June 10, Week 2

Today: Chapter 2, Constant Acceleration Problems

Homework #2 now available on webpage

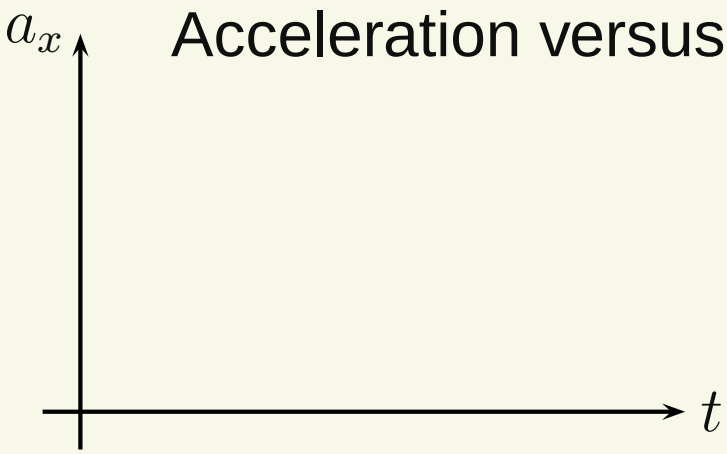
Please register your clicker. (There are 5 students without registered clickers.)

Constant Acceleration

For a constant acceleration:

Constant Acceleration

For a constant acceleration:



Acceleration versus time

Constant Acceleration

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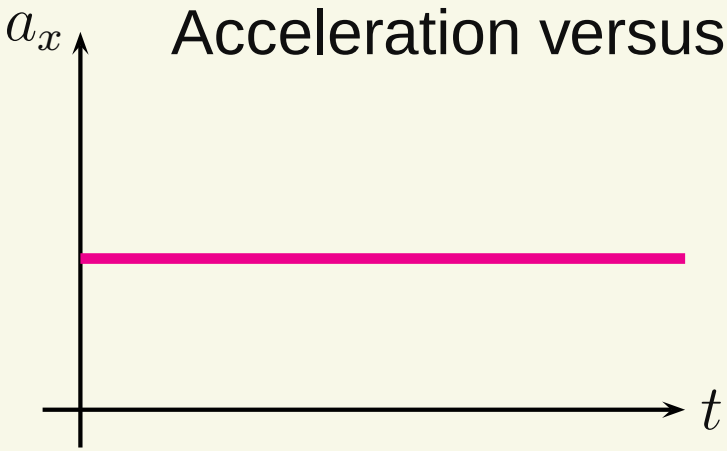

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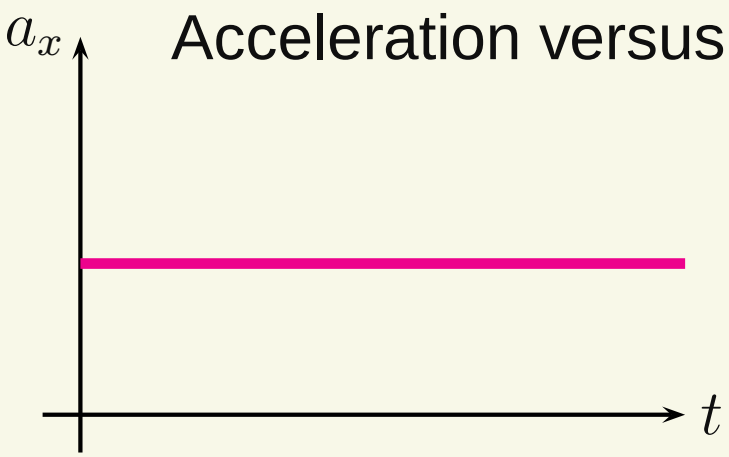

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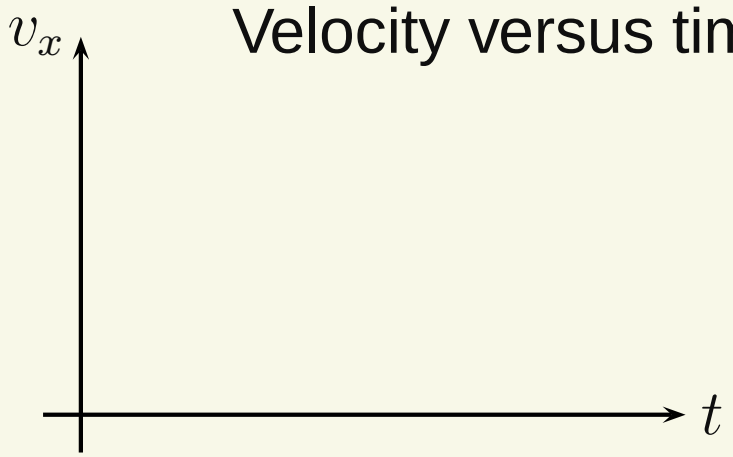

