Spring 2014

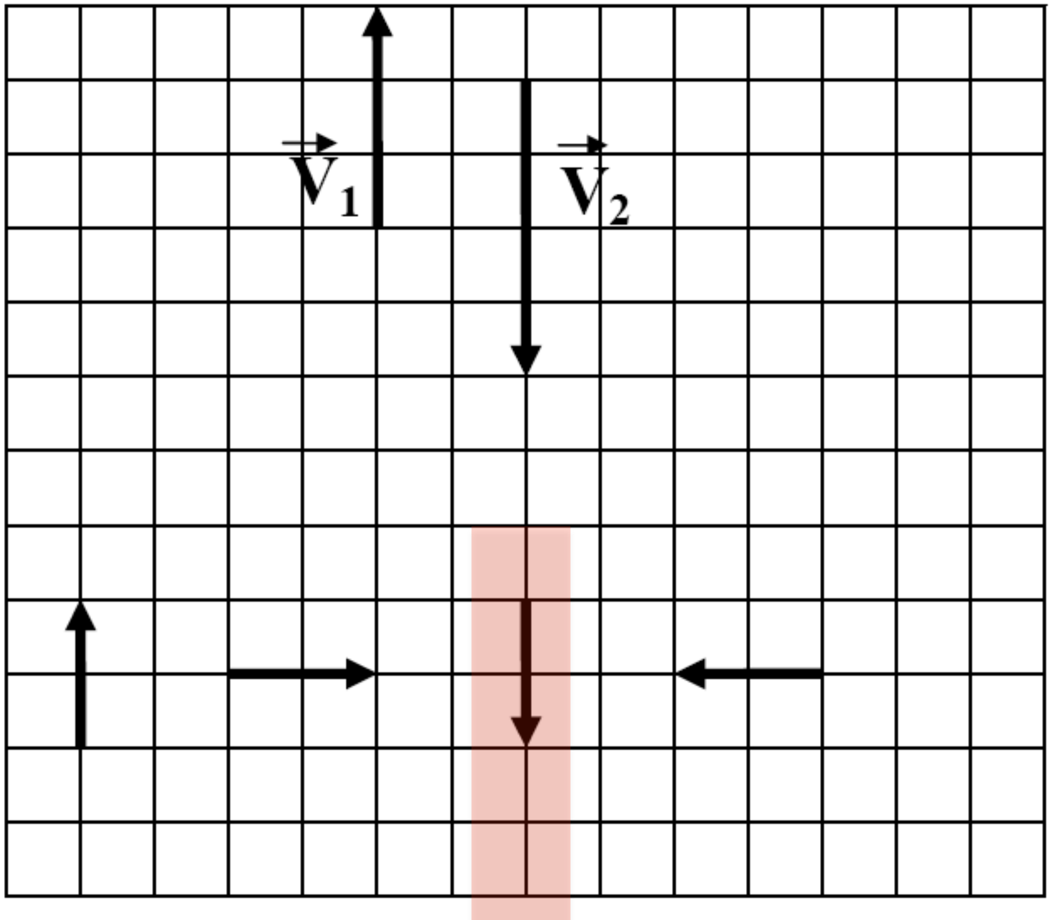
PHYS-2010

Lecture 11

Clicker Question

Room Frequency BA

CT3-10. The velocity vector of a particle moving with constant acceleration is shown below at two different times, an earlier time t_1 and a later time t_2. What is the direction of the acceleration vector?



