

General Physics A - PHY 2048C

Concepts of Motion



08/28/2019

My Office Hours:

Thursday 2:00 - 3:00 PM

212 Keen Building

Some Sensible Advice

- **Physics is (mostly) based on understanding, and not memorizing.** We will do all we can to help you, but only you know if you really understand something or not! Work in groups and discuss physics problems.
- **Test yourself on additional problems!**
- When you prepare for the exams, make sure you understand and can do all the homework problems. You are strongly encouraged to do extra problems. **Again, do not just memorize the solutions.**
- **Attend all classes!** There happens to be a strong correlation between lecture attendance and student performance.
- **TutoringZone *et al.*** will cost you a lot of money!

What is
Motion?

Position and
Displacement

Velocity and
Speed

- 1 What is Motion?
- 2 Position and Displacement
- 3 Velocity and Speed

The Motions of the Planets

What is
Motion?

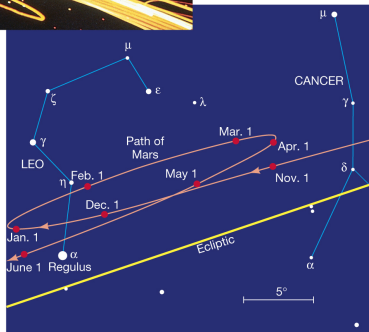
Position and
Displacement

Velocity and
Speed

Sun, Moon, and stars all have simple movements in the sky, consistent with an earth-centered system:

Moon moves smoothly and steadily.

Sun progresses along ecliptic at (almost) constant rate, varying little in brightness.



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Aristotle: 384 - 322 B.C.

- At age 17, he entered Academy of Plato
→ Later founded his own school.
- His systematic approach became method from which Western science arose.
- Knowledge got lost in the Dark (Medieval) Ages.

Two main classes of motion

- 1 Natural Motion
- 2 Violent Motion

Natural state is one of rest.



Mechanics

Mechanics is concerned with the motion of objects.

Two questions need to be answered to understand mechanics:

- 1 What causes motion or a change in motion?
- 2 Given a particular situation, how will an object move?

Mechanics

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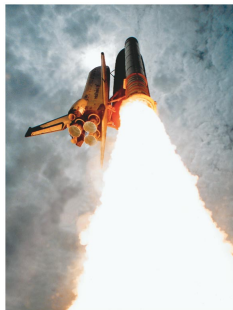
- 1 What causes motion or a change in motion?
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Motion

One way to think about motion is in terms of velocity.

Velocity is a vector quantity:

- The magnitude is the distance traveled in one second.
- The direction is the direction of motion.



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Question 1

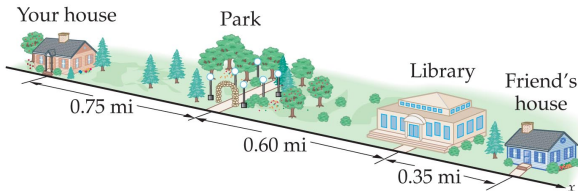
What is
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Velocity and
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In one-dimensional motion, the average speed of an object that moves from one place to another and then back to its original place has which of the following properties?

- A It is positive.
- B It is negative.
- C It is zero.
- D It can be positive, negative, or zero.



Question 1

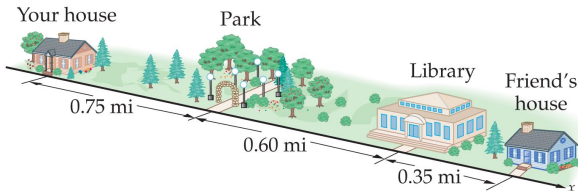
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Question 2

What is
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Velocity and
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In one-dimensional motion where the direction is indicated by a plus or minus sign, the average velocity of an object has which of the following properties?

- A It is positive.
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Question 2

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The magnitude of the velocity is called the speed and is a scalar quantity. The speed cannot be negative.

Remember that speed and velocity are not the same!

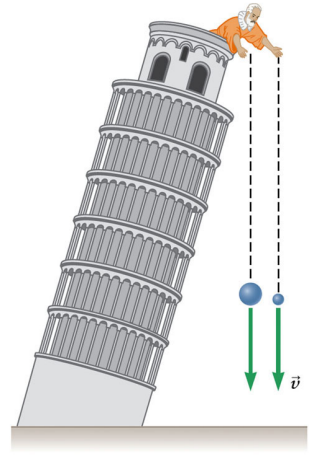
Failure of Aristotle's Laws

What is
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Aristotle thought the velocity of the object was proportional to the force acting on it.