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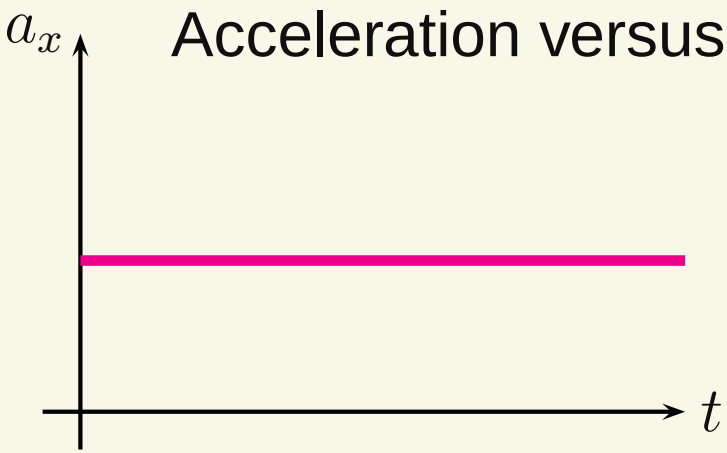

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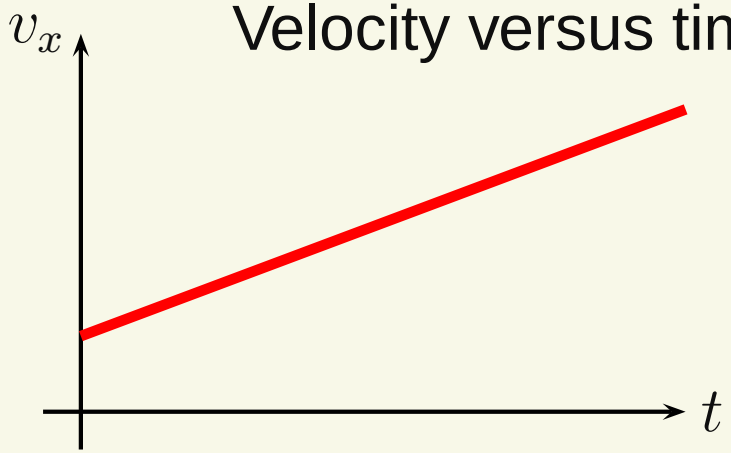

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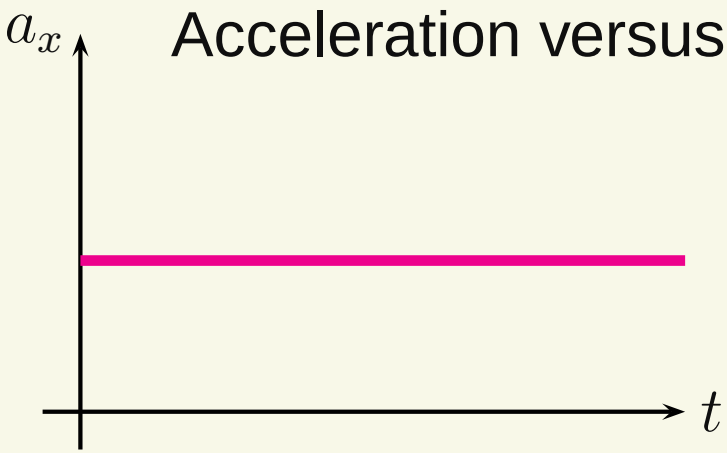

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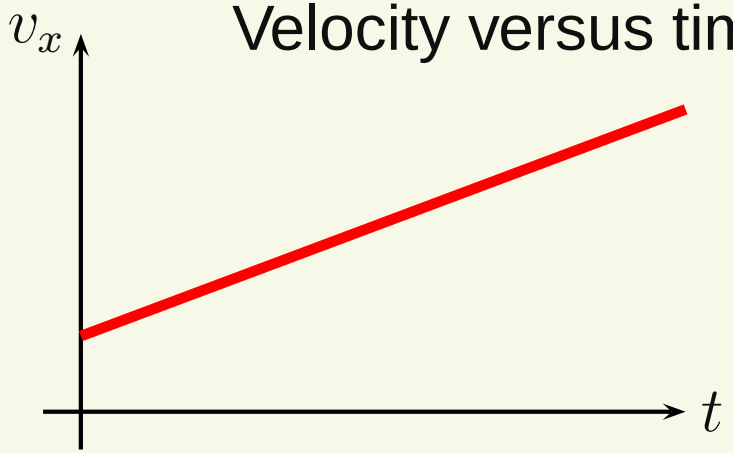
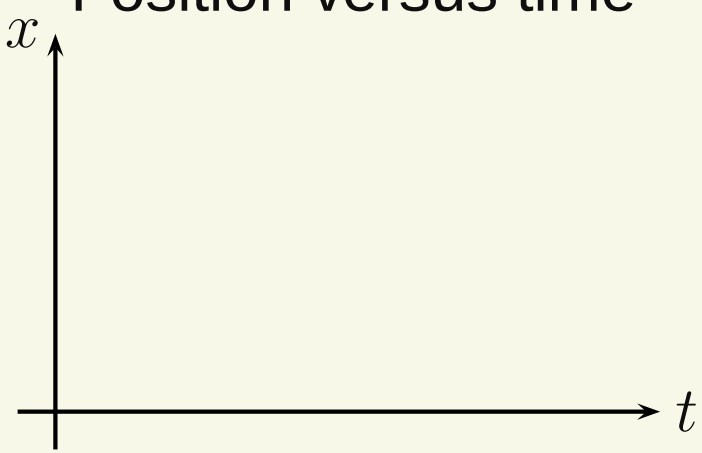


