First Law of Thermodynamics: $\Delta E_{int} = Q - W$

Summary of Thermodynamic Relationships Involving IDEAL GASES:

Equation of State: $PV = nRT$ For Closed System: $\frac{PV}{T} = nR = \text{constant}$

Process	ΔE_{int}	Q	W
Isochoric ($\Delta V = 0$)	$nc_v\Delta T$	$nc_v\Delta T$	0
Isobaric ($\Delta P = 0$)	$nc_v\Delta T$	$nc_p\Delta T$	$P\Delta V$
Isothermal ($\Delta T = 0$)	0	$nRT\ln\left(\frac{V_f}{V_i}\right)$	$nRT\ln\left(\frac{V_f}{V_i}\right)$
Adiabatic ($Q = 0$)	$nc_v\Delta T$	0	$\frac{P_fV_f - P_iV_i}{1-\gamma} = \frac{nR(\Delta T)}{1-\gamma}$
Cycle	0	$\oint dQ$ = Area of Cycle	$\oint dW$ = Area of Cycle

$$c_p - c_v = R \qquad c_v = \left(\frac{f}{2}\right)R \qquad \gamma = \frac{c_p}{c_v} = 1 + \frac{2}{f}$$

(where f = # of degrees of freedom)

Type of Gas	c_v	c_p	f	γ
Monatomic	$\frac{3}{2}R$	$\frac{5}{2}R$	3	$\frac{5}{3}$
Diatomic (Rigid)	$\frac{5}{2}R$	$\frac{7}{2}R$	5	$\frac{7}{5}$
Diatomic (w/ Vib.)	$\frac{7}{2}R$	$\frac{9}{2}R$	7	$\frac{9}{7}$
Polyatomic (Rigid)	$3R$	$4R$	6	$\frac{4}{3}$

For adiabatic processes: $PV^{\gamma} = \text{constant}$ $TV^{\gamma-1} = \text{constant}$ $P^{1-\gamma}T^{\gamma} = \text{constant}$