Physics 225

Section 2,
Fall 2018

Clicker question #1

Question 3.4a Firing Balls I

A small cart is rolling at constant velocity on a flat track. It fires a ball straight up into the air as it moves. After it is fired, what happens to the ball?

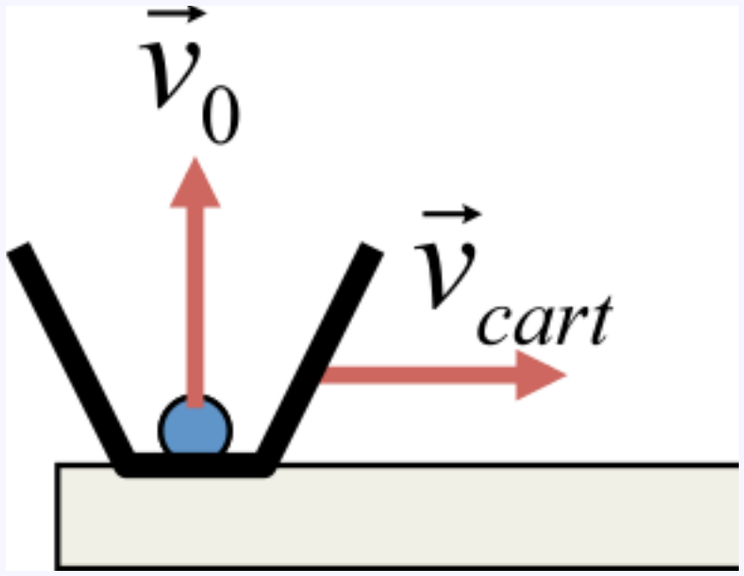
A it depends on how fast the cart is moving

B it falls behind the cart

C it falls in front of the cart

D it falls right back into the cart

it remains at rest



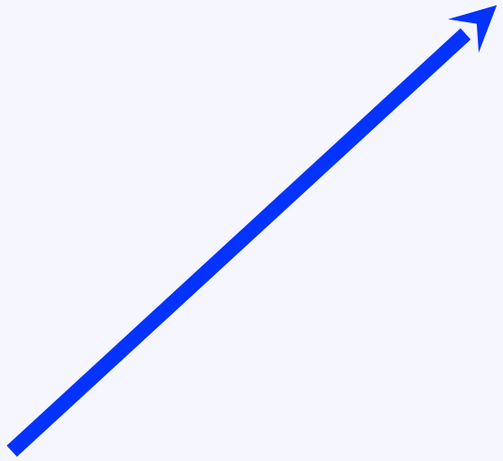
Clicker question #2

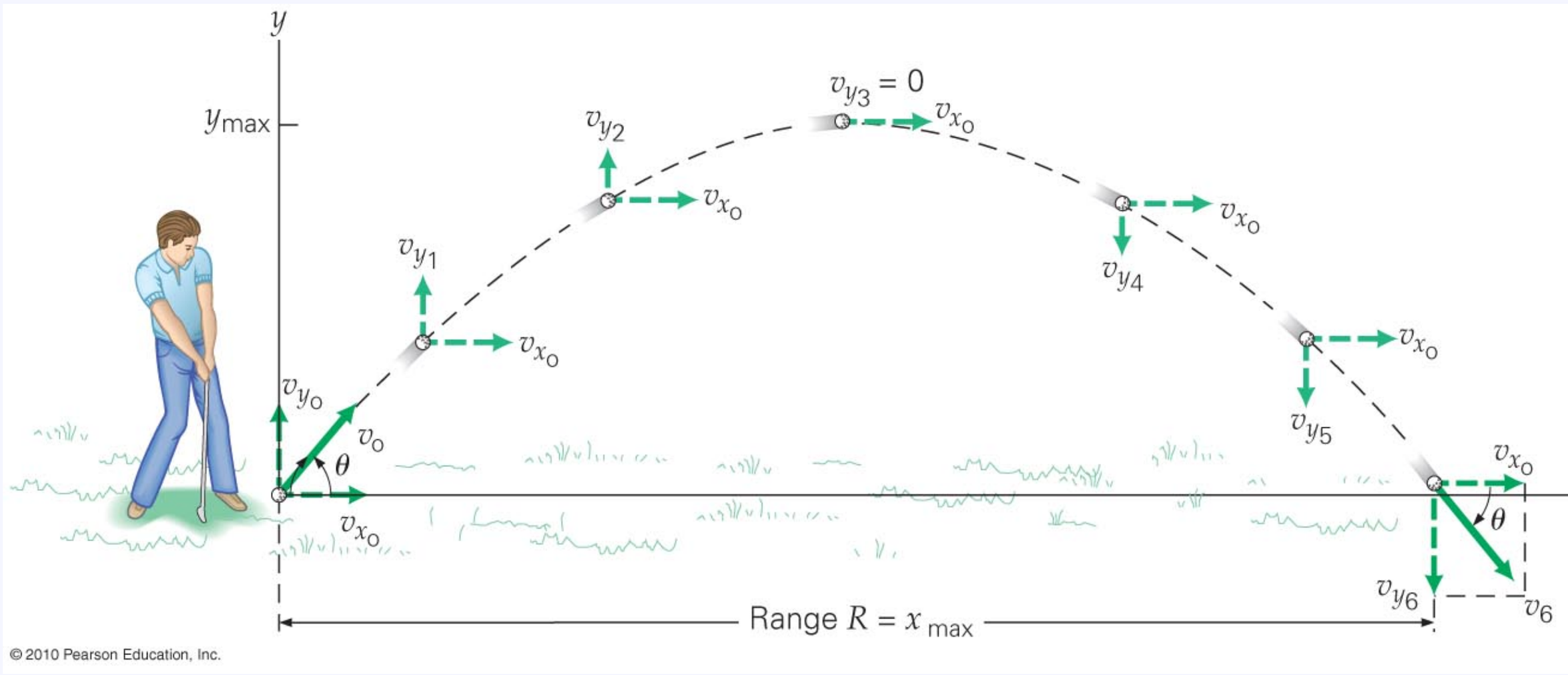
Which is the initial *velocity*?