Position versus time



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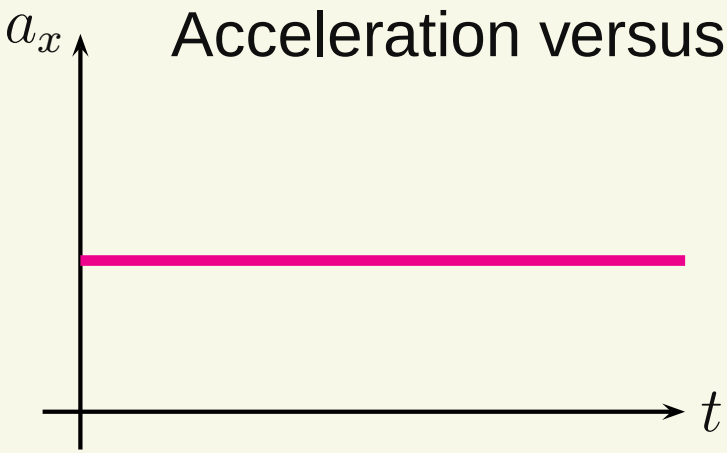

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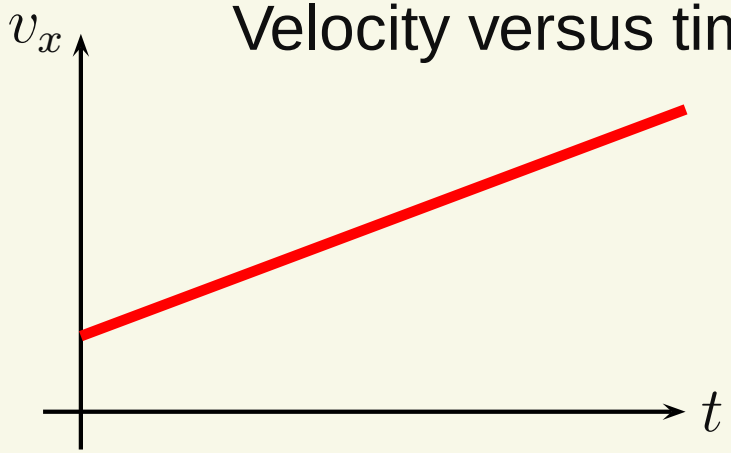

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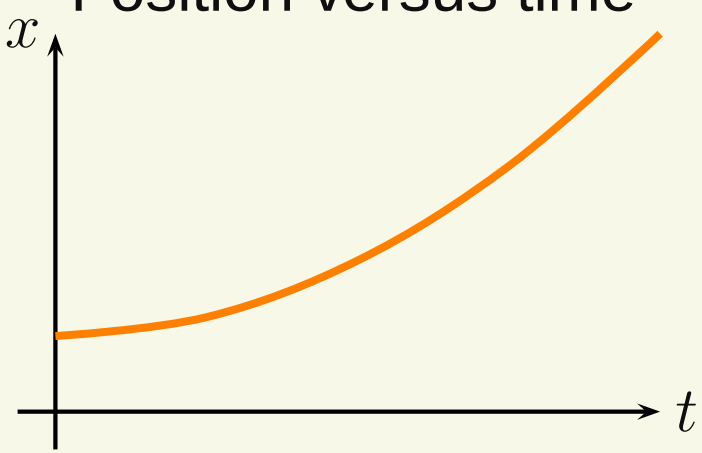

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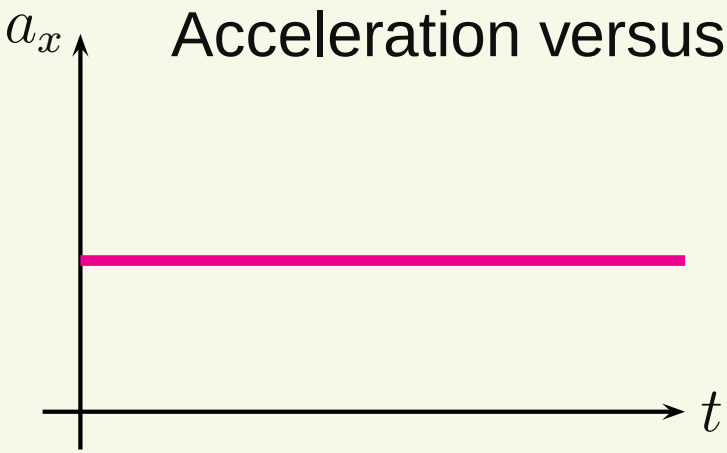

