

Thermodynamics Formulas

Name	Formula	
1 st Law of Thermodynamics	$\Delta E_{\text{universe}} = \Delta E_{\text{system}} + \Delta E_{\text{surroundings}}$	Energy cannot be created nor destroyed – only change forms.
2 nd Law of Thermodynamics	$\Delta S_{\text{universe}} = \Delta S_{\text{sys}} + \Delta S_{\text{sur}} \geq 0$	Entropy of the universe is always increasing.
3 rd Law of Thermodynamics	$S = K_B \ln W = K_B \ln(1) = 0$	S of a pure crystal at 0K, is 0 J/mol·K
Enthalpy	$\Delta H = q$	Enthalpy, ΔH , is the measure of heat energy in a system at constant pressure.
Standard Enthalpy	$\Delta H^{\circ} = \sum \Delta H^{\circ}_{f, \text{products}} + \sum \Delta H^{\circ}_{f, \text{reactants}}$	Enthalpy change when one mole of a substance is made from its elements in standard conditions. (Enthalpy Change of Formation)
Entropy	$\Delta S = \frac{q_{\text{reversible}}}{T}$	Entropy, ΔS , is the measure of disorder in a system. A higher entropy = A greater amount of disorder. Solids < Liquids < Gases.
	$\Delta S_{\text{surroundings}} = - \frac{\Delta H_{\text{system}}}{T}$	
Standard Entropy	$\Delta S^{\circ} = \sum \Delta S^{\circ}_{\text{products}} + \sum \Delta S^{\circ}_{\text{reactants}}$	(Standard Molar Entropies)
Gibb's Free Energy	$\Delta G = \sum \Delta G_{\text{products}} + \sum \Delta G_{\text{reactants}}$	Used to to predict whether a process will occur spontaneously at a constant temperature and pressure.
	$\Delta G = \Delta H - T \Delta S$	
	$\Delta G = \Delta G^{\circ} + RT \cdot \ln(Q)$	Q = Reaction Quotient R = 8.3145 J/mol·K
Standard Free Energy	$\Delta G^{\circ} = \sum \Delta G^{\circ}_{f, \text{products}} + \sum \Delta G^{\circ}_{f, \text{reactants}}$	
Specific Heat Capacity, c	$q = mc \Delta T$	The amount of heat energy needed to raise the temperature of 1 gram of a substance by 1°C. Used in "coffee-cup" calorimetry. m = mass in grams. (Specific Heat Capacities)
Heat Capacity, C	$q = C \Delta T$	The amount of energy required to raise the temperature of a substance by 1°C. Used in "bomb" calorimetry.

Thermodynamics Equations Cheat Sheet

Josiah Willard Gibbs



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Basic Statistical Mechanics Peeter Joot, This document is based on my lecture notes for the Winter 2013 University of Toronto Basic Statistical Mechanics course PHY452H1S taught by Prof Arun Paramekanti Official course description Classical and quantum statistical mechanics of noninteracting systems the statistical basis of thermodynamics ensembles partition function thermodynamic equilibrium stability and fluctuations formulation of quantum statistics theory of simple gases ideal Bose and Fermi systems This document contains Plain old lecture notes These mirror what was covered in class possibly augmented with additional details Personal notes exploring details that were not clear to me from the lectures or from the texts associated with the lecture material Assigned problems two problem sets Some worked problems attempted as course prep for fun or for test preparation or post test reflection Links to Mathematica workbooks associated with these notes

Physics I Workbook For Dummies Steven Holzner, 2014-03-31 Unleash your inner Einstein and score higher in physics Do you have a handle on basic physics terms and concepts but your problem solving skills could use some static friction Physics I Workbook For Dummies helps you build upon what you already know to learn how to solve the most common physics problems with confidence and ease Physics I Workbook For Dummies gets the ball rolling with a brief overview of the nuts and bolts of physics i e converting measure counting signification figures applying math skills to physics problems etc before getting in the nitty gritty If you re already a pro you can skip this section and jump right into the practice problems There you ll get the lowdown on how to take your problem solving skills to a whole new plane without ever feeling like you ve been left spiraling down a black hole Easy to follow instructions and practical tips Complete answer explanations are included so you can see where you went wrong or right Covers the ten most common mistakes people make when solving practice physics problems When push comes to shove this friendly guide is just what you need to set your physics problem solving skills in motion

