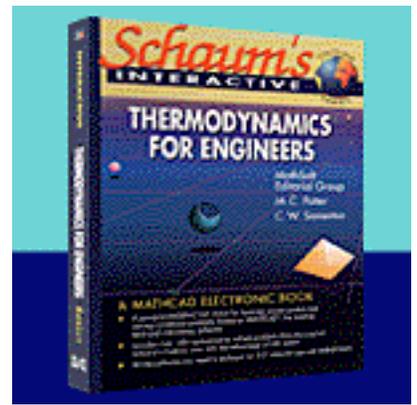


Schaums Interactive Outline Series: Thermodynamics for Engineers



Platform: Windows

Includes the Mathcad Engine; requires 4 MB hard disk space

Available for ground shipment

This Electronic Book presents and solves over 90 diverse thermodynamic problems as they apply to mechanical systems and emphasizes the connections between related problems. It summarizes key theoretical points and provides tabulated data for reference, including interpolated forms of common steam tables. Students will learn and explore the laws of thermodynamics as applied to engineering and the relationships between thermodynamic properties. The comprehensive lab and homework exercises will help educators with course material. And professionals can review theory and applications or refer to tabular data on basic elements.

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Mathcad - [Thermodynamics: Steam Tables]

File Edit Text Math Graphics Symbolic Window Books Help

Table B-2 Properties of Saturated Water as a Function of Pressure

Enter the pressure for which you want to determine the thermodynamic properties of water: $P_i = 10 \text{ kPa}$

The corresponding properties are then:

$T_K = 318.95$ (Kelvin)	
$v_f = 0.001 \cdot \frac{\text{m}^3}{\text{kg}}$	$v_g = 14.67 \cdot \frac{\text{m}^3}{\text{kg}}$
$s_f = 0.649 \cdot \frac{\text{kJ}}{\text{kg K}}$	$s_g = 8.151 \cdot \frac{\text{kJ}}{\text{kg K}}$
$h_f = 191.8 \cdot \frac{\text{kJ}}{\text{kg}}$	$h_g = 2584.6 \cdot \frac{\text{kJ}}{\text{kg}}$
$u_f = 191.8 \cdot \frac{\text{kJ}}{\text{kg}}$	$u_g = 2437.9 \cdot \frac{\text{kJ}}{\text{kg}}$

The graph below allows you to see how u_f and u_g vary with pressure:

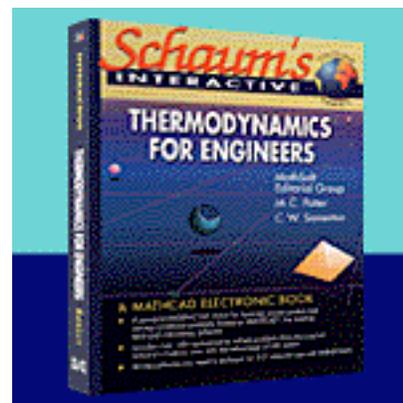
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Determine the thermodynamic properties of water as a function of pressure.

Topics include: Properties of Ideal and Real Gases, The First and Second Laws of Thermodynamics, Entropy and Enthalpy, Reversible Work, Irreversibility and Availability, Power and Refrigeration Vapor Cycles, Power and Refrigeration Gas Cycles, Combustion, and much more.

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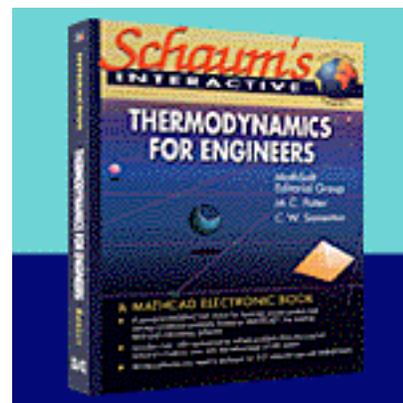
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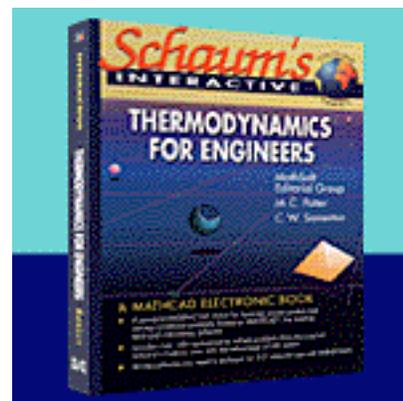
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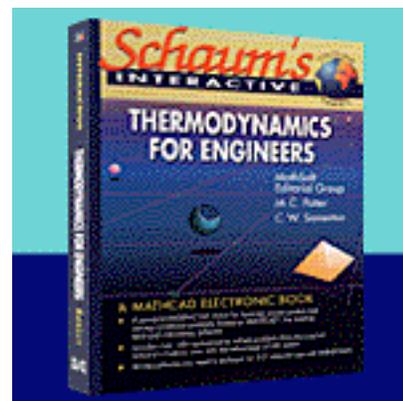