(A) **(B)** **(C)** **(D)**

(E) None of these!

$$\vec{V}_1 = (0,3)$$

$$\vec{V}_2 = (0,-4)$$

$$\overrightarrow{\Delta V} = \vec{V}_2 - \vec{V}_1$$

$$= (0,-4) - (0,3)$$

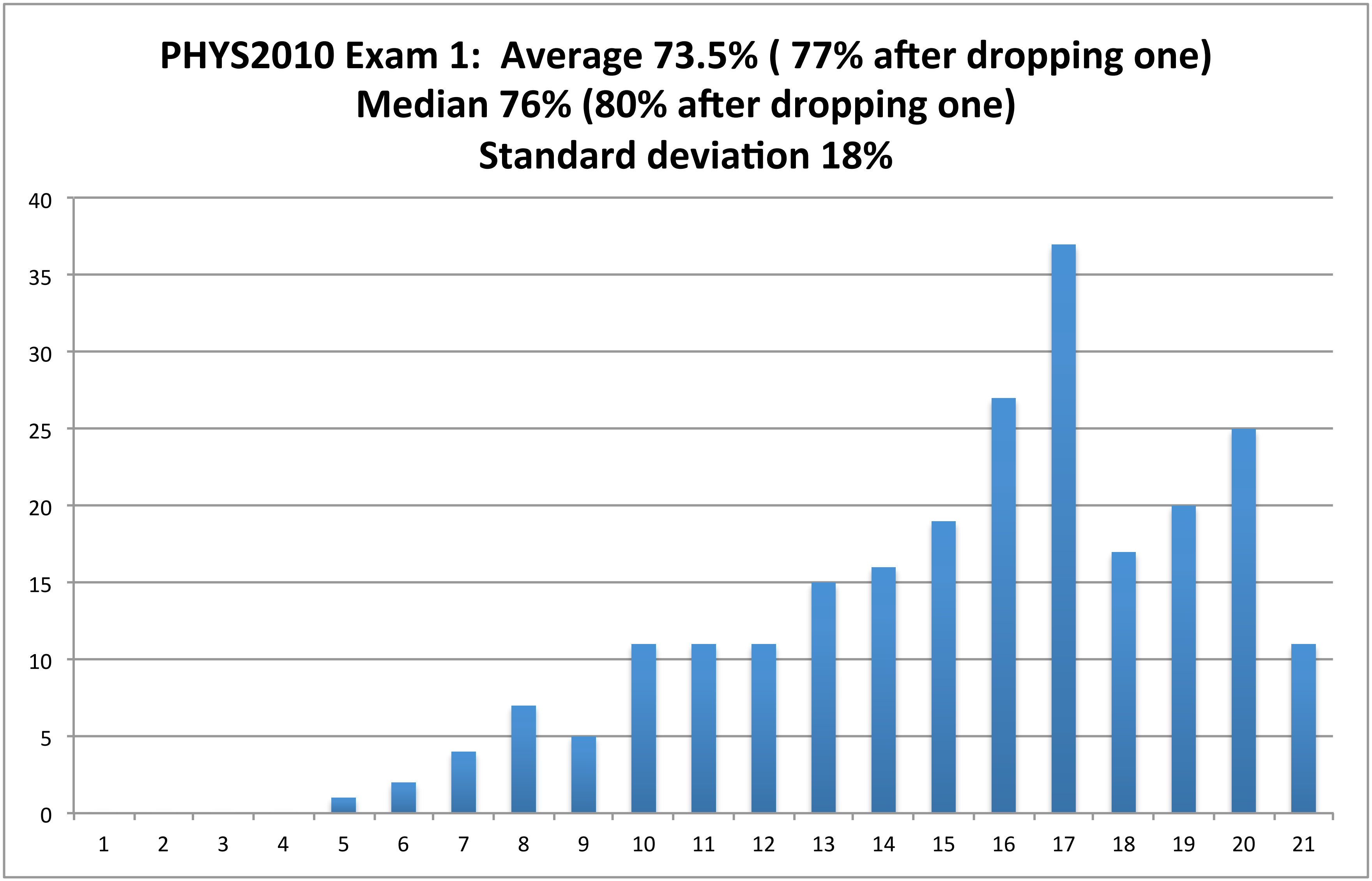
$$= (0,-7)$$

Direction of acceleration = direction of $\overrightarrow{\Delta V}$, which is DOWN.

Announcements

- Finish reading Giancoli Chapter 3.
- **CAPA # 4** is due next Tuesday.
- **No Written homework** this week.
- Next Week: Lab # 2 with a prelab (print out and complete ahead of time, submit to your TA at the start of lab)
- Midterm solutions are posted on D2L
- Exam scores will be posted over the weekend.

