EASTERN UNIVERSITY, SRI LANKA

THIRD EXAMINATION IN SCIENCE - 2002/2003 - FIRST SEMESTER

(JUNE/JULY 2003)

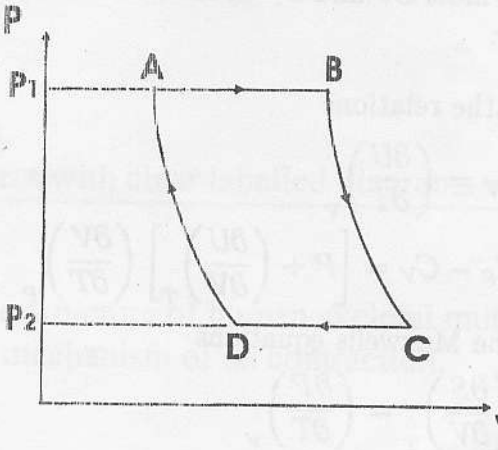
REPEAT

PH 302 Thermodynamics

Time: 01 hour.

Answer ALL Questions

1. What is a heat engine? Obtain a general expression for its efficiency.



The Joule cycle shown above consists of two constant-pressure steps connected by two adiabatics. Show that the Thermal efficiency of a reversible engine operating in this cycle, with an ideal gas of constant heat capacities as the working medium is

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

where $\gamma_p = \frac{p_2}{p_1}$ and $\gamma = \frac{c_p}{c_v}$

The symbols have their usual meanings.

2. A gas obeys the equation of state $P(V-b)=RT$ and has the heat capacities per mole C_V and C_P at constant volume and constant pressure respectively.

(a) Prove the relations

(i) $C_V=\left(\frac{\partial U}{\partial T}\right)_V$

(ii) $C_P-C_V=\left[P+\left(\frac{\partial U}{\partial V}\right)_T\right]\left(\frac{\partial V}{\partial T}\right)_P$

and the Maxwells equations

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

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

(b) Hence show that the internal energy U of the gas is the function of only temperature T by finding $\left(\frac{\partial U}{\partial V}\right)_T$ and $\left(\frac{\partial U}{\partial P}\right)_T$.

(c) Prove that $C_P-C_V=R$

(d) Show that for an adiabatic expansion $P(V-b)^\gamma=$ constant

The symbols have their usual meanings.