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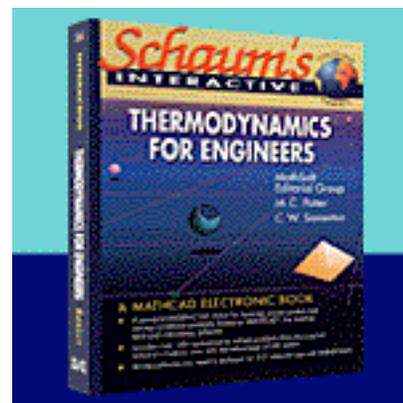
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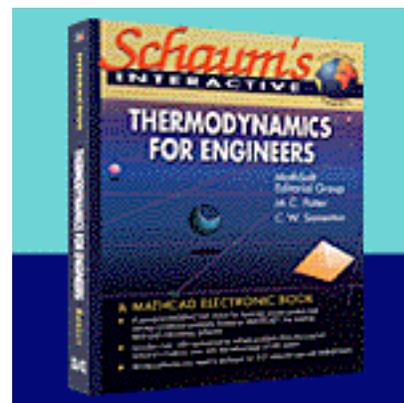
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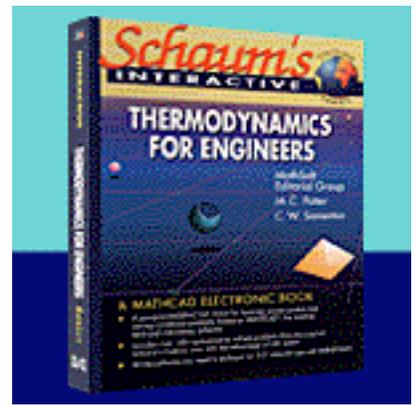
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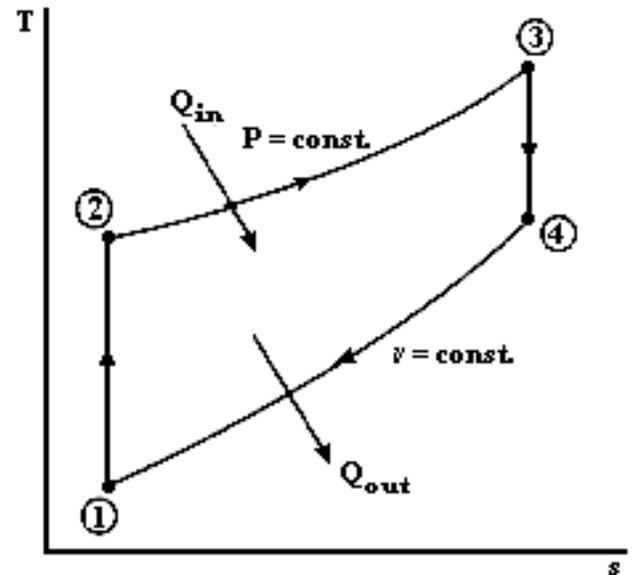
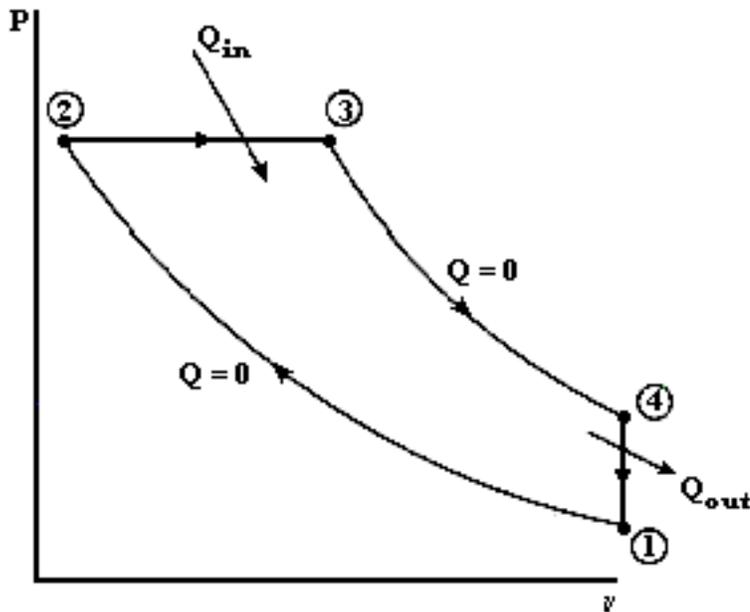


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Diesel Cycle

Statement

A diesel engine intakes atmospheric air at temperature T_1 and adds q_{in} of energy. If the maximum pressure is P_2 and the air mass flow rate is m' , calculate the cutoff ratio r_c , the thermal efficiency η , and the power output W'_{out} .



