Palestine Technical University- Kadoorie (PTUK)

Mechanical Engineering Department

12210244: Dynamics

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This is an explanation of the Dynamics course

offered at Palestine Technical University - Kadoorie

Prepared by:

Dr. Hammam Daraghma

Textbook:

Engineering Mechanics: Dynamics, 7th Edition

Author:

J.L. Meriam and L.G. Kraige, 2013

Chapter Three: Kinetics of Particles

Section One: Introduction

3 Chapter Three: Kinetics of Particles

3.1 Introduction

The three general approaches to the solution of kinetics problems are:

1. Direct application of Newton's second law (called the force-mass-acceleration method)
2. Use of work and energy principles
3. Solution by impulse and momentum methods

Each approach has its special characteristics and advantages, and Chapter 3 is subdivided into Parts A, B, and C, according to these three methods of solution.

Part A: Force, Mass, and Acceleration

- A-1 **Newton's Second Law**
- A-2 **Equation of Motion and Solution of Problems**
- A-3 **Rectilinear Motion**
- A-4 **Curvilinear Motion**

Part B: Work and Energy

- B-1 **Work and Kinetic Energy**
- B-2 **Potential Energy**

Part C: Impulse and Momentum

- C-1 **Linear Impulse and Linear Momentum**
- C-2 **Angular Impulse and Angular Momentum**

End of Section 3.1

3.2 Newton's Second Law

$$\vec{F} = m\vec{a}$$

Units

Quantity	SI Unit	US Customary Unit
Force	N	lbf
Mass	kg	slug
Acceleration	m/s^2	ft/s^2

Conversion Factors and Acceleration due to Gravity

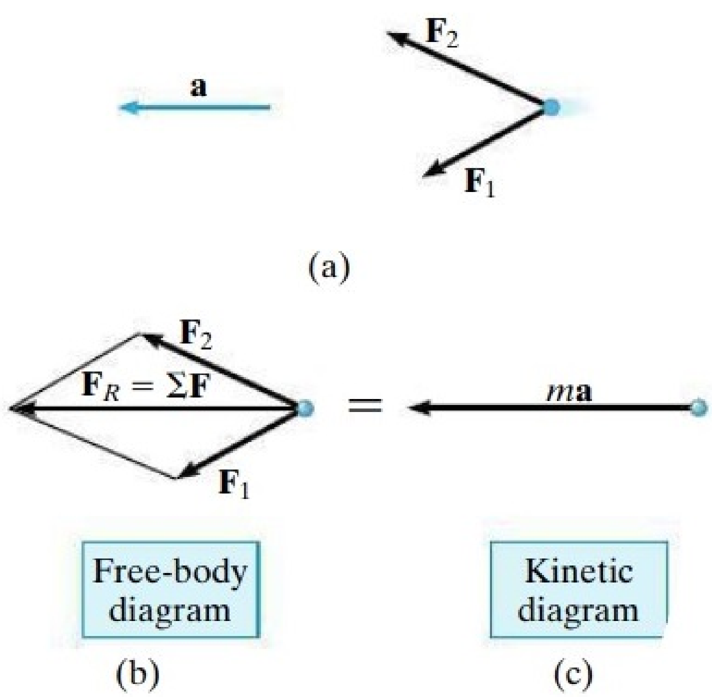
Quantity	SI Unit	US Customary Unit	Conversion Factor
Force	Newton (N)	Pound-force (lbf)	$1\ \text{N} = 0.22481\ \text{lbf}$
Mass	Kilogram (kg)	Slug	$1\ \text{kg} = 0.0685218\ \text{slug}$

Acceleration due to Gravity (g):

Unit	Value
SI (m/s^2)	9.81
US Customary (ft/s^2)	32.2

End of Section 3.2

3.3 Equation of Motion



$$\sum \vec{F} = m\vec{a}$$

End of Section 3.3

4 Rectilinear Motion

$$\sum \boldsymbol{F_x} = \boldsymbol{m a_x}$$

$$\sum \boldsymbol{F_y} = \boldsymbol{m a_y}$$

$$\sum \boldsymbol{F_z} = \boldsymbol{m a_z}$$

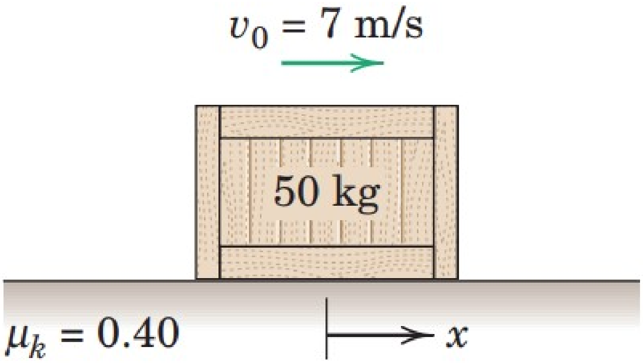
$$\vec{\boldsymbol{a}} = \boldsymbol{a_x} \hat{\boldsymbol{i}} + \boldsymbol{a_y} \hat{\boldsymbol{j}}$$

$$\sum \vec{\boldsymbol{F}} = \sum \boldsymbol{F_x} \hat{\boldsymbol{i}} + \sum \boldsymbol{F_y} \hat{\boldsymbol{j}}$$

