

Physics

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(Chapter 11) (Thermodynamics) (Exercises) (Class 11)

Question 11.1:

A geyser heats water flowing at the rate of 3.0 litres per minute from 27 °C to 77 °C. If the geyser operates on a gas burner, what is the rate of consumption of the fuel if its heat of combustion is 4.0×10^4 J/g?

Answer 11.1:

Water is flowing at a rate of 3.0 litre/min.

The geyser heats the water, raising the temperature from 27°C to 77°C.

Initial temperature, $T_1 = 27^\circ\text{C}$ and Final temperature, $T_2 = 77^\circ\text{C}$

Rise in temperature, $\Delta T = T_2 - T_1 = 77 - 27 = 50^\circ\text{C}$

Heat of combustion = 4×10^4 J/g

Specific heat of water, $c = 4.2 \text{ J g}^{-1} \text{ }^\circ\text{C}^{-1}$

Mass of flowing water, $m = 3.0 \text{ litre/min} = 3000 \text{ g/min}$

Total heat used, $\Delta Q = mc \Delta T = 3000 \times 4.2 \times 50 = 6.3 \times 10^5 \text{ J/min}$

\therefore Rate of consumption = $\frac{6.3 \times 10^5}{4 \times 10^4} = 15.75 \text{ g/min}$

Question 11.2:

What amount of heat must be supplied to 2.0×10^{-2} kg of nitrogen (at room temperature) to raise its temperature by 45 °C at constant pressure? (Molecular mass of $\text{N}_2 = 28$; $R = 8.3 \text{ J mol}^{-1} \text{ K}^{-1}$.)

Answer 11.2:

Mass of nitrogen, $m = 2.0 \times 10^{-2} \text{ kg} = 20 \text{ g}$ and Rise in temperature, $\Delta T = 45^\circ\text{C}$

Molecular mass of N_2 , $M = 28$

Universal gas constant, $R = 8.3 \text{ J mol}^{-1} \text{ K}^{-1}$

Number of moles, $n = \frac{m}{M} = \frac{2.0 \times 10^{-2} \times 10^3}{28} = 0.714$

Molar specific heat at constant pressure for nitrogen $C_p = \frac{7}{2}R = \frac{7}{2} \times 8.3 = 29.05 \text{ J mol}^{-1} \text{ K}^{-1}$

The total amount of heat to be supplied is given by the relation: $\Delta Q = nC_p \Delta T$

$= 0.714 \times 29.05 \times 45 = 933.38 \text{ J}$

Therefore, the amount of heat to be supplied is 933.38 J.

Question 11.3:

Explain why

- Two bodies at different temperatures T_1 and T_2 if brought in thermal contact do not necessarily settle to the mean temperature $(T_1 + T_2)/2$.
- The coolant in a chemical or a nuclear plant (i.e., the liquid used to prevent the different parts of a plant from getting too hot) should have high specific heat.
- Air pressure in a car tyre increases during driving.
- The climate of a harbour town is more temperate than that of a town in a desert at the same latitude.

Answer 11.3:

- When two bodies at different temperatures T_1 and T_2 are brought in thermal contact, heat flows from the body at the higher temperature to the body at the lower temperature till equilibrium is achieved, i.e., the temperatures of both the bodies become equal. The equilibrium temperature is equal to the mean temperature $(T_1 + T_2)/2$ only when the thermal capacities of both the bodies are equal.

Chapter 1 Solutions Thermodynamics

David Kirk



Chapter 1 Solutions Thermodynamics:

