Physics 121: Free Fall, Inclined Plane Motion

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Reminders

- There is a HW assignment due this Thursday on Mastering Physics. How did last week go?
- On Thursday we are doing the V: Vectors lab. This is in the appendix of the labs so make sure to bring it (just in case some of you only bring 2-3 labs at a time like me).

Quick Review - Derivatives

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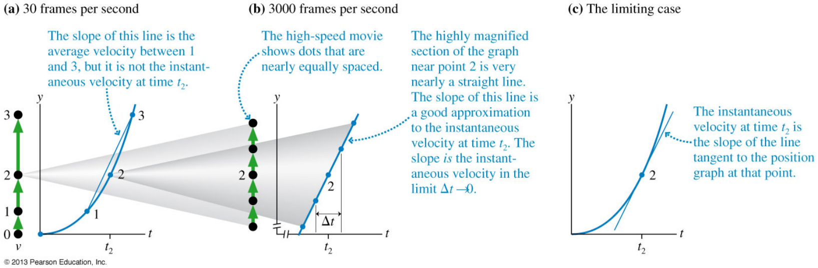
- The instantaneous velocity is the slope of the tangent line to the $x(t)$ curve.



Quick Review - Integrals

- If you want to determine the position at time t given the position at time $t = 0$ and the velocity you use an integral.

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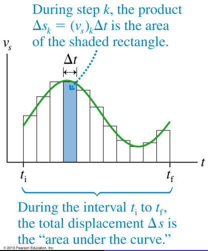
- This is the area under the $v(t)$ curve.



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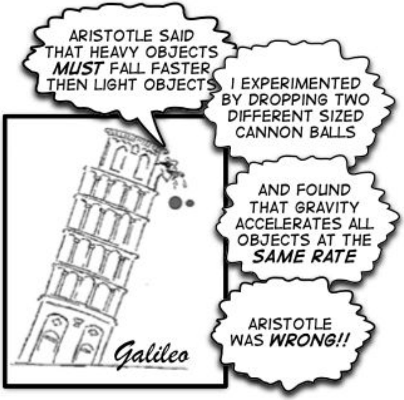
- Using these ideas you can write down the kinematic equations (which will be used A LOT in this class to calculation the motion of objects in various situations with constant acceleration)

$$\begin{aligned} v_f &= v_i + a\Delta t \\ s_f &= s_i + v_i \Delta t + \frac{1}{2} a (\Delta t)^2 \\ v_f^2 &= v_i^2 + 2a\Delta s \end{aligned}$$

FREE FALL MOTION!

- Galileo Galilei (1564-1642) supposedly dropped objects from bell towers in Italy to study object in free fall motion. Here are two of his main discoveries.



1. If you drop two objects from the same height, if there is no air resistance, will hit the ground at the same time at the same speed.
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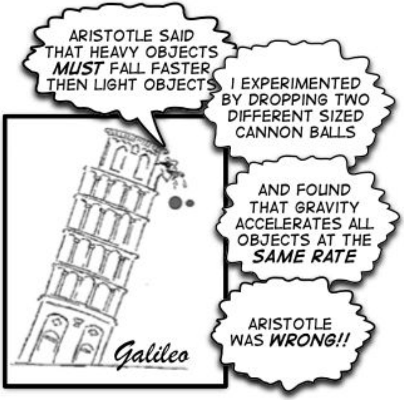

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What about a feather and a bowling ball?

Vacuum Chamber

Free Fall

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- Since free fall motion is *constant acceleration* motion you can use the equations mentioned before, but with $a = -g$.
- $g = 9.80\ \text{m}/\text{s}^2$ only on earth. We'll see more about this when we talk about gravity.

Quick Check

A ball is tossed straight up in the air. At its very highest point, the ball's instantaneous acceleration a_y is

A. Positive

B. Negative

C. Zero

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EXAMPLE 2.14 **Finding the height of a leap**

The springbok, an antelope found in Africa, gets its name from its remarkable jumping ability. When startled, a springbok will leap straight up into the air—a maneuver called a "pronk." A springbok goes into a crouch to perform a pronk. It then extends its legs forcefully, accelerating at 35 m/s^2 for 0.70 m as its legs straighten. Legs fully extended, it leaves the ground and rises into the air. How high does it go?

