

## The Ramp (and Friction) PhET Simulation Lab

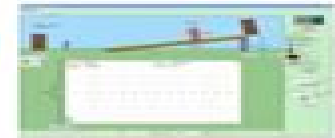
### Introduction:

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  $F_n = W$ . 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 ( $F_n$  and  $F_{\parallel}$ ) using the basic trig functions.  $F_{\parallel}$  is the force parallel to the inclined plane.  $F_f$  is assumed to be going down the plane.

kg is a mass. To convert it to a weight you need to multiply it by the force of gravity ( $g$ ). Gravity is  $9.8 \text{ m/s}^2$ . The formula  $W = mg$  is weight equals mass times gravity.



The Ramp

- 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

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

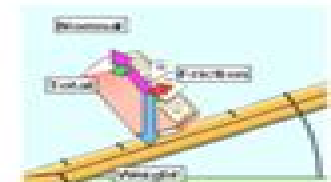
Inclined plane

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

- Before we add an applied force on the ramp, there is a force of \_\_\_\_\_ that acts against the force down the plane( Force parallel).

- When we apply a force to get the cabinet moving, the friction force acts in the \_\_\_\_\_ direction as movement of the cabinet.

- Slowly increase angle of the ramp until the cabinet starts to move on its own. What angle is this? \_\_\_\_\_ =  $\theta$



- At this point, the force down the plane is \_\_\_\_\_ than the force of friction.

- Since the ramp is now at an angle, the normal force is \_\_\_\_\_ than the weight.

- At the angle above, the normal force equals \_\_\_\_\_ N. (Hint: Trig function)

- At the angle above, the force down the plane equals \_\_\_\_\_ N.

$$g = 9.8 \text{ m/s}^2$$

- Using the formula for friction above, the force of friction is \_\_\_\_\_ N.

- If the plane-cabinet were frictionless, what angle would be required for the cabinet to move? \_\_\_\_\_ Calculate first, then test each object in the table below with the simulation on a horizontal plane.

# Friction Lab Answer Key

**United States. Office of Saline Water**

A red circular graphic with a gradient, appearing as a stylized arrow or a partial circle, located to the right of the text 'United States. Office of Saline Water'.

## Friction Lab Answer Key:

*Riso Report*, 1965      *Central Valley Project, West San Joaquin Division, San Luis Unit, California* United States. Bureau of Reclamation, 1974      ASD Technical Report, 1957      **Central Valley Project, West San Joaquin Division, San Luis Unit, California: San Luis Dam and pumping-generating plant, and O'Neill Dam and pumping plant: design** United States. Bureau of Reclamation, 1974      *Language Power: Grades 6-8 Level B Teacher's Guide* Elizabeth C. McNally, 2012-10-30      **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, 2005-12-20

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      **The Academic Skills Handbook** Diana Hopkins, Tom Reid, 2024-02-29 This is your complete guide to success in navigating writing thinking and communicating at university Packed with tips diagnostic tools guided exercises and full text examples it equips you to boost your grades ace your assignments and get the most out of your time at university This book helps you Prepare for and navigate university culture Develop the academic skills needed for success at university Communicate your ideas with confidence and clarity Watch your skills grow with diagnostic tools Create your own study plan tailored to the skills you need Know what your tutor is looking for and how to deliver Turn your skills into success after university The Academic Skills Handbook is specially designed to show you where your strengths are and what you need to work on so you get a practice plan that is perfect for your needs It then arms you with the principles and practice to get ahead in your academic writing presentations and group work What s new to this edition Three chapters on university culture writing blogs and online and blended learning including best practices for using AI as a support tool as well as new annotated examples of course work and increased coverage of wellbeing Student Success is a series of essential guides for students of all levels From how to

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**Report** ,1973      *Introduction to Experimental Methods* Terry W. Armstrong,2023-07-31 Introduction to Experimental Methods succinctly explains fundamental engineering concepts in mechanics dynamics heat transfer and fluid dynamics From conceptualizing an engineering experiment to conducting a comprehensive lab this book enables students to work through the entire experimental design process Offering a complete overview of instruction for engineering lab methodology the book includes practical lab manuals for student use directly complementing the instruction Numerous worked examples

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### **Table of Contents Friction Lab Answer Key**

1. Understanding the eBook Friction Lab Answer Key
  - The Rise of Digital Reading Friction Lab Answer Key
  - Advantages of eBooks Over Traditional Books
2. Identifying Friction Lab Answer Key
  - 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 Friction Lab Answer Key
  - User-Friendly Interface
4. Exploring eBook Recommendations from Friction Lab Answer Key
  - Personalized Recommendations

- Friction Lab Answer Key User Reviews and Ratings
- Friction Lab Answer Key and Bestseller Lists
- 5. Accessing Friction Lab Answer Key Free and Paid eBooks
  - Friction Lab Answer Key Public Domain eBooks
  - Friction Lab Answer Key eBook Subscription Services
  - Friction Lab Answer Key Budget-Friendly Options
- 6. Navigating Friction Lab Answer Key eBook Formats
  - ePub, PDF, MOBI, and More
  - Friction Lab Answer Key Compatibility with Devices
  - Friction Lab Answer Key Enhanced eBook Features
- 7. Enhancing Your Reading Experience
  - Adjustable Fonts and Text Sizes of Friction Lab Answer Key
  - Highlighting and Note-Taking Friction Lab Answer Key
  - Interactive Elements Friction Lab Answer Key
- 8. Staying Engaged with Friction Lab Answer Key
  - Joining Online Reading Communities
  - Participating in Virtual Book Clubs
  - Following Authors and Publishers Friction Lab Answer Key
- 9. Balancing eBooks and Physical Books Friction Lab Answer Key
  - Benefits of a Digital Library
  - Creating a Diverse Reading Collection Friction Lab Answer Key
- 10. Overcoming Reading Challenges
  - Dealing with Digital Eye Strain
  - Minimizing Distractions
  - Managing Screen Time
- 11. Cultivating a Reading Routine Friction Lab Answer Key
  - Setting Reading Goals Friction Lab Answer Key
  - Carving Out Dedicated Reading Time
- 12. Sourcing Reliable Information of Friction Lab Answer Key
  - Fact-Checking eBook Content of Friction Lab Answer Key

- 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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