Theoretical Dynamics

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Homework 3

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1 Goldstein 8.1

1.1 Part (a)

The Hamiltonian is given by

$$H(q_i, p_i, t) = p_i \dot{q}_i - L(q_i, \dot{q}_i, t)$$
 (1)

where all the \dot{q}_i 's on the RHS are to be expressed in terms of q_i , p_i and t. Now,

$$dH = \frac{\partial H}{\partial q_i}dq_i + \frac{\partial H}{\partial p_i}dp_i + \frac{\partial H}{\partial t}dt$$
 (2)

From (1).

$$dH = p_i d\hat{q}_i + \hat{q}_i dp_i - dL$$

$$= p_i d\hat{q}_i + \hat{q}_i dp_i - \left(\frac{\partial L}{\partial q_i} dq_i + \frac{\partial L}{\partial \hat{q}_i} d\hat{q}_i + \frac{\partial L}{\partial t} dt\right)$$

$$= -\frac{\partial L}{\partial q_i} dq_i + \hat{q}_i dp_i + \left(p_i - \frac{\partial L}{\partial \hat{q}_i}\right) d\hat{q}_i - \frac{\partial L}{\partial t} dt \qquad (3)$$

Comparing (2) and (3) we get

$$\frac{\partial H}{\partial q_i} = -\frac{\partial L}{\partial q_i} = -\hat{p}_i$$
 (2nd equality from Hamilton's equation) (4)

$$\dot{q}_i = \frac{\partial H}{\partial q_i}$$
 (also Hamilton's equation) (5)

$$p_i - \frac{\partial L}{\partial \hat{q}_i} = 0$$
 (H is not explicitly dependent on \hat{q}_i) (6)

$$-\frac{\partial L}{\partial t} = \frac{\partial H}{\partial t}$$
(7)

From (4) and (6) we have

$$\frac{d}{dt}\left(\frac{\partial L}{\partial \dot{q}_i}\right) - \frac{\partial L}{\partial q_i} = 0, \quad i = 1, 2, ..., n$$
 (8)

which are the Euler-Lagrange equations.

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DP Hallahan

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Principles of Electron Optics, Volume 1 Peter W. Hawkes, Erwin Kasper, 2017-10-29 Volume one of Principles of Electron Optics Basic Geometrical Optics Second Edition explores the geometrical optics needed to analyze an extremely wide range of instruments cathode ray tubes the family of electron microscopes including the fixed beam and scanning transmission instruments the scanning electron microscope and the emission microscope electron spectrometers and mass spectrograph image converters electron interferometers and diffraction devices electron welding machines and electron beam lithography devices The book provides a self contained detailed modern account of electron optics for anyone involved with particle beams of modest current density in the energy range up to a few mega electronvolts You will find all the basic equations with their derivations recent ideas concerning aberration studies extensive discussion of the numerical methods needed to calculate the properties of specific systems and quidance to the literature of all the topics covered A continuation of these topics can be found in volume two Principles of Electron Optics Applied Geometrical Optics The book is intended for postgraduate students and teachers in physics and electron optics as well as researchers and scientists in academia and industry working in the field of electron optics electron and ion microscopy and nanolithography Offers a fully revised and expanded new edition based on the latest research developments in electron optics Written by the top experts in the field Covers every significant advance in electron optics since the subject originated Contains exceptionally complete and carefully selected references and notes Serves both as a reference and text Molecular Dynamics Ruben Santamaria, 2023-12-19 This molecular dynamics textbook takes the reader from classical mechanics to quantum mechanics and vice versa and from few body systems to many body systems It is self contained comprehensive and builds the theory of molecular dynamics from basic principles to applications allowing the subject to be appreciated by readers from physics chemistry and biology backgrounds while maintaining mathematical rigor The book is enhanced with illustrations problems and solutions and suggested reading making it ideal for undergraduate and graduate courses or self study With coverage of recent developments the book is essential reading for students who explore and characterize phenomena at the atomic level It is a useful reference for researchers in physics and chemistry and can act as an entry point for researchers in nanoscience materials engineering genetics and related fields who are seeking a deeper understanding of nature Mathematics in Science and Engineering ,1970 Classical Mechanics And Relativity Harald J W Muller-kirsten, 2008-08-21 This text provides a pedagogical tour through mechanics from Newton to Einstein with detailed explanations and a large number of worked examples From the very beginning relativity is kept in mind along with its relation to concepts of basic mechanics

such as inertia escape velocity Newton's potential Kepler motion and curvature The Lagrange and Hamilton formalisms are treated in detail and extensive applications to central forces and rigid bodies are presented After consideration of the motivation of relativity the essential tensor calculus is developed and thereafter Einstein's equation is solved for special cases with explicit presentation of calculational steps The combined treatment of classical mechanics and relativity thus enables the reader to see the connection between Newton's gravitational potential Kepler motion and Einstein's corrections as well as diverse aspects of mechanics. The text addresses students and others pursuing a course in classical mechanics as well as those interested in a detailed course on relativity Ensembles on Configuration Space Michael J. W. Hall, Marcel Reginatto, 2016-06-11 This book describes a promising approach to problems in the foundations of quantum mechanics including the measurement problem The dynamics of ensembles on configuration space is shown here to be a valuable tool for unifying the formalisms of classical and quantum mechanics for deriving and extending the latter in various ways and for addressing the quantum measurement problem A description of physical systems by means of ensembles on configuration space can be introduced at a very fundamental level the basic building blocks are a configuration space probabilities and Hamiltonian equations of motion for the probabilities The formalism can describe both classical and quantum systems and their thermodynamics with the main difference being the choice of ensemble Hamiltonian Furthermore there is a natural way of introducing ensemble Hamiltonians that describe the evolution of hybrid systems i e interacting systems that have distinct classical and quantum sectors allowing for consistent descriptions of quantum systems interacting with classical measurement devices and quantum matter fields interacting gravitationally with a classical spacetime **Core Concepts of Mechanics and Thermodynamics** Rituraj Dalal, 2025-02-20 Core Concepts of Mechanics and Thermodynamics is a textbook designed for students and anyone interested in these crucial areas of physics. The book begins with the basics of mechanics covering motion forces and energy and then moves on to thermodynamics discussing heat temperature and the laws of thermodynamics The book emphasizes clear explanations and real world examples to illustrate concepts and it also provides problem solving techniques to apply what you learn It covers mechanics and thermodynamics from basic principles to advanced topics explains concepts clearly with examples teaches problem solving techniques connects theory to real world applications in engineering physics and materials science and includes historical context to show the development of these ideas Core Concepts of Mechanics and Thermodynamics is a valuable resource for students teachers and self learners Whether you are beginning your journey or seeking to deepen your understanding this book provides a solid foundation in Nematicons Gaetano Assanto, 2012-10-16 The first book of its kind to introduce the fundamentals these essential subjects basic features and models potential applications and novel phenomena and its important applications in liquid crystal technology Recognized leader in the field Gaetano Assanto outlines the peculiar characteristics of nematicons and the promise they have for the future growth of this captivating new field Semiclassical Mechanics with Molecular

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