MIDTERM RESULTS



Clicker Question

Room Frequency BA

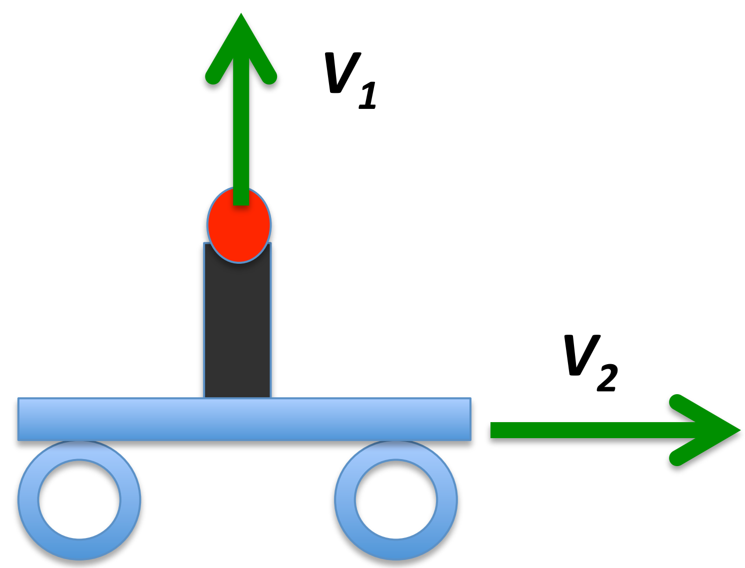
A cannon aimed straight up fires a cannonball from a cart moving to the right with constant speed V_2. The initial vertical velocity of the cannonball relative to the cannon is V_1. Will the cannonball land …

A) Ahead of the cart

B) Behind the cart

C) Right on the cart

D) Depends on the ratio of V_1 to V_2



Cannon on Cart Demonstration

Clicker Question

Room Frequency BA

A cannon aimed straight up fires a cannonball from a cart moving to the right with constant speed V_2. The initial vertical velocity of the cannonball relative to the cannon is V_1. Will the cannonball land …

