Important Formulae on Equipartition Principle and Heat Capacity Formulas PDF

Formulas Examples with Units

List of 20
Important Formulae on Equipartition Principle and Heat Capacity Formulas

1) Atomicity given Molar Heat Capacity at Constant Pressure and Volume of Linear Molecule Formula

Evaluate Formula

Formula

$$N = \frac{\left(2.5 \cdot \left(\frac{C_p}{C_v}\right)\right) - 1.5}{\left(3 \cdot \left(\frac{C_p}{C_v}\right)\right) - 3}$$

Example with Units

$$2.6404 = \frac{\left(2.5 \cdot \left(\frac{122\,\mathrm{J/K{*}mol}}{103\,\mathrm{J/K{*}mol}}\right)\right) - 1.5}{\left(3 \cdot \left(\frac{122\,\mathrm{J/K{*}mol}}{103\,\mathrm{J/K{*}mol}}\right)\right) - 3}$$

2) Atomicity given Molar Vibrational Energy of Non-Linear Molecule Formula

Evaluate Formula

Formula

$$N = \frac{\left(\frac{E_v}{[R] \cdot T}\right) + 6}{3}$$

Example with Units

$$2.2594 = \frac{\left(\frac{550\,\mathrm{J/mol}}{8.3145 \cdot 85\,\mathrm{K}}\right) + 6}{3}$$

3) Atomicity given Ratio of Molar Heat Capacity of Linear Molecule Formula

Evaluate Formula

Formula

$$N = \frac{(2.5 \cdot \gamma) - 1.5}{(3 \cdot \gamma) - 3}$$

Example

$$1.5 = \frac{(2.5 \cdot 1.5) - 1.5}{(3 \cdot 1.5) - 3}$$

4) Atomicity given Vibrational Degree of Freedom in Non-Linear Molecule Formula

Evaluate Formula

Formula

$$N = \frac{F + 6}{3}$$

Example

$$2.6667 = \frac{2 + 6}{3}$$

5) Average Thermal Energy of Linear Polyatomic Gas Molecule given Atomicity Formula

Evaluate Formula

Formula

$$Q_{atomicity} = ((6 \cdot N) - 5) \cdot (0.5 \cdot [BoltZ] \cdot T)$$

Example with Units

$$7.6E\text{-}21\,\mathrm{J} = ((6 \cdot 3) - 5) \cdot (0.5 \cdot 1.4E\text{-}23\,\mathrm{J/K} \cdot 85\,\mathrm{K})$$

6) Average Thermal Energy of Non-linear polyatomic Gas Molecule given Atomicity Formula

Evaluate Formula

Formula

$$Q_{atomicity} = ((6 \cdot N) - 6) \cdot (0.5 \cdot [BoltZ] \cdot T)$$

Example with Units

$$7E\text{-}21\,\mathrm{J} = ((6 \cdot 3) - 6) \cdot (0.5 \cdot 1.4E\text{-}23\,\mathrm{J/K} \cdot 85\,\mathrm{K})$$

7) Degree of Freedom given Ratio of Molar Heat Capacity Formula

Evaluate Formula

Formula

$$F = \frac{2}{\gamma - 1}$$

Example

$$4 = \frac{2}{1.5 - 1}$$

8) Internal Molar Energy of Linear Molecule Formula

Evaluate Formula

Formula

$$U_{molar} = \left(\left(\frac{3}{2}\right) \cdot [R] \cdot T\right) + \left(\left(0.5 \cdot I_y \cdot \left(\omega_y^{\,2}\right)\right) + \left(0.5 \cdot I_z \cdot \left(\omega_z^{\,2}\right)\right)\right) + ((3 \cdot N) - 5) \cdot ([R] \cdot T)$$

Example with Units

$$3914.0461\,\mathrm{J} = \left(\left(\frac{3}{2}\right) \cdot 8.3145 \cdot 85\,\mathrm{K}\right) + \left(\left(0.5 \cdot 60\,\mathrm{kg{\cdot}m^2} \cdot \left(35\,\mathrm{degree/s}^{2}\right)\right) + \left(0.5 \cdot 65\,\mathrm{kg{\cdot}m^2} \cdot \left(40\,\mathrm{degree/s}^{2}\right)\right)\right) + ((3 \cdot 3) - 5) \cdot (8.3145 \cdot 85\,\mathrm{K})$$

9) Internal Molar Energy of Linear Molecule given Atomicity Formula

Evaluate Formula

Formula

$$U_{molar} = ((6 \cdot N) - 5) \cdot (0.5 \cdot [R] \cdot T)$$

Example with Units

$$4593.7406\,\mathrm{J} = ((6 \cdot 3) - 5) \cdot (0.5 \cdot 8.3145 \cdot 85\,\mathrm{K})$$

