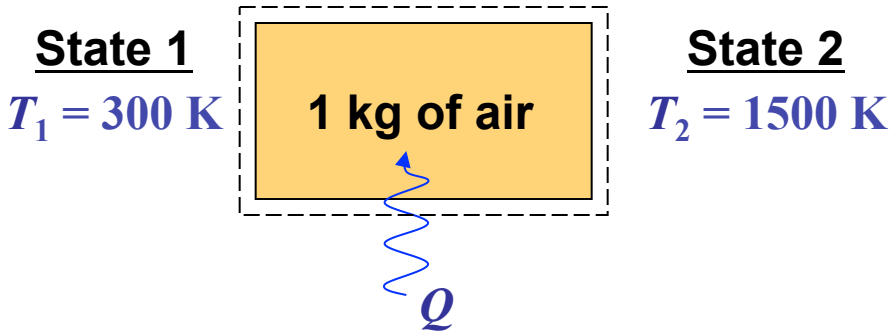
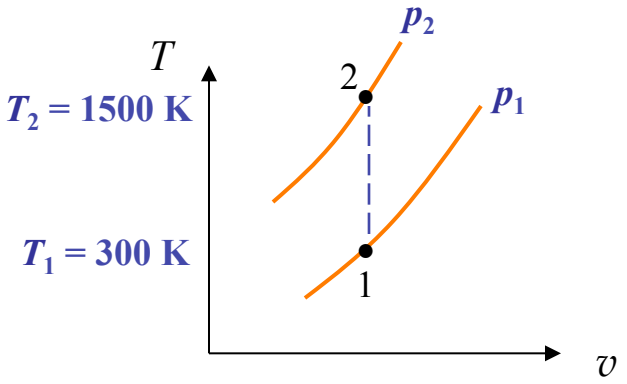
Property Data Use in the Closed System Energy Balance

Example: A closed, rigid tank consists of 1 kg of air at 300 K. The air is heated until its temperature becomes 1500 K. Neglecting changes in kinetic energy and potential energy and modeling air as an ideal gas, determine the heat transfer, in kJ, during the process of the air.





Property Data Use in the Closed System Energy Balance

Solution: An energy balance for the closed system is

$$\cancel{\Delta KE}^{\,0} + \cancel{\Delta PE}^{\,0} + \Delta U = Q - \cancel{W}^{\,0}$$

where the kinetic and potential energy changes are neglected and $W = 0$ because there is no work mode.

Thus $Q = m(u_2 - u_1)$

Substituting values for specific internal energy from **Table A-22**

$$Q = (1\text{ kg})(1205.41 - 214.07)\text{ kJ/kg} = 991.34\text{ kJ}$$

TABLE A-22

Ideal Gas Properties of Air

T(K), h and u(kJ/kg), s° (kJ/kg·K)											
				when Δs = 0						when Δs = 0	
T	h	u	s°	p_r	v_r	T	h	u	s°	p_r	v_r
250	250.05	178.28	1.51917	0.7329	979.	1400	1515.42	1113.52	3.36200	450.5	8.919
260	260.09	185.45	1.55848	0.8405	887.8	1420	1539.44	1131.77	3.37901	478.0	8.526
270	270.11	192.60	1.59634	0.9590	808.0	1440	1563.51	1150.13	3.39586	506.9	8.153
280	280.13	199.75	1.63279	1.0889	738.0	1460	1587.63	1168.49	3.41247	537.1	7.801
285	285.14	203.33	1.65055	1.1584	706.1	1480	1611.79	1186.95	3.42892	568.8	7.468
290	290.16	206.91	1.66802	1.2311	676.1	1500	1635.97	1205.41	3.44516	601.9	7.152
295	295.17	210.49	1.68515	1.3068	647.9	1520	1660.23	1223.87	3.46120	636.5	6.854
300	300.19	214.07	1.70203	1.3860	621.2	1540	1684.51	1242.43	3.47712	672.8	6.569
305	305.22	217.67	1.71865	1.4686	596.0	1560	1708.82	1260.99	3.49276	710.5	6.301
310	310.24	221.25	1.73498	1.5546	572.3	1580	1733.17	1279.65	3.50829	750.0	6.046

Polytropic Process

- A polytropic process is a quasiequilibrium process described by

$$pV^n = constant \qquad \textbf{(Eq. 3.52)}$$

- The exponent, n, may take on any value from $-\infty$ to $+\infty$ depending on the particular process.
  - For any gas (or liquid), when $\boldsymbol{n = 0}$, the process is a constant-pressure (isobaric) process.
  - For any gas (or liquid), when $\boldsymbol{n = \pm\infty}$, the process is a constant-volume (isometric) process.
  - For a gas modeled as an ideal gas, when $n = 1$, the process is a constant-temperature (isothermal) process.