Reminders 11-29-10:

-Thermal Physics Conceptual Questions Due Monday.

-Exam 4 Wednesday December 1, Ch. 10-12.

-Watch for sig. fig questions on Final Exam.

-Read and Understand Examples and Quick Quizzes in textbook for Chapters 10-12. Look for one or two of them on the next exam.

-Final Exam Wednesday December 8 (THIS EXAM CANNOT BE ONE OF YOUR DROPPED EXAMS)

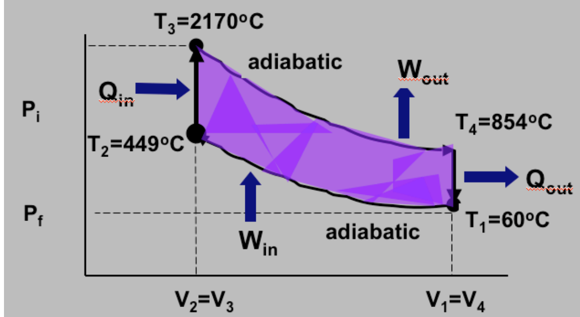
Objectives:

-Carnot Cycle

-Second Law of Thermodynamics

-Entropy

PV diagram of Internal Combustion Engine Cycle



Otto Cycle (1876)

Internal Combustion Engine Cycle Continued

Given Information

P_1=1atm; T_1=60°C;n=1
P_2=15atm; T_3=2170°C
$\gamma=C_p/C_v$=1.4 (diatomic ideal gas)
$V_2=V_3$; $V_1=V_4$
$P_i(V_i^{\gamma}) = P_f(V_f^{\gamma})$
$TP^{(\gamma-1)/\gamma}$=constant
$TV^{(\gamma-1)}$=constant

Calculated Values

T_2=449°C; T_4=854°C
W_{in}=-8.13kJ
Q_{in}= 36.0kJ
W_{out}=27.5kJ
Q_{out}= -16.6kJ
W_{cycle}=19.4kJ

$e=W_{cycle}/Q_{in}$=19.4J/36.0J=0.54

$$T_1 V_1^{(r-1)} = T_2 V_2^{(r-1)}$$

From ideal gas law $PV = nRT$

$$V = \frac{nRT}{P}$$

$$T_1\left[\frac{nRT_1}{P_1}\right]^{r-1} = T_2\left[\frac{nRT_2}{P_2}\right]^{r-1}$$

$$T_1^{1}\left(\frac{T_1^{r-1}}{P_1^{r-1}}\right) = T_2\left(\frac{T_2^{r-1}}{P_2^{r-1}}\right)$$

$$\frac{T_1^{r}}{P_1^{r-1}} = \frac{T_2^{r}}{P_2^{r-1}} \Rightarrow T_1^{r}P_1^{1-r} = T_2^{r}P_2^{1-r}$$

$1-r$

$$\left(\frac{T_1}{T_2}\right)^r = \left(\frac{P_2}{P_1}\right) = \left(\frac{15}{1}\right)^{1-r} = 15^{(-0.4)}$$

$$\left(\left(\frac{T_1}{T_2}\right)^r\right)^{1/r} = \left[15^{(-0.4)}\right]^{\frac{1}{r}}$$

$$\frac{T_1}{T_2} = \left[15^{(-0.4)}\right]^{\frac{1}{1.4}}$$

solve for T_2

- A heat engine absorbs 200J of heat from a hot reservoir, and exhausts 160J to a cold reservoir. What is the efficiency of this engine?

$Q_{in} = 200J$

$Q_{out} = 160$

$W = 40$

$e = \frac{40}{200} = .2$ or 20%

$= \frac{W_{out}}{Q_{in}} = \frac{Q_{H} - Q_{out}}{Q_{in}} = 1 - \frac{Q_{out}}{Q_{in}}$

- A heat pump has a COP of 3.0 and is rated to do work at a rate of 1500W. How much heat can be added to a room per second? If you ran this as an air conditioner, what do you expect the COP to be?

$$COP = \frac{Q_H}{W} = 3$$

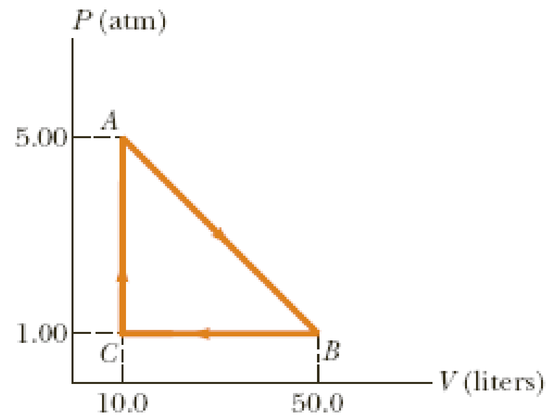
$$\therefore Q_H = 3W$$
$$= 3(1500) = 4500W$$

If $Q_H = 4500\,W$ $\quad W = 1500\,W$

$$Q_c = 3000W$$

$$(COP)_R = \frac{Q_c}{W} = \frac{3000W}{1500W} = 2$$

A substance undergoes the cyclic process shown in Figure P12.51. Work output occurs along path AB while work input is required along path BC, and no work is involved in the constant volume process CA. Energy transfers by heat occur during each process involved in the cycle.



(a) What is the work output during process AB?
12200 J
(b) How much work input is required during process BC?
4050 J
(c) What is the net energy input Q during this cycle?
8150 J

One mole of an ideal gas is taken through the cycle shown in Figure P12.58, with n = 7 and m = 6. At point A, the pressure, volume, and temperature are P0, V0, and T0. In terms of R and T0, find each of the following. (Hint: Recall that work equals the area under a PV curve.)

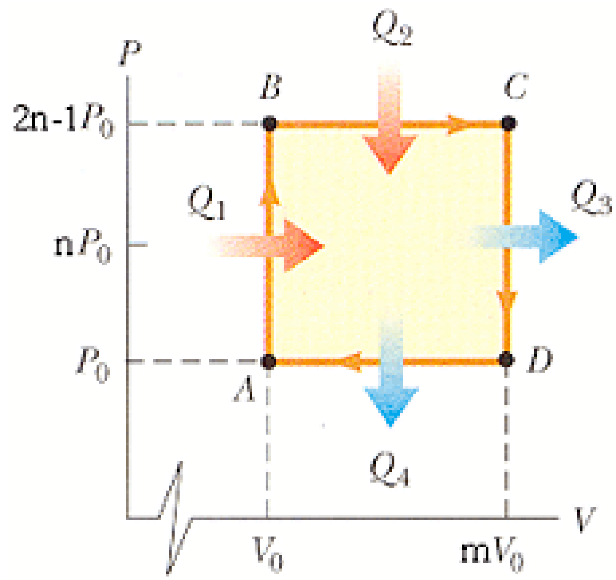


Figure P12.58

(a) the total energy entering the system by heat per cycle
180 RT0

(b) the total energy leaving the system by heat per cycle
120 RT0

(c) the efficiency of an engine operating in this cycle
33.2%

(d) the efficiency of an engine operating in a Carnot cycle between the temperature extremes for this process.
98.7%