal gas, calculate the final temperature. Take  $\gamma$  is 5/3 for helium. (07 marks)

- 03) I. Distinguish between reversible and irreversible process. (09 marks)
- II. What are the conditions to be reversible? (09 marks)
- III. Use an indicator diagram (p-v diagram) to show reversible process. (07 marks)
- 04) A high altitude balloon contains helium whose molecular weight is 4 grams/mole. At its maximum altitude the balloon's volume is  $830 \text{ m}^3$ . The outside temperature and pressure are  $-51.0 \text{ }^\circ\text{C}$  and  $5.40 \text{ kPa}$  at the balloon's maximum altitude. Assuming that the helium in the balloon is in equilibrium with the outside air temperature and pressure, i.e., they are the same:
- I. What is the mass of the helium in the balloon at its maximum altitude? (07 marks)
- II. Assuming no loss of helium, what would be the volume of the balloon when it was launched from the ground where the air temperature and pressure are  $22.0 \text{ }^\circ\text{C}$  and  $101 \text{ kPa}$ ? (12 marks)
- III. If the volume of the balloon when it was launched was  $61.0 \text{ m}^3$ , how many atoms of helium were lost during the balloon's ascent? (06 marks)
- 05) I. State the Kelvin-Planck and the Clausius forms of the second law of thermodynamics. (02 marks)
- II. Discuss the construction and working of a heat engine. (06 marks)
- III. Define its efficiency and show that the efficiency  $\eta$  depends only on the quantity of heat absorbed ( $Q_1$ ) from and rejected ( $Q_2$ ) to the respective heat reservoirs. (05 marks)
- IV. A Carnot engine absorbs  $2000 \text{ J}$  of heat from source of heat engine at  $227 \text{ }^\circ\text{C}$  and rejects  $1200 \text{ J}$  of heat during each cycle to sink. Calculate
- (a) efficiency of engine.
- (b) temperature of sink.
- (c) amount of work done during each cycle. (12 marks)