Vp140 Recitation III

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June 6, 2019

Overview

Newton's First law

Newton's First Law

A body acted on by no net force has a constant velocity (which may be zero) and zero acceleration.

Inertia

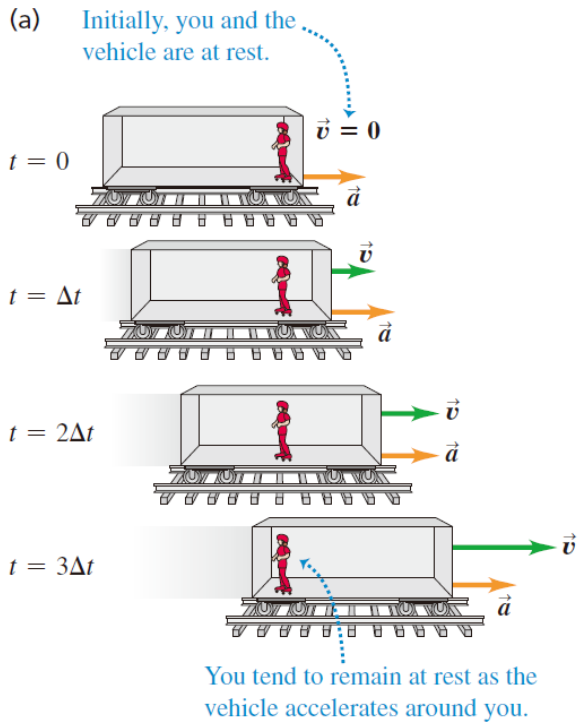
The tendency of a body to keep moving once it is set in motion.

Inertial frame of reference

Definition

A frame of reference in which Newton's first law is valid.

Example



Second and third laws

Newton's second law

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

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Newton's third law

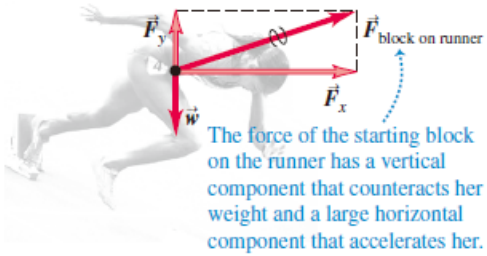
$$\vec{F}_{A \text{ on } B} = -\vec{F}_{B \text{ on } A}$$

Free body diagram

Free body diagram

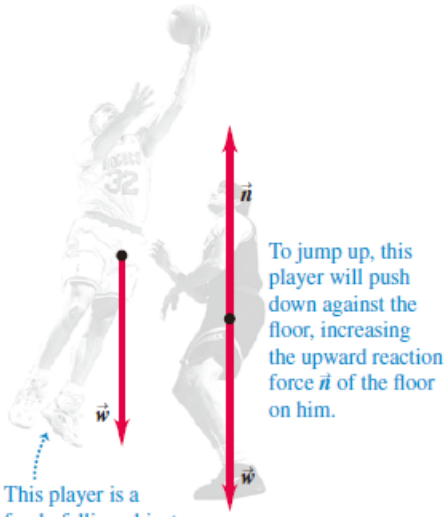
4.29 Examples of free-body diagrams. Each free-body diagram shows all of the external forces that act on the object in question.

(a)



The force of the starting block on the runner has a vertical component that counteracts her weight and a large horizontal component that accelerates her.

(b)

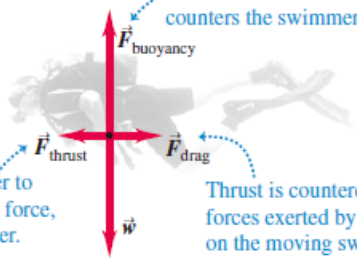


To jump up, this player will push down against the floor, increasing the upward reaction force $\vec{n}$ of the floor on him.

This player is a freely falling object.

(c)

The water exerts a buoyancy force that counters the swimmer's weight.



Kicking causes the water to exert a forward reaction force, or thrust, on the swimmer.

Thrust is countered by drag forces exerted by the water on the moving swimmer.

Exercise I

Free body diagram

Mark all forces acting on an object placed on:

1. a horizontal surface;
2. an inclined rough plane.

