

The Ramp (and Friction) PhET Simulation Lab

Introduction:

When an object is dragged across a horizontal surface, the force of friction that must be overcome depends on the normal force as $F_f = \mu F_n$ and the normal force is given by $F_n = F_g$. When the surface becomes an inclined plane, the normal force changes and when the normal force changes, so does the friction. In this lab, you will change the angle of an inclined plane and observe how weight is resolved into its components ($F_{n\theta}$ and $F_{g\theta}$) using the basic trig functions.



The Ramp

Procedure: Play with the Sims \Rightarrow Physics \Rightarrow Motion \Rightarrow The Ramp **Run Now!**

• Be sure to stay in the introduction part of the simulation. *More features* will be used later when we investigate energy. Start by playing with the cabinet some. Have fun, really... Now... back to work.

- Move the cabinet up and down the ramp by dragging it with your mouse.
- Move the ramp to an angle of zero (horizontal) and draw a free body diagram of the cabinet here:

Horizontal plane

1. On a horizontal plane, the normal force is _____ to the weight.
2. The cabinet has a mass of 100kg. It therefore has a normal force of _____ N and a friction force (on the horizontal plane) of _____ $\mu = 0.30$

Inclined plane

• **Reset** the ramp and draw a free body diagram of the cabinet in the box here:

3. The force down the plane and normal force are components of _____.
4. Before we add an applied force on the ramp, there is a force of _____ that acts against the force down the plane(Force parallel).
5. When we apply a force to get the cabinet moving, the friction force acts in the _____ direction as movement of the cabinet.
6. **Slowly** increase angle (0.1 degrees at a time) of the ramp until the cabinet starts to move on its own. What angle is this? _____ = θ
7. At this point, the force down the plane is _____ than the force of friction.
8. Since the ramp is now at an angle, the normal force is _____ than the weight.
9. At the angle above, the normal force equals _____ N. (hint: what trig function?)
10. At the angle above, the force down the plane equals _____ N. (trig function?)
11. Using the formula for friction above, the force of friction is _____ N.
12. If the plane-cabinet were frictionless, what angle would be required for the cabinet to move? _____
13. Why? _____



$g = 9.8m/s^2$

Calculate first, then test each object in the table below with the simulation on a horizontal plane.

Object	Mass	Weight	Normal Force	μ , Coef of Friction	Friction Force to Overcome
Dog				0.10	
Crate				0.70	
Piano				0.40	
Refrigerator				0.50	

Conclusion Calculations:

GRADED

Phet Lab Answers The Ramp

**Thomas I. Strasser, Erik C. W. de
Jong, Maria Sosnina**



Phet Lab Answers The Ramp

Simulation with Arena W. David Kelton, Randall P. Sadowski, David T. Sturrock, 2004 The first edition of this book was the first text to be written on the Arena software which is a very popular simulation modeling software What makes this text the authoritative source on Arena is that it was written by the creators of Arena themselves The new third edition follows in the tradition of the successful first and second editions in its tutorial style via a sequence of carefully crafted examples and an accessible writing style The updates include thorough coverage of the new version of the Arena software Arena 7 01 enhanced support for Excel and Access and updated examples to reflect the new version of software The CD ROM that accompanies the book contains the Academic version of the Arena software The software features new capabilities such as model documentation enhanced plots file reading and writing printing and animation symbols *Applied Simulation*

Malcolm Beaverstock, Bill Nordgren, Allen Greenwood, Eamonn Lavery, William Nordgren, 2012-07-15 **APhysics** Dan Fullerton, 2011-04-28 APlusPhysics Your Guide to Regents Physics Essentials is a clear and concise roadmap to the entire New York State Regents Physics curriculum preparing students for success in their high school physics class as well as review for high marks on the Regents Physics Exam Topics covered include pre requisite math and trigonometry kinematics forces Newton's Laws of Motion circular motion and gravity impulse and momentum work energy and power electrostatics electric circuits magnetism waves optics and modern physics Featuring more than five hundred questions from past Regents exams with worked out solutions and detailed illustrations this book is integrated with the APlusPhysics.com website which includes online question and answer forums videos animations and supplemental problems to help you master Regents Physics essentials The best physics books are the ones kids will actually read Advance Praise for APlusPhysics Regents Physics Essentials Very well written simple clear engaging and accessible You hit a grand slam with this review book Anthony NY Regents Physics Teacher Does a great job giving students what they need to know The value provided is amazing Tom NY Regents Physics Teacher This was tremendous preparation for my physics test I love the detailed problem solutions Jenny NY Regents Physics Student Regents Physics Essentials has all the information you could ever need and is much easier to understand than many other textbooks it is an excellent review tool and is truly written for students Cat NY Regents Physics Student *Interactive Lecture Demonstrations* David R. Sokoloff, Ronald K. Thornton, 2006-09-18 Interactive Lecture Demonstrations ILDs are designed to enhance conceptual learning in physics lectures through active engagement of students in the learning process Students observe real physics demonstrations make predictions about the outcomes on a prediction sheet and collaborate with fellow students by discussing their predictions in small groups Students then examine the results of the live demonstration often displayed as real time graphs using computer data acquisition tools compare these results with their predictions and attempt to explain the observed phenomena ILDs are available for all of the major topics in the

