

Velocity and Acceleration

James H Dann, Ph.D.

Say Thanks to the Authors

Click <http://www.ck12.org/saythanks>

(No sign in required)



To access a customizable version of this book, as well as other interactive content, visit www.ck12.org

CK-12 Foundation is a non-profit organization with a mission to reduce the cost of textbook materials for the K-12 market both in the U.S. and worldwide. Using an open-content, web-based collaborative model termed the **FlexBook®**, CK-12 intends to pioneer the generation and distribution of high-quality educational content that will serve both as core text as well as provide an adaptive environment for learning, powered through the **FlexBook Platform®**.

Copyright © 2012 CK-12 Foundation, www.ck12.org

The names “CK-12” and “CK12” and associated logos and the terms “**FlexBook®**” and “**FlexBook Platform®**” (collectively “CK-12 Marks”) are trademarks and service marks of CK-12 Foundation and are protected by federal, state, and international laws.

Any form of reproduction of this book in any format or medium, in whole or in sections must include the referral attribution link <http://www.ck12.org/saythanks> (placed in a visible location) in addition to the following terms.

Except as otherwise noted, all CK-12 Content (including CK-12 Curriculum Material) is made available to Users in accordance with the Creative Commons Attribution/Non-Commercial/Share Alike 3.0 Unported (CC BY-NC-SA) License (<http://creativecommons.org/licenses/by-nc-sa/3.0/>), as amended and updated by Creative Commons from time to time (the “CC License”), which is incorporated herein by this reference.

Complete terms can be found at <http://www.ck12.org/terms>.

Printed: June 14, 2012

flexbook
next generation textbooks



AUTHORS

James H Dann, Ph.D.

CONTRIBUTORS

Antonio De Jesus López

Chris Addiego

CONCEPT

1

Velocity and Acceleration

Students will learn the meaning of acceleration, how it is different than velocity and how to calculate average acceleration.

Students will learn the meaning of acceleration, how it is different than velocity and how to calculate average acceleration.

Key Equations

v = velocity (m/s)

v_i = initial velocity

v_f = final velocity

Δv = change in velocity = $v_f - v_i$

$v_{avg} = \frac{\Delta x}{\Delta t}$

a = acceleration (m/s^2)

$a_{avg} = \frac{\Delta v}{\Delta t}$

Guidance

- Acceleration is the rate of change of velocity. So in other words, acceleration tells you how quickly the velocity is increasing or decreasing. An acceleration of $5 m/s^2$ indicates that the velocity is increasing by $5m/s$ in the positive direction every second.
- Gravity near the Earth pulls an object downwards toward the surface of the Earth with an acceleration of $9.8 m/s^2 (\approx 10 m/s^2)$. In the absence of air resistance, all objects will fall with the same acceleration. The letter g is used as the symbol for the acceleration of gravity.
 - When talking about an object's acceleration, whether it is due to gravity or not, the acceleration of gravity is sometimes used as a unit of measurement where $1g = 9.8m/s^2$. So an object accelerating at $2g$'s is accelerating at $2 * 9.8m/s^2$ or $19.6m/s^2$
- *Deceleration* is the term used when an object's *speed* (i.e. magnitude of its velocity) is decreasing due to acceleration in the opposite direction of its velocity.

Example 1 A Top Fuel dragster can accelerate from 0 to 100 mph (160 km/hr) in 0.8 seconds. What is the average acceleration in m/s^2 ?

Question: $a_{avg} = ? [m/s^2]$

Given: $v_i = 0 m/s$

$v_f = 160 km/hr$

$t = 0.8 s$

Equation: $a_{avg} = \frac{\Delta v}{t}$

Plug n' Chug: Step 1: Convert km/hr to m/s

$$v_f = (160 \frac{km}{hr}) \left(\frac{1,000 m}{1 km} \right) \left(\frac{1 hr}{3,600 s} \right) = 44.4 m/s$$

Step 2: Solve for average acceleration:

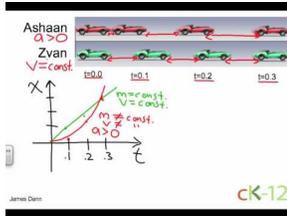
$$a_{avg} = \frac{\Delta v}{t} = \frac{v_f - v_i}{t} = \frac{44.4 \text{ m/s} - 0 \text{ m/s}}{0.8 \text{ s}} = 56 \text{ m/s}^2$$

Answer:

$$56 \text{ m/s}^2$$

Note that this is over $5\frac{1}{2}g$'s!

