22.9 A pump with a shaft input of 7.5 kW and an efficiency of 70 percent is connected in a water line carrying 0.1 m³/s. The pump has a 150-mm-diameter suction line and a 120-mm-diameter discharge line. The suction line enters the pump 1 m below the discharge line. For a suction pressure of 70 kN/m², calculate the pressure at the discharge flange and the rise in the hydraulic grade line across the pump.

■ The energy added per unit weight of water, E, is given by $Q\gamma E = 7500(0.70)$, or $E = 7500(0.7)/[0.1(9806)] = 5.354$ m. Applying the energy equation from suction flange to discharge flange gives $(V_s^2/2g) + (p_s/\gamma) + 0 + 5.354 = (V_d^2/2g) + (p_d/\gamma) + 1$ in which the subscripts s and d refer to the suction and discharge conditions, respectively. From the continuity equation, $V_s = 0.1(4)/(0.15^2\pi) = 5.66$ m/s, $V_d = 0.1(4)/(0.12^2\pi) = 8.84$ m/s. Solving for p_d gives $p_d/\gamma = [5.66^2/2(9.806)] + (70\,000/9806) + 5.354 - [8.84^2/2(9.806)] - 1 = 9.141$ m and $p_d = 89.6$ kPa. The rise in hydraulic grade line is $[(p_d/\gamma) + 1] - (p_s/\gamma) = 9.141 + 1 - (70\,000/9806) = 3.002$ m.

22.10 Sketch the hydraulic and energy grade lines for Fig. 22-9a ($H = 10$ m).

■ $$p_1/\gamma + V_1^2/2g + z_1 = p_2/\gamma + V_2^2/2g + z_2 + h_L \qquad h_L = h_f + h_m \qquad h_f = (f)(L/D)(V^2/2g)$$

$(\epsilon/D)_1 = 0.000046/0.150 = 0.000307$; try $f_1 = 0.015$. $(\epsilon/D)_2 = 0.000046/0.300 = 0.000153$; try $f_2 = 0.015$.

$$h_f = (0.015)[25/0.150]\{V_1^2/[(2)(9.807)]\} + (0.015)[(20+8)/0.300]\{(V_1/4)^2/[(2)(9.807)]\} = 0.1319V_1^2$$

$$h_m = KV^2/2g = [1 + (1 - \tfrac{1}{4})^2 + 3.5/16 + \tfrac{1}{16}]\{V_1^2/[(2)(9.807)]\} = 0.09400V_1^2$$

$$h_L = 0.1319V_1^2 + 0.09400V_1^2 = 0.2259V_1^2 \qquad 0 + 0 + 10 = 0 + 0 + 0 + 0.2259V_1^2 \qquad V_1 = 6.653 \text{ m/s}$$

$$V_1^2/2g = 6.653^2/[(2)(9.807)] = 2.257 \text{ m} \qquad V_2 = 6.653/4 = 1.663 \text{ m/s} \qquad V_2^2/2g = 1.663^2/[(2)(9.807)] = 0.141 \text{ m}$$