Exercise II

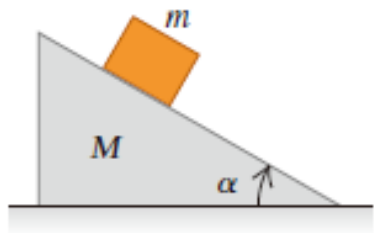
Newton's Law

A wedge with mass M rests on a frictionless, horizontal tabletop. A block with mass m is placed on the wedge. There is no friction between the block and the wedge. The system is released from rest.

a. Calculate the acceleration of the wedge and the horizontal and vertical components of the acceleration of the block.

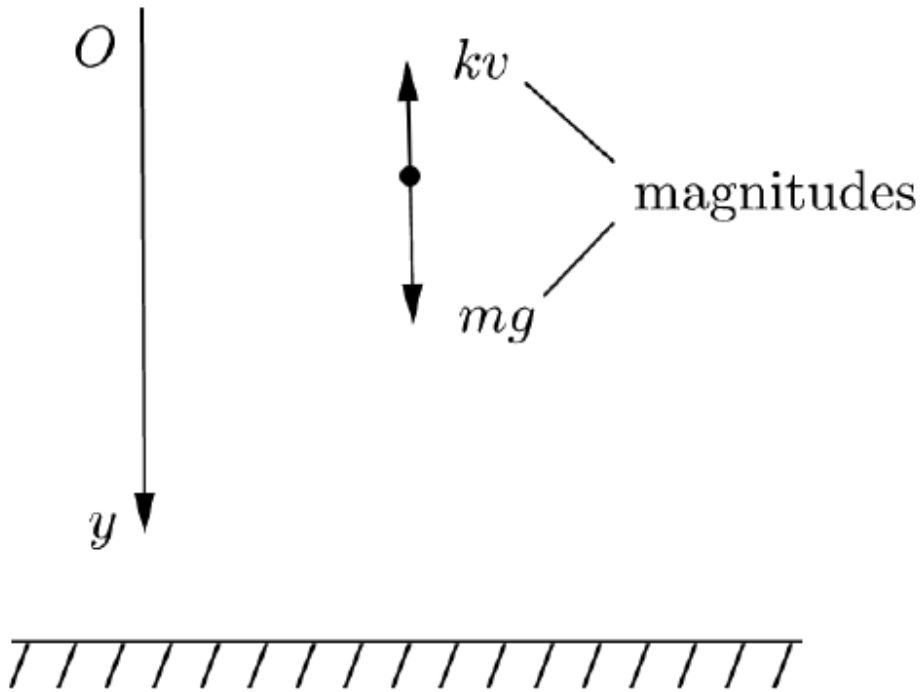
b. Do your answers to part (a) reduce to the correct results when M is very large?

c. As seen by a stationary observer, what is the shape of the trajectory of the block?



