

Since the satellite has a surface area $4\pi r^2$ and a uniform temperature T it must radiate power

$$4\pi r^2 \sigma T^4 \epsilon.$$

At equilibrium the absorbed and radiated powers must be equal, so

$$r^2 \Omega \sigma T_s^4 \epsilon = 4\pi r^2 \sigma T^4 \epsilon,$$

which can be rearranged to give

$$T = T_s \left(\frac{\Omega}{4\pi} \right)^{1/4}.$$

- Taking $\Omega = 7 \times 10^{-5}$ sr and $T_s = 5800$ K gives $T = 280$ K.

[This problem gives a simplified understanding of the Earth's mean temperature, since the Sun subtends a mean solid angle of 6.80×10^{-5} sr at the Earth.]

Problem 172

A frictionless piston of mass m is a precise fit in the vertical cylindrical neck of a large container of volume V . The container is filled with a gas and there is a vacuum above the piston. The cross-sectional area of the neck is A .

(i) Calculate the pressure of the gas in the container when the piston is in equilibrium.

(ii) Assuming that the pressure and volume of the gas are related by Boyle's law, calculate the restoring force on the piston when it is displaced by a small distance x .

(iii) Assuming that the motion of the piston is slow enough for Boyle's law to be valid, obtain the differential equation for small displacements of the piston about its equilibrium position.

(iv) Show that the angular frequency of oscillation ω is independent of m .

(v) Calculate ω for $V = 2000$ litres and $A = 1.0 \times 10^{-4}$ m².

Solution

- (i) The weight of the piston is mg , and this must be balanced by the upward force pA exerted by the gas pressure, so $p = mg/A$.
 (ii) Boyle's law states that pV is constant at constant temperature.

Thermodynamic Example Problems

Kavati Venkateswarlu



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Thermodynamics Problem Solving in Physical Chemistry Kathleen E. Murphy, 2020-03-23 Thermodynamics Problem Solving in Physical Chemistry Study Guide and Map is an innovative and unique workbook that guides physical chemistry students through the decision making process to assess a problem situation create appropriate solutions and gain confidence through practice solving physical chemistry problems The workbook includes six major sections with 20 30 solved problems in each section that span from easy single objective questions to difficult multistep analysis problems Each section of the workbook contains key points that highlight major features of the topic to remind students of what they need to apply to solve problems in the topic area Key Features Provides instructor access to a visual map depicting how all equations used in thermodynamics are connected and how they are derived from the three major energy laws Acts as a guide in deriving the correct solution to a problem Illustrates the questions students should ask themselves about the critical features of the concepts to solve problems in physical chemistry Can be used as a stand alone product for review of Thermodynamics questions for major tests Thermodynamics 1 With No Calculations Edenilson Brandl, Have you ever wanted to

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Engineering Thermodynamics D.C. Look, G. Alexander, 2012-12-06 Energy its discovery its availability its use concerns all of us in general and the engineers of today and

tomorrow in particular The study of thermodynamics the science of energy is a critical element in the education of all types of engineers Engineering Thermodynamics provides a thorough introduction to the art and science of engineering thermodynamics It describes in a straightforward fashion the basic tools necessary to obtain quantitative solutions to common engineering applications involving energy and its conversion conservation and transfer This book is directed toward sophomore junior and senior students who have studied elementary physics and calculus and who are majoring in mechanical engineering it serves as a convenient reference for other engineering disciplines as well The first part of the book is devoted to basic thermodynamic principles essentially presented in the classic way the second part applies these principles to many situations including air conditioning and the interpretation of statistical phenomena **Engineering Thermodynamics**

Kavati Venkateswarlu, 2020-12-10 This textbook comprehensively covers the fundamentals and advanced concepts of thermodynamics in a single volume It provides a detailed discussion of advanced concepts that include energy efficiency energy sustainability energy security organic Rankine cycle combined cycle power plants combined cycle power plant integrated with organic Rankine cycle and absorption refrigeration system integrated coal gasification combined cycle power plants energy conservation in domestic refrigerators and next generation low global warming potential refrigerants Pedagogical features include solved problems and unsolved exercises interspersed throughout the text for better understanding This textbook is primarily written for senior undergraduate students in the fields of mechanical automobile chemical civil and aerospace engineering for courses on engineering thermodynamics thermodynamics and for graduate students in thermal engineering and energy engineering for courses on advanced thermodynamics It is accompanied by teaching resources including a solutions manual for instructors FEATURES Provides design and experimental problems for better understanding Comprehensively discusses power cycles and refrigeration cycles and their advancements Explores the design of energy efficient buildings to reduce energy consumption Property tables charts and multiple choice questions comprise appendices of the book and are available at <https://www.routledge.com/9780367646288> **Advanced**

Thermodynamics Engineering Kalyan Annamalai, Ishwar K. Puri, Milind A. Jog, 2011-03-22 Advanced Thermodynamics Engineering Second Edition is designed for readers who need to understand and apply the engineering physics of thermodynamic concepts It employs a self teaching format that reinforces presentation of critical concepts mathematical relationships and equations with concrete physical examples and explanations of application *Thermodynamics and Energy Conversion* Henning Struchtrup, 2024-06-27 This comprehensive textbook covers engineering thermodynamics from beginner to advanced level The presentation is concise with material for about three full term university courses on 700 pages without compromising breadth or depth First and second law of thermodynamics are developed from everyday observations with accessible and rational arguments The laws of thermodynamics are applied to a multitude of systems and processes from simple equilibration processes over steam and gas power cycles refrigerators and heat pumps to chemical

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thermodynamics and the connection between statistical concepts and observable macroscopic properties of a thermodynamic system Chapter 1 discusses the first law of thermodynamics while Chapters 2 through 4 deal with statistical concepts The succeeding chapters describe the link between entropy and the reversible heat process concept of entropy the second law of thermodynamics Legendre transformations and Jacobian algebra Finally Chapter 10 provides an introduction to irreversible thermodynamics This book will be useful as an introductory text to thermodynamics for engineering students

Practical Chemical Thermodynamics for Geoscientists Bruce Fegley, Rose Osborne, 2013 Presents brief historical summaries and biographies of key thermodynamics scientists alongside the fundamentals they were responsible for

Extended Irreversible Thermodynamics D. Jou, J. Casas-Vazquez, G. Lebon, 2011-06-27 Covers a wide spectrum of applications and contains a wide discussion of the foundations and the scope of the most current theories of non equilibrium thermodynamics The new edition reflects new developments and contains a new chapter on the interplay between hydrodynamics and thermodynamics

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