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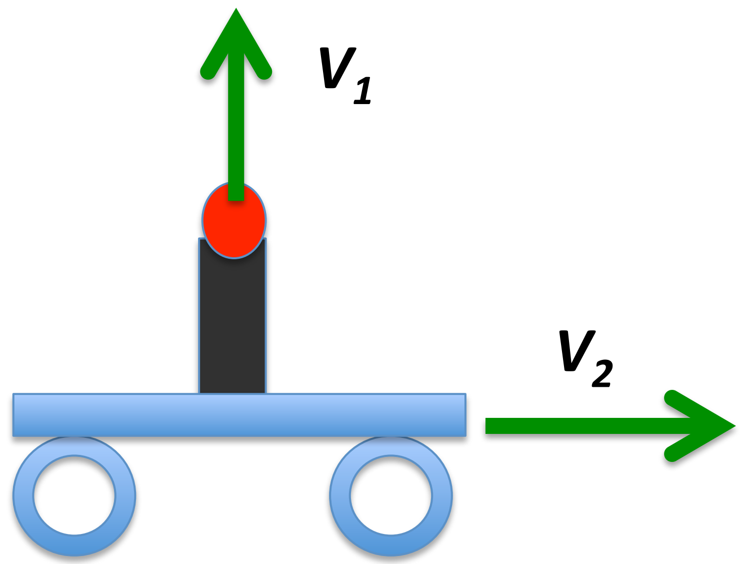
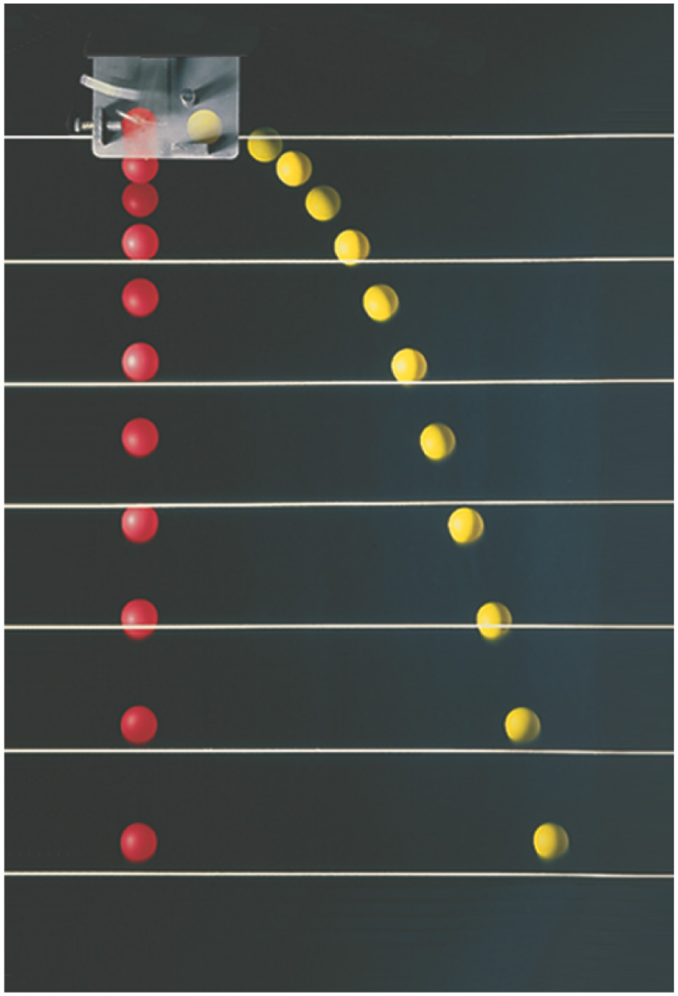


Horizontal motion is independent of the vertical motion!

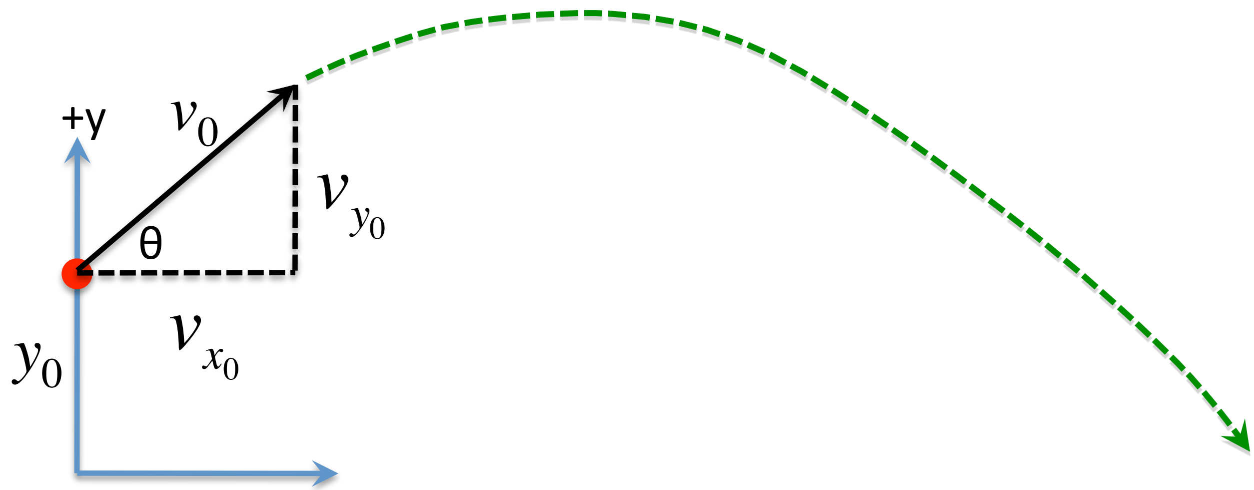
Is the *y* motion independent?