Example 1:

The 50-kg crate is projected along the floor with an initial speed of 7 m/s. The coefficient of kinetic friction is 0.40. Calculate the time required for the crate to come to rest and the corresponding distance x traveled.

$ans.$ $t = 1.78\ sec$ $x = 6.25\ m$



Ans.

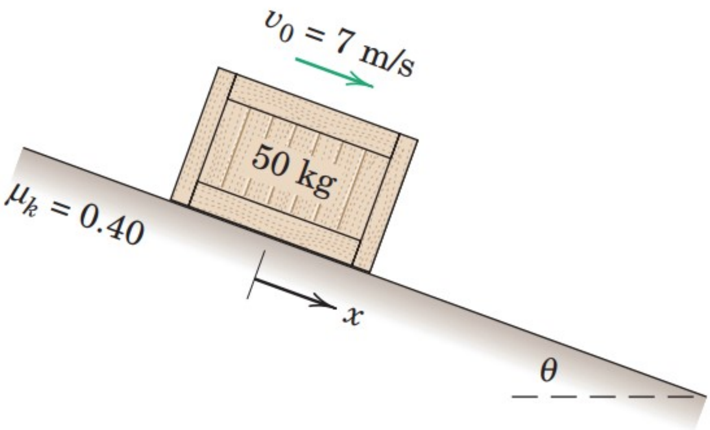
Example 2:

The 50-kg crate is projected down an incline as shown with an initial speed of 7 m/s. Investigate the time t required for the crate to come to rest and the corresponding distance x traveled if:

(a) $\theta = 15°$

(b) $\theta = 30°$

ans. $a)\ t = 5.6\ sec \quad x = 19.6\ m \quad b)\ t = N/A \quad x = N/A$



Ans.

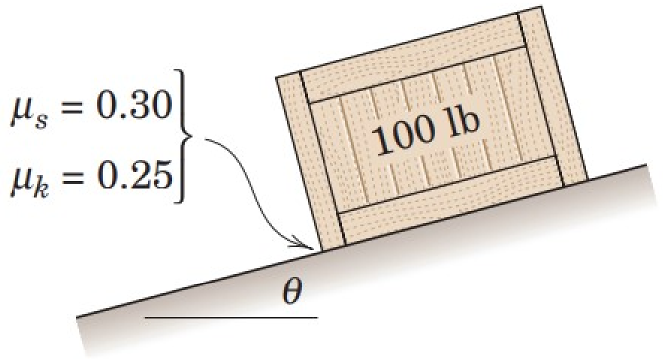
Example 3:

The 100-lb crate is carefully placed with zero velocity on the incline. Describe what happens if:

(a) $\theta = 15°$

(b) $\theta = 20°$

ans. $a)\ t = 5.6\ sec \quad x = 19.6\ m \quad b)\ t = N/A \quad x = N/A$

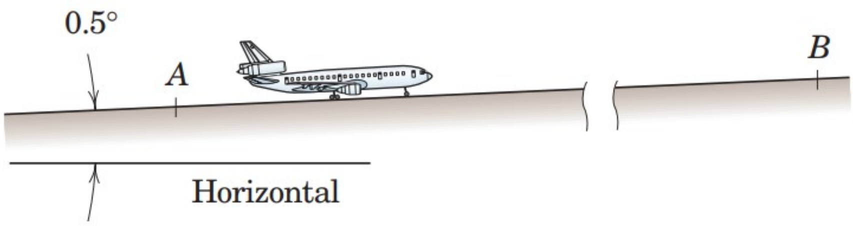


Ans.