Friction losses are $(f_1)(L/D)(v_1^2/2g) = 5.642$ m, $(f_2)(L/D)(v_2^2/2g) = 0.197$ m. Minor losses are $(V_1 - V_2)^2/2g = 1.270$ m, $3.5V_2^2/2g = 0.494$ m. The hydraulic and energy grade lines are sketched in Fig. 22-9b. [Further checking (not shown) of the Reynolds number indicates that the assumed values of f_1 and f_2 are acceptable.]
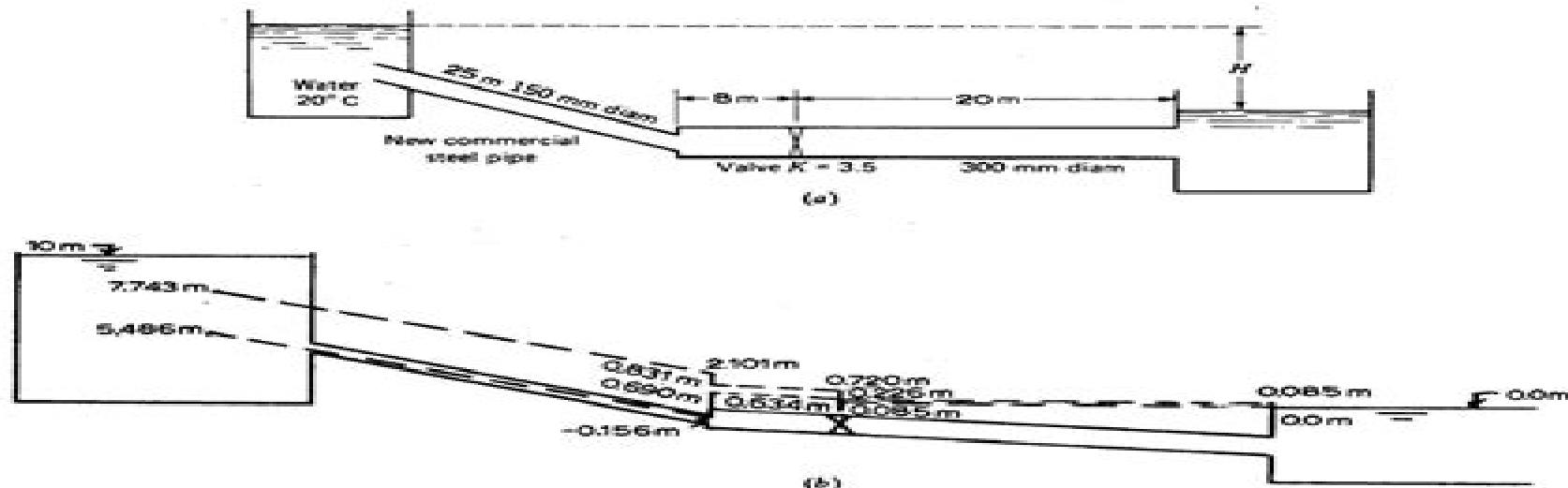

Fig. 22-9

22.11 Determine the slope of the hydraulic grade line for flow of atmospheric air through a rectangular 21-in by 7-in galvanized iron conduit ($V = 25$ fps).

Solved Problems In Mechanics

Wolfgang Guggemos

Solved Problems In Mechanics:

Exploring Classical Mechanics G. L. Kotkin,V. G. Serbo,2020-08-10 This new edition of a popular textbook offers an original collection of problems in analytical mechanics Analytical mechanics is the first chapter in the study and understanding of theoretical physics Its methods and ideas are crucially important as they form the basis of all other branches of theoretical physics including quantum mechanics statistical physics and field theory Such concepts as the Lagrangian and Hamiltonian formalisms normal oscillations adiabatic invariants Liouville theorem and canonical transformations lay the foundation without which any further in depth study of theoretical physics is impossible Wherever possible the authors draw analogies and comparisons with similar processes in electrodynamics quantum mechanics or statistical mechanics while presenting the solutions to the problems The book is based on the authors many years of experience delivering lectures and seminars at the Department of Physics at Novosibirsk State University totalling an impressive 110 years of combined teaching experience Most of the problems are original and will be useful not only for those studying mechanics but also for those who teach it The content of the book corresponds to and roughly follows the mechanics course in the well known textbooks by Landau and Lifshitz Goldstein or ter Haar The Collection starts with the Newtonian equations motion in a central field and scattering Then the text proceeds to the established traditional sections of analytical mechanics as part of the course on theoretical physics the Lagrangian equations the Noether theorem linear and nonlinear oscillations Hamilton formalism and motion of a solid body As a rule the solution of a problem is not complete by just obtaining the required formulae It s necessary to analyse the result This can be an interesting process of discovery for the student and is by no means a mechanical part of the solution It is also very useful to investigate what happens if the conditions of the problem are varied With this in mind the authors offer suggestions of further problems at the end of several solutions First published in 1969 in Russian this text has become widely used in classrooms around the world It has been translated into several languages and has seen multiple editions in various languages   **Solved Problems of Classical Mechanics** Rolando Pérez-Álvarez,Miguel Eduardo Mora-Ramos,2024-10-31 Despite being a well established and robust science Classical Mechanics continues to evolve with new advancements emerging its methods extending into other branches of Physics and Science more broadly For these reasons it remains a fundamental subject for students of Physics certain Engineering disciplines and other related fields This book presents one hundred solved problems in Classical Mechanics with the authors aiming to provide detailed solutions to support students who are still developing their skills Many problems include practical applications numerical examples and result analysis The book addresses key topics such as Newtonian Mechanics Lagrangian Mechanics Hamiltonian Mechanics Central Force Fields Rigid Bodies Small Oscillations Poisson Brackets and Canonical Transformations The authors welcome feedback from readers to further enrich this collection in future editions tailoring it to meet their evolving interests   **Solved Problems in Classical Mechanics** O.L. de Lange,J.

