Hibbeler Dynamics 13th Edition Chapter 17 Solutions

*12–20.

The velocity of a particle traveling along a straight line is $v = (3t^2 - 6t)$ ft/s, where t is in seconds. If $s = 4$ ft when $t = 0$, determine the position of the particle when $t = 4$ s. What is the total distance traveled during the time interval $t = 0$ to $t = 4$ s? Also, what is the acceleration when $t = 2$ s?

SOLUTION

Position: The position of the particle can be determined by integrating the kinematic equation $ds = v\,dt$ using the initial condition $s = 4$ ft when $t = 0$ s. Thus,

$(\overset{+}{\rightarrow})$ $$ds = v\,dt$$

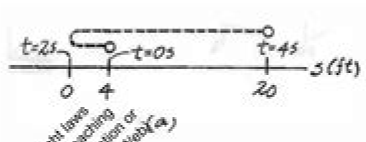
$$\int_{4\text{ ft}}^{s} ds = \int_0^t (3t^2 - 6t)\,dt$$

$$s\Big|_{4\text{ ft}}^{s} = (t^3 - 3t^2)\Big|_0^t$$

$$s = (t^3 - 3t^2 + 4)\text{ ft}$$

When $t = 4$ s,

$$s|_{4\text{ s}} = 4^3 - 3(4^2) + 4 = 20\text{ ft}$$



The velocity of the particle changes direction at the instant when it is momentarily brought to rest. Thus,

$$v = 3t^2 - 6t = 0$$

$$t(3t - 6) = 0$$

$$t = 0 \text{ and } t = 2\text{ s}$$

The position of the particle at $t = 0$ and 2 s is

$$s|_{0\text{ s}} = 0 - 3(0^2) + 4 = 4\text{ ft}$$

$$s|_{2\text{ s}} = 2^3 - 3(2^2) + 4 = 0$$

Using the above result, the path of the particle shown in Fig. *a* is plotted. From this figure,

$$s_{Tot} = 4 + 20 = 24\text{ ft}$$ **Ans.**

Acceleration:

$(\overset{+}{\rightarrow})$ $$a = \frac{dv}{dt} = \frac{d}{dt}(3t^2 - 6t)$$

$$a = (6t - 6)\text{ ft/s}^2$$

When $t = 2$ s,

$$a|_{t=2\text{ s}} = 6(2) - 6 = 6\text{ ft/s}^2 \rightarrow$$ **Ans.**

Hibbeler Dynamics 13th Edition Chapter 17 Solutions is a crucial resource for students and professionals in the field of engineering mechanics. This chapter focuses on the principles of dynamics, particularly on the analysis of rigid bodies in motion. Understanding the solutions provided in this chapter is essential for grasping concepts that are foundational for more advanced studies in engineering. This article delves into the key concepts from Chapter 17, solutions to common problems, and tips for mastering the material.

Overview of Chapter 17: Dynamics of Rigid

Bodies

Chapter 17 of Hibbeler's Dynamics primarily deals with the motion of rigid bodies. It emphasizes the principles of translation and rotation, covering various topics that include:

- Equations of Motion
- Kinematic Analysis
- Kinetic Energy
- Work-Energy Principle
- Impulse and Momentum

Understanding these elements is crucial for solving problems related to the dynamics of rigid bodies, making it a vital chapter for students pursuing courses in mechanical or civil engineering.

Kinematic Analysis in Dynamics

Kinematic analysis is vital for understanding the motion of rigid bodies. In this section, we explore the key concepts that are essential for solving problems in this chapter.

Definitions and Key Concepts

- Displacement: The change in position of a rigid body.
- Velocity: The rate of change of displacement.
- Acceleration: The rate of change of velocity.

These concepts form the foundation for analyzing the motion of rigid bodies. When approaching problems in Chapter 17, it’s important to accurately define these terms and apply them correctly.

Equations of Motion

The equations of motion describe the relationship between displacement, velocity, acceleration, and time. In the context of rigid bodies, the following equations are frequently used:

1. First Equation of Motion: $v = u + at$
2. Second Equation of Motion: $s = ut + \frac{1}{2}at^2$
3. Third Equation of Motion: $v^2 = u^2 + 2as$

Where:
- v = final velocity
- u = initial velocity

- a = acceleration
- s = displacement
- t = time

Mastering these equations is essential for solving kinematic problems in Chapter 17.

Kinetic Energy and Work-Energy Principle

Another significant aspect of dynamics covered in this chapter is the work-energy principle, which relates the work done on a rigid body to its kinetic energy.

Kinetic Energy

The kinetic energy (KE) of a rigid body can be expressed as:

$$KE = \frac{1}{2} mv^2$$

where m is the mass of the body and v is its velocity. Understanding how to calculate kinetic energy is crucial for solving many dynamics problems.

