

**PHYSICS 110A : CLASSICAL MECHANICS**  
**PROBLEM SET #4**

[1] Consider the mechanical thingy in Fig. 1. Two masses  $m$  are connected to the central axis and to a third mass  $M$  by massless rigid rods of length  $\ell$ , as shown. The mass  $M$  slides frictionlessly along the axis. There is one degree of freedom, which is the angle  $\theta$ , also shown. The thingy is rotated about its symmetry axis with angular velocity  $\omega$ .

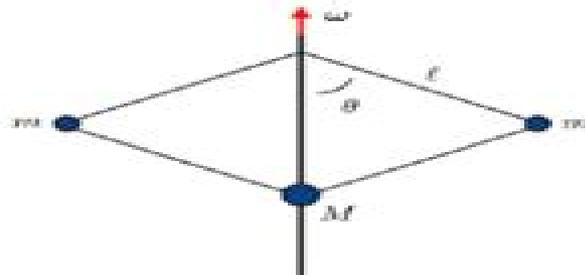


Figure 1: The thingy.

- (a) Find the Lagrangian for the thingy.
- (b) Find the equation of motion.
- (c) Show that there is one stable equilibrium when  $\omega$  is small. Find the equilibrium point and find the frequency of small oscillations about this equilibrium.
- (d) Show that for  $\omega > \omega_c$ , the stable equilibrium shifts to a nonzero value of  $\theta$ . Find the location of the new equilibrium and compute the corresponding frequency of small oscillations.
- (e) Identify any and all conserved quantities.

[2] A mechanical system is described by the Lagrangian

$$L = \frac{1}{2}m(\dot{x}^2 + \dot{y}^2 + \dot{z}^2) + \frac{1}{2}m(\dot{\phi}^2 + \rho^2\dot{\phi}^2) - V(x + ky + lz, y + a\phi), \quad (1)$$

where  $k$ ,  $l$ , and  $a$  are constants.

- (a) How many independent one-parameter families of transformations leave  $L$  invariant?
- (b) For each continuous symmetry, identify the associated conserved quantity.
- (c) Are there any other conserved quantities? Find an expression for any other conserved quantities which may exist.

# Classical Mechanics Problem Solutions

**K Likharev**



## **Classical Mechanics Problem Solutions:**

Classical Mechanics Konstantin Konstantinovich Likharev, 2017 Essential Advanced Physics is a series comprising four parts Classical Mechanics Classical Electrodynamics Quantum Mechanics and Statistical Mechanics Each part consists of two volumes Lecture notes and Problems with solutions further supplemented by an additional collection of test problems and solutions available to qualifying university instructors This volume Classical Mechanics Problems with solutions contains detailed model solutions to the exercise problems formulated in the companion Lecture notes volume In many cases the solutions include result discussions that enhance the lecture material For the reader's convenience the problem assignments are reproduced in this volume Source r sum de l diteur

**Introduction to Classical Mechanics** David Morin, 2008-01-10 This textbook covers all the standard introductory topics in classical mechanics including Newton's laws oscillations energy momentum angular momentum planetary motion and special relativity It also explores more advanced topics such as normal modes the Lagrangian method gyroscopic motion fictitious forces 4 vectors and general relativity It contains more than 250 problems with detailed solutions so students can easily check their understanding of the topic There are also over 350 unworked exercises which are ideal for homework assignments Password protected solutions are available to instructors at [www.cambridge.org/9780521876223](http://www.cambridge.org/9780521876223) The vast number of problems alone makes it an ideal supplementary text for all levels of undergraduate physics courses in classical mechanics Remarks are scattered throughout the text discussing issues that are often glossed over in other textbooks and it is thoroughly illustrated with more than 600 figures to help demonstrate key concepts

**Classical Mechanics** Carolina C. Ilie, Zachariah S. Schrecengost, Elina M. van Kempen, 2022-12-29 This book of problems and solutions in classical mechanics is dedicated to junior or senior undergraduate students in physics engineering applied mathematics astronomy or chemistry who may want to improve their problems solving skills or to freshman graduate students who may be seeking a refresh of the material The book is structured in ten chapters starting with Newton's laws motion with air resistance conservation laws oscillations and the Lagrangian and Hamiltonian Formalisms The last two chapters introduce some ideas in nonlinear dynamics chaos and special relativity Each chapter starts with a brief theoretical outline and continues with problems and detailed solutions A concise presentation of differential equations can be found in the appendix A variety of problems are presented from the standard classical mechanics problems to context rich problems and more challenging problems Key features Presents a theoretical outline for each chapter Motivates the students with standard mechanics problems with step by step explanations Challenges the students with more complex problems with detailed solutions

**Solved Problems in Classical Mechanics** O. L. de Lange, J. Pierrus, 2010-05-06 Apart from an introductory chapter giving a brief summary of Newtonian and Lagrangian mechanics this book consists entirely of questions and solutions on topics in classical mechanics that will be encountered in undergraduate and graduate courses These include one two and three dimensional motion linear and nonlinear oscillations energy potentials momentum and angular momentum

spherically symmetric potentials multi particle systems rigid bodies translation and rotation of the reference frame the relativity principle and some of its consequences The solutions are followed by a set of comments intended to stimulate inductive reasoning and provide additional information of interest Both analytical and numerical computer techniques are used to obtain and analyze solutions The computer calculations use Mathematica version 7 and the relevant code is given in the text It includes use of the interactive Manipulate function which enables one to observe simulated motion on a computer screen and to study the effects of changing parameters The book will be useful to students and lecturers in undergraduate and graduate courses on classical mechanics and students and lecturers in courses in computational physics