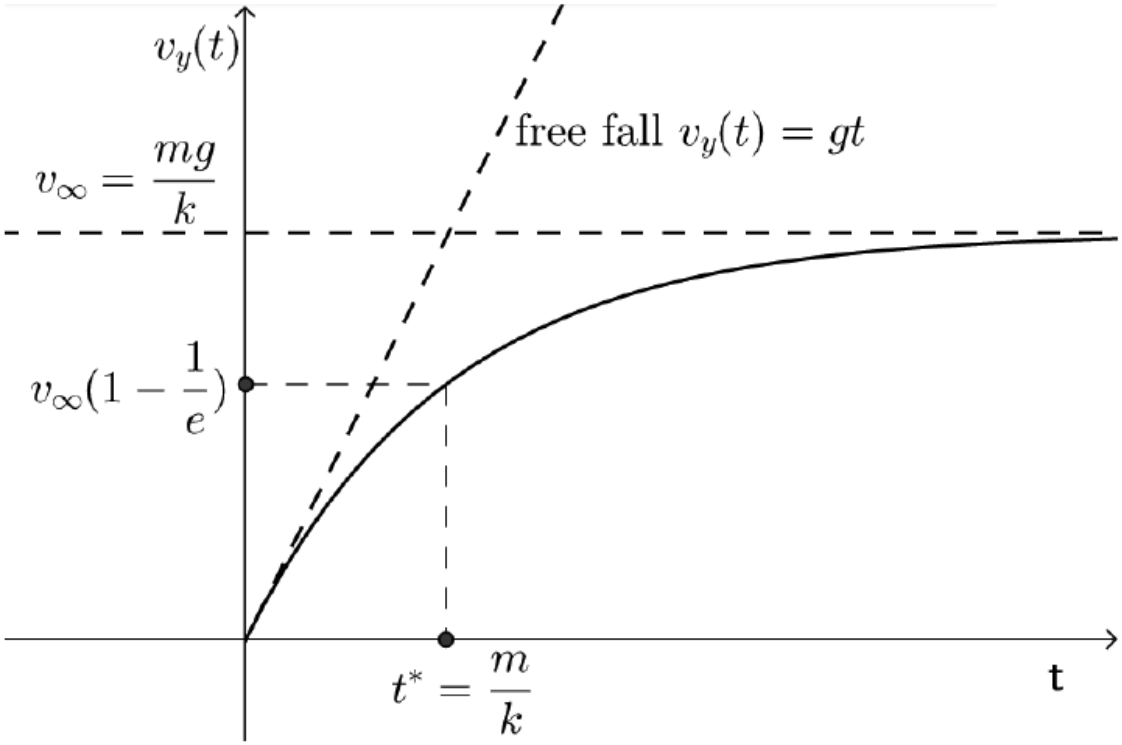
Linear drag

Figure



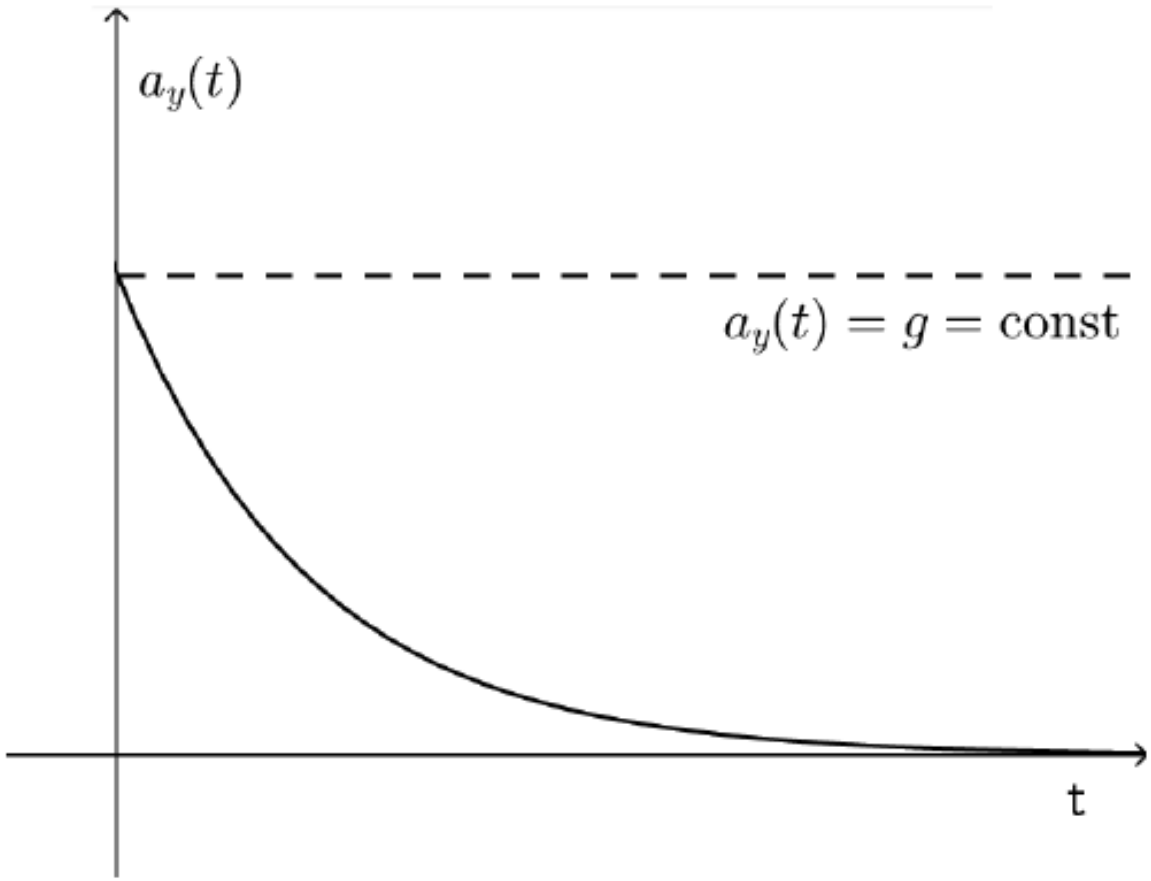
Linear drag

v-t relation



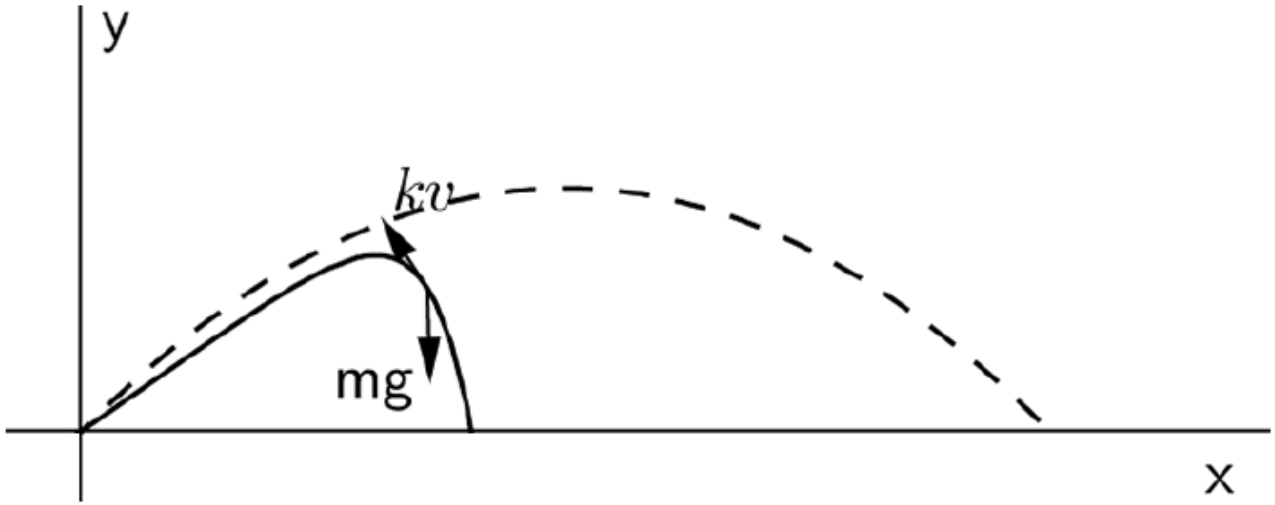
Linear drag

a-t relation



Projectile motion with linear air drag

Figure



Observation

1. reduces the maximum height
2. shortens the range

Simple Harmonic Oscillator

Simple Harmonic Oscillator

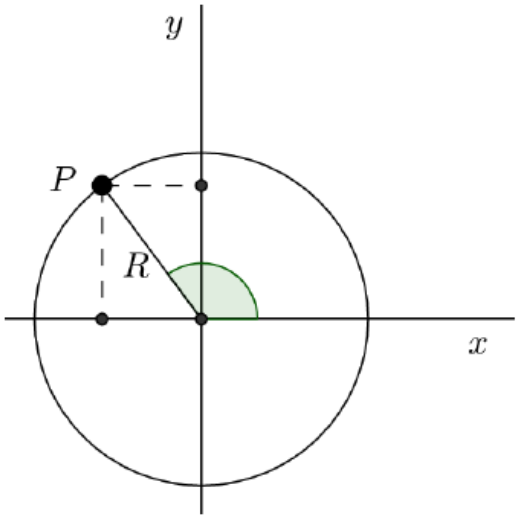
$$\ddot{x} + \omega_0^2 x = 0$$

General Solution

$$x(t) = A\cos(\omega_0 t + \phi)$$

Back to uniform circular motion

Figure



Observation

The projection of P onto the x axis (or the y axis) moves as if it was in a simple harmonic motion.

