EASTERN UNIVERSITY, SRI LANKA

THIRD EXAMINATION IN SCIENCE - 2003/2004

(NOV/DEC 2004)

FIRST SEMESTER

PH 302 THERMODYNAMICS

Time: 01 hour.

Answer ALL Questions

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1. Establish the Maxwell's thermodynamic relation

$$\left(\frac{\partial S}{\partial V}\right)_T = \left(\frac{\partial P}{\partial T}\right)_V$$

i. Show that for any simple hydrostatic system

(a) $dS = C_v \dfrac{dT}{T} + \left(\dfrac{\partial P}{\partial T}\right)_V dV$

(b) $C_p - C_v = T\left(\dfrac{\partial V}{\partial T}\right)_P \left(\dfrac{\partial P}{\partial T}\right)_V = \left\{\left(\dfrac{\partial U}{\partial V}\right)_T + P\right\}\left(\dfrac{\partial V}{\partial T}\right)_P$

ii. Hence prove that for a perfect gas

$$C_P - C_V = R$$

iii. A Van der Waal's gas has the equation of state

$$\left(P + {a}/{V^2}\right)(V - b) = RT$$

and has the specific internal energy of

$$U = C_v T - \frac{a}{V} + const$$

Show that for a Van der Waal's gas

$$C_p - C_V = \frac{R}{1 - \dfrac{2a(V-b)^2}{RTV^3}}$$

2. What is a heat engine? Obtain a general expression for its efficiency. Explain what is meant by reversible and irreversible engine?

Diagram for the ideal gas cycle is shown in the figure below. All processes are quasi-static and the heat capacities are constant. Prove that the thermal efficiency of an engine performing this cycle is

$$\eta = 1 - \gamma\left[\frac{T_4 - T_1}{T_3 - T_2}\right]$$

$$\text{Where } \gamma = \frac{C_P}{C_V}$$