

**Instructions:**

**Answer 3 out of the 5 questions.** No extra credit will be given for more than three answers. If more than three questions are attempted, CLEARLY indicate which questions are to be graded, otherwise only the first three 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.

**Power Equations**

$$P = 2\pi TN/60,000$$

$$P = (MEP * A * L * N * n) / (rc * 60 * 10^6)$$

$$P = (MEP * D * N) / (rc * 60 * 10^3)$$

$$P = M_f * HV / 3600$$

$$P = 2\pi TN/33,000$$

$$P = (MEP * A * (L/12) * N * n) / (rc * 33000)$$

$$P = (MEP * (D/12) * N) / (rc * 33000)$$

$$P = M_f * HV * 778 / 60 / 33000$$

**Gas Equations**

IDEAL GAS

$$PV = (M/m)RT$$

m for air = 29

Under Constant Pressure

$$V1/V2 = T1/T2$$

Under Constant Volume

$$P1/P2 = T1/T2$$

Adiabatic, Polytropic Expansion/Compression

$$T2/T1 = (V1/V2)^{(k-1)} = (P2/P1)^{(k-1)/k}$$

$$P2/P1 = (V1/V2)^k = (T2/T1)^{k/(k-1)}$$

Heat Addition

$$Q_{in} = M C_v(T2-T1)$$

$$R = 8.314 \text{ kJ} / (\text{kg mole K})$$

$$\text{Kelvin} = 273 + \text{degrees Celsius}$$

$$Q_{in} = M C_p(T2-T1)$$

$$R = 1545 \text{ ft} / (\text{lb} \cdot \text{R})$$

$$\text{Rankin} = 460 + \text{degrees Fahrenheit}$$

$$K = C_p / C_v$$

**Units Conversions**

$$1 \text{ BTU} = 778 \text{ ft}\cdot\text{lb of work}$$

$$33000 \text{ ft}\cdot\text{lb/min} = 1 \text{ Hp}$$

$$550 \text{ ft}\cdot\text{lb/sec} = 1 \text{ Hp}$$

$$1000 \text{ cm}^3 = 1 \text{ liter}$$

$$1 \text{ ft} = 0.3048 \text{ meters}$$

$$1 \text{ kN}\cdot\text{m} = 1 \text{ kJ}$$

$$1 \text{ kJ/sec} = 1 \text{ kW}$$

$$1000 \text{ liters} = 1 \text{ m}^3$$

$$1 \text{ inch} = 0.0254 \text{ m}$$

$$g = 9.81 \text{ (m/s}^2\text{)}$$

$$\text{Force (N)} = \text{mass(kg)} * \text{gravity(m/s}^2\text{)} \quad 1 \text{ (N)} = 1 \text{ (kg)} * 9.81 \text{ (m/s}^2\text{)}$$

$$1 \text{ lb force} = 4.45 \text{ Newton}$$

$$1 \text{ gal} = 3.785 \text{ liters}$$

$$1 \text{ psi} = 6.8948 \text{ kPa}$$

$$1 \text{ mile} = 5280 \text{ ft}$$

$$g = 32.2 \text{ (ft/s}^2\text{)}$$

$$1 \text{ Hp} = 0.7457 \text{ kW}$$

$$1 \text{ BTU} = 1.0551 \text{ kJ}$$

$$1 \text{ gal} = 231 \text{ cubic inches}$$

$$1 \text{ ft}\cdot\text{lb} = 1.356 \text{ N}\cdot\text{m}$$