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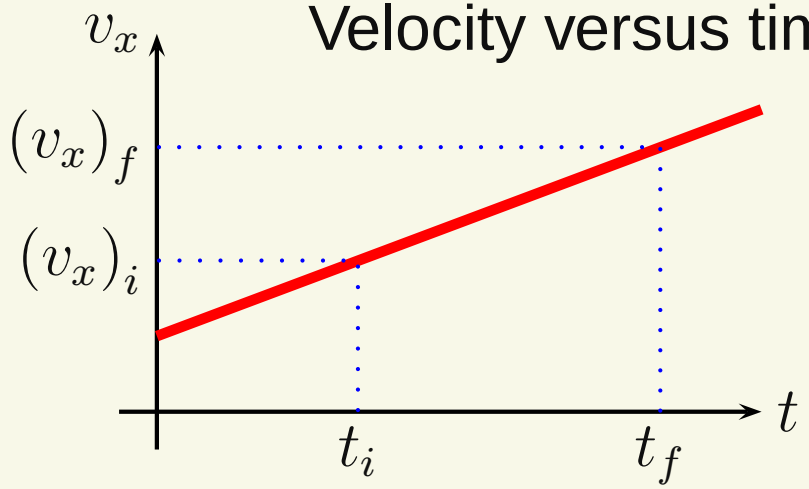

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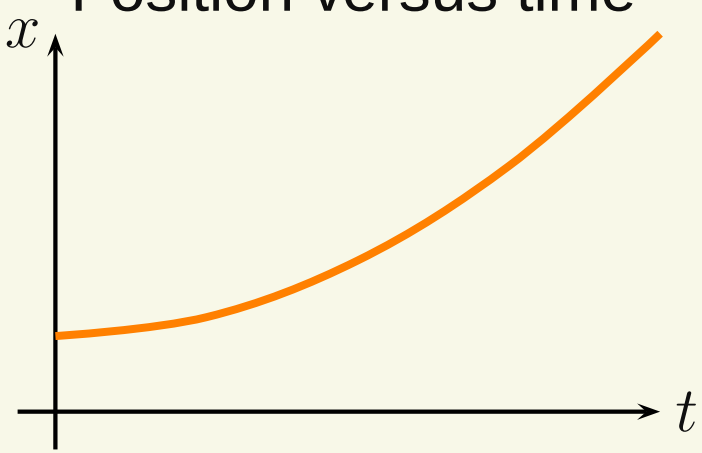

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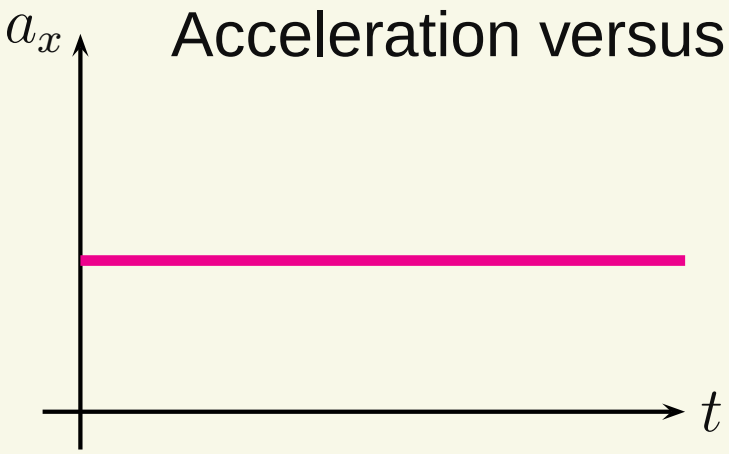

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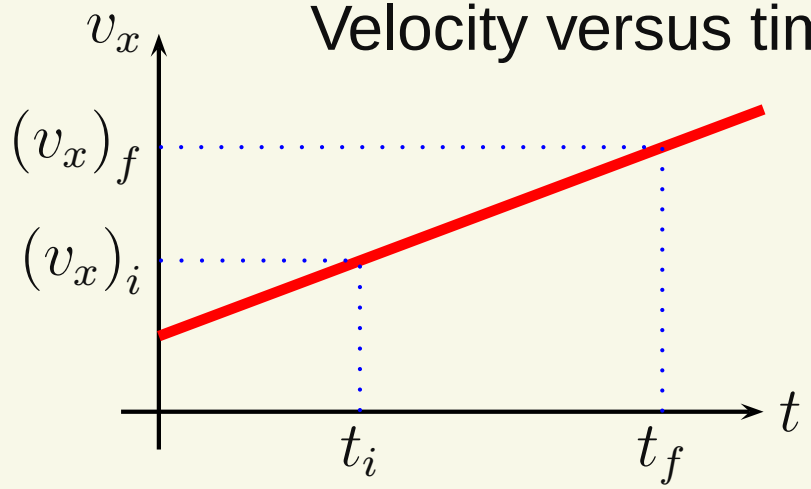

