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Basic Relationship of Thermodynamics Formulas

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List of 22 Basic Relationship of Thermodynamics Formulas

Basic Relationship of Thermodynamics

1) Absolute Pressure given Absolute Temperature

$$\text{fx } P_{\text{abs}} = \rho_{\text{gas}} \cdot R_{\text{specific}} \cdot T_{\text{Abs}}$$

[Open Calculator !\[\]\(a870788d6ed9b8fd294b7654a8c8526b_img.jpg\)](#)

$$\text{ex } 53688.52 \text{ Pa} = 1.02 \text{ kg/m}^3 \cdot 287 \text{ J/kg}^\circ\text{K} \cdot 183.4 \text{ K}$$

2) Absolute Temperature given Absolute Pressure

$$\text{fx } T_{\text{Abs}} = \frac{P_{\text{abs}}}{\rho_{\text{gas}} \cdot R_{\text{specific}}}$$

[Open Calculator !\[\]\(c50c8b7b2cc2cf9ff925edec0ee94c0d_img.jpg\)](#)

$$\text{ex } 183.3999 \text{ K} = \frac{53688.5 \text{ Pa}}{1.02 \text{ kg/m}^3 \cdot 287 \text{ J/kg}^\circ\text{K}}$$

3) Change in Internal Energy given Total Heat Supplied to Gas

$$\text{fx } \Delta U = H - w$$

[Open Calculator !\[\]\(f60b7a900783ac3fd531bfd9c111be6d_img.jpg\)](#)

$$\text{ex } 9400 \text{ J} = 39.4 \text{ KJ} - 30 \text{ KJ}$$



4) Constant for External Work Done in Adiabatic process Introducing Pressure

$$C = \left(\left(\frac{1}{w} \right) \cdot (P_1 \cdot v_1 - P_2 \cdot v_2) \right) + 1$$

[Open Calculator !\[\]\(cbe80b694ebd74fcfe136a095b608235_img.jpg\)](#)

ex

$$0.522667 = \left(\left(\frac{1}{30\text{KJ}} \right) \cdot (2.5\text{Bar} \cdot 1.64\text{m}^3/\text{kg} - 5.2\text{Bar} \cdot 0.816\text{m}^3/\text{kg}) \right) + 1$$

5) Continuity Equation for Compressible Fluids

$$A = \rho_f \cdot A_{cs} \cdot V_{Avg}$$

[Open Calculator !\[\]\(5361750c22c4e047a52f4eac1ec2d4cc_img.jpg\)](#)

$$991516.5 = 997\text{kg}/\text{m}^3 \cdot 13\text{m}^2 \cdot 76.5\text{m}/\text{s}$$

6) External Work Done by Gas given Total Heat Supplied

$$w = H - \Delta U$$

[Open Calculator !\[\]\(b792654f2cef9719eabeb6c5be00811e_img.jpg\)](#)

$$30\text{KJ} = 39.4\text{KJ} - 9400\text{J}$$

7) External Work Done by Gas in Adiabatic Process Introducing Pressure

$$w = \left(\frac{1}{C - 1} \right) \cdot (P_1 \cdot v_1 - P_2 \cdot v_2)$$

[Open Calculator !\[\]\(84f47badaad7772cd95667a7c387a639_img.jpg\)](#)

$$28.64\text{KJ} = \left(\frac{1}{0.5 - 1} \right) \cdot (2.5\text{Bar} \cdot 1.64\text{m}^3/\text{kg} - 5.2\text{Bar} \cdot 0.816\text{m}^3/\text{kg})$$



8) Gas Constant given Absolute Pressure

$$\text{fx } R_{\text{specific}} = \frac{P_{\text{abs}}}{\rho_{\text{gas}} \cdot T_{\text{Abs}}}$$

[Open Calculator !\[\]\(e78f798d4ea5c530c9db49e7d26e6b95_img.jpg\)](#)

$$\text{ex } 286.9999 \text{ J/kg} \cdot \text{K} = \frac{53688.5 \text{ Pa}}{1.02 \text{ kg/m}^3 \cdot 183.4 \text{ K}}$$