Physics I For Dummies Steven Holzner, 2016-05-17 The fun and easy way to get up to speed on the basic concepts of physics For high school and undergraduate students alike physics classes are recommended or required courses for a wide variety of majors and continue to be a challenging and often confusing course Physics I For Dummies tracks specifically to an introductory course and keeping with the traditionally easy to follow Dummies style teaches you the basic principles and formulas in a clear and concise manner proving that you don t have to be Einstein to understand physics Explains the basic principles in a simple clear and entertaining fashion New edition includes updated examples and explanations as well as the newest discoveries in the field Contains the newest teaching techniques If just thinking about the laws of physics makes your head spin this hands on friendly guide gets you out of the black hole and sheds light on this often intimidating subject *Bulletin of the Atomic Scientists*, 1970-12 The Bulletin of the Atomic Scientists is the premier public resource on scientific and technological developments that impact global security Founded by Manhattan Project Scientists the Bulletin s iconic Doomsday Clock stimulates solutions for a safer world *Petroleum*

Abstracts, 1969 **A Condensed Collection of Thermodynamic Formulas** Percy Williams Bridgman, 1925 **Physics - Thermodynamics** Brett Kraabel, 2019-05 For this challenging area of Physics get the answers you need at your fingertips faster than any other source Success in Physics is critical when entering the growing fields of technology computer science and engineering that will support our future progress and innovation with breakthroughs and advances To help retain the facts equations and concepts essential to success in class and beyond these 6 laminated pages can be referenced quickly and easily while studying as a refresher before exams or even as a desktop reference beyond school Expertly written by author editor and professor Brett Kaabel PhD and designed for quick use and high retention Be sure to get our original Physics guide and Physics 2 for more complete coverage and better grades for an unmatched value 6 page laminated guide includes Introduction Conventions Extensive vs Intensive Properties Moles Thermal Energy Temperature Definitions Temperature Scales Laws of Thermodynamics Zeroth Law of Thermodynamics First Law of Thermodynamics Second Law of Thermodynamics Thermodynamic Potentials Fundamental Thermodynamic Relationships Maxwell Relations Thermal Properties of Systems Linear Expansion Volume Expansion Heat Capacity Phases Phase Diagram Change of Phase Kinetic Theory of Gasses Kinetic Theory of Ideal Gas Equation of State for Ideal Gas Van der Waals Equation of State Equations of the State of Liquids Transfer of Thermal Energy Conduction Convection Evaporation Radiation Thermodynamic Processes Change in Internal Energy for Any Ideal Gas Process Change in Entropy for Any Ideal Gas Process Constrained Ideal Gas Processes Heat Engines **Essential Engineering Thermodynamics** Yumin Zhang, 2018-09-19 Engineering Thermodynamics is a core course for students majoring in Mechanical and Aerospace Engineering Before taking this course students usually have learned Engineering Mechanics Statics and Dynamics and they are used to solving problems with calculus and differential equations Unfortunately these approaches do not apply for Thermodynamics Instead they have to rely on many data tables and graphs to solve problems In addition many concepts are hard to understand such as entropy Therefore most students feel very frustrated while taking this course The key concept in Engineering Thermodynamics is state properties If one knows two properties the state can be determined as well as the other four properties Unlike most textbooks the first two chapters of this book introduce thermodynamic properties and laws with the ideal gas model where equations can be engaged In this way students can employ their familiar approaches and thus can understand them much better In order to help students understand entropy in depth interpretation with statistical physics is introduced Chapters 3 and 4 discuss control mass and control volume processes with general fluids where the data tables are used to solve problems Chapter 5 covers a few advanced topics which can also help students understand the concepts in thermodynamics from a broader perspective **Chemical Thermodynamics** Leo Lue, 2009 Thermodynamics U. Kivi, 2020-06-02 The basic theory of thermodynamics is treated in the book using ideal gas as an example A clear explanation for the quantity entropy is given in the book Analytic formulas for the mutual functional dependence of the quantities volume pressure

