"PROBLEM STATEMENT"
"A 4-stroke SI engine with 3.0 liters of displacement and a 8.9:1compression ratio"
"has an output torque of 236 Nm at 3000 RPM. At this operating point, the brake"
"specific fuel consumption is measured as .090 MJ/kg. The volumetric flowrate of"
"air is .068 m^3/s and the inlet conditions of 20 C and 1 bar. The heating value of"
"the fuel used in the engine is 44 MJ/kg. Find the volumetric efficiency, the mass"
"flow rate of air, the mass flow rate of fuel, the air/fuel ratio, the arbitrary efficiency,"
"and the ideal otto cycle efficiency."

"KNOWNS"
nr = 2[dim]
Vs = 3000E-6[m^3]
T = 236[N-m]
Bsfc = .09[kg/MJ]*1/convert(MJ,kJ)
Vdot_air = .068[m^3/s]
rc = 8.9[dim]
T_in = 293[K]
P_in = 101[kPa]
Q_HV = 44E3[kJ/kg]
N =50[1/s]
R = .286[kJ/kg-K]
k =1.4[dim]

"EQUATIONS"
P = T*2*pi*N
P = bmep*Vs*N/nr

eta_o = 1/(Bsfc*Q_HV)
eta_otto = 1-1/(rc)^(k-1)
eta_v = Vdot_air/(Vs*N/nr)

rho_in = P_in/(R*T_in)
mdot_air = Vdot_air*rho_in*convert(kg/s, g/s)
mdot_fuel = Bsfc*P
A_F = mdot_air/mdot_fuel

SOLUTION
**Unit Settings: SI C kPa kJ mass deg**

| | | |
|---|---|---|
| $A_F$ = 12.28 [dim] | bmep = 988554 [Pa] | Bsfc = 0.00009 [kg/kJ] |
| $\eta_o$ = 0.2525 [dim] | $\eta_{otto}$ = 0.5829 [dim] | $\eta_v$ = 0.9067 [dim] |
| k = 1.4 [dim] | $mdot_{air}$ = 81.96 [g/s] | $mdot_{fuel}$ = 6.673 [g/s] |
| N = 50 [1/s] | nr = 2 [dim] | P = 74142 [w] |
| $P_{in}$ = 101 [kPa] | $Q_{HV}$ = 44000 [kJ/kg] | R = 0.286 [kJ/kg-K] |
| rc = 8.9 [dim] | $\rho_{in}$ = 1.205 [kg/m$^3$] | T = 236 [N-m] |
| $T_{in}$ = 293 [K] | $Vdot_{air}$ = 0.068 [m$^3$/s] | Vs = 0.003 [m$^3$] |

No unit problems were detected.

KEY VARIABLES
$\eta_v$ = 0.9067 [dim] *volumetric efficiency*

| | |
|---|---|
| $mdot_{air}$ = 81.96 [g/s] | *mass flow rate of air* |
| $mdot_{fuel}$ = 6.673 [g/s] | *mass flow rate of fuel* |
| $A_F$ = 12.28 [dim] | *air/fuel ratio* |
| $\eta_o$ = 0.2525 [dim] | *arbitrary efficiency* |
| $\eta_{otto}$ = 0.5829 [dim] | *otto cycle efficiency* |