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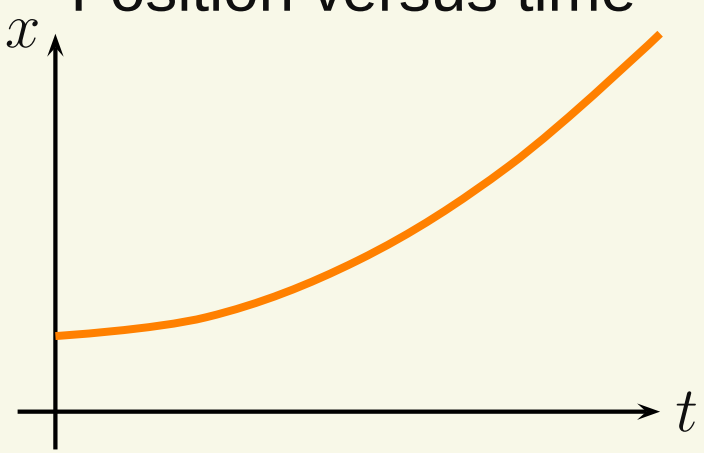

$$(v_x)_f = (v_x)_i + a_x \Delta t$$

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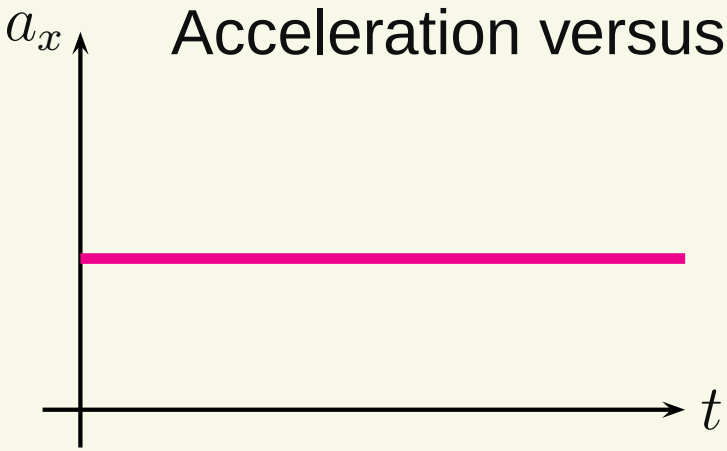

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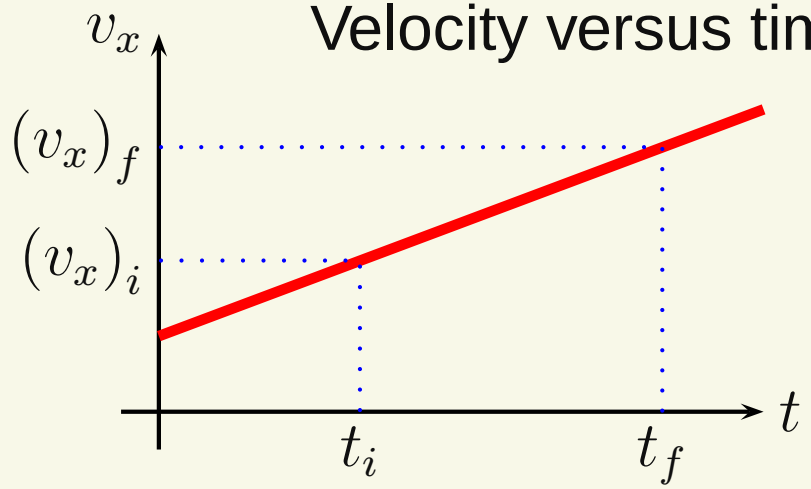

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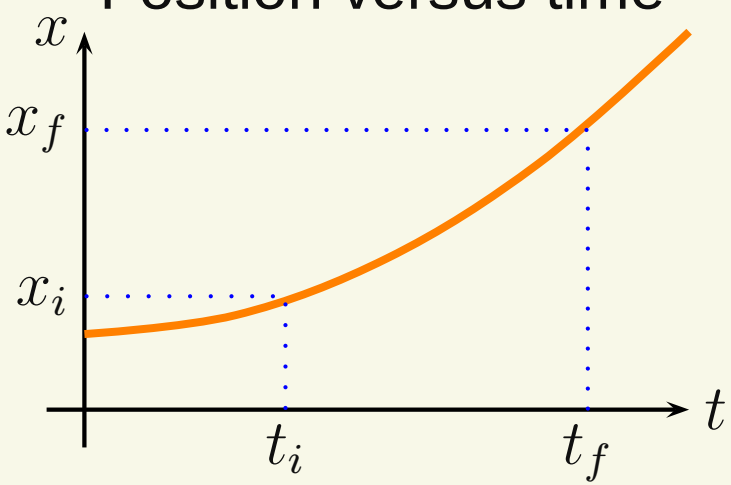