Exercise III

Oscillation

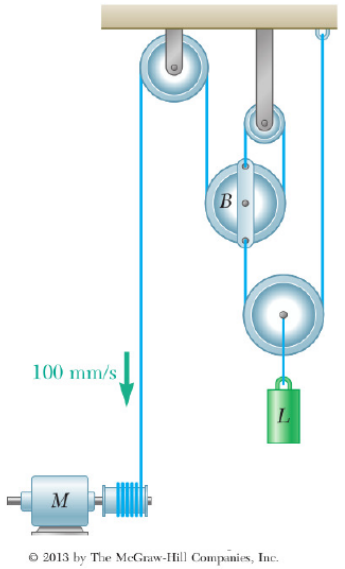
An object is undergoing SHM with period 0.300 s and amplitude 6.00 cm. At t = 0 the object is instantaneously at rest at x = 6.00 cm. Calculate the time it takes the object to go from x = 6.00 cm to x = -1.50 cm.

Homework2-P1

Figure

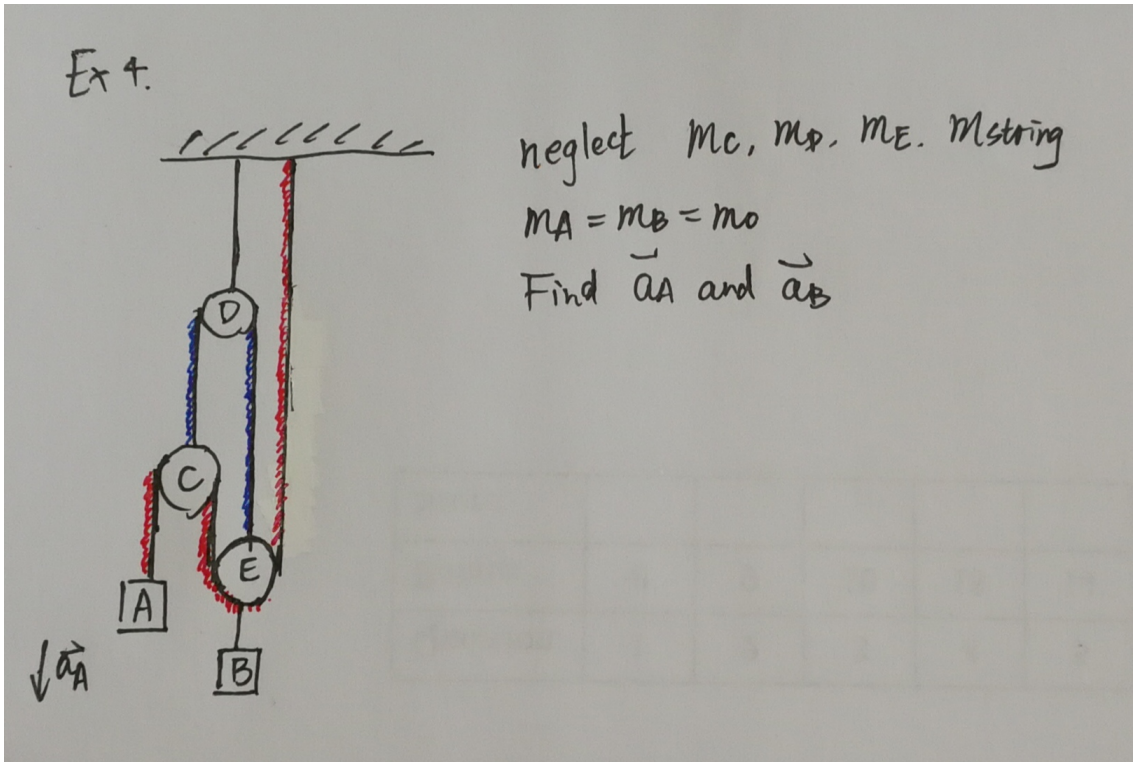
Problem 1. The motor M reels in the cable at a constant rate of 100 mm/s. Determine (a) the velocity of load L, (b) the velocity of pulley B with respect to load L.

(1 + 1 points)



Exercise IV

Figure



The End

- Office hour: Wed 8:00-10:00 (Discussion Room 326I)
- Email: *zhanghaomeng@sjtu.edu.cn*