System Parameters

Inlet air pressure: $P_1 := 14.7 \cdot \text{psi}$

Inlet air temperature: $T_1 := 520 \cdot \text{R}$

Maximum air pressure: $P_2 := 1200 \cdot \text{psi}$

Specific energy input: $q_{in} := 800 \cdot \frac{\text{BTU}}{\text{lb}}$

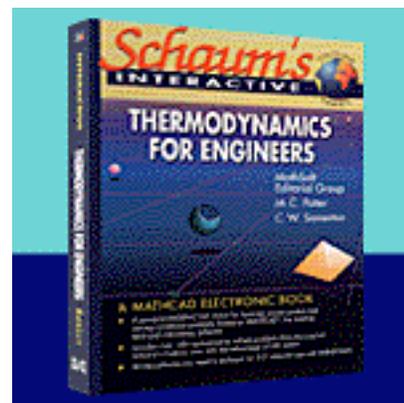
Mass flow rate: $m' := 0.2 \cdot \frac{\text{lb}}{\text{sec}}$

Units: $R \equiv \frac{K}{1.8}$

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Constants

Specific heat ratio for air: $k := 1.4$

Gas constant for air: $R_{\text{air}} := 53.34 \frac{\text{ft} \cdot \text{lbf}}{\text{lb} \cdot \text{R}}$

Solution

To determine the cutoff ratio and the thermal efficiency, it is first necessary to find the pressure, temperature and specific volumes at the various states.

Since the compression process 1 \rightarrow 2 is isentropic ($Ds = 0$),

$$T_2 := T_1 \cdot \left(\frac{P_2}{P_1} \right)^{\frac{k-1}{k}} \quad T_2 = 1829 \text{ } ^\circ\text{R}$$

and the temperature at state 3 is found from the **first law** (Chapter 4a):

$$q_{\text{in}} = c_p \cdot (T_3 - T_2) = \frac{R_{\text{air}} \cdot k}{k-1} \cdot (T_3 - T_2)$$

$$T_3 := T_2 + \frac{q_{\text{in}} \cdot (k-1)}{R_{\text{air}} \cdot k} \quad T_3 = 5164 \text{ } ^\circ\text{R}$$

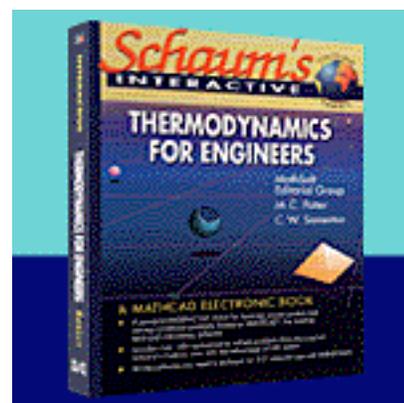
The pressure remains constant between states 2 and 3, giving

$$P_3 := P_2 \quad P_3 = 1200 \text{ } \text{psi}$$

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The specific volumes of the three states are found from the ideal-gas equation of state $Pv = RT$ (Chapter 2)

$$v_1 := \frac{R_{\text{air}} \cdot T_1}{P_1} \quad v_1 = 13.103 \frac{\text{ft}^3}{\text{lb}}$$

$$v_2 := \frac{R_{\text{air}} \cdot T_2}{P_2} \quad v_2 = 0.565 \frac{\text{ft}^3}{\text{lb}}$$

$$v_3 := \frac{R_{\text{air}} \cdot T_3}{P_3} \quad v_3 = 1.594 \frac{\text{ft}^3}{\text{lb}}$$

The cutoff ratio is then

$$r_c := \frac{v_3}{v_2} \quad r_c = 2.823$$

and the compression ratio is

$$r := \frac{v_1}{v_2} \quad r = 23.207$$

Thus the thermal efficiency is

$$\eta := 1 - r^{1-k} \cdot \frac{r_c^k - 1}{k \cdot (r_c - 1)} \quad \eta = 0.635$$

and the power output is

$$W_{\text{out}} := \eta \cdot \dot{m} \cdot q_{\text{in}} \quad W_{\text{out}} = 143.78 \text{ hp}$$

Try inputting r into 9.2 Otto Cycle to compare the efficiency of the two cycles.

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