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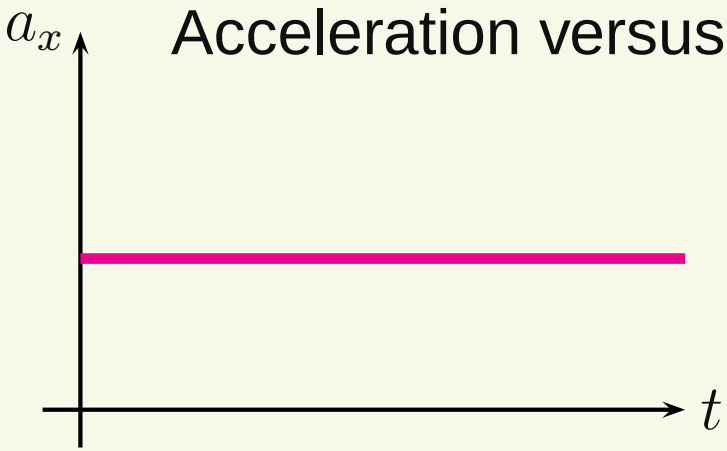

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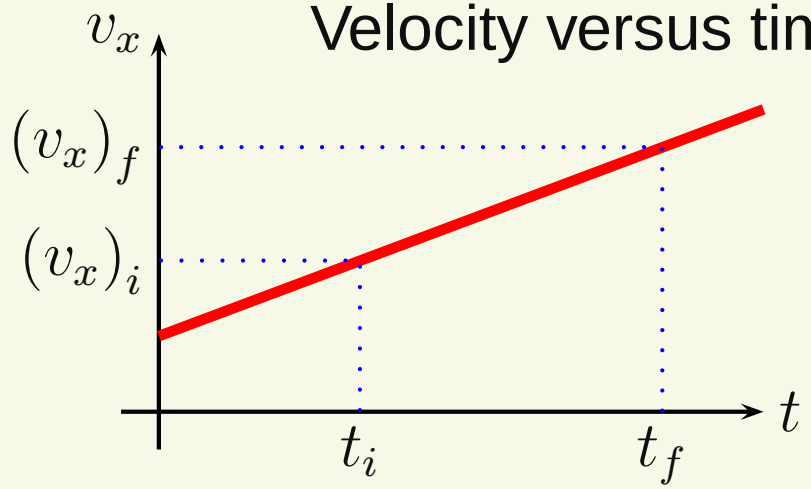

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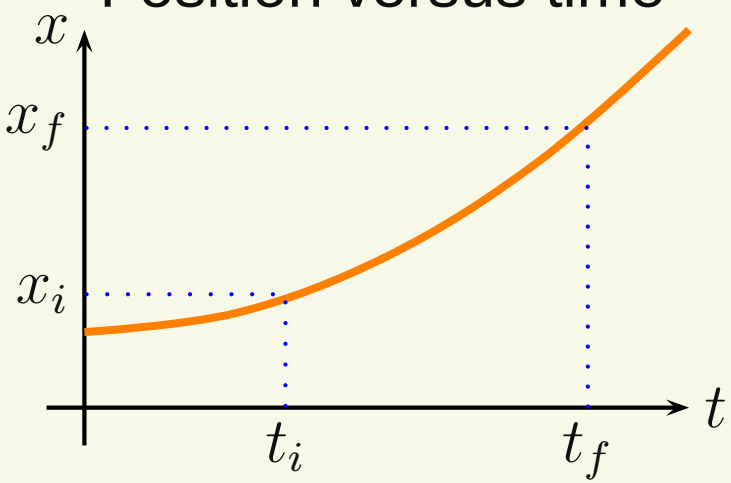

$$(v_x)_f = (v_x)_i + a_x \Delta t$$

$$x_f = x_i + (v_x)_i \, \Delta t + \frac{1}{2} a_x \, (\Delta t)^2$$

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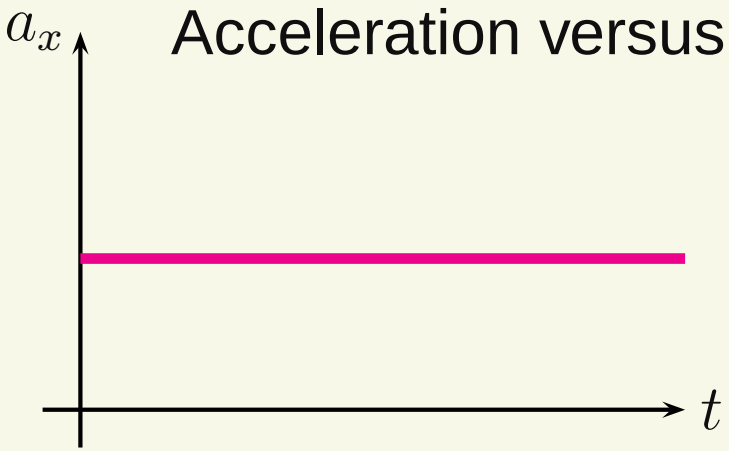