- *x*-direction: constant velocity;
- *y*-direction: constant acceleration *g*.

The photograph shows two balls that start to fall at the same time. The one on the right has an initial speed in the *x*-direction. It can be seen that vertical positions of the two balls are identical at identical times, while the horizontal position of the yellow ball increases linearly.

Constant Acceleration Equations in 2D



Horizontal and vertical motions are independent

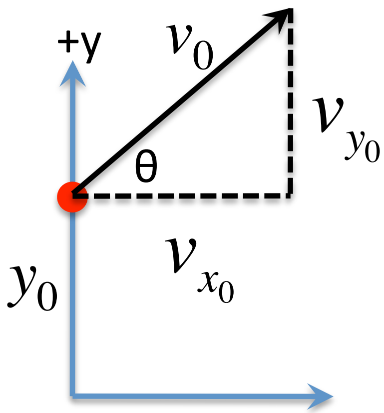
General 2D Constant Acceleration Equations:

$$v_x = v_{0x} + a_x t \qquad v_y = v_{0y} + a_y t$$

$$x = x_0 + v_{0x} t + \tfrac{1}{2} a_x t^2 \qquad y = y_0 + v_{0y} t + \tfrac{1}{2} a_y t^2$$

$$v_x^2 = v_{0x}^2 + 2a_x(x - x_0) \qquad v_y^2 = v_{0y}^2 + 2a_y(y - y_0)$$

Projectile Motion in 2D



Horizontal
***x*-direction**

$$a_x = 0$$

$$x_0$$

$$v_{0_x} = v_0 \cos\theta$$

Vertical
***y*-direction**

$$a_y = -g$$

$$y_0$$

$$v_{0_y} = v_0 \sin\theta$$

Special equations for projectiles for this reference frame

$$v_x = v_{0x} = v_0 \cos\theta$$

$$x = x_0 + v_{0x} t$$

$$v_x^2 = v_{0x}^2$$

$$v_y = v_{0y} - gt = v_0 \sin\theta - gt$$

$$y = y_0 + v_{0y} t - \tfrac{1}{2} g t^2$$

$$v_y^2 = v_{0y}^2 - 2g(y - y_0)$$

Clicker Question

Room Frequency BA

Consider a ball shot from the ground level at angle θ and initial speed v_0. Neglecting air resistance, what are v_y and v_x when the ball reaches its ***apex*** ?

