EngineeringRise

# Equation of state, pressure and temperature in kinetic theory

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

| Result | Formula | Units or note |
|---|---|---|
| **Ideal gas equation** | P V = n R T = N k T Valid when: ideal gas; SI units (Pa, m^3, K) | Pa (m^3, mol, K; R = 8.31 J/(mol K), k = 1.38 x 10^-23 J/K) |
| **Combined gas law** | P1 V1 / T1 = P2 V2 / T2 (fixed amount) Valid when: ideal gas, fixed amount of gas | any consistent units, T in K |
| **Density of a gas** | rho = P M / (R T) Valid when: ideal gas; M in kg/mol, SI units | kg/m^3 (M in kg/mol) |
| **Number density** | N/V = P / (k T) Valid when: ideal gas; SI units | per m^3 |
| **Kinetic pressure** | P = (1/3) n m v_rms^2 = (1/3) rho v_rms^2 = (2/3) E per unit volume Valid when: ideal gas, elastic collisions with walls, point molecules | Pa |
| **Mean translational energy** | (1/2) m v_rms^2 = (3/2) k T; per mole (3/2) R T Valid when: ideal gas; translational energy only; any ideal gas at same T | J |
| **Speeds** | v_rms = sqrt(3RT/M); v_mean = sqrt(8RT/(pi M)); v_p = sqrt(2RT/M) Valid when: ideal gas in equilibrium; M in kg/mol; T in kelvin | m/s (M in kg/mol) |
| **Isobaric and isothermal work on gas** | W = P (V1 - V2); W = n R T ln(V1/V2) Valid when: isobaric: P constant; isothermal: ideal gas, reversible; W is work done on gas | J |
| **Avogadro number and molecule mass** | N_A = 6.02 x 10^23 per mol; m_0 = M/N_A | per mol (kg) |

Full lesson with worked examples:
https://www.engineeringrise.in/learn/learn/jee-main/physics/kinetic-theory-of-gases/equation-of-state-pressure-and-temperature-in-k

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