FIRST LAW AND RELATED RESULTS

First Law: $\Delta U = Q - W$
n = number of moles
C_p defined: $Q = nC_p\Delta T$ for P = constant
C_v defined: $Q = nC_v\Delta T$ for V = constant
Ideal gas:
$PV = nRT$
$U = \frac{q}{2}nRT = \frac{1}{\gamma-1}nRT \quad \Delta U = nC_v\Delta T$
q = number of degrees of freedom
$C_v = \frac{q}{2}R = \frac{1}{\gamma-1}R \quad C_p = \frac{\gamma}{\gamma-1}R \quad C_p/C_v = \gamma \quad C_p = C_v + R$

ADIABATIC: $Q = 0$
$\Delta U = -W \quad P_1V_1^\gamma = P_2V_2^\gamma \quad T_1V_1^{\gamma-1} = T_2V_2^{\gamma-1}$
$Q = 0 \quad \Delta U = -W = nC_v\Delta T \quad W = -(P_2V_2 - P_1V_1)/(\gamma - 1)$

ISOBARIC: P = constant
$\Delta U = Q - W \quad P\Delta V = nR\Delta T \quad V_2/V_1 = T_2/T_1$
$Q = nC_p\Delta T \quad \Delta U = nC_v\Delta T \quad W = P\Delta V$

ISOTHERMAL: T = constant
$\Delta U = Q - W \quad \Delta(PV) = 0 \quad P_1V_1 = P_2V_2$
$Q = nRT\ln(V_2/V_1) = P_1V_1\ln(P_1/P_2) \quad \Delta U = 0 \quad W = Q$

ISOCHORIC: V = constant
$\Delta U = Q \quad V\Delta P = nR\Delta T \quad P_2/P_1 = T_2/T_1$
$Q = nC_v\Delta T \quad \Delta U = nC_v\Delta T \quad W = 0$