$A)\ v_y = gt \qquad v_x = v_0 \cos\theta$

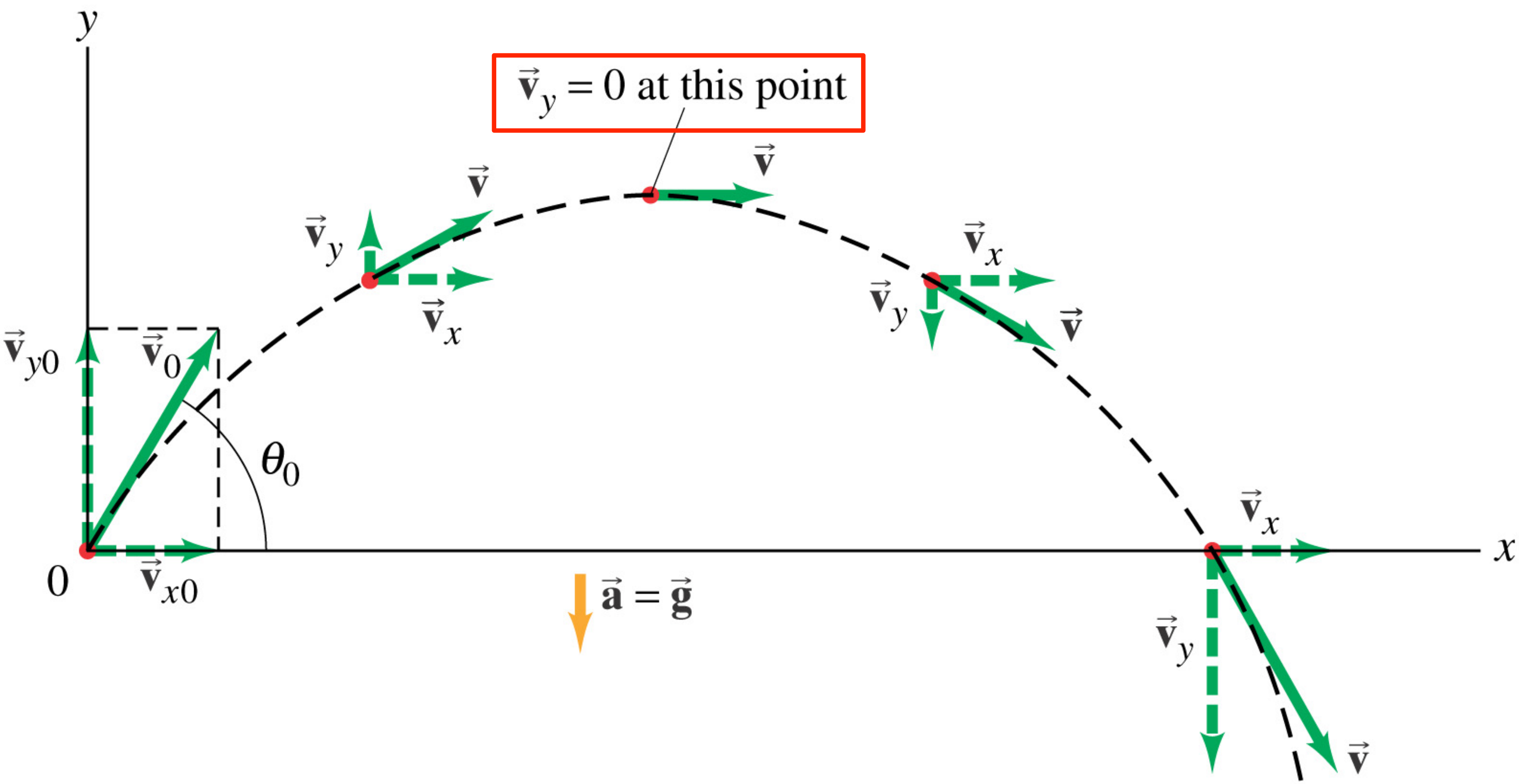
$B)\ v_y = 0 \qquad v_x = v_0 \cos\theta$

$C)\ v_y = 0 \qquad v_x = 0$

$D)\ v_y = v_0 \sin\theta \qquad v_x = 0$

$$v_y(t) = v_{y0} + a_y t = v_0 \sin\theta - gt \qquad v_x(t) = v_{x0} + a_x t = v_0 \cos\theta$$

Finding the Apex (Maximum height)



Clicker Question

Room Frequency BA

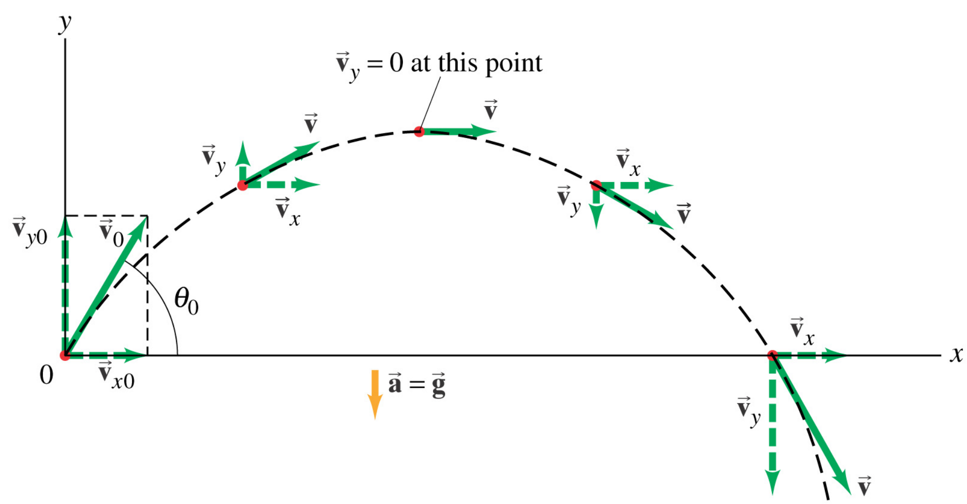
Now, consider the same ball shot from the ground level at angle θ and initial speed v_0. Neglecting air resistance, when will the ball reach its apex?