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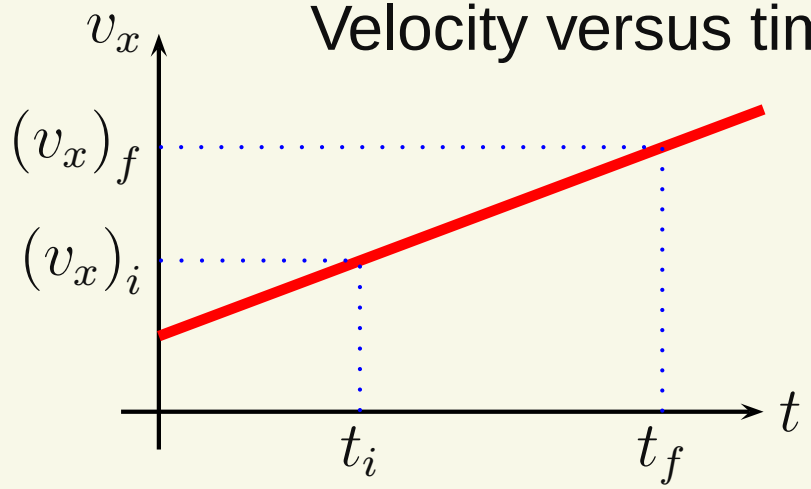

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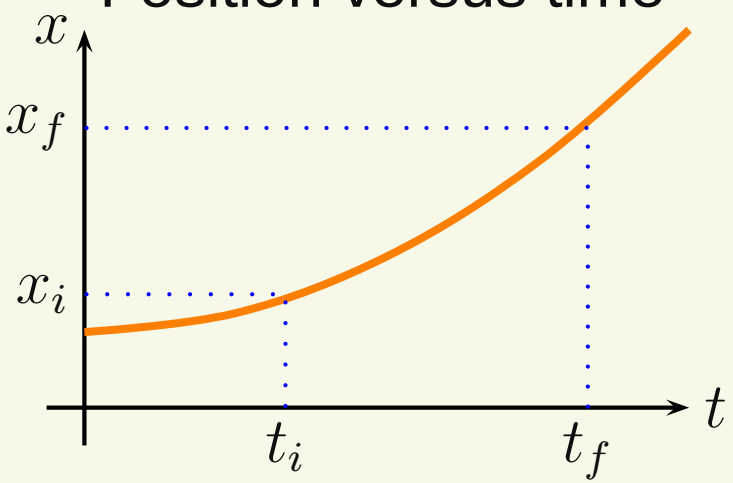

$$(v_x)_f = (v_x)_i + a_x \Delta t$$

$$x_f = x_i + (v_x)_i \Delta t + \frac{1}{2} a_x (\Delta t)^2$$

$$(v_x)_f^2 = (v_x)_i^2 + 2 a_x \Delta x \quad \leftarrow \text{From Algebra}$$

Free Fall

In the absence of air resistance, near the surface of *any* planet, gravity causes any object to have a constant acceleration. Acceleration due to gravity has a magnitude always abbreviated g.

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On earth, $g = 9.8\,m/s^2$

Note: g is always given as positive. The direction of gravity is down, so negative signs may have to be used in problem solving.

Free-Fall Exercise I

A person at the top of a building throws an egg upwards at $15\,m/s$. To determine whether the egg is going up or down after $3\,s$, we would solve for:

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(a) y_f

(b) y_i

(c) $(v_y)_f$

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A person at the top of a building throws an egg upwards at $15\,m/s$. To determine whether the egg is going up or down after $3\,s$, we would solve for:

(c) $(v_y)_f$

↑

Velocity gives speed and direction

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Known:

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A person at the top of a building throws an egg upwards at $15\,m/s$. To determine whether the egg is going up or down after $3\,s$, we would solve for:

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$$(v_y)_i = 15\,m/s$$

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$(v_y)_i = 15\,m/s \leftarrow$ Up is positive

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$\Delta t = 3\,s$

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$\Delta t = 3\,s$

$(v_y)_f = (v_y)_i + a_y \Delta t$ gives

$(v_y)_y = -14.4\,m/s \Rightarrow 14.4\,m/s$, down

Free-Fall Exercise II

A person at the top of a building throws an egg upwards at $15\,m/s$.
To determine the egg's maximum height, we would use the fact that:

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(a) Both the velocity and acceleration are zero.

