

Solutions to Problems in Goldstein,
Classical Mechanics, Second Edition

Homer Reid

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Chapter 3

Problem 3.1

A particle of mass m is constrained to move under gravity without friction on the inside of a paraboloid of revolution whose axis is vertical. Find the one-dimensional problem equivalent to its motion. What is the condition on the particle's initial velocity to produce circular motion? Find the period of small oscillations about this circular motion.

We'll take the paraboloid to be defined by the equation $z = \alpha r^2$. The kinetic and potential energies of the particle are

$$\begin{aligned} T &= \frac{m}{2}(\dot{r}^2 + r^2\dot{\theta}^2 + \dot{z}^2) \\ &= \frac{m}{2}(\dot{r}^2 + r^2\dot{\theta}^2 + 4\alpha^2 r^2\dot{r}^2) \\ V &= mgz = mg\alpha r^2. \end{aligned}$$

Hence the Lagrangian is

$$L = \frac{m}{2}[(1 + 4\alpha^2 r^2)\dot{r}^2 + r^2\dot{\theta}^2] - mg\alpha r^2.$$

This is cyclic in θ , so the angular momentum is conserved:

$$l = mr^2\dot{\theta} = \text{constant}.$$

Goldstein Classical Mechanics Solutions Chapter 3

R Barnett



Goldstein Classical Mechanics Solutions Chapter 3:

This book delves into Goldstein Classical Mechanics Solutions Chapter 3. Goldstein Classical Mechanics Solutions Chapter 3 is an essential topic that must be grasped by everyone, ranging from students and scholars to the general public. The book will furnish comprehensive and in-depth insights into Goldstein Classical Mechanics Solutions Chapter 3, encompassing both the fundamentals and more intricate discussions.

1. This book is structured into several chapters, namely:
 - Chapter 1: Introduction to Goldstein Classical Mechanics Solutions Chapter 3
 - Chapter 2: Essential Elements of Goldstein Classical Mechanics Solutions Chapter 3
 - Chapter 3: Goldstein Classical Mechanics Solutions Chapter 3 in Everyday Life
 - Chapter 4: Goldstein Classical Mechanics Solutions Chapter 3 in Specific Contexts
 - Chapter 5: Conclusion
 2. In chapter 1, this book will provide an overview of Goldstein Classical Mechanics Solutions Chapter 3. This chapter will explore what Goldstein Classical Mechanics Solutions Chapter 3 is, why Goldstein Classical Mechanics Solutions Chapter 3 is vital, and how to effectively learn about Goldstein Classical Mechanics Solutions Chapter 3.
 3. In chapter 2, this book will delve into the foundational concepts of Goldstein Classical Mechanics Solutions Chapter 3. This chapter will elucidate the essential principles that must be understood to grasp Goldstein Classical Mechanics Solutions Chapter 3 in its entirety.
 4. In chapter 3, this book will examine the practical applications of Goldstein Classical Mechanics Solutions Chapter 3 in daily life. This chapter will showcase real-world examples of how Goldstein Classical Mechanics Solutions Chapter 3 can be effectively utilized in everyday scenarios.
 5. In chapter 4, the author will scrutinize the relevance of Goldstein Classical Mechanics Solutions Chapter 3 in specific contexts. This chapter will explore how Goldstein Classical Mechanics Solutions Chapter 3 is applied in specialized fields, such as education, business, and technology.
 6. In chapter 5, this book will draw a conclusion about Goldstein Classical Mechanics Solutions Chapter 3. The final chapter will summarize the key points that have been discussed throughout the book.
- This book is crafted in an easy-to-understand language and is complemented by engaging illustrations. It is highly recommended for anyone seeking to gain a comprehensive understanding of Goldstein Classical Mechanics Solutions Chapter 3.

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