EngineeringRise

First law, isothermal and adiabatic processes

Formulas and units, JEE Main. Status: Reviewed on 2026-11-20.

Result	Formula	Units or note
First law	Q = dU + W (W by the gas) Valid when: any process; W is work done by the gas	J
Ideal gas internal energy change	dU = n Cv dT, Cv = (f/2) R Valid when: ideal gas, any process; Cv=(f/2)R with no vibrational modes	J
Mayer relation and gamma	Cp - Cv = R; gamma = Cp/Cv = 1 + 2/f Valid when: ideal gas; gamma=1+2/f with no vibrational modes	J/(mol K) (dimensionless)
Isothermal	P V = constant; W = Q = n R T ln(V2/V1) Valid when: ideal gas, reversible isothermal process; ln is natural log	J
Adiabatic relations	P V^gamma = T V^(gamma - 1) = T^gamma P^(1 - gamma) = constant Valid when: ideal gas, reversible (quasi-static) adiabatic process, constant gamma	n/a (as stated)
Adiabatic work	W = (P1 V1 - P2 V2)/(gamma - 1) = n Cv (T1 - T2) Valid when: ideal gas, reversible adiabatic process	J
Isobaric	W = P dV = n R dT; Q = n Cp dT Valid when: ideal gas at constant pressure	J
Isochoric	W = 0; Q = n Cv dT Valid when: ideal gas at constant volume	J
Polytropic P V^x = constant	W = n R (T1 - T2)/(x - 1); C = Cv + R/(1 - x) Valid when: ideal gas, reversible polytropic process, x not equal to 1	J (J/(mol K))
Slope on P-V plot	adiabat slope = gamma x isotherm slope at the same point Valid when: ideal gas; adiabat and isotherm through the same point on a P-V plot	Pa/m^3

Full lesson with worked examples:
https://www.engineeringrise.in/learn/learn/jee-main/physics/thermodynamics/first-law-isothermal-and-adiabatic-processes

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