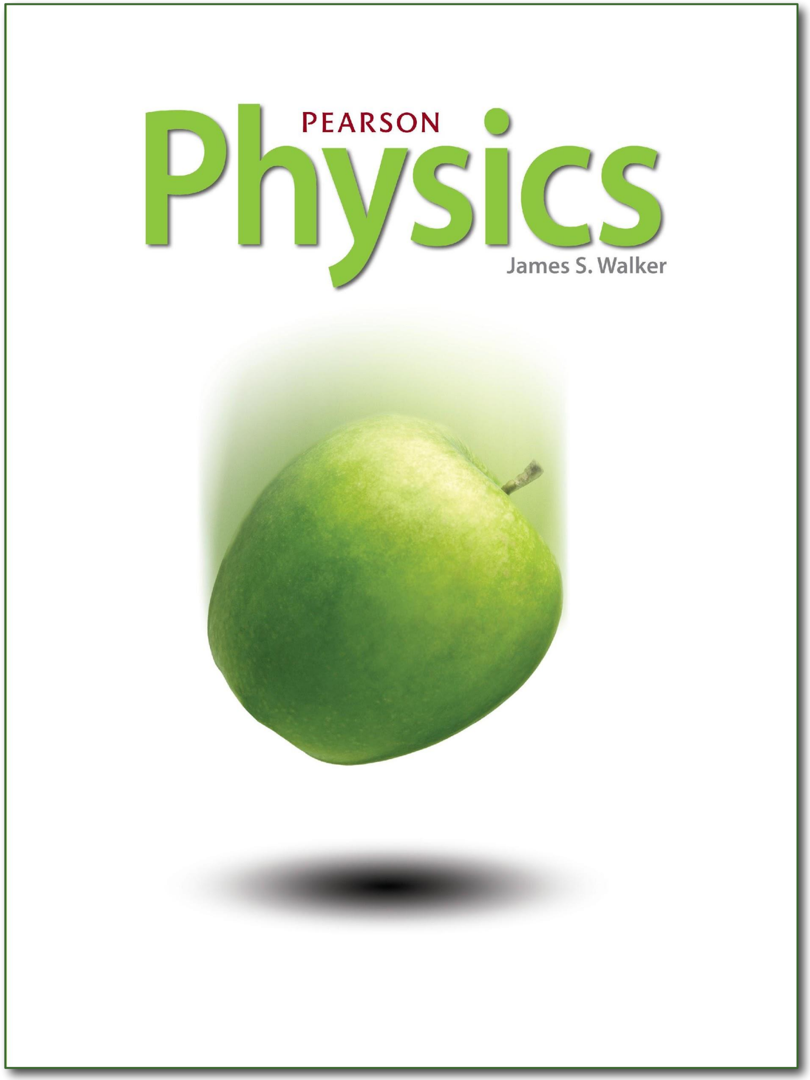
Chapter 3 Lecture

Pearson Physics



Acceleration and Accelerated Motion

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Learning Target

I will be able to identify whether an object is accelerating .

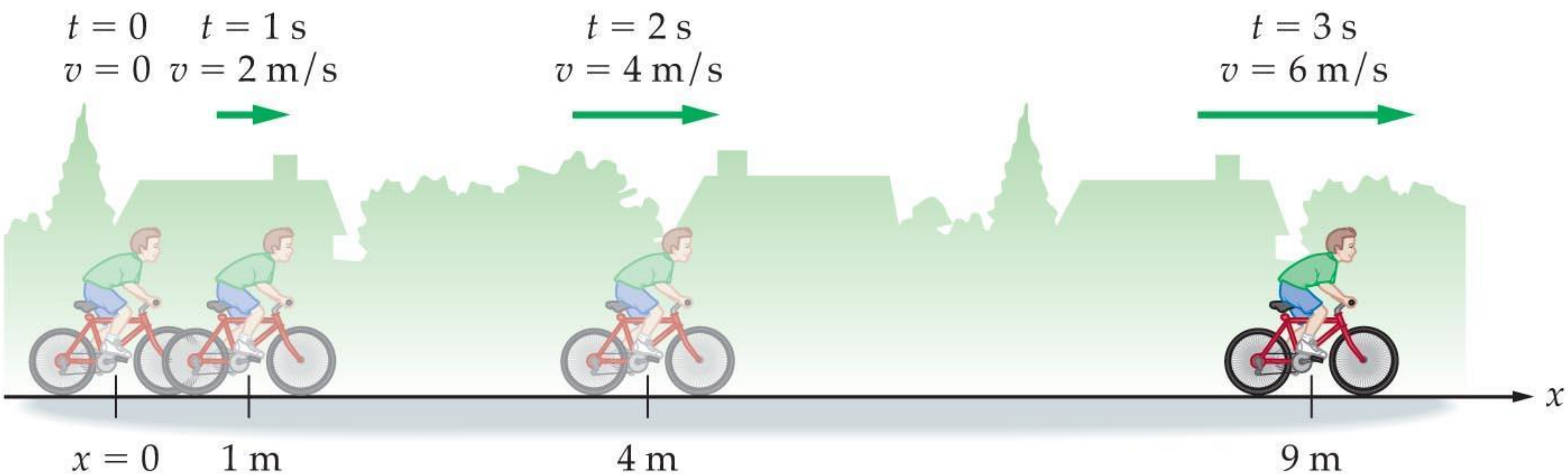
I will be able to calculate the average acceleration for an object.