10) Internal Molar Energy of Non-Linear Molecule Formula

Evaluate Formula

Formula

$$U_{molar} = \left(\left(\frac{3}{2}\right) \cdot [R] \cdot T\right) + \left(\left(0.5 \cdot I_y \cdot \left(\omega_y^{\ 2}\right)\right) + \left(0.5 \cdot I_z \cdot \left(\omega_z^{\ 2}\right)\right) + \left(0.5 \cdot I_x \cdot \left(\omega_x^{\ 2}\right)\right)\right) + \left(\left(3 \cdot N\right) - 6\right) \cdot \left([R] \cdot T\right)$$

Example with Units

$$3214.856\,\text{J} = \left(\left(\frac{3}{2}\right) \cdot 8.3145 \cdot 85\,\text{K}\right) + \left(\left(0.5 \cdot 60\,\text{kg·m²} \cdot \left(35\,\text{degree/s}^{\ 2}\right)\right) + \left(0.5 \cdot 65\,\text{kg·m²} \cdot \left(40\,\text{degree/s}^{\ 2}\right)\right) + \left(0.5 \cdot 55\,\text{kg·m²} \cdot \left(30\,\text{degree/s}^{\ 2}\right)\right)\right) + \left(\left(3 \cdot 3\right) - 6\right) \cdot (8.3$$

11) Internal Molar Energy of Non-Linear Molecule given Atomicity Formula

Evaluate Formula

Formula

$$U_{molar} = \left(\left(6 \cdot N\right) - 6\right) \cdot \left(0.5 \cdot [R] \cdot T\right)$$

Example with Units

$$4240.3759\,\text{J} = \left(\left(6 \cdot 3\right) - 6\right) \cdot \left(0.5 \cdot 8.3145 \cdot 85\,\text{K}\right)$$

12) Molar Heat Capacity at Constant Pressure given Compressibility Formula

Evaluate Formula

Formula

$$C_p = \left(\frac{K_T}{K_S}\right) \cdot C_v$$

Example with Units

$$110.3571\,\text{J/K*mol} = \left(\frac{75\,\text{m²/N}}{70\,\text{m²/N}}\right) \cdot 103\,\text{J/K*mol}$$

13) Molar Vibrational Energy of Linear Molecule Formula

Evaluate Formula

Formula

$$E_{viv} = \left(\left(3 \cdot N\right) - 5\right) \cdot \left([R] \cdot T\right)$$

Example with Units

$$2826.9173\,\text{J/mol} = \left(\left(3 \cdot 3\right) - 5\right) \cdot \left(8.3145 \cdot 85\,\text{K}\right)$$

14) Molar Vibrational Energy of Non-Linear Molecule Formula

Evaluate Formula

Formula

$$E_{viv} = \left(\left(3 \cdot N\right) - 6\right) \cdot \left([R] \cdot T\right)$$

Example with Units

$$2120.188\,\text{J/mol} = \left(\left(3 \cdot 3\right) - 6\right) \cdot \left(8.3145 \cdot 85\,\text{K}\right)$$

15) Number of Modes in Non-Linear Molecule Formula

Evaluate Formula

Formula

$$N_{modes} = \left(6 \cdot N\right) - 6$$

Example

$$12 = \left(6 \cdot 3\right) - 6$$

16) Ratio of Molar Heat Capacity given Degree of Freedom Formula

Evaluate Formula

Formula

$$\gamma = 1 + \left(\frac{2}{F}\right)$$

Example

$$2 = 1 + \left(\frac{2}{2}\right)$$

17) Ratio of Molar Heat Capacity of Linear Molecule Formula

Evaluate Formula

Formula

$$\gamma = \frac{\left(\left(\left(3 \cdot N\right) - 2.5\right) \cdot [R]\right) + [R]}{\left(\left(3 \cdot N\right) - 2.5\right) \cdot [R]}$$

Example

$$1.1538 = \frac{\left(\left(\left(3 \cdot 3\right) - 2.5\right) \cdot 8.3145\right) + 8.3145}{\left(\left(3 \cdot 3\right) - 2.5\right) \cdot 8.3145}$$