*Essential Classical Mechanics* Choonkyu Lee,Hyunsoo Min,2018-04-17 The authors deliver a highly readable text which should assure a continued supply of practitioners of classical mechanics and its applications Contemporary Physics This is a book on intermediate classical mechanics In this book classical mechanics is presented as a useful tool to analyze the physical universe and also as the base on which the whole pyramid of modern physics has been erected Various mechanical concepts are developed in a highly logical manner with relatively thorough treatments on mathematical procedures and many physically interesting applications Connections to more modern theoretical developments including statistical physics relativity and quantum mechanics are emphasized

**Introduction To Classical Mechanics: Solutions To Problems** John Dirk Walecka,2020-08-24 The textbook Introduction to Classical Mechanics aims to provide a clear and concise set of lectures that take one from the introduction and application of Newton's laws up to Hamilton's principle of stationary action and the lagrangian mechanics of continuous systems An extensive set of accessible problems enhances and extends the coverage It serves as a prequel to the author's recently published book entitled Introduction to Electricity and Magnetism based on an introductory course taught some time ago at Stanford with over 400 students enrolled Both lectures assume a good concurrent course in calculus and familiarity with basic concepts in physics the development is otherwise self contained As an aid for teaching and learning and as was previously done with the publication of Introduction to Electricity and Magnetism Solutions to Problems this additional book provides the solutions to the problems in the text Introduction to Classical Mechanics

Solution Manual For Classical Mechanics And Electrodynamics (Second Edition). Jon Magne Leinaas,2025 *Introduction to Classical Mechanics* David J. Morin,2008 Supplementary textbook for all levels of undergraduate physics courses in classical mechanics

Classical Mechanics Student Solutions Manual John R Taylor,Jeff Adams,Greg Francis,2020-07-10 This is the authorized Student Solutions Manual for John R Taylor's internationally best selling textbook Classical Mechanics In response to popular demand University Science Books is delighted to announce the one and only authorized Student Solutions Manual for John R Taylor's internationally best selling textbook Classical Mechanics This splendid little manual by the textbook's own author restates the odd numbered problems from the book and the provides crystal clear detailed solutions Of course the author strongly recommends that students avoid sneaking a peek

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**The Mechanics Problem Solver** Research and Education Association, 1995

*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

*Cognitive Structures in Scientific Inquiry* Roberto Festa, Atocha Aliseda, Adriana Johanna Maria Peijnenburg, 2005 This book is the first of two volumes devoted to the work of Theo Kuipers a leading Dutch philosopher of science Philosophers and scientists from all over the world thirty seven in all comment on Kuipers philosophy and each of their commentaries is followed by a reply from Kuipers The present volume focuses on Kuipers views on confirmation empirical progress and truth approximation as laid down in his *From Instrumentalism to Constructive Realism* Kluwer 2000 In this book Kuipers offered a synthesis of Carnap's and Hempel's confirmation theory on the one hand and Popper's theory of truth approximation on the other The key element of this synthesis is a sophisticated methodology which enables the evaluation of theories in terms of their problems and successes even if the theories are already falsified and which also fits well with the claim that one theory is closer to the truth than another Ilkka Niiniluoto Patrick Maher John Welch Gerhard Schurz Igor Douven Bert Hamminga David Miller Johan van Benthem Sjoerd Zwart Thomas Mormann Jes's Zamora Bonilla Isabella Burger andamp Johannes Heidema Joke Meheus Hans Mooij and Diderik Batens comment on these ideas of Kuipers and many present their own account The present book also contains a synopsis of *From Instrumentalism to Constructive Realism* It can be read independently of the second volume of *Essays in Debate with Theo Kuipers* which is devoted to Kuipers *Structures in Science* 2001

**Cognitive Structures in Scientific Inquiry**, 2016-08-01 This book is the second of two volumes devoted to the work of Theo Kuipers a leading Dutch philosopher of science Philosophers and scientists from all over the world thirty seven in all comment on Kuipers philosophy and each of their commentaries is followed by a reply from Kuipers The present volume is devoted to Kuipers neo classical philosophy of science as laid down in his *Structures in Science* Kluwer 2001 Kuipers defends a dialectical interaction between science and philosophy in that he views philosophy of science as a meta science which formulates cognitive structures that provide heuristic patterns for actual scientific research including design research In addition Kuipers pays considerable attention to the computational approaches to philosophy of science as well as to the ethics of doing research Thomas Nickles David Atkinson Jean Paul van Bendegem Maarten Franssen Anne Ruth Mackor Arno Wouters Erik Weber Helena de Preester Eric Scerri Adam Grobler Andrzej Wisniewski Alexander van den Bosch Gerard Vreeswijk Jaap Kamps Paul Thagard Emma Ruttkamp Robert Causey Henk Zandvoort comment on these ideas of Kuipers and many present their

own account The present book also contains a synopsis of Structures in Science It can be read independently of the first volume of Essays in Debate with Theo Kuipers which is devoted to Kuipers From Instrumentalism to Constructive Realism 2000 *Essential Classical Mechanics* Choonkyu Lee,1998 **Collected Papers on Wave Mechanics** Erwin Schrödinger,1928 *Classical Mechanics, Volume 2* K Likharev,2018-04-30 **Thinking Across Cultures** Donald M. Topping,Doris C. Crowell,Victor N. Kobayashi,2013-09-05 This volume compares and contrasts contemporary theories of cognition modes of perception and learning from cross cultural perspectives The participants were asked to consider and assess the question of whether people from different cultures think differently Moreover they were asked to consider whether the same approaches to teaching and development of thinking will work in all cultures as well as they do in Western literate societies **Scientific and Technical Aerospace Reports** ,1967 **Proceedings of the Royal Society of London** Royal Society (Great Britain),1926 *Solutions of Weekly Problem Papers* John James Milne,1885

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