Acceleration

- Acceleration is the rate at which velocity changes with time.
- The velocity changes
  - when the speed of an object changes.
  - when the direction of motion changes.
- Therefore, acceleration occurs when there is a change in speed, a change in direction, or a change in both speed and direction.

Acceleration

- Example: A cyclist accelerates by increasing his speed 2 m/s every second. After 1 second his speed is 2 m/s, after 2 seconds his speed is 4 m/s, and so on.



Acceleration

- While the human body cannot detect constant velocity, it can sense acceleration.
- Passengers in a car
  - feel the seat pushing forward on them when the car speeds up.
  - feel the seat belt pushing back on them when the car slows down.
  - tend to lend to one side when the car rounds a corner.


Acceleration?
400k+
views

Accelerating or NOT?

- A boy walks down the street at 3 m/s and decides to turn right.
- A car sets cruise control to 50 miles/hour on a curvy road.
- A boy walks down the street in a straight line at 4 m/s.

Acceleration

- Average acceleration of an object is the change in its velocity divided by the change in time.
- Stated mathematically, the definition of average acceleration a_{av} is

$$a_{av} = \frac{\text{change in velocity}}{\text{change in time}} = \frac{\Delta v}{\Delta t} = \frac{v_f - v_i}{\Delta t}$$

Acceleration

- The dimensions of average acceleration are the dimensions of velocity per time or (meters per second) per second. That is,

$$\frac{\text{meters per second}}{\text{second}} = \frac{\text{m/s}}{\text{s}} = \frac{\text{m}}{\text{s}^2}$$

- Written symbolically as m/s^2, the units of average acceleration are expressed as "meters per second squared."

Example:

1. car accelerates from 50m/s to 100m/s in 10 seconds.
   a. What is the initial velocity? 50m/s
   b. What is the final velocity? 100m/s
   c. What is the time? 10 s
   d. What is the acceleration? (SHOW WORK)

$$\frac{(100-50\text{m/s})}{10\text{s}} = 5\ \text{m/s}^2$$

Practice

1. A car accelerates from 20m/s to 30m/s in 5 seconds.
    a. What is the initial velocity?
    b. What is the final velocity?
    c. What is the time?
    d. What is the acceleration? (SHOW WORK)

GUESS Problem Solving Method

G- Stands for Given

U- Stands for Unknown

E- Stands for Equation

S- Stands for Substitute

S- Stands for Solve

G- Given

A freight train is traveling with a velocity of 18.0 m/s begins braking as it approaches a train yard. The train's acceleration while braking is -0.33 m/s^2. What is the train's velocity after 23 s?

Givens:

initial velocity = 18.0 m/s

acceleration = -0.33m/s^2

time = 23 s

U - Unknown

A freight train is traveling with a velocity of 18.0 m/s begins braking as it approaches a train yard. The train's acceleration while braking is -0.33 m/s^2. What is the train's velocity after 23 s?

