

Instructions:

Answer four out of the six questions. No extra credit will be given for more than four answers. If more than four questions are attempted, CLEARLY indicate which questions are to be graded, otherwise only the first four relevant answers will be graded, and the rest ignored.

Note: All information is given in metric and English units. You may select the units of your choice for each of the questions. **However, do NOT use different unit systems within a single question.**

Show all calculation steps to ensure that partial credit is earned, even if the final answer is incorrect. In cases where the answer is obviously wrong, some credit will be given if you identify this as an improbable answer.

Combustion

Atomic Mass of Carbon (C) =12, Hydrogen (H) =1 Nitrogen (N) =14, Oxygen (O) =16,

$$r_s = (\rho_s/\rho_p) * (f_s/f_p) * (m_p/m_s)$$

IDEAL GAS $PV=(M/m)RT$ $R=8.134 \text{ kJ / (kg mole K)}$

Turbines

Compressor Work

$$W = M C_p(T_2-T_1)$$

$$P_{rc} = (P_1 + \text{Boost})/P_1 = P_2/P_1$$

$$1/T_{rc} = T_2/T_1 = 1 + [P_{rc}^{(k-1)/k} - 1] / e_c$$

$$e_v = P_{rc} * T_{rc} = [P_{rc} * e_c] / [e_c + (P_{rc}^{(k-1)/k} - 1)]$$

Note: e_c = (Theoretical Temperature Difference / Actual Temperature Difference)

Units Conversions

1 BTU = 778 ft.lb of work	1 kN.m = 1 kJ	1 pound force = 4.45 Newton
33000 ft.lb/min = 1 Hp	1 kJ/sec = 1 kW	1 gal = 3.785 liters
550 ft.lb/sec = 1 Hp	1000 liters = 1 m ³	1 psi = 6.8948 kPa
1 gal = 231 cubic inches	1000 cm ³ = 1 liter	1 inch = 0.0254 meters
1 mile = 5280 ft	1 ft.lb = 1.356 N.m	1 ft = 0.3048 meters
1 Hp = 0.7457 kW	1 BTU = 1.0551 kJ	

$$\text{Force (N)} = \text{mass(kg)} * \text{gravity(m/s}^2) \quad 1 \text{ (N)} = 1 \text{ (kg)} * 9.8 \text{ (m/s}^2)$$