

## Cyclic Process Example Solutions

(a) Find the temperature, pressure, and volume at each of the lettered points. Make a neat table.

	pressure [kPa]	Volume [m <sup>3</sup> ]	Temperature [K]
<b>A</b>	150	0.50	= PV/nR = 150e3*.5 / (4.5*8.31) = <b>2006</b>
<b>B</b>	150	1.95	7822
<b>C</b>	22.3	1.95	1163
<b>D</b>	22.3	0.50	298

(b) Find the work, heat, and change in internal energy for each of the processes AB, BC, etc. Make a table.

	Work [kJ]	Q [kJ]	$\Delta E_{int}$ [kJ]
<b>A -&gt; B</b>	P V = 217	$nC_p$ T = 759	= Q - W = 541.5
<b>B -&gt; C</b>	0	$nC_v$ T = -620	-620
<b>C -&gt; D</b>	-32.3	$nC_p$ T = -113	-80.5
<b>D -&gt; A</b>	0	$nC_v$ T = 159	159
<b>cycle = A -&gt; B -&gt; C -&gt; D -&gt; A</b>	185	185	<b>0</b>

(c) Find the net work done in one cycle.

$$\text{net work} = \text{sum of above} = 217 + (-32.3) \text{ kJ} = 185 \text{ kJ}$$

(d) You pay money for the heat source that provides Q that is positive. The exhaust is generally free (exhaust to the air, or to cooling water.) Find the efficiency defined as net work done divided by heat paid for.

$$\text{efficiency} = \text{net work} / \text{heat in} = 185 \text{ kJ} / [759 + 159] \text{ kJ} = \mathbf{0.2015} = 20.2\%$$

Note how small this number is!