9) Kinetic Energy given Total Energy in Compressible Fluids

$$\text{fx } KE = E_{(\text{Total})} - (PE + E_p + E_m)$$

[Open Calculator !\[\]\(05be7c7a8995decd503647c99211f7c2_img.jpg\)](#)

$$\text{ex } 75 \text{ J} = 279 \text{ J} - (4 \text{ J} + 50 \text{ J} + 150 \text{ J})$$

10) Mass Density given Absolute Pressure

$$\text{fx } \rho_{\text{gas}} = \frac{P_{\text{abs}}}{R_{\text{specific}} \cdot T_{\text{Abs}}}$$

[Open Calculator !\[\]\(fe3aebe81acea8d45108cd2768939da7_img.jpg\)](#)

$$\text{ex } 1.02 \text{ kg/m}^3 = \frac{53688.5 \text{ Pa}}{287 \text{ J/kg} \cdot \text{K} \cdot 183.4 \text{ K}}$$

11) Molecular Energy given Total Energy in Compressible Fluids

$$\text{fx } E_m = E_{(\text{Total})} - (KE + PE + E_p)$$

[Open Calculator !\[\]\(899d8b7697d64725bf017d3296cfcf1b_img.jpg\)](#)

$$\text{ex } 150 \text{ J} = 279 \text{ J} - (75 \text{ J} + 4 \text{ J} + 50 \text{ J})$$

12) Potential Energy given Total Energy in Compressible Fluids

$$\text{fx } PE = E_{(\text{Total})} - (KE + E_p + E_m)$$

[Open Calculator !\[\]\(40770d9ed6ed4f1222ebf89a1396e8b2_img.jpg\)](#)

$$\text{ex } 4 \text{ J} = 279 \text{ J} - (75 \text{ J} + 50 \text{ J} + 150 \text{ J})$$



13) Pressure Energy given Total Energy in Compressible Fluids

$$\text{fx } E_p = E_{(\text{Total})} - (\text{KE} + \text{PE} + E_m)$$

[Open Calculator !\[\]\(e2376d476d06eb31946dc01a69a4403a_img.jpg\)](#)

$$\text{ex } 50\text{J} = 279\text{J} - (75\text{J} + 4\text{J} + 150\text{J})$$

14) Pressure for External Work Done by Gas in Adiabatic Process Introducing Pressure

$$\text{fx } P_2 = - \frac{(w \cdot (C - 1)) - (P_1 \cdot v_1)}{v_2}$$

[Open Calculator !\[\]\(0b5e7e25e8775f7e7e80906ada4f0021_img.jpg\)](#)

$$\text{ex } 5.208333\text{Bar} = - \frac{(30\text{KJ} \cdot (0.5 - 1)) - (2.5\text{Bar} \cdot 1.64\text{m}^3/\text{kg})}{0.816\text{m}^3/\text{kg}}$$

15) Pressure given Constant

$$\text{fx } p_c = \frac{R_a}{v}$$

[Open Calculator !\[\]\(bd3b31712ad9bab5a241210fa6925cdd_img.jpg\)](#)

$$\text{ex } 0.049727\text{Pa} = \frac{5.47\text{e-}1\text{J/kg}^*\text{K}}{11\text{m}^3/\text{kg}}$$

16) Specific Volume for External Work Done in Adiabatic Process Introducing Pressure

$$\text{fx } v_1 = \frac{(w \cdot (C - 1)) + (P_2 \cdot v_2)}{P_1}$$

[Open Calculator !\[\]\(7bc43b319a082987e20f7bf78f4bab80_img.jpg\)](#)

$$\text{ex } 1.63728\text{m}^3/\text{kg} = \frac{(30\text{KJ} \cdot (0.5 - 1)) + (5.2\text{Bar} \cdot 0.816\text{m}^3/\text{kg})}{2.5\text{Bar}}$$



17) Total Energy in Compressible Fluids

$$\text{fx } E_{(\text{Total})} = KE + PE + E_p + E_m$$

[Open Calculator !\[\]\(d3fb9f94af8b26d1c844efa9a98805b0_img.jpg\)](#)

$$\text{ex } 279\text{J} = 75\text{J} + 4\text{J} + 50\text{J} + 150\text{J}$$

18) Total Heat Supplied to Gas

$$\text{fx } H = \Delta U + w$$

[Open Calculator !\[\]\(e1d6102fe77919492c04879c8450f1f5_img.jpg\)](#)

$$\text{ex } 39.4\text{KJ} = 9400\text{J} + 30\text{KJ}$$

Boyle's law

19) Boyle's Law According to Adiabatic Process

$$\text{fx } R_a = p_c \cdot (v^C)$$

[Open Calculator !\[\]\(104fbf564e2e5a8fbd84f31656d114c7_img.jpg\)](#)

$$\text{ex } 198.9975\text{J/kg}\cdot\text{K} = 60\text{Pa} \cdot \left((11\text{m}^3/\text{kg})^{0.5}\right)$$