Handbook of Polymer Solution Thermodynamics Ronald P. Danner, Martin S. High, 2010-09-14 Created for engineers and students working with pure polymers and polymer solutions this handbook provides up to date easy to use methods to obtain specific volumes and phase equilibrium data A comprehensive database for the phase equilibria of a wide range of polymer solvent systems and PVT behavior of pure polymers are given as are accurate predictive techniques using group contributions and readily available pure component data Two computer programs on diskettes are included POLYPROG implements procedures given for prediction and correlation for specific volume of pure polymer liquids and calculation of vapor liquid equilibria VLE of polymer solutions POLYDATA provides an easy method of accessing the data contained in the many databases in the book Both disks require a computer with a math coprocessor This handbook is a valuable resource in the design and operation of many polymer processes such as polymerization devolatilization drying extrusion and heat exchange Special Details Hardcover with Disks Special offer Purchase this book along with X 131 Handbook of Diffusion and Thermal Properties of Polymers and Polymer Solutions and receive a 20 percent discount off the list or member price *The Physical Chemistry of Biopolymer Solutions* Robert F. Steiner, Louise Garone, 1991 The book is concerned with the application of physical techniques to the study of the structure and interactions of biopolymers The treatment is confined to those procedures applicable to solutions The material has been tested on students in actual classes thereby permitting the elimination of ambiguities and potential points of difficulty Stress has been placed upon lucidity of treatment and difficult steps in derivations have been explained The mathematical exposition has been made as clear and simple as feasible Examples of actual data are given *Thermodynamics of Solutions* Eli Ruckenstein, Ivan L. Shulgin, 2009-06-17 This book consists of a number of papers regarding the thermodynamics and structure of multicomponent systems that we have published during the last decade Even though they involve different topics and different systems they have something in common which can be considered as the signature of the present book First these papers are concerned with difficult or very nonideal systems i e systems with very strong interactions e g hydrogen bonding between components or systems with large differences in the partial molar volumes of the components e g the aqueous solutions of proteins or systems that are far from normal conditions e g critical or near critical mixtures Second the conventional thermodynamic methods are not sufficient for the accurate treatment of these mixtures Last but not least these systems are of interest for the pharmaceutical biomedical and related industries In order to meet the thermodynamic challenges involved in these complex mixtures we employed a variety of traditional methods but also new methods such as the fluctuation theory of Kirkwood and Buff and ab initio quantum mechanical techniques The Kirkwood Buff KB theory is a rigorous formalism which is free of any of the approximations usually used in the thermodynamic treatment of multicomponent systems This theory appears to be very fruitful when applied to the above mentioned difficult systems **CRC Handbook of Phase Equilibria and Thermodynamic Data of Copolymer**

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Structure and Thermodynamics of a Divalent Metal Ion Binding Site in an RNA Pseudoknot Ruben Leonardo Gonzalez, 2000 **CRC Handbook of Thermodynamic Data of Polymer Solutions, Three Volume Set** Christian Wohlfarth, 2018-10-03 Providing valuable insight on physical behavior of polymer solutions intermolecular interactions and the molecular nature of mixtures each volume in this one of a kind handbook brings together reliable easy to use entries references tables examples and appendices on experimental data from hundreds of primary journal articles dissertations and other published papers This three volume set presents hundreds of data sets including VLE gas solubility isotherms LLE and HPPE for polymer systems in supercritical fluids as well as volumetric enthalpic and virial coefficient data sets essential for handling industrial and laboratory processes involving all types of polymer systems **CRC Handbook of Thermodynamic**

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Chemical Thermodynamics: Advanced Applications J. Bevan Ott, Juliana Boerio-Goates, 2000-06-16 This book is an excellent companion to *Chemical Thermodynamics Principles and Applications* Together they make a complete reference set for the practicing scientist This volume extends the range of topics and applications to ones that are not usually covered in a beginning thermodynamics text In a sense the book covers a middle ground between the basic principles developed in a beginning thermodynamics textbook and the very specialized applications that are a part of an ongoing research project As

such it could prove invaluable to the practicing scientist who needs to apply thermodynamic relationships to aid in the understanding of the chemical process under consideration The writing style in this volume remains informal but more technical than in Principles and Applications It starts with Chapter 11 which summarizes the thermodynamic relationships developed in this earlier volume For those who want or need more detail references are given to the sections in Principles and Applications where one could go to learn more about the development limitations and conditions where these equations apply This is the only place where Advanced Applications ties back to the previous volume Chapter 11 can serve as a review of the fundamental thermodynamic equations that are necessary for the more sophisticated applications described in the remainder of this book This may be all that is necessary for the practicing scientist who has been away from the field for some time and needs some review The remainder of this book applies thermodynamics to the description of a variety of problems The topics covered are those that are probably of the most fundamental and broadest interest Throughout the book examples of real systems are used as much as possible This is in contrast to many books where generic examples are used almost exclusively A complete set of references to all sources of data and to supplementary reading sources is included Problems are given at the end of each chapter This makes the book ideally suited for use as a textbook in an advanced topics course in chemical thermodynamics An excellent review of thermodynamic principles and mathematical relationships along with references to the relevant sections in Principles and Applications where these equations are developed Applications of thermodynamics in a wide variety of chemical processes including phase equilibria chemical equilibrium properties of mixtures and surface chemistry Case study approach to demonstrate the application of thermodynamics to biochemical geochemical and industrial processes Applications at the cutting edge of thermodynamics Examples and problems to assist in learning Includes a complete set of references to all literature sources

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