introductory physics course and can be used within the traditional structure of an introductory physics course All of the printed materials needed to implement them are included in this book

America's Lab Report National Research Council, Division of Behavioral and Social Sciences and Education, Center for Education, Board on Science Education, Committee on High School Laboratories: Role and Vision, 2006-01-20 Laboratory experiences as a part of most U S high school science curricula have been taken for granted for decades but they have rarely been carefully examined What do they contribute to science learning What can they contribute to science learning What is the current status of labs in our nation s high schools as a context for learning science This book looks at a range of questions about how laboratory experiences fit into U S high schools What is effective laboratory teaching What does research tell us about learning in high school science labs How should student learning in laboratory experiences be assessed Do all student have access to laboratory experiences What changes need to be made to improve laboratory experiences for high school students How can school organization contribute to effective laboratory teaching With increased attention to the U S education system and student outcomes no part of the high school curriculum should escape scrutiny This timely book investigates factors that influence a high school laboratory experience looking closely at what currently takes place and what the goals of those experiences are and should be Science educators school administrators policy makers and parents will all benefit from a better understanding of the need for laboratory experiences to be an integral part of the science curriculum and how that can be accomplished

Simulation of Dynamic Systems with MATLAB® and Simulink® Harold Klee, Randal Allen, 2018-02-02 Continuous system simulation is an increasingly important tool for optimizing the performance of real world systems The book presents an integrated treatment of continuous simulation with all the background and essential prerequisites in one setting It features updated chapters and two new sections on Black Swan and the Stochastic Information Packet SIP and Stochastic Library Units with Relationships Preserved SLURP Standard The new edition includes basic concepts mathematical tools and the common principles of various simulation models for different phenomena as well as an abundance of case studies real world examples homework problems and equations to develop a practical understanding of concepts

College Physics for AP® Courses Irna Lyublinskaya, Douglas Ingram, Gregg Wolfe, Roger Hinrichs, Kim Dirks, Liza Pujji, Manjula Devi Sharma, Sudhi Oberoi, Nathan Czuba, Julie Kretchman, John Stoke, David Anderson, Erika Gasper, 2015-07-31 This introductory algebra based two semester college physics book is grounded with real world examples illustrations and explanations to help students grasp key fundamental physics concepts This online fully editable and customizable title includes learning objectives concept questions links to labs and simulations and ample practice opportunities to solve traditional physics application problems Website of book

Software-Defined Radio for Engineers Alexander M. Wyglinski, Robin Getz, Travis Collins, Di Pu, 2018-04-30 Based on the popular Artech House classic Digital Communication Systems Engineering with Software Defined Radio this book provides a practical approach to quickly

learning the software defined radio SDR concepts needed for work in the field This up to date volume guides readers on how to quickly prototype wireless designs using SDR for real world testing and experimentation This book explores advanced wireless communication techniques such as OFDM LTE WLA and hardware targeting Readers will gain an understanding of the core concepts behind wireless hardware such as the radio frequency front end analog to digital and digital to analog converters as well as various processing technologies Moreover this volume includes chapters on timing estimation matched filtering frame synchronization message decoding and source coding The orthogonal frequency division multiplexing is explained and details about HDL code generation and deployment are provided The book concludes with coverage of the WLAN toolbox with OFDM beacon reception and the LTE toolbox with downlink reception Multiple case studies are provided throughout the book Both MATLAB and Simulink source code are included to assist readers with their projects in the field

University Physics Volume 1 of 3 (1st Edition Textbook) Samuel J. Ling, William Moebs, Jeff Sanny, 2023-05-14 Black white print University Physics is a three volume collection that meets the scope and sequence requirements for two and three semester calculus based physics courses Volume 1 covers mechanics sound oscillations and waves Volume 2 covers thermodynamics electricity and magnetism Volume 3 covers optics and modern physics This textbook emphasizes connections between theory and application making physics concepts interesting and accessible to students while maintaining the mathematical rigor inherent in the subject Frequent strong examples focus on how to approach a problem how to work with the equations and how to check and generalize the result