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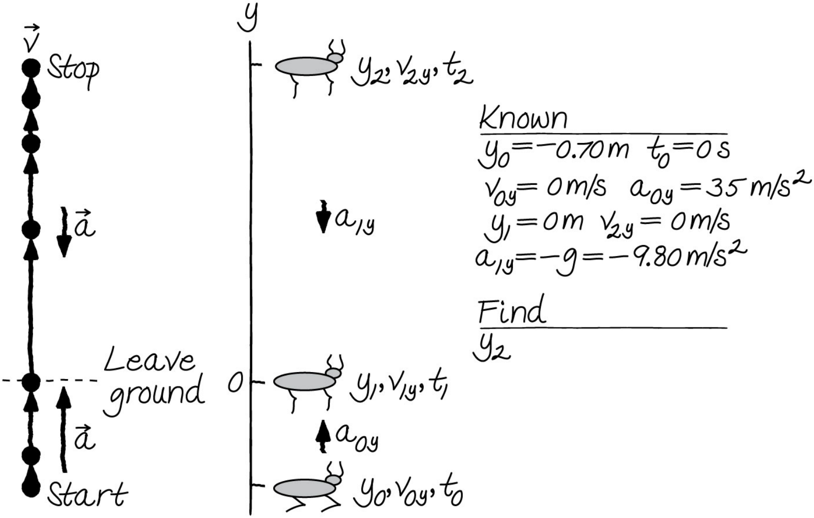

Stop
Leave ground
Start
y
0
y_2, v_{2y}, t_2
a_{1y}
y_1, v_{1y}, t_1
a_{0y}
y_0, v_{0y}, t_0
Known
$y_0 = -0.70\,m$ $t_0 = 0\,s$
$v_{0y} = 0\,m/s$ $a_{0y} = 35\,m/s^2$
$y_1 = 0\,m$ $v_{2y} = 0\,m/s$
$a_{1y} = -g = -9.80\,m/s^2$
Find
y_2

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Motion on an Inclined Plane

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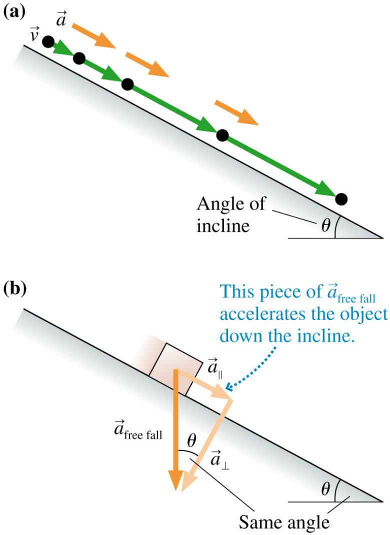

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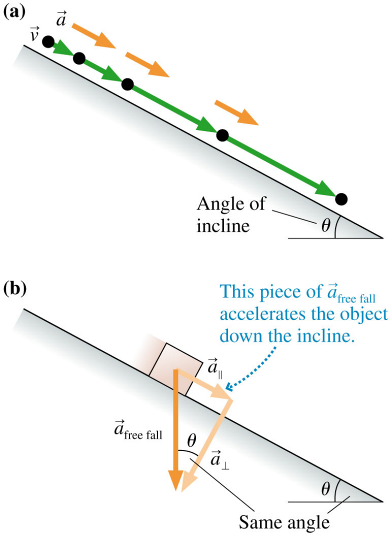
- The vector $\vec{a}_{ff}$ can be broken into two components, $\vec{a}_{\perp}$ and $\vec{a}_{||}$
- Somehow the surface blocks $\vec{a}_{\perp}$ (which we'll talk about later), which means that the acceleration alone the surface is given by

$$a_s = a_{||} = \pm g \sin\theta$$



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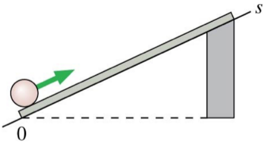
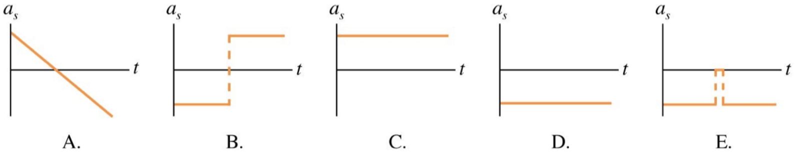
A ball rolls up the ramp, then back down. Which is the correct acceleration graph?





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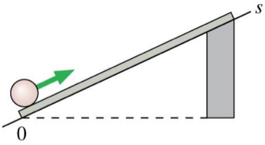

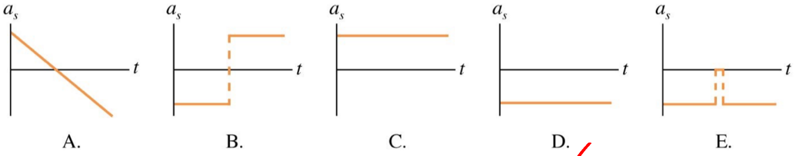

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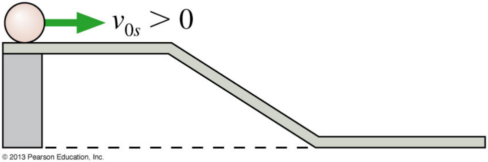

Draw the x, v_s and a_s vs. t graphs for a ball rolling down the inclined plane here. Include all three sections of motion.