Work-Energy Principle

The work-energy principle states that the work done by the net force acting on a body equals the change in its kinetic energy. Mathematically, this can be expressed as:

$$W = \Delta KE$$

Where:
- W = work done on the body
- ΔKE = change in kinetic energy

Applying this principle helps in solving various problems related to motion and energy in rigid bodies.

Impulse and Momentum

Impulse and momentum are critical concepts in dynamics, particularly in understanding collisions and interactions between rigid bodies.

Momentum

Momentum (p) is defined as the product of mass and velocity:

$$p = mv$$

Understanding momentum is crucial when analyzing the motion of rigid bodies, especially during collisions.

Impulse

Impulse is defined as the change in momentum and can be calculated using the formula:

$$J = \Delta p = F \Delta t$$

Where:
- J = impulse
- F = force applied
- Δt = time duration of the force application

This relation is significant when solving problems that involve sudden forces acting on rigid bodies.

Common Problems and Solutions in Chapter 17

Students often face challenges when working through the problems presented in Chapter 17. Below are some common types of problems along with their solutions.

Example Problem 1: Kinematic Analysis

Problem Statement: A car accelerates from rest at a rate of $3 \, \text{m/s}^2$. Calculate the distance traveled after 5 seconds.

Solution:
Using the second equation of motion:

$$s = ut + \frac{1}{2}at^2$$

Where:
- $u = 0 \, \text{m/s}$
- $a = 3 \, \text{m/s}^2$
- $t = 5 \, \text{s}$

Calculating:

$$s = 0 \cdot 5 + \frac{1}{2} \cdot 3 \cdot (5^2) = \frac{1}{2} \cdot 3 \cdot 25 = 37.5 \, \text{m}$$

So, the distance traveled is $37.5 \, \text{m}$.

Example Problem 2: Work-Energy Principle

Problem Statement: A block of mass $10 \, \text{kg}$ is pushed with a force of $50 \, \text{N}$ for $4 \, \text{m}$. Find the change in kinetic energy.

Solution:
First, calculate the work done:

$$ W = F \cdot d = 50 \cdot 4 = 200 \, \text{J} $$

According to the work-energy principle:

$$ \Delta KE = W $$

Thus, the change in kinetic energy is $200 \, \text{J}$.

Tips for Mastering Chapter 17 Solutions

To effectively master the solutions in Hibbeler Dynamics 13th Edition Chapter 17, consider the following tips:

- Practice regularly: Solve a variety of problems to enhance your understanding of the concepts.
- Understand the principles: Focus on the underlying principles rather than just memorizing formulas.
- Use visual aids: Diagrams can help in understanding the motion of rigid bodies and the forces involved.
- Study in groups: Collaborating with peers can provide different perspectives on problem-solving.
- Seek help when needed: Don't hesitate to ask for help from instructors or tutors when you encounter difficult problems.

Conclusion

In summary, **Hibbeler Dynamics 13th Edition Chapter 17 Solutions** are integral to understanding the dynamics of rigid bodies. By mastering kinematic analysis, kinetic energy, the work-energy principle, impulse, and momentum, students can confidently tackle complex problems. Utilizing the tips and examples provided in this article will aid in navigating the challenges of this pivotal chapter, laying a strong foundation for future studies in engineering mechanics.

Frequently Asked Questions

What are the main topics covered in Chapter 17 of Hibbeler's Dynamics 13th edition?

Chapter 17 focuses on the principles of vibrations, including free vibrations of single-degree-of-freedom systems, damping, and the response of systems to harmonic forces.

Where can I find solutions for the problems in Chapter 17 of Hibbeler's Dynamics?

Solutions for Chapter 17 can typically be found in the accompanying solutions manual or through educational resources like university websites, tutoring centers, or online platforms that provide study aids.

What types of problems are typically included in Chapter 17 of Hibbeler's Dynamics?

Problems in Chapter 17 usually involve calculating natural frequencies, damping ratios, and the response of vibrating systems to external forces, including examples with springs and masses.

How does Chapter 17 of Hibbeler's Dynamics relate to real-world engineering applications?

Chapter 17 is crucial for understanding how structures and mechanical systems respond to dynamic loads, which is essential for design considerations in civil, mechanical, and aerospace engineering.

What is the significance of understanding vibrations in engineering as discussed in Hibbeler's Dynamics?

Understanding vibrations is important for predicting the behavior of structures and machinery under dynamic loads, ensuring safety, stability, and longevity in engineering designs.

Are there any online resources or forums for discussing Hibbeler's Dynamics Chapter 17 solutions?

Yes, there are several online forums, including Reddit, Chegg, and various engineering study groups, where students can discuss and seek help on Chapter 17 solutions and concepts.

Hibbeler Dynamics 13th Edition Chapter 17 Solutions

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