$$a = \frac{\text{(final velocity - initial velocity)}}{\text{Time}}$$

Unknown = final velocity

E = Equation

$$a = \frac{(V_f - V_i)}{t}$$

$$t = \frac{(V_f - Vi)}{a}$$

$$Vf = at + Vi$$

$$Vi = Vf - at$$

S - Substitute

Givens:

initial velocity = 18.0 m/s

acceleration = -0.33m/s^2

time = 23 s

$$V_f = at + Vi$$

$$V_f = (-0.33m/s^2)(23s) + 18m/s$$

S - Solve

$$Vf = (-0.33m/s^2)(23s) + 18m/s$$

$$Vf = 10.4\ m/s$$

Your Turn

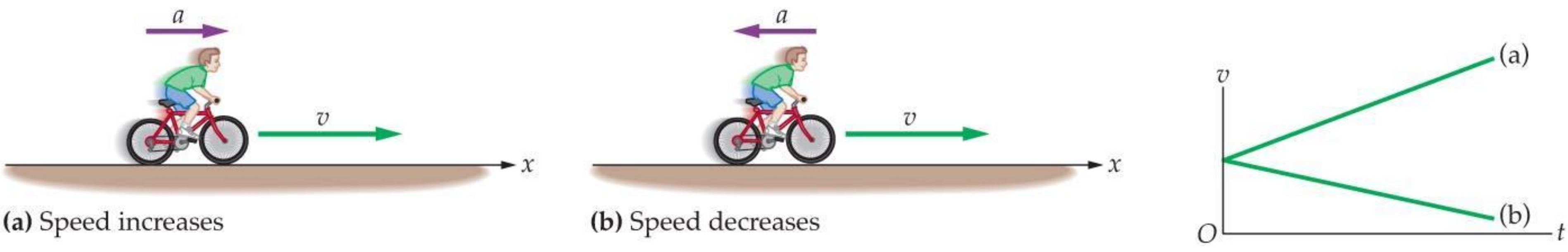
Work on the five practice problems.

When you are done raise your hand to have your answers checked.

Velocity Vs. Time Graphs

Acceleration

- The speed of an object increases when its velocity and acceleration are in the same direction, but decreases when its velocity and acceleration are in opposite directions.

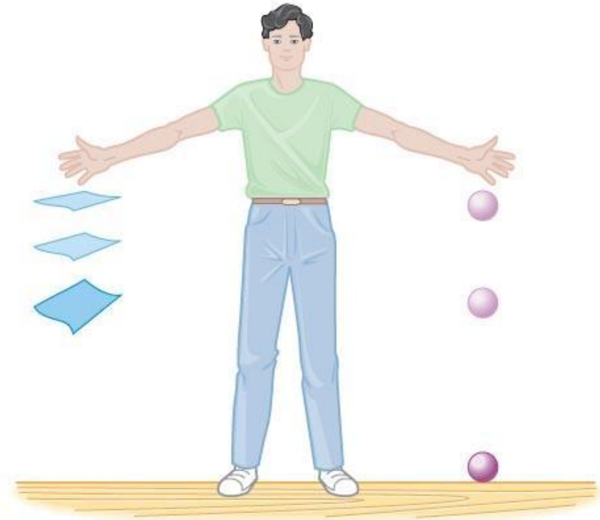


Free Fall

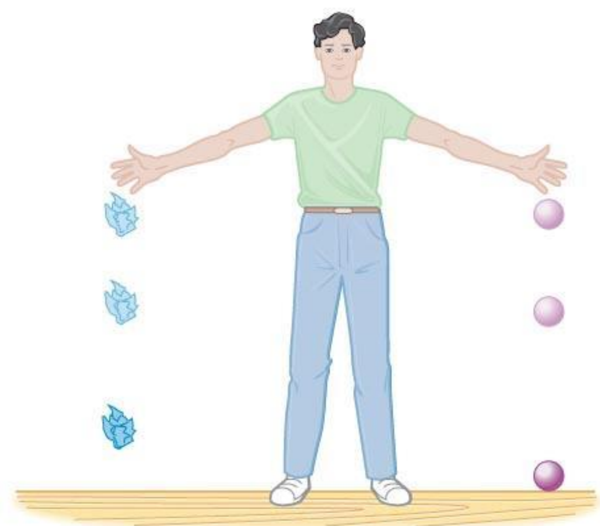
- Free fall refers to motion determined solely by gravity, free from all other influences.
- Galileo concluded that if the effects of air resistance can be neglected, then all objects have the same constant downward acceleration.

Free Fall

- The motion of many falling objects approximate free fall. A wadded-up sheet of paper approximates free-fall motion since the effects of air resistance are small enough to ignore.