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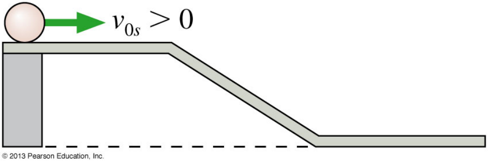

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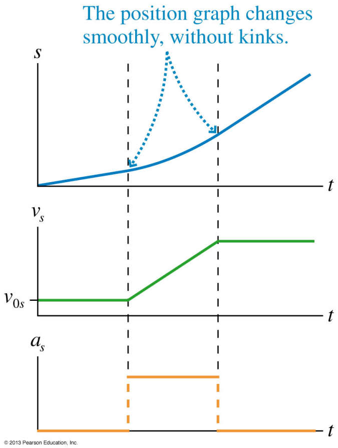

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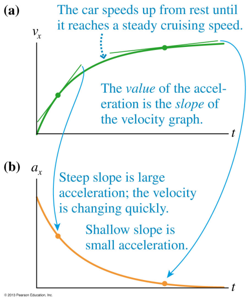

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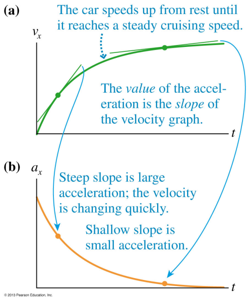

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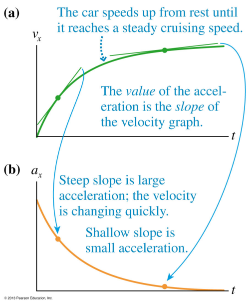

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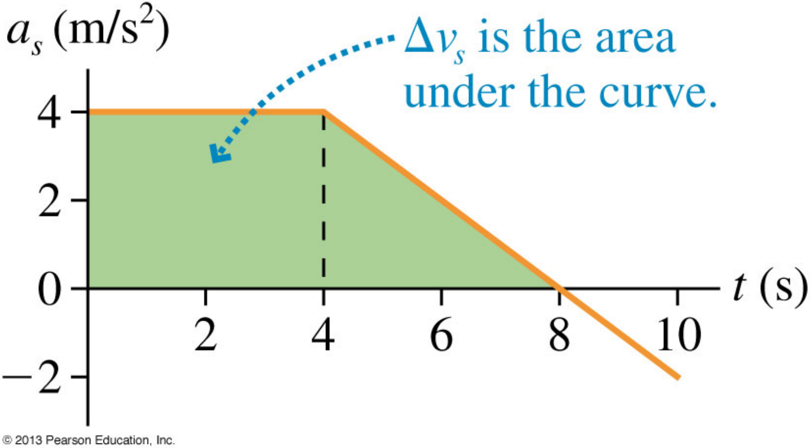
- Also you can use an integral determine $v(t)$ from the acceleration and initial $v(t = 0)$

$$v_{fs} = v_{is} + \int_{t_i}^{t_f} a_s dt$$

If an object is initially moving at 10 m/s and has this acceleration curve what is the velocity of the object at t=8 s?



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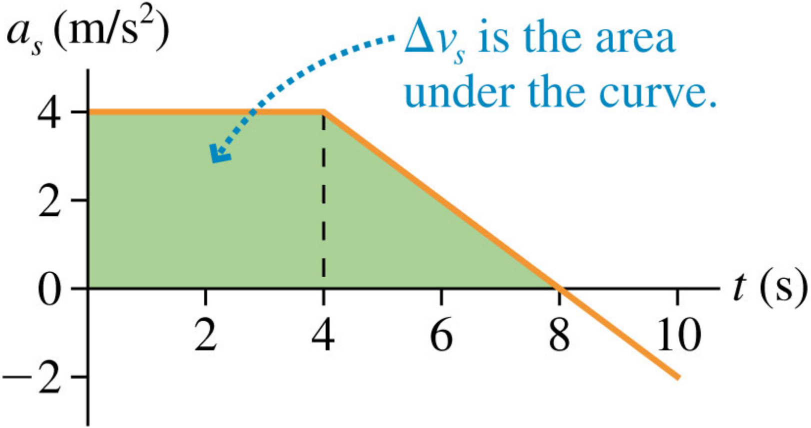

$$v_s(t = 8\text{ s}) = 34\text{ m/s}$$

Picture References

Galileo Galilei on the tower (accessed 4 Sep 17):
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