EngineeringRise

Second law, reversible and irreversible processes

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

Result	Formula	Units or note
Engine and work	W = Q1 - Q2 per cycle Valid when: heat engine over one complete cycle	J
Efficiency	efficiency = W/Q1 = 1 - Q2/Q1 Valid when: heat engine over one complete cycle	dimensionless
Carnot efficiency	efficiency = 1 - T2/T1 (kelvin) Valid when: reversible (Carnot) engine between two reservoirs; T in kelvin	dimensionless
Carnot heat ratio	Q2/Q1 = T2/T1 Valid when: reversible (Carnot) cycle between two reservoirs; T in kelvin	dimensionless
Refrigerator COP	COP = Q2/W = Q2/(Q1 - Q2) Valid when: refrigerator over one complete cycle; Q2 from the cold space	dimensionless
Reversible refrigerator	COP = T2/(T1 - T2) Valid when: reversible refrigerator between two reservoirs; T in kelvin	dimensionless
Heat pump (heating) COP	Q1/W = T1/(T1 - T2) = COP_refrigerator + 1 Valid when: reversible heat pump between two reservoirs; T in kelvin	dimensionless
Engine and refrigerator link	COP = (1 - efficiency)/efficiency, same reservoirs Valid when: refrigerator is the same cycle as the engine run in reverse	dimensionless
Kelvin-Planck	no cyclic engine converts heat from one reservoir entirely into work	n/a (statement)
Clausius	no cyclic device moves heat cold to hot with no other effect	n/a (statement)

Full lesson with worked examples:
https://www.engineeringrise.in/learn/learn/jee-main/physics/thermodynamics/second-law-reversible-and-irreversible-processes

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