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A person at the top of a building throws an egg upwards at $15\,m/s$.
To determine the egg's maximum height, we would use the fact that:

(a) Both the velocity and acceleration are zero.

(b) Neither the velocity nor acceleration are zero.

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A person at the top of a building throws an egg upwards at $15\,m/s$.
To determine the egg's maximum height, we would use the fact that:

(a) Both the velocity and acceleration are zero.

(b) Neither the velocity nor acceleration are zero.

(c) The acceleration is zero but the velocity is non-zero.

Free-Fall Exercise II

A person at the top of a building throws an egg upwards at $15\,m/s$.
To determine the egg's maximum height, we would use the fact that:

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(e) None of these.

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Free-Fall Exercise II

A person at the top of a building throws an egg upwards at $15\,m/s$. To determine the egg's maximum height, we would use the fact that:

(d) The velocity is zero but the acceleration is non-zero.

Known:

$(v_y)_i = 15\,m/s$

$a_y = -9.8\,m/s^2$

$(v_y)_f = 0$

$y_i = 0$

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A person at the top of a building throws an egg upwards at $15\,m/s$. To determine the egg's maximum height, we would use the fact that:

(d) The velocity is zero but the acceleration is non-zero.

Known:

$(v_y)_i = 15\,m/s$

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$(v_y)_f = 0$

$y_i = 0$

Unknown:

$y_f = ?$

$\Delta t = ?$

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$a_y = -9.8\,m/s^2$

$(v_y)_f = 0$

$y_i = 0$

Unknown:

$y_f = ?$

$\Delta t = ?$

Using $(v_y)_f^2 = (v_y)_i^2 + 2a_y\Delta y$ gives $y_f = 11.5\,m$

Free-Fall Exercise III

A person at the top of a building $30\,m$ high, throws an egg upwards at $15\,m/s$. Which of the following statements about the egg hitting the ground is *False*?

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(a) We could set $y_i = 0$ and $y_f = -30\,m$.

Free-Fall Exercise III

A person at the top of a building $30\,m$ high, throws an egg upwards at $15\,m/s$. Which of the following statements about the egg hitting the ground is *False*?

(a) We could set $y_i = 0$ and $y_f = -30\,m$.

(b) We could set $y_i = 30\,m$ and $y_f = 0$.

Free-Fall Exercise III

A person at the top of a building $30\,m$ high, throws an egg upwards at $15\,m/s$. Which of the following statements about the egg hitting the ground is *False*?

(a) We could set $y_i = 0$ and $y_f = -30\,m$.

(b) We could set $y_i = 30\,m$ and $y_f = 0$.

(c) Its velocity is zero.

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A person at the top of a building $30\,m$ high, throws an egg upwards at $15\,m/s$. Which of the following statements about the egg hitting the ground is *False*?

(a) We could set $y_i = 0$ and $y_f = -30\,m$.

(b) We could set $y_i = 30\,m$ and $y_f = 0$.

(c) Its velocity is zero.

(d) We are actually considering the instant before it hits the ground, so its acceleration is still $-g$.

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A person at the top of a building $30\,m$ high, throws an egg upwards at $15\,m/s$. Which of the following statements about the egg hitting the ground is *False*?

(a) We could set $y_i = 0$ and $y_f = -30\,m$.

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(e) Both (c) and (d) are false.

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(b) We could set $y_i = 30\,m$ and $y_f = 0$.

(c) Its velocity is zero.

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(e) Both (c) and (d) are false.

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Known:

$(v_y)_i = 15\,m/s$

$a_y = -9.8\,m/s^2$

$y_f = -30\,m$

$y_i = 0$

Unknown:

$(v_y)_f = ?$

$\Delta t = ?$

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$a_y = -9.8\,m/s^2$

$y_f = -30\,m$

$y_i = 0$

Unknown:

$(v_y)_f = ?$

$\Delta t = ?$

Using $y_f = y_i + (v_y)_i\,\Delta t + \frac{1}{2}a_y\,(\Delta t)^2$ and solving a quadratic equation gives $\Delta t = 4.44\,s$

Example I

$$x_f = x_i + (v_x)_i \Delta t + \frac{1}{2} a_x (\Delta t)^2$$

$$(v_x)_f = (v_x)_i + a_x \Delta t$$

$$(v_x)_f^2 = (v_x)_i^2 + 2 a_x \Delta x$$

Example: Phyllis is traveling on a straight highway with a speed of $30.0\,m/s$ and wishes to pass Stanley who is in the car in front of her. Phyllis hits the gas causing a constant acceleration of $1.25\,m/s^2$. After going $150\,m$, phyllis is a safe distance in front of Stanley, so she decelerates back down to $30.0\,m/s$ in $5.0\,s$. How long did it take and what total distance did Phyllis cover while passing Stanley? Assume Phyllis stayed in the same lane the whole time.