Q.1) Derive an expression for air standered efficiency of otto cycle. (4)
and comment on it.

Ans The Present day Petrol engine operates on this cycle. This is known so because it was introduced in practical form by a Gremon Scientist otto, in 1876 Although it was discribed by Beande Rochal in 1862.

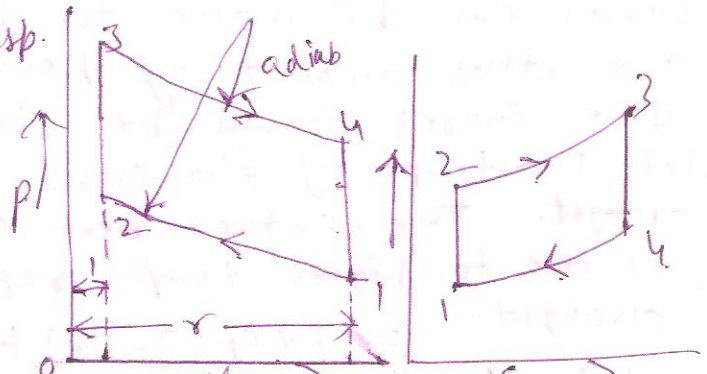

fig. shows p-v and T-s Diagram Resp.
1-2 Adiabatic compression
2-3 Heat addition
3-4 Adiabatic expension
4-1 Heat rejection.

Let P_1, V_1, T_1 be the conditions of air in the cyllinder initialy to the Point 1. The piston compressor the air adiabatically and at the end of stoke. let the conditions are P_2, V_2 and T_2.

Let clearance volume $= V_3 = V_2 = 1$

Ratio of Expansion during the adiabatic expansion 3-4

$$r = \frac{V_4}{V_3} = \frac{V_4}{1} = V_4$$

$$\therefore V_4 = r$$

Ratio of compression during the Adiabatic Compression 1-2.

$$= \frac{V_1}{V_2} = \frac{V_4}{V_3} = r \quad [\because V_3 = V_2, \; V_4 = V_1]$$

Consider one kg of air in the cyllinder

Heat supplied by hot body = Heat supplied during the const Vol. Stoke 2-3 $= C_v (T_3 - T_2)$

Heat rejected to the cold body = Heat rejected during const Vol 4-1
$= C_v (T_4 - T_1)$

Work Done = Heat supplied − Heat rejected
$= C_v (T_3 - T_2) - C_v (T_4 - T_1)$

$$\text{Efficency } (\eta) = \frac{\text{work Done}}{\text{Heat supplied}} = \frac{C_v (T_3 - T_2) - C_v (T_4 - T_1)}{C_v (T_3 - T_2)} = 1 - \frac{T_4 - T_1}{T_3 - T_2} \quad \text{---(1)}$$

Now Process 1-2 $\frac{T_2}{T_1} = r^{\gamma - 1}$ or $T_1 = \frac{T_2}{r^{\gamma-1}}$ ---(ii)

Similerly Process 3-4 $\frac{T_3}{T_4} = r^{\gamma-1}$ or $T_4 = \frac{T_3}{r^{\gamma-1}}$ ---(iii)

Substituting the value of T_1 and T_4 from (ii) & (iii) in (i)

$$\eta = 1 - \frac{\frac{T_3}{r^{\gamma-1}} - \frac{T_2}{r^{\gamma-1}}}{T_3 - T_2} = 1 - \frac{1}{r^{\gamma-1}} \cdot \frac{T_3 - T_2}{T_3 - T_2}$$

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