20) Boyle's Law According to Isothermal Process

$$\text{fx } R_a = p_c \cdot v$$

[Open Calculator !\[\]\(21226b58c700e5231ab98d27101bac58_img.jpg\)](#)

$$\text{ex } 660\text{J/kg}\cdot\text{K} = 60\text{Pa} \cdot 11\text{m}^3/\text{kg}$$

21) Boyle's Law given Mass Density

$$\text{fx } R_a = \frac{p_c}{\rho_f^C}$$

[Open Calculator !\[\]\(6befd466863f06afb75445d91429f055_img.jpg\)](#)

$$\text{ex } 1.900219\text{J/kg}\cdot\text{K} = \frac{60\text{Pa}}{(997\text{kg}/\text{m}^3)^{0.5}}$$



22) Boyle's Law given Weight Density in Adiabatic Process

fx $R_a = \frac{p_c}{\omega C}$

Open Calculator 

ex $0.268328 \text{ J/kg} \cdot \text{K} = \frac{60 \text{ Pa}}{(0.05 \text{ g/mm}^3)^{0.5}}$



Variables Used

- **A** Constant A1
- **A_{CS}** Cross-Sectional Area of Flow Channel (Square Meter)
- **C** Heat Capacity Ratio
- **E_(Total)** Total Energy in Compressible Fluids (Joule)
- **E_m** Molecular Energy (Joule)
- **E_p** Pressure Energy (Joule)
- **H** Total Heat (Kilojoule)
- **KE** Kinetic Energy (Joule)
- **P₁** Pressure 1 (Bar)
- **P₂** Pressure 2 (Bar)
- **P_{abs}** Absolute Pressure by Fluid Density (Pascal)
- **p_c** Pressure of Compressible Flow (Pascal)
- **PE** Potential Energy (Joule)
- **R_a** Gas Constant a (Joule per Kilogram K)
- **R_{specific}** Ideal Gas Constant (Joule per Kilogram K)
- **T_{Abs}** Absolute Temperature of Compressible Fluid (Kelvin)
- **v** Specific Volume (Cubic Meter per Kilogram)
- **v₁** Specific Volume for Point 1 (Cubic Meter per Kilogram)
- **v₂** Specific Volume for Point 2 (Cubic Meter per Kilogram)
- **V_{Avg}** Average Velocity (Meter per Second)
- **w** Work Done (Kilojoule)
- **ΔU** Change in Internal Energy (Joule)
- **ρ_f** Mass Density of Fluid (Kilogram per Cubic Meter)



- ρ_{gas} Mass Density of Gas (Kilogram per Cubic Meter)
- ω Weight Density (Gram per Cubic Millimeter)



Constants, Functions, Measurements used

- **Measurement: Temperature** in Kelvin (K)
Temperature Unit Conversion 
- **Measurement: Area** in Square Meter (m^2)
Area Unit Conversion 
- **Measurement: Pressure** in Pascal (Pa), Bar (Bar)
Pressure Unit Conversion 
- **Measurement: Speed** in Meter per Second (m/s)
Speed Unit Conversion 
- **Measurement: Energy** in Joule (J), Kilojoule (KJ)
Energy Unit Conversion 
- **Measurement: Mass Concentration** in Kilogram per Cubic Meter (kg/m^3)
Mass Concentration Unit Conversion 
- **Measurement: Density** in Gram per Cubic Millimeter (g/mm^3)
Density Unit Conversion 
- **Measurement: Specific Volume** in Cubic Meter per Kilogram (m^3/kg)
Specific Volume Unit Conversion 
- **Measurement: Specific Entropy** in Joule per Kilogram K ($\text{J}/\text{kg}\cdot\text{K}$)
Specific Entropy Unit Conversion 



Check other formula lists

- **Basic Relationship of Thermodynamics Formulas** 

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