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power is liable to be stretched to its limit Emphasis is given to computational procedures suitable to computing systems with vector and parallel architectures Each chapter proceeds logically first with theory then with algorithmic computational analysis and finally applications to real problems This is a comprehensive state of the art treatment of theory and practice illustrated by extensive numerical examples which should serve as an essential reference book on the subject **Selected Problems of Solid Mechanics and Solving Methods** Holm Altenbach,Viacheslav Bogdanov,Alexander Ya. Grigorenko,Roman M. Kushnir,Vladimir M. Nazarenko,Victor A. Eremeyev,2024-06-04 This book examines new approaches for the estimation of errors in approximate theories Numerical and analytical methods in mechanics often require the establishment of a set of basic equations and various approaches exist to create approximate theories from them The problem is that nobody knows the boundaries of the estimation of errors in approximate theories This book presents new approaches to overcome this problem and to provide the reader with suitable methods for the relevant field including a representation of different scientific schools and different countries These new methods are helping to solve many problems not only in analytical Mechanics but also in Physics Mathematics and Civil Engineering **Analytical Mechanics** Ioan Merches,Daniel Radu,2014-08-26 Giving students a thorough grounding in basic problems and their solutions Analytical Mechanics Solutions to Problems in Classical Physics presents a short theoretical description of the principles and methods of analytical mechanics followed by solved problems The authors thoroughly discuss solutions to the problems by taking a comprehensive approach to explore the methods of investigation They carefully perform the calculations step by step graphically displaying some solutions via Mathematica 4 0 This collection of solved problems gives students experience in applying theory Lagrangian and Hamiltonian formalisms for discrete and continuous systems Hamilton Jacobi method variational calculus theory of stability and more to problems in classical physics The authors develop some theoretical subjects so that students can follow solutions to the problems without appealing to other reference sources This has been done for both discrete and continuous physical systems or in analytical terms systems with finite and infinite degrees of freedom The authors also highlight the basics of vector algebra and vector analysis in Appendix B They thoroughly develop and discuss notions like gradient divergence curl and tensor together with their physical applications There are many excellent textbooks dedicated to applied analytical mechanics for both students and their instructors but this one takes an unusual approach with a thorough analysis of solutions to the problems and an appropriate choice of applications in various branches of physics It lays out the similarities and differences between various analytical approaches and their specific efficiency Solved Problems in Quantum and Statistical Mechanics Michele Cini,Francesco Fucito,Mauro Sbragaglia,2012-03-30 This textbook is the result of many years of teaching quantum and statistical mechanics drawing on exercises and exam papers used on courses taught by the authors The subjects of the exercises have been carefully selected to cover all the material which is most needed by students Each exercise is carefully solved in full details explaining the

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émigré engineer and english mother sophie kingdom after an education in both england and france brunel started an apprenticeship with his father on the construction on the thames tunnel in london

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