Example 4:

The 300-Mg jet airliner has three engines, each of which produces a nearly constant thrust of 240 KN during the takeoff roll. Determine the length s of runway required if the takeoff speed is 220 Km/hr. Compute s first for an uphill takeoff direction from A to B and second for a downhill takeoff from B to A on the slightly inclined runway. Neglect air and rolling resistance.

ans. $s_u = 807\ m$ and $s_d = 750\ m$

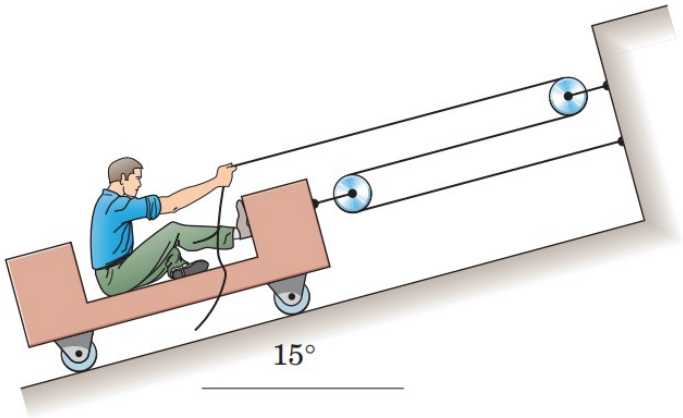


Ans.

Example 5:

A man pulls himself up the incline by the method shown. If the combined mass of the man and cart is 100 kg, determine the acceleration of the cart if the man exerts a pull of 250 N on the rope. Neglect all friction and the mass of the rope, pulleys, and wheels.

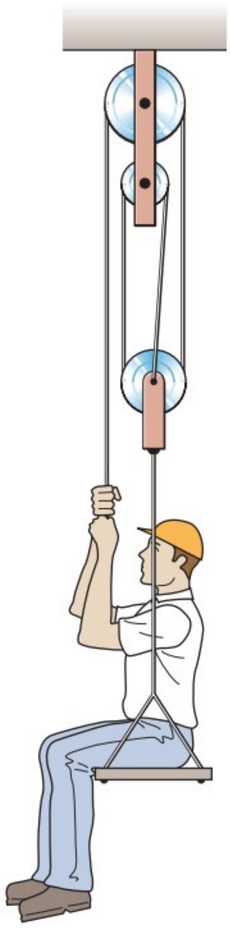
ans. $a = 4.96\ m/sec^2$



Ans.

Example 6:

The 180-lb man in the bosun's chair exerts a pull of 50 lb on the rope for a short interval. Find his acceleration. Neglect the mass of the chair, rope, and pulleys.
ans. $a = 3.58\ ft/sec^2\ Up$



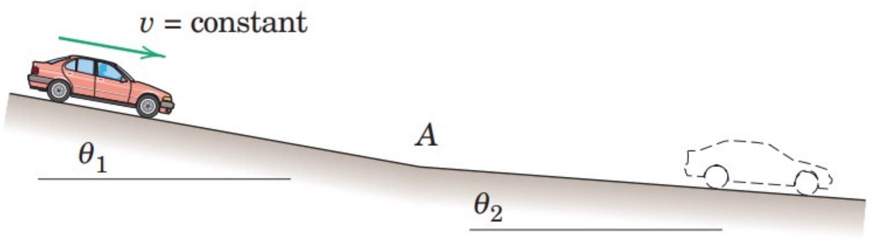
Ans.

Example 7:

A driver finds that her car will descend the slope $\theta_1 = 3°$ at a certain constant speed with no brakes or throttle required. The slope decreases fairly abruptly to θ_2 at point A. If the driver takes no action but continues to coast, determine the acceleration a of the car just after it passes point A for the conditions:

1. $\theta_2 = 1.5°$
2. $\theta_2 = 0°$

ans. 1. $a = -0.257\ m/sec^2$ 2. $a = -0.513\ m/sec^2$

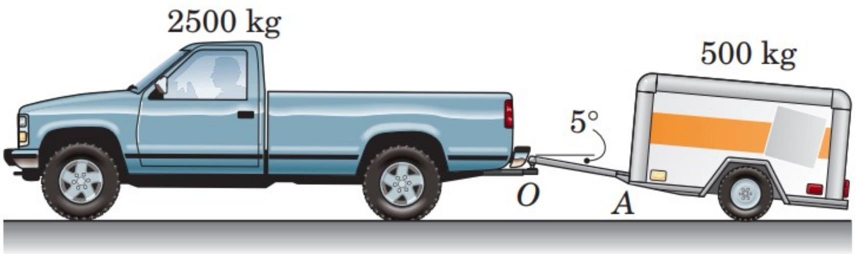


Ans.

Example 8:

By itself, the 2500-kg pickup truck executes a 0–100 km/h acceleration run in 10 s along a level road. What would be the corresponding time when pulling the 500-kg trailer? Assume constant acceleration and neglect all retarding forces.

ans. $t = 0.075\ sec$ and $s = 4.47\ m$



Ans.