European Guide to Power System Testing Thomas I. Strasser, Erik C. W. de Jong, Maria Sosnina, 2020-06-11 This book is an open access book This book provides an overview of the ERIGrid validation methodology for validating CPES a holistic power system testing method It introduces readers to corresponding simulation and laboratory based tools including co simulation real time simulation and hardware in the loop Selected test cases and validation examples are provided in order to support the theory discussed The book begins with an introduction to current power system testing methods and an overview of the ERIGrid system level validation approach It then moves on to discuss various validation methods concepts and tools including simulation and laboratory based assessment methods The book presents test cases and validation examples of the proposed methodologies and summarises the lessons learned from the holistic validation approach In the final section of the book the educational aspects of these methods the outlook for the future and overall conclusions are discussed Given its scope the book will be of interest to researchers engineers and laboratory personnel in the fields of power systems and smart grids as well as undergraduate and graduate students studying related engineering topics

Practical Physics G. L. Squires, 2001-08-30 This book sets out to demonstrate the purpose and critical approach that should be made to all experimental work in physics It does not describe a systematic course in practical work The present edition retains the basic outlook of earlier editions but modifications have been made in response to important changes in computational and experimental methods in the past

decade The text is in three parts The first deals with the statistical treatment of data and here the text has been extensively revised to take account of the now widespread use of electronic calculators The second deals with experimental methods giving details of particular experiments that demonstrate the art and craft of the experimenter The third part deals with such essential matters as keeping efficient records accuracy in arithmetic and writing good scientific English Copyright Libri GmbH All rights reserved

The Principles of Quantum Mechanics Paul Adrien Maurice Dirac,1981 The first edition of this work appeared in 1930 and its originality won it immediate recognition as a classic of modern physical theory The fourth edition has been bought out to meet a continued demand Some improvements have been made the main one being the complete rewriting of the chapter on quantum electrodymanics to bring in electron pair creation This makes it suitable as an introduction to recent works on quantum field theories

SAT For Dummies Geraldine Woods,2011-11-30 SAT For Dummies Premier 8th Edition with CD features include Five full length print practice tests 1 more than prior edition plus 2 additional unique tests on the CD all with detailed answers and explanations Review of foundational concepts for every section from identifying root words and using commas correctly to solving math word problems and using the quadratic formula Complete explanations of every question type Practice problems for each of the test s 10 sections

TIPERs C. J. Hieggelke,D. P. Maloney,Stephen E. Kanim,Thomas L. O'Kuma,2013-12-17 TIPERs Sensemaking Tasks for Introductory Physics gives introductory physics students the type of practice they need to promote a conceptual understanding of problem solving This supplementary text helps students to connect the physical rules of the universe with the mathematical tools used to express them The exercises in this workbook are intended to promote sensemaking The various formats of the questions are difficult to solve just by using physics equations as formulas Students will need to develop a solid qualitative understanding of the concepts principles and relationships in physics In addition they will have to decide what is relevant and what isn t which equations apply and which don t and what the equations tell one about physical situations The goal is that when students are given a physics problem where they are asked solve for an unknown quantity they will understand the physics of the problem in addition to finding the answer

Physics for Scientists and Engineers Raymond Serway,John Jewett,2013-01-01 As a market leader PHYSICS FOR SCIENTISTS AND ENGINEERS is one of the most powerful brands in the physics market While preserving concise language state of the art educational pedagogy and top notch worked examples the Ninth Edition highlights the Analysis Model approach to problem solving including brand new Analysis Model Tutorials written by text co author John Jewett and available in Enhanced WebAssign The Analysis Model approach lays out a standard set of situations that appear in most physics problems and serves as a bridge to help students identify the correct fundamental principle and then the equation to utilize in solving that problem The unified art program and the carefully thought out problem sets also enhance the thoughtful instruction for which Raymond A Serway and John W Jewett Jr earned their reputations The Ninth Edition of PHYSICS FOR SCIENTISTS AND ENGINEERS continues to be accompanied by

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Aircraft Design Projects Lloyd R. Jenkinson, Jim Marchman, 2003-04-28 Written with students of aerospace or aeronautical engineering firmly in mind this is a practical and wide ranging book that draws together the various theoretical elements of aircraft design structures aerodynamics propulsion control and others and guides the reader in applying them in practice Based on a range of detailed real life aircraft design projects including military training commercial and concept aircraft the experienced UK and US based authors present engineering students with an essential toolkit and reference to support their own project work All aircraft projects are unique and it is impossible to provide a template for the work involved in the design process However with the knowledge of the steps in the initial design process and of previous experience from similar projects students will be freer to concentrate on the innovative and analytical aspects of their course project The authors bring a unique combination of perspectives and experience to this text It reflects both British and

