Ideal-Gas Heat Capacity: Mean c_p, Enthalpy and Entropy Change

Heat capacity at two temperatures, mean heat capacity, enthalpy change and entropy change of an ideal gas from user coefficients of $c_p = a + bT + cT^2 + dT^3$.

Method: Perry's Chemical Engineers' Handbook; 9th ed. (McGraw-Hill, 2019); ...

Input parameters

Unit system: SI

Parameter	Value	Unit
a (J/(mol·K))	28.110	
b (J/(mol·K²))	-3.6800e-06	
c (J/(mol·K³))	1.7460e-05	
d (J/(mol·K⁴))	-1.0650e-08	
Temperature 1	25.000	°C
Temperature 2	500.00	°C
Molar mass	32.000	kg/kmol

Calculated results

Parameter	Value	Unit
c_p at T_1 (J/(mol·K))	29.379	
c_p at T_2 (J/(mol·K))	33.622	
Mean c_p between T_1 and T_2	0.98398	kJ/(kg·K)
Enthalpy change	467.39	kJ/kg
Entropy change at constant pressure	0.92748	kJ/(kg·K)

Formula and method

$$c_p = a + bT + cT^2 + dT^3, \quad \Delta h = \int c_p\,dT, \quad \Delta s = \int \frac{c_p}{T} dT$$

Variables

a	a (J/(mol·K))	-
b	b (J/(mol·K²))	-
c	c (J/(mol·K³))	-
d	d (J/(mol·K⁴))	-
T_1	Temperature 1	K
T_2	Temperature 2	K
M	Molar mass	kg/kmol
$c_p(T_1)$	c_p at T_1	-
$c_p(T_2)$	c_p at T_2 (J/(mol·K))	-
$\bar{c}_p$	Mean c_p between T_1 and T_2	J/(kg·K)
Δh	Enthalpy change	J/kg
Δs	Entropy change at constant pressure	J/(kg·K)

Method and standards

Polynomial integration (per mole, then per kg).

Assumptions and limits

- Ideal gas.
- Coefficients must give c_p in J/(mol·K) with T in kelvin (kJ/(kmol·K) has the same numbers). Sets in calories or with T in °C must be converted first. c_p at T_1 and T_2 is shown per mole; the mean c_p, Δh and Δs are per kg.
- The coefficients' fitted temperature range is not checked: keep T_1 and T_2 inside it.

References

- Perry's Chemical Engineers' Handbook
- 9th ed. (McGraw-Hill, 2019)
- sec. 2 (ideal-gas heat capacity correlations)
- Integration of c_p(T) (definitions)

Report details

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Release checks	2 reference cases of this calculator, computed independently, are checked on every release

Results are for engineering estimation. Verify critical designs against the referenced standards and your own data.

This calculator online

https://calc.firecad.com/chemical/physical-properties/ideal-gas-cp-polynomial

Open this case on calc.firecad.com →

Reopens the calculator with the inputs of this report.