EngineeringRise

First law, enthalpy and calorimetry

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

Result	Formula	Units or note
First law	delta U = q + w (IUPAC: w is work done on the system) Valid when: closed system; w = work done on the system	J or kJ
Work at constant external pressure	w = -p_ext (V2 - V1) Valid when: constant external pressure, only pV work, irreversible path	J (1 L bar = 100 J; pascal x cubic metre = J)
Reversible isothermal work (ideal gas)	w = -n R T ln(V2/V1); q = -w Valid when: ideal gas, reversible isothermal change	J (with R = 8.314 J/(mol K))
Adiabatic change (ideal gas)	q = 0; delta U = w = n C_v (T2 - T1) Valid when: ideal gas, adiabatic process, C_v constant	J
Heat capacities (ideal gas)	C_p - C_v = R; monatomic C_v = 3R/2; diatomic C_v = 5R/2 Valid when: ideal gas; C_v values ignore vibration at ordinary temperature	J/(mol K)
Enthalpy	H = U + pV; q_p = delta H; q_v = delta U Valid when: only pV work; q_p at constant p, q_v at constant V	J or kJ
Delta H and delta U for a reaction	delta H = delta U + delta n(g) R T Valid when: ideal gases; constant T; count only gaseous species	kJ (divide delta n R T by 1000 when R is in J/(mol K))
Heat from heat capacity	q = C delta T = m c delta T = n C_m delta T Valid when: no phase change or reaction; heat capacity constant over range	J (c in J/(g K); C_m in J/(mol K))
Heating a gas	q_v = n C_v delta T = delta U; q_p = n C_p delta T = delta H Valid when: ideal gas; q equals those only at constant V or p respectively	J
Cyclic process	delta U = 0, delta H = 0, so q = -w Valid when: system returns to its initial state after a cycle	J

Full lesson with worked examples:
https://www.engineeringrise.in/learn/learn/jee-main/chemistry/chemical-thermodynamics/first-law-enthalpy-and-calorimetry

EngineeringRise is an unofficial study site. It is not affiliated with NTA, the IITs, BITS, VIT, SRM or any exam body.