3 Work and Internal Energy

$Nk = nR$	$E_{int} = \frac{d}{2} nRT$	$W = \int p \, \mathrm{d}V =$ (work done **by** the gas)
Isothermal:	$pV =$ const.	$W = nRT \ln \frac{V_f}{V_i}$
Adiabatic:	$pV^\gamma =$ const.	$W = -\frac{p_i V_i}{\gamma - 1}\left[\left(\frac{V_i}{V_f}\right)^\gamma - 1\right] = -\frac{1}{\gamma - 1}(p_f V_f - p_i V_i)$

3.a RHK Exercises

23.25 . Suppose that a sample of gas expands from 2.0 to 8.0 m^3 along the diagonal path in the PV diagram shown in Fig. 23- 33. It is then compressed back to 2.0 m^3 along either path 1 or path 2. Compute the net work done by the gas for the complete cycle in each case.

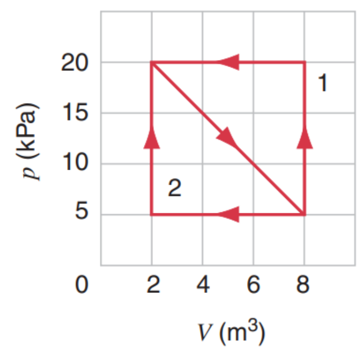

FIGURE 23-33. Exercise 25.

23.26 *(Modified)* An ideal gas that occupies volume V_1 at pressure p_1 is expanded isothermally until $V_2 = 3V_1$ and then cooled at constant pressure until it returns to its initial volume. *(a)* Compute the work done on the gas. *(b)* Calculate the change in internal energy of the gas.

23.30 An air compressor takes air at T_1 and pressure p_1 and delivers compressed air at pressure $p_2 = 2p_1$. The compressor operates at 200 W of useful power. Assume that the compressor operates adiabatically. *(a)* Find the temperature of the compressed air. *(b)* How much compressed air, in liters, is delivered each second?

3.b RHK Problems

23.14 The van der Waals equation of state

$$\left(p + \frac{an^2}{V^2}\right)(V - nb) = nRT \tag{3.1}$$

is a modification of the ideal gas law that incorporates the finite size b of molecules, and the weak attraction a between them. (The constants a and b are usually determined experimentally.) Calculate the work done by n moles of a van der Waals gas in an isothermal expansion from volume V_i to V_f .

23.16 A room of volume V is filled with diatomic ideal gas (air) at temperature T_1 and pressure p_0. The air is heated to a higher temperature T_2 , the pressure remaining constant at p_0 because the walls of the room are not airtight. Show that the internal energy content of the air remaining in the room is the same at T_1 and T_2. If we add no energy to the air inside, why bother to light the furnace?

23.XX An ideal gas with N particles undergoes a thermodynamic process from (T_0, V_0) to (T_f, V_f). Along the process, the quantity T/V^2 is held constant. *(a)* What does the process look like on a PV diagram? *(b)* Calculate the work done by the gas, and the change in internal energy.