temperature and entropy are given in the book in the case of an ideal gas A thorough treatment of ideal gas thermodynamic processes is presented in the book In a process two quantities are given as functions of time and other quantities are calculated as functions of time I hope that the thorough treatment helps especially those people for example students who take their first steps in learning thermodynamics The book includes a list of a computer program that calculates basic thermodynamic processes for an ideal gas An example calculation for every process is presented in the book input file is given and the result is presented as curves Every curve is given a thorough description *Thermodynamics and Chemistry*, by F. H. MacDougall Frank Henry Macdougall,1921

Equations for Calculating the Thermodynamic Properties of Fluids, Including Those in the Two-phase Region, from an Empirical Equation of State Robert E. Barieau,1967

Thermodynamics and Chemistry Frank Henry MacDougall,1921 **Methods of Thermodynamics** Howard Reiss,1996-01-01 Outstanding text focuses on physical technique of thermodynamics typical problems and significance and use of thermodynamic potential Mathematical apparatus first law of thermodynamics second law and entropy more 1965 edition **Thermodynamics: Principles And Applications (Second Edition)** Ismail Tosun,2020-02-18 This method of teaching really helps the reader to understand these sometimes difficult concepts of thermodynamics especially with concepts such as Gibbs free energy enthalpy and entropy anyone who wants to either learn about thermodynamics or get a very good refresher will find this book to be one of the best at explaining these abstract concepts IEEE Electrical Insulation Magazine Thermodynamics is considered the core engineering course in many engineering disciplines Since the laws of thermodynamics are expressed in abstract terms it is the one of the most challenging courses encountered by students during their undergraduate education This eminent compendium provides a firm grasp of the abstract concepts and shows how to apply these concepts to solve practical problems with numerous clear examples Answers to all problems are provided Four additional chapters are illuminated to show students how to deal with the thermodynamic problems involving nonideal pure substances as well as multicomponent mixtures The concepts are highlighted with utmost clarity in simple language Mathcad worksheets are provided in problems dealing with the cubic equations of state This readable reference text is useful to researchers academics professionals undergraduate and graduate students in chemical engineering mechanical engineering and energy studies **Notes on Thermodynamics** Henry Wilson Spangler,1908 [Chemical](#)

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thermodynamics is the study of the interrelation of heat and work with chemical reactions or with physical changes of state within the confines of the laws of thermodynamics Chemical thermodynamics involves not only laboratory measurements of various thermodynamic properties but also the application of mathematical methods to the study of chemical questions and the spontaneity of processes The structure of chemical thermodynamics is based on the first two laws of thermodynamics Starting from the first and second laws of thermodynamics four equations called the fundamental equations of Gibbs can be derived From these four a multitude of equations relating the thermodynamic properties of the thermodynamic system can be derived using relatively simple mathematics This outlines the mathematical framework of chemical thermodynamics J Willard Gibbs founder of chemical thermodynamics In 1865 the German physicist Rudolf Clausius in his Mechanical Theory of Heat suggested that the principles of thermochemistry e g the heat evolved in combustion reactions could be applied to the principles of thermodynamics Building on the work of Clausius between the years 1873 76 the American mathematical physicist Willard Gibbs published a series of three papers the most famous *Fundamental laws of thermodynamics, theory of gases* Gustav Zeuner, 1906 **The Chart of Equations Used in Peabody's Thermodynamics** Gilbert Amos Young, Cecil Hobart Peabody, 1915 Thermodynamics Josiah Willard Gibbs, 1906

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