Introduction to Mechanics
Free-Fall

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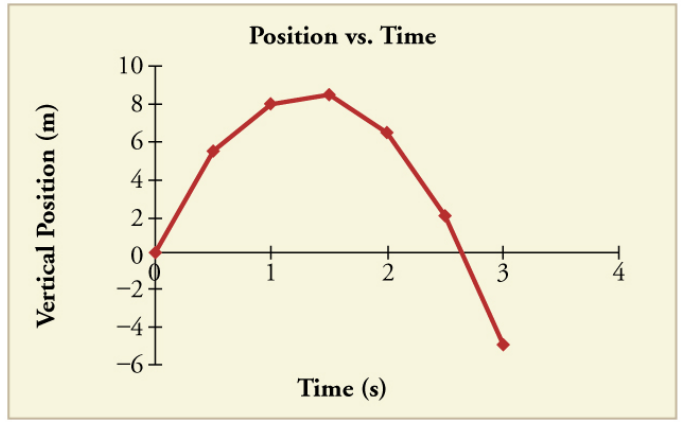
Last time

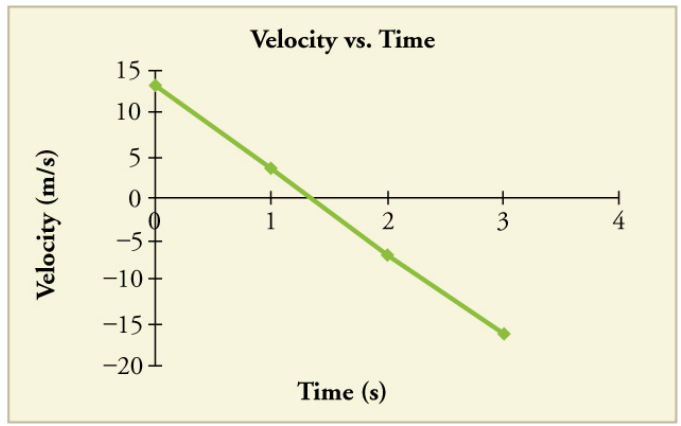
- inertia
- free fall

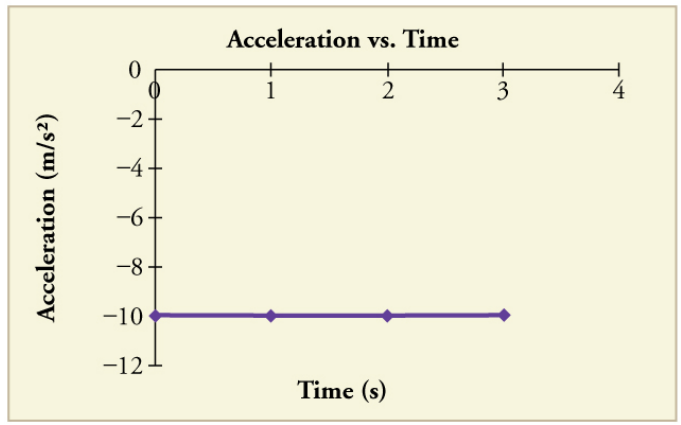
Overview

- free fall
- problems with objects in free fall
- class activity: measure your reaction time

Falling Objects







[1] OpenStax Physics

Ex: Free-Fall with Upward Motion

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SKETCH. Let the y-axis run vertically. ($\uparrow +y$, here)

HYPOTHESIS: A bit more than 1 second. (Travels upward for about half a second, and downward for more than half a second.)

Know: $\vec{\mathbf{v}}_0$, $\vec{\mathbf{a}}$, $\overrightarrow{\boldsymbol{\Delta y}}$ (displacement in y-direction).
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Don't know / care about: $\vec{\mathbf{v}}$. $\Rightarrow$ Strategy: Use $\overrightarrow{\Delta \boldsymbol{y}} = \vec{\mathbf{v}}_0 t + \frac{1}{2}\vec{\mathbf{a}} t^2$

Ex: Free-Fall with Upward Motion

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\begin{aligned}
\Delta y &= v_0 t + \frac{1}{2} a t^2 \\
\Delta y &= v_0 t - \frac{1}{2} g t^2 \\
0 &= \frac{1}{2} g t^2 - v_0 t + \Delta y \\
t &= \frac{v_0 \pm \sqrt{v_0^2 - 4(g/2)(\Delta y)}}{g} \\
t &= \frac{5 \text{ m/s} \pm \sqrt{(5 \text{ m/s})^2 - 4(9.8/2 \text{ m/s}^2)(-1.5 \text{ m})}}{9.8 \text{ m/s}^2} \\
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ANALYSIS: Yes, my answer is a bit more than 1 second, as anticipated. It's probably correct.

Acceleration in terms of g

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Consider the drag race car in the earlier example. For a drag race car the maximum acceleration could be as high as $a = 26.0$ m s^{-2}. How many gs ("gees") is that?

A 0

B roughly 1

C roughly 2 and a half

D 26

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Acceleration of a Falling Object

Question

A baseball is thrown straight up. It reaches a peak height of 15 m, measured from the ground, in a time 1.7 s. Treating "up" as the positive direction, what is the acceleration of the ball when it reached its peak height?

A $0\ \text{m/s}^2$

B $-8.8\ \text{m/s}^2$

C $+8.8\ \text{m/s}^2$

D $-9.8\ \text{m/s}^2$

[1] Leduc, "Cracking the AP Physics B Exam" Princeton Review.

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Measure your reaction time!

Work with a partner.

Put your arm down along your desk, with your hand sticking off the edge.

Your partner will hold a ruler so that the zero mark of the ruler is right between your fingers.

Then, your partner will drop the ruler. As soon as you see it start to move, catch it.

Read off the measurement where your fingers grip the ruler.

How can you calculate your reaction time?

Questions before the test?

Questions about the Interpreting Graphs worksheet or the quiz?

Other questions?

Summary

- free-fall
- reaction time

First Test tomorrow.

Homework

- Study!