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Failure of Aristotle's Laws

What is
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Position and
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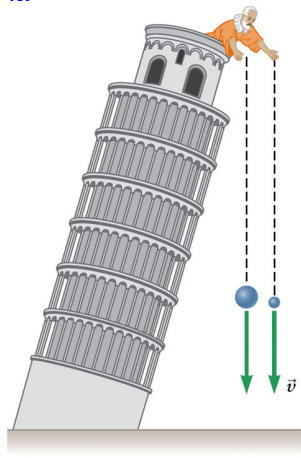
Velocity and
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Aristotle thought the velocity of the object was proportional to the force acting on it.

Question

Which object will fall faster?

- 1 The heavy object.
- 2 The light object.
- 3 Light objects fall at the same rate as heavy objects.



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Failure of Aristotle's Laws

What is
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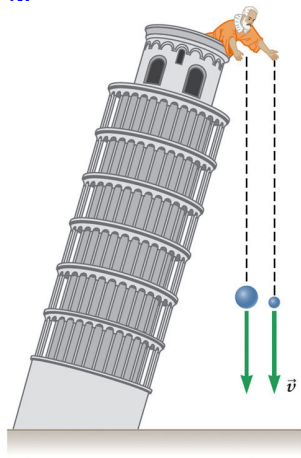
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What is Motion?

What is
Motion?

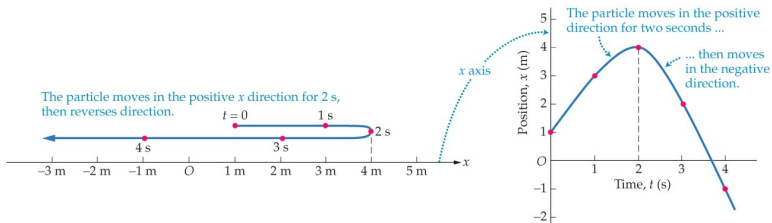
Position and
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Velocity and
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Motion is defined in terms of various concepts:

- Position
- Velocity
- Acceleration

Motion can be illustrated by a *motion diagram*.



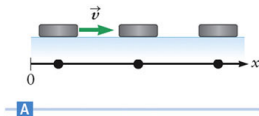
(a) The particle's path shown on a coordinate axis

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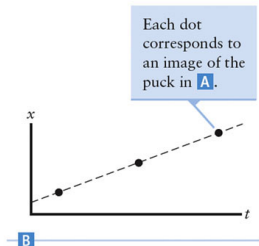
(b) The same path as a graph of position x versus time t

What is Motion?

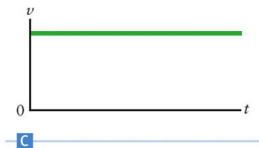
A shows a motion diagram
→ Multiple images of a hockey puck traveling across an icy surface.



B shows a position - time
graph of the motion
→ The dots correspond to
the images of the puck.



C shows a velocity - time
graph of the motion.



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- 1 What is Motion?
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Position and Displacement

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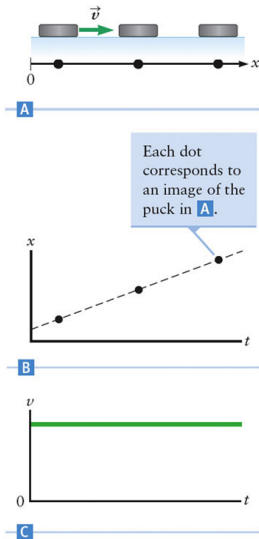
An object's change in position is its *displacement*:

$$\Delta x = x_{\text{final}} - x_{\text{initial}}$$

Average velocity is the displacement per unit time:

$$v_{\text{ave}} = \frac{x_{\text{final}} - x_{\text{initial}}}{t_{\text{final}} - t_{\text{initial}}} = \frac{\Delta x}{\Delta t}$$

If an object moves with a constant speed, then the average velocity is constant throughout the motion.



Position and Displacement

What is
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Velocity and
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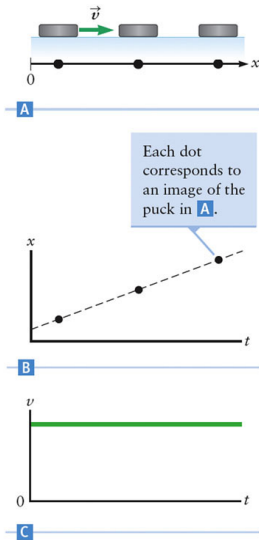
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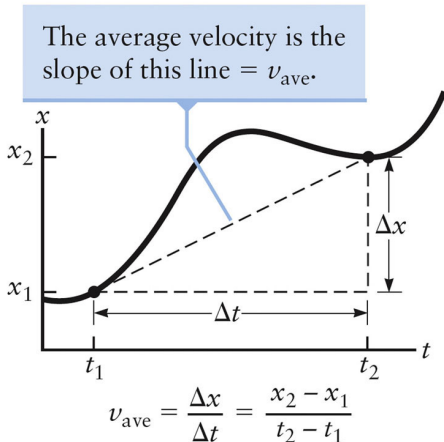
Position and
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Velocity and Position

In general, the average velocity is the slope of the line segment that connects the positions at the beginning and end of the time interval.