American academic practices in teaching aircraft design Lloyd Jenkinson has taught aircraft design at both Loughborough and Southampton universities in the UK and Jim Marchman has taught both aircraft and spacecraft design at Virginia Tech in the US Demonstrates how basic aircraft design processes can be successfully applied in reality Case studies allow both student and instructor to examine particular design challenges Covers commercial and successful student design projects and includes over 200 high quality illustrations *Space Simulation*, 1972 Space simulation conference **Physical Science Two** Newton College of the Sacred Heart, 1972 *Physlets* Wolfgang Christian, Mario Belloni, 2001 This manual CD package shows physics instructors both web novices and Java savvy programmers alike how to author their own interactive curricular material using Physlets Java applets written for physics pedagogy that can be embedded directly into html documents and that can interact with the user It demonstrates the use of Physlets in conjunction with JavaScript to deliver a wide variety of web based interactive physics activities and provides examples of Physlets created for classroom demonstrations traditional and Just in Time Teaching homework problems pre and post laboratory exercises and Interactive Engagement activities More than just a technical how to book the manual gives instructors some ideas about the new possibilities that Physlets offer and is designed to make the transition to using Physlets quick and easy Covers Pedagogy and Technology JITT and Physlets PER and Physlets technology overview and scripting tutorial Curricular Material in class activities mechanics waves and thermodynamics problems electromagnetism and optics problems and modern physics problems and References on resources inherited methods naming conventions Animator EFIELD DATAGRAPH DATATABLE Version Four Physlets For Physics instructors

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Table of Contents Phet Lab Answers The Ramp

1. Understanding the eBook Phet Lab Answers The Ramp
 - The Rise of Digital Reading Phet Lab Answers The Ramp
 - Advantages of eBooks Over Traditional Books
2. Identifying Phet Lab Answers The Ramp
 - Exploring Different Genres
 - Considering Fiction vs. Non-Fiction
 - Determining Your Reading Goals
3. Choosing the Right eBook Platform
 - Popular eBook Platforms
 - Features to Look for in an Phet Lab Answers The Ramp

- User-Friendly Interface
- 4. Exploring eBook Recommendations from Phet Lab Answers The Ramp
 - Personalized Recommendations
 - Phet Lab Answers The Ramp User Reviews and Ratings
 - Phet Lab Answers The Ramp and Bestseller Lists
- 5. Accessing Phet Lab Answers The Ramp Free and Paid eBooks
 - Phet Lab Answers The Ramp Public Domain eBooks
 - Phet Lab Answers The Ramp eBook Subscription Services
 - Phet Lab Answers The Ramp Budget-Friendly Options
- 6. Navigating Phet Lab Answers The Ramp eBook Formats
 - ePub, PDF, MOBI, and More
 - Phet Lab Answers The Ramp Compatibility with Devices
 - Phet Lab Answers The Ramp Enhanced eBook Features
- 7. Enhancing Your Reading Experience
 - Adjustable Fonts and Text Sizes of Phet Lab Answers The Ramp
 - Highlighting and Note-Taking Phet Lab Answers The Ramp
 - Interactive Elements Phet Lab Answers The Ramp
- 8. Staying Engaged with Phet Lab Answers The Ramp
 - Joining Online Reading Communities
 - Participating in Virtual Book Clubs
 - Following Authors and Publishers Phet Lab Answers The Ramp
- 9. Balancing eBooks and Physical Books Phet Lab Answers The Ramp
 - Benefits of a Digital Library
 - Creating a Diverse Reading Collection Phet Lab Answers The Ramp
- 10. Overcoming Reading Challenges
 - Dealing with Digital Eye Strain
 - Minimizing Distractions
 - Managing Screen Time
- 11. Cultivating a Reading Routine Phet Lab Answers The Ramp
 - Setting Reading Goals Phet Lab Answers The Ramp

- Carving Out Dedicated Reading Time
- 12. Sourcing Reliable Information of Phet Lab Answers The Ramp
 - Fact-Checking eBook Content of Phet Lab Answers The Ramp
 - Distinguishing Credible Sources
- 13. Promoting Lifelong Learning
 - Utilizing eBooks for Skill Development
 - Exploring Educational eBooks
- 14. Embracing eBook Trends
 - Integration of Multimedia Elements
 - Interactive and Gamified eBooks

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