EASTERN UNIVERSITY, SRI LANKA

THIRD EXAMINATION IN SCIENCE - 2001/2002

(APRIL 2002)

PH 302 THERMODYNAMICS

Time: 01 hour.

Answer ALL Questions

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1. Define the heat capacity at constant volume and show that

$$C_v = \left(\frac{\partial U}{\partial T}\right)_v$$

The symbols have their usual meanings.

The internal combustion petrol engine can be modelled on the otto cycle. The four stages consist of

(a) an adiabatic compression from (P_3, V_1) to (P_1, V_2)

(b) an isochoric pressure increase from P_1 to P_2.

(c) an adiabatic expansion from (P_2, V_2) to (P_4, V_1)

(d) an isochoric pressure decrease from P_4 to P_3.

Sketch the PV diagram for the above cyclic process. Assuming that the gas behaves ideally with the constant heat capacity find the heat input during the process b and heat output during the process d and hence show that the efficiency of the cycle is

$$\eta = 1 - \frac{1}{r^{\gamma-1}}$$

where the compression ratio $r = \frac{V_1}{V_2}$

2. A gas has the equation of state

$$P(V - b) = RT$$

(i) Write down Maxwell's relations and use them to show that the internal energy U is a function of only T by finding $\left(\frac{\partial U}{\partial v}\right)_T$ and $\left(\frac{\partial U}{\partial P}\right)_T$.

(ii) Show that for an adiabatic expansion

$$P(V - b)^\gamma = constant$$

where $\gamma = \frac{C_p}{C_v}$ and $C_p - C_v = R$. The symbols have their usual meanings.