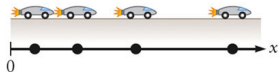
Example of Velocity

What is
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Position and
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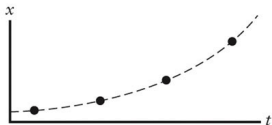
Velocity and
Speed

A shows a multiple exposure sketch of a rocket powered car.



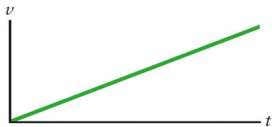
A

B shows the position – time graph.



B

C shows the velocity – time graph.



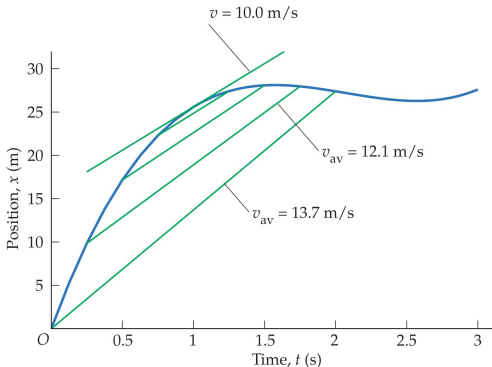
C

In this case, the speed of the car increases with time.

Instantaneous Velocity

Average velocity does not tell us anything about details during the time interval. The slope of the curve at the time of interest will give the instantaneous velocity at that time:

$$v = \lim_{\Delta t \rightarrow 0} \frac{\Delta x}{\Delta t}$$



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Velocity of a Bicycle

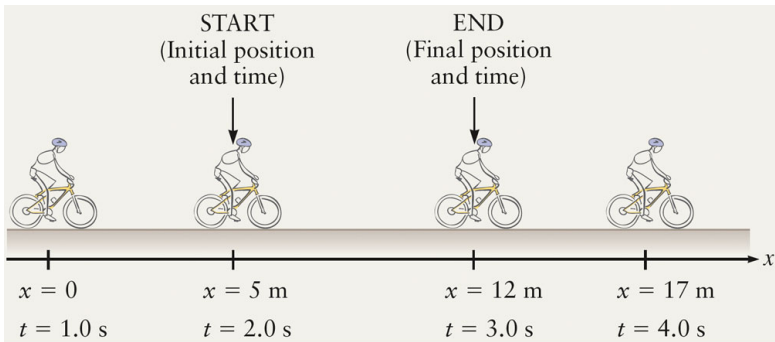
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Find average velocity from 2.0 to 3.0 seconds.

- Find displacement: $\Delta x =$



Velocity of a Bicycle

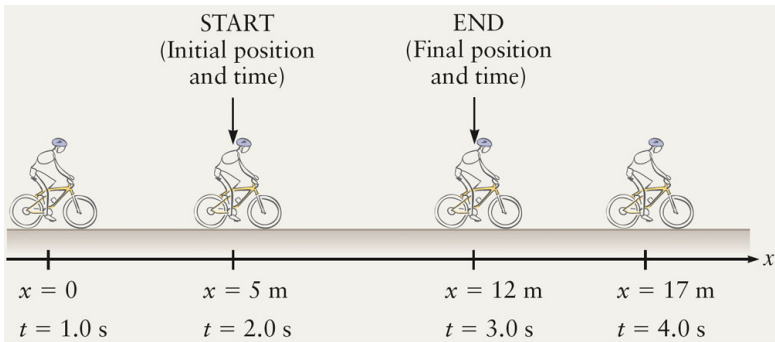
What is
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Find average velocity from 2.0 to 3.0 seconds.

- Find displacement: $\Delta x = 12 \text{ m} - 5 \text{ m} = 7 \text{ m}$
- Find average velocity: $v_{\text{ave}} = \Delta x / \Delta t$
- Solve

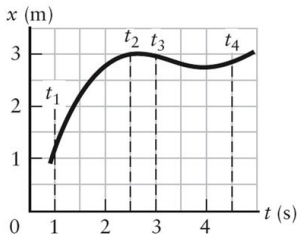


Graphical Analysis of Velocity

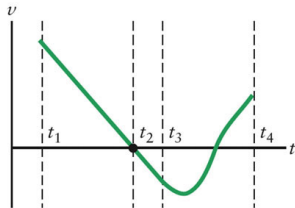
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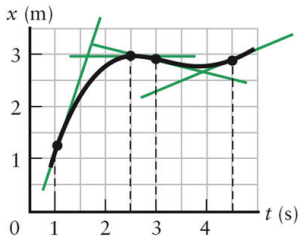
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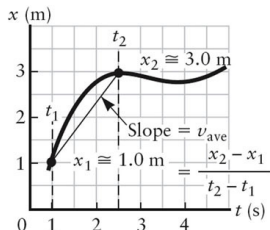
A



A



B



B