(a) Dropping a sheet of paper and a rubber ball



(b) Dropping a wadded-up sheet of paper and a rubber ball

Free Fall

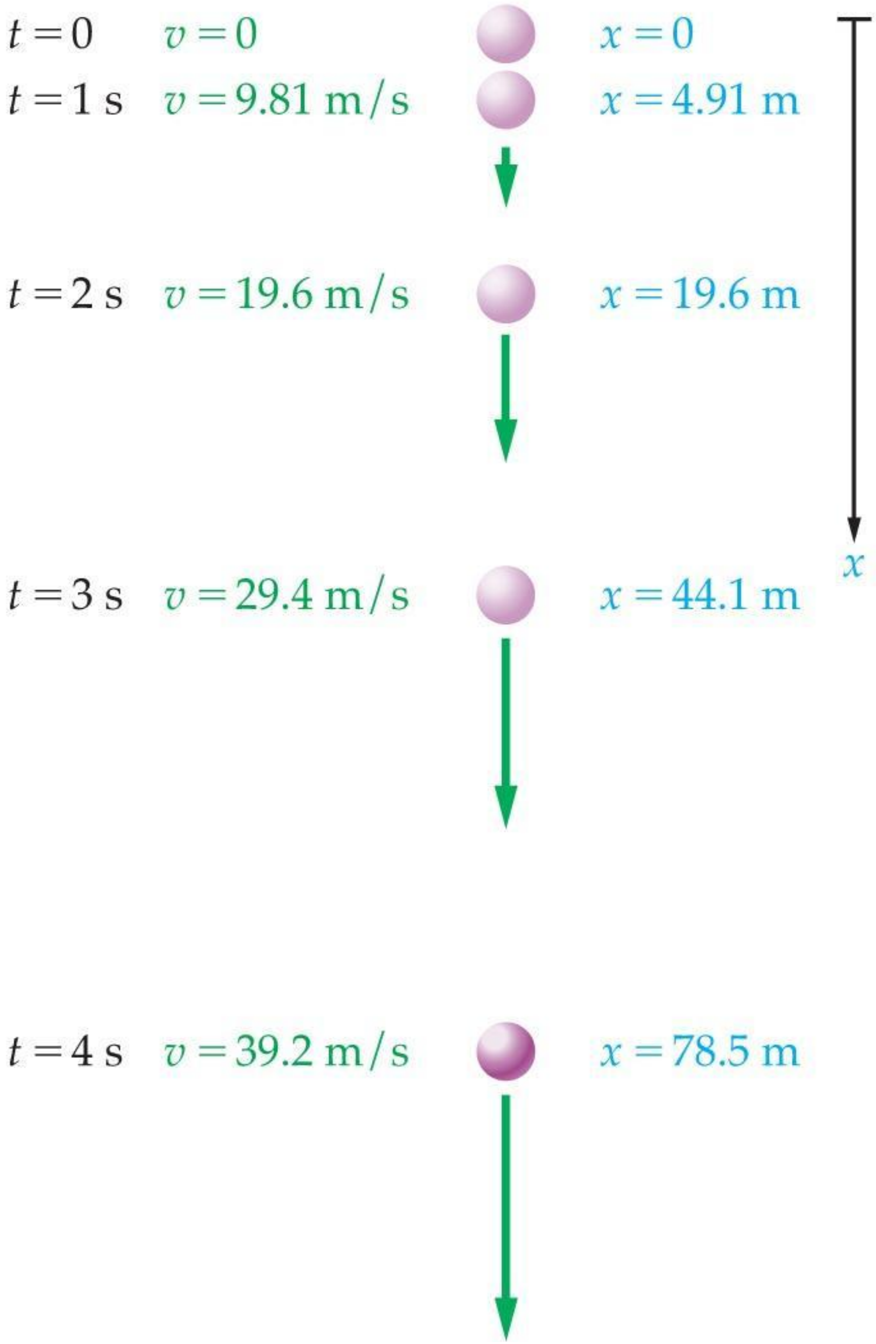
- Freely falling objects are always accelerating.
- For an object tossed into the air, the acceleration is the same on the way up, at the top of the flight, and on the way down, regardless of whether the object is thrown upward or downward or just dropped.

Free Fall

- The acceleration produced by gravity at the Earth's surface is denoted with the symbol *g*.
- In our calculations we will use $g = -9.8\ m/s^2$;

Free Fall

- The constant acceleration equations of motion can be used to determine the position and velocity of a freely falling object by substituting *g* for *a*.
- The velocity of an object in free fall increases linearly with time. The distance increases with time squared.



Free Fall

- The motion of objects in free fall is symmetrical.
- A position-time graph of free-fall motion reveals this symmetry.