18) Total Kinetic Energy Formula

Evaluate Formula

Formula

$$E_{total} = E_T + E_{rot} + E_{vf}$$

Example with Units

$$850\,\text{J} = 600\,\text{J} + 150\,\text{J} + 100\,\text{J}$$

19) Translational Energy Formula

Evaluate Formula

Formula

$$E_T = \left(\frac{p_x^{\ 2}}{2 \cdot Mass_{flight\ path}}\right) + \left(\frac{p_y^{\ 2}}{2 \cdot Mass_{flight\ path}}\right) + \left(\frac{p_z^{\ 2}}{2 \cdot Mass_{flight\ path}}\right)$$

Example with Units

$$512.6939\,\text{J} = \left(\frac{105\,\text{kg*m/s}^{\ 2}}{2 \cdot 35.45\,\text{kg}}\right) + \left(\frac{110\,\text{kg*m/s}^{\ 2}}{2 \cdot 35.45\,\text{kg}}\right) + \left(\frac{115\,\text{kg*m/s}^{\ 2}}{2 \cdot 35.45\,\text{kg}}\right)$$

20) Vibrational Mode of Linear Molecule Formula

Evaluate Formula

Formula

$$N_{vib} = \left(3 \cdot N\right) - 5$$

Example

$$4 = \left(3 \cdot 3\right) - 5$$

Variables used in list of Important Formulae on Equipartition Principle and Heat Capacity above

- C_p Molar Specific Heat Capacity at Constant Pressure *(Joule Per Kelvin Per Mole)*
- C_v Molar Specific Heat Capacity at Constant Volume *(Joule Per Kelvin Per Mole)*
- E_{rot} Rotational Energy *(Joule)*
- E_T Translational Energy *(Joule)*
- E_{total} Total Energy *(Joule)*
- E_v Molar Vibrational Energy *(Joule Per Mole)*
- E_{vf} Vibrational Energy *(Joule)*
- E_{viv} Vibrational Molar Energy *(Joule Per Mole)*
- F Degree of Freedom
- I_x Moment of Inertia along X-axis *(Kilogram Square Meter)*
- I_y Moment of Inertia along Y-axis *(Kilogram Square Meter)*
- I_z Moment of Inertia along Z-axis *(Kilogram Square Meter)*
- K_S Isentropic Compressibility *(Square Meter per Newton)*
- K_T Isothermal Compressibility *(Square Meter per Newton)*
- $Mass_{flight\ path}$ Mass *(Kilogram)*
- N Atomicity
- N_{modes} Number of Normal modes for Non Linear
- N_{vib} Number of Normal modes
- p_x Momentum along X-axis *(Kilogram Meter per Second)*
- p_y Momentum along Y-axis *(Kilogram Meter per Second)*
- p_z Momentum along Z-axis *(Kilogram Meter per Second)*
- $Q_{atomicity}$ Thermal Energy given Atomicity *(Joule)*
- T Temperature *(Kelvin)*
- U_{molar} Molar Internal Energy *(Joule)*
- γ Ratio of Molar Heat Capacity
- ω_x Angular Velocity along X-axis *(Degree per Second)*
- ω_y Angular Velocity along Y-axis *(Degree per Second)*
- ω_z Angular Velocity along Z-axis *(Degree per Second)*

Constants, Functions, Measurements used in list of Important Formulae on Equipartition Principle and Heat Capacity above

- constant(s): **[BoltZ]**, 1.38064852E-23
  Boltzmann constant
- constant(s): **[R]**, 8.31446261815324
  Universal gas constant
- Measurement: **Weight** in Kilogram (kg)
  Weight Unit Conversion
- Measurement: **Temperature** in Kelvin (K)
  Temperature Unit Conversion
- Measurement: **Energy** in Joule (J)
  Energy Unit Conversion
- Measurement: **Angular Velocity** in Degree per Second (degree/s)
  Angular Velocity Unit Conversion
- Measurement: **Moment of Inertia** in Kilogram Square Meter (kg·m²)
  Moment of Inertia Unit Conversion
- Measurement: **Momentum** in Kilogram Meter per Second (kg*m/s)
  Momentum Unit Conversion
- Measurement: **Energy Per Mole** in Joule Per Mole (J/mol)
  Energy Per Mole Unit Conversion
- Measurement: **Compressibility** in Square Meter per Newton (m²/N)
  Compressibility Unit Conversion
- Measurement: **Molar Specific Heat Capacity at Constant Pressure** in Joule Per Kelvin Per Mole (J/K*mol)
  Molar Specific Heat Capacity at Constant Pressure Unit Conversion
- Measurement: **Molar Specific Heat Capacity at Constant Volume** in Joule Per Kelvin Per Mole (J/K*mol)
  Molar Specific Heat Capacity at Constant Volume Unit Conversion

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