Watch this Explanation



MEDIA

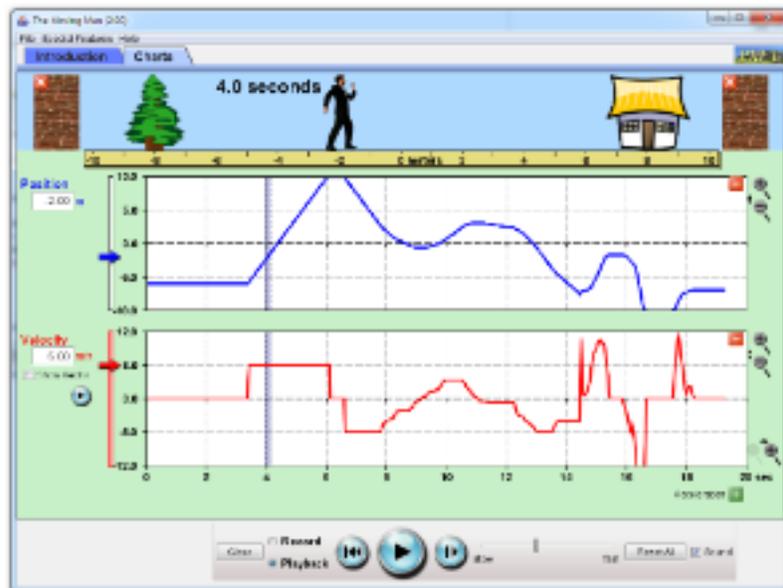
Click image to the left for more content.

Simulation



MEDIA

Click image to the left for more content.

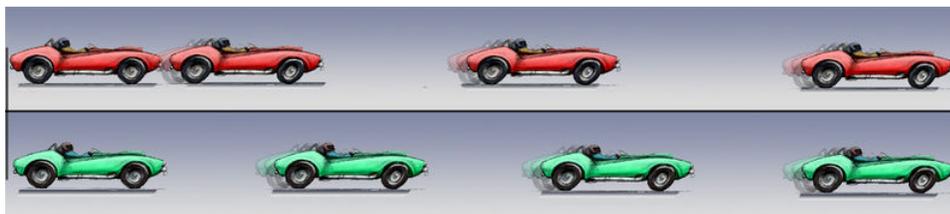


The Moving Man (PhET Simulation)

Time for Practice

1. Ms. Reitman's scooter starts from rest and accelerates at 2.0 m/s^2 .

- a. Where will the scooter be relative to its starting point after 7.0 seconds?
 - b. What is the scooter's velocity after 1s? after 2s? after 7s?
2. A horse is galloping forward with an acceleration of 3 m/s^2 . Which of the following statements is not necessarily true? You may choose more than one.
- a. The horse is increasing its speed by 3 m/s every second, from 0 m/s to 3 m/s to 6 m/s to 9 m/s.
 - b. The speed of the horse will triple every second, from 0 m/s to 3 m/s to 9 m/s to 27 m/s.
 - c. Starting from rest, the horse will cover 3 m of ground in the first second.
 - d. Starting from rest, the horse will cover 1.5 m of ground in the first second.
3. Below are images from a race between Ashaan (above) and Zyan (below), two daring racecar drivers. High speed cameras took four pictures in rapid succession. The first picture shows the positions of the cars at $t = 0.0$. Each car image to the right represents times 0.1, 0.2, and 0.3 seconds later.



- a. Who is ahead at $t = 0.2 \text{ s}$? Explain.
- b. Who is accelerating? Explain.
- c. Who is going fastest at $t = 0.3 \text{ s}$? Explain.
- d. Which car has a constant velocity throughout? Explain.
- e. Graph x vs. t and v vs. t . Put both cars on same graph; label which line is which car.
- f. Which car is going faster at $t = 0.2 \text{ s}$ (Hint: Assume they travel the same distance between 0.1 and 0.2 seconds)?

Answers

1. a. 49 m b. 2 m/s, 4 m/s, 14 m/s
2. discuss in class
3. See Video above

