

SOLUTION

NAME: _____

This is an open book quiz. You may use a four function calculator. An unsigned honors pledge will result in a zero.

1. Compute the work produced by an air-standard Otto cycle during a minute of operation when it operates at 5,000 cycles/min. The compression ratio for the cycle is 9.5, the temperature at the end of the compression is 397°C and the temperature at the end of the expansion is 767°C. The mass of air in the cylinder is 4.3 grams.

GIVEN: $r = 9.5$; T_2 , T_4 , m , $\omega = 5000$ cycles/min

FIND: W for 5000 cycles

ISSUE: Standard Otto cycle assumptions

ANALYSIS: $\frac{W_{net}}{m} = W_{34} - W_{12} = (u_3 - u_4) - (u_2 - u_1)$

$$W_{net/cycle} = m[(u_3 - u_4) - (u_2 - u_1)]$$

② $T_2 = 397^\circ\text{C} = 670\text{K}$ ④ $T_4 = 767^\circ\text{C} = 1040\text{K}$
 $u_2 = 488.81 \text{ kJ/kg}$ $u_4 = 793.36 \text{ kJ/kg}$
 $r_{12} = 78.61$ $r_{34} = 22.39$

①→② and ③→④ are isentropic. So

$$\frac{v_1}{v_2} = \frac{v_{r1}}{v_{r2}} = \frac{v_{r1}}{78.61} = 9.5 \Rightarrow v_{r1} = 746.80 \text{ interpolating in A-22}$$

$$\frac{738.0 - 746.8}{738.0 - 808.0} = \frac{199.75 \text{ kJ/kg} - u_1}{199.75 \text{ kJ/kg} - 192.60 \text{ kJ/kg}}$$

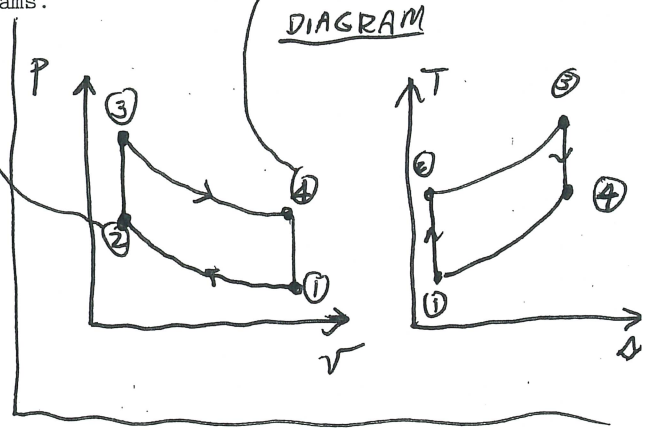
$$u_1 = 198.85 \text{ kJ/kg}$$

$$\frac{v_4}{v_3} = \frac{v_{r4}}{v_{r3}} = \frac{22.39}{v_{r3}} = 9.5 \Rightarrow v_{r3} = 2.356 \text{ looking up in A-22} \rightarrow u_3 = 1775.3 \text{ kJ/kg}$$

$$\Rightarrow \frac{W_{net}}{m_{cycle}} = (0.0043 \text{ kg}) \left[(1775.3 \frac{\text{kJ}}{\text{kg}} - 793.36 \frac{\text{kJ}}{\text{kg}}) - (488.81 \frac{\text{kJ}}{\text{kg}} - 198.85 \frac{\text{kJ}}{\text{kg}}) \right]$$

$$\frac{W_{net}}{cyc} = 2.975 \text{ kJ/cyc}$$

so, for one minute $W_{net} = 14,875 \text{ kJ} \leftarrow \text{ANS.}$



I HAVE NEITHER PROVIDED OR RECEIVED HELP DURING THIS QUIZ.

SIGNATURE _____