A) $t = v_0 / g$

B) $t = v_0^2 / g$

C) $t = v_0 \sin\theta / g$

D) $t = v_0 \cos\theta / g$



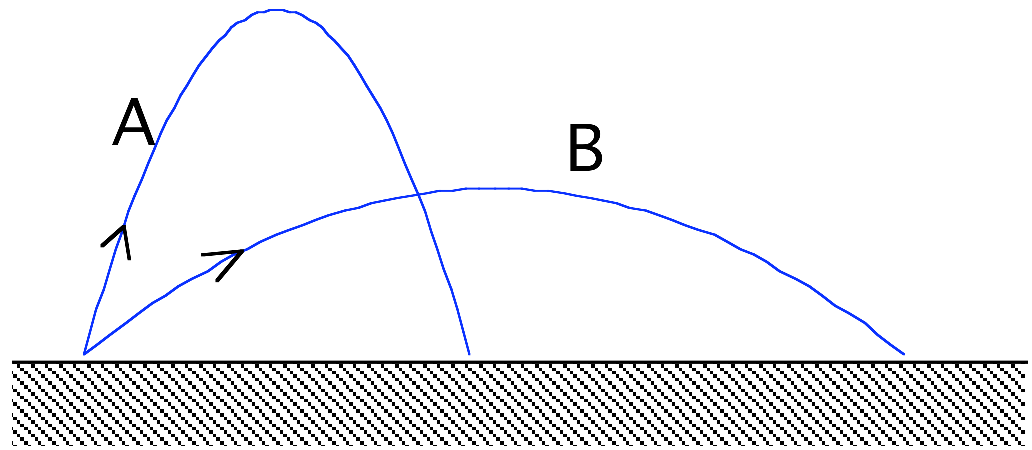
$$v_y(t) = v_{y0} + a_y t = v_0 \sin\theta - gt$$

$$v_x(t) = v_{x0} + a_x t = v_0 \cos\theta$$

Clicker Question

Room Frequency BA

Two projectiles are fired from a cannon. For projectile A, the cannon is tilted upward at an angle twice that of projectile B. Both projectiles are fired with the same initial speed. (As usual, neglect air resistance.)



Which projectile was in the air longer?

A) A

B) B

C) A and B were in the air the **same** length of time.

D) Not enough information to answer the question.

$$t = 2v_{0y} / g$$

Clicker Question

Room Frequency BA

Last lecture we found the *time* to reach the apex. Now, consider the same ball shot from the ground level at angle θ and initial speed v_0. What is the maximum height h of the ball above ground level? (Neglecting air resistance, as usual.)

A) $h = \frac{1}{2} g t^2$

B) $h = 2g / v_{0y}^2$

C) $h = 2v_{0y}^2 / g$

D) $h = v_{0y}^2 / 2g$

E) $h = v_{0y}^2 / g$

Use v_y = 0, and no need of time t

$$v_x = v_{0x} = v_0 \cos\theta$$
$$x = v_{0x} t$$
$$v_x^2 = v_{0x}^2$$

$$v_y = v_{0y} - gt = v_0 \sin\theta - gt$$
$$y = y_0 + v_{0y} t - \frac{1}{2} g t^2$$
$$v_y^2 = v_{0y}^2 - 2g(y - y_0)$$

$$0^2 = v_{0y}^2 - 2gh \Rightarrow h = v_{0y}^2 / 2g$$