Q.1] b). Ideal efficiency,

$$\eta = \frac{T_1 - T_2}{T_1}$$

$$\therefore \eta = \frac{373 - 293}{373}$$

$$\therefore \boxed{\eta = 21.45\%}$$

Inventors claim of 25% efficiency is not feasible as the ideal efficiency is only 21.45%.

Q.2] a)

$$\frac{PV}{RT} = Z = 1 + \frac{B}{V} + \frac{C}{V^2} \quad \text{---} (1)$$

At, $Z = 1$, $V = \frac{RT}{P} = 3101 \text{ cm}^3$

∴ from (1),

$$V^3 - \frac{RT}{P} V^2 - \frac{RT}{P} B \cdot V - \frac{RT}{P} C = 0 = f(V)$$

$$V^{n+1} = V^n - \frac{f(V)}{f'(V)}$$

by interating we get

$V = 2939 \text{ cm}^3$ & $Z = 0.9478$.

Q.4] b)

By 1st law,

$\Delta U = Q - W$

$W = 0$ ——— ∵ no external force applied.

∴ $\Delta U = Q = C_V [\Delta T_A + \Delta T_B]$

∴ $\Delta U = Q = 12.56 [(T_{A_2} - 298) + (T_{B_2} - 298)]$

∴ $T_{A_2} + T_{B_2} = 796$ ——— (2)

Total volume of both the cylinders $= \frac{2RT_1}{P_1}$

$= 49.59 m^3$.

At equilibrium, pressure in compartment A & B are same.

$$\therefore \frac{2RT_1}{P_1} = \frac{R(T_{A_2} + T_{B_2})}{P_2}$$

$$\therefore \frac{P_2}{P_1} = 1.3355 \qquad \therefore \boxed{P_2 = 133.55 \, kPa}$$

Now, $\gamma = 1.6624$.

$$T_{B_2} = 298 (1.3355)^{\frac{1.6624-1}{1.6624}}$$

$$\therefore \boxed{T_{B_2} = 334.41 K}$$

from eqn (2), $\boxed{T_{A_2} = 461.59 K}$

$$V_{A_2} = \frac{RT_{A_2}}{P_2} = \underline{28.74 \, m^3}$$

$$\boxed{V_{B_2} = 20.82 \, m^3}$$