A 

B 

C 

D 



Clicker question #2a

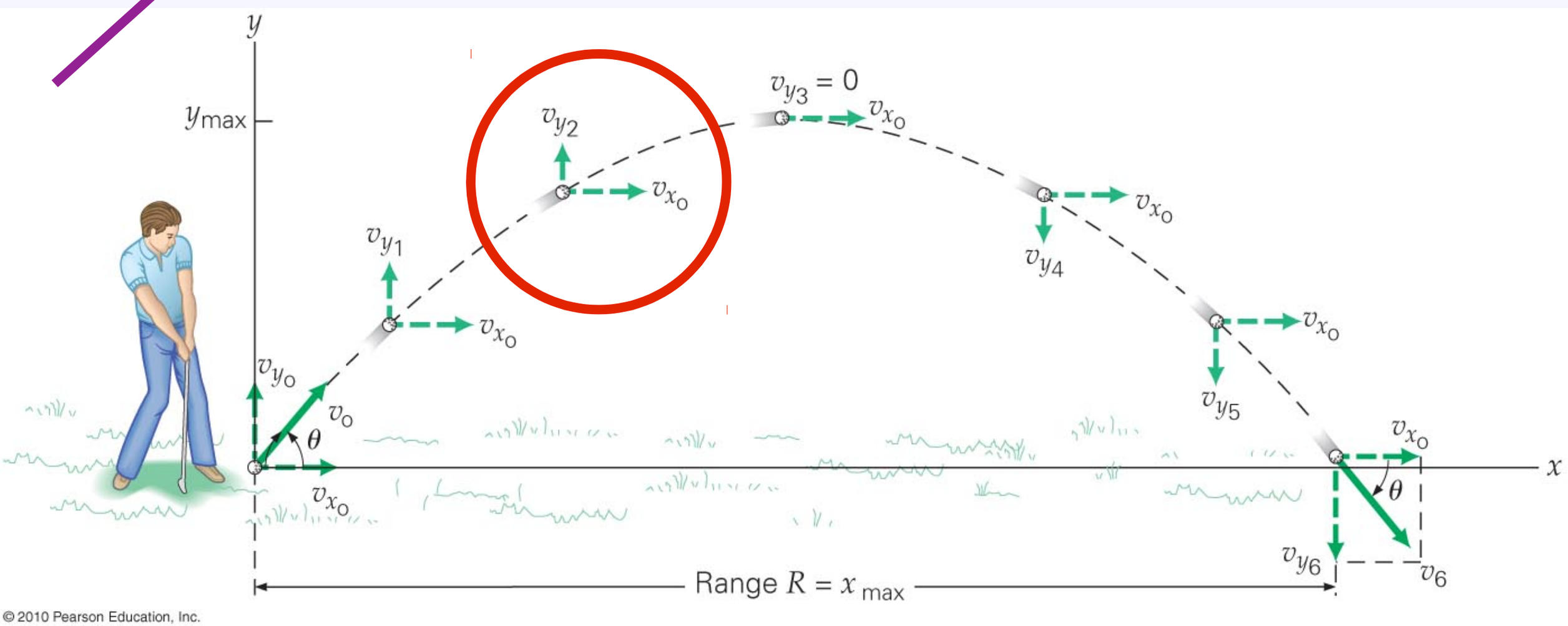
Which is the *position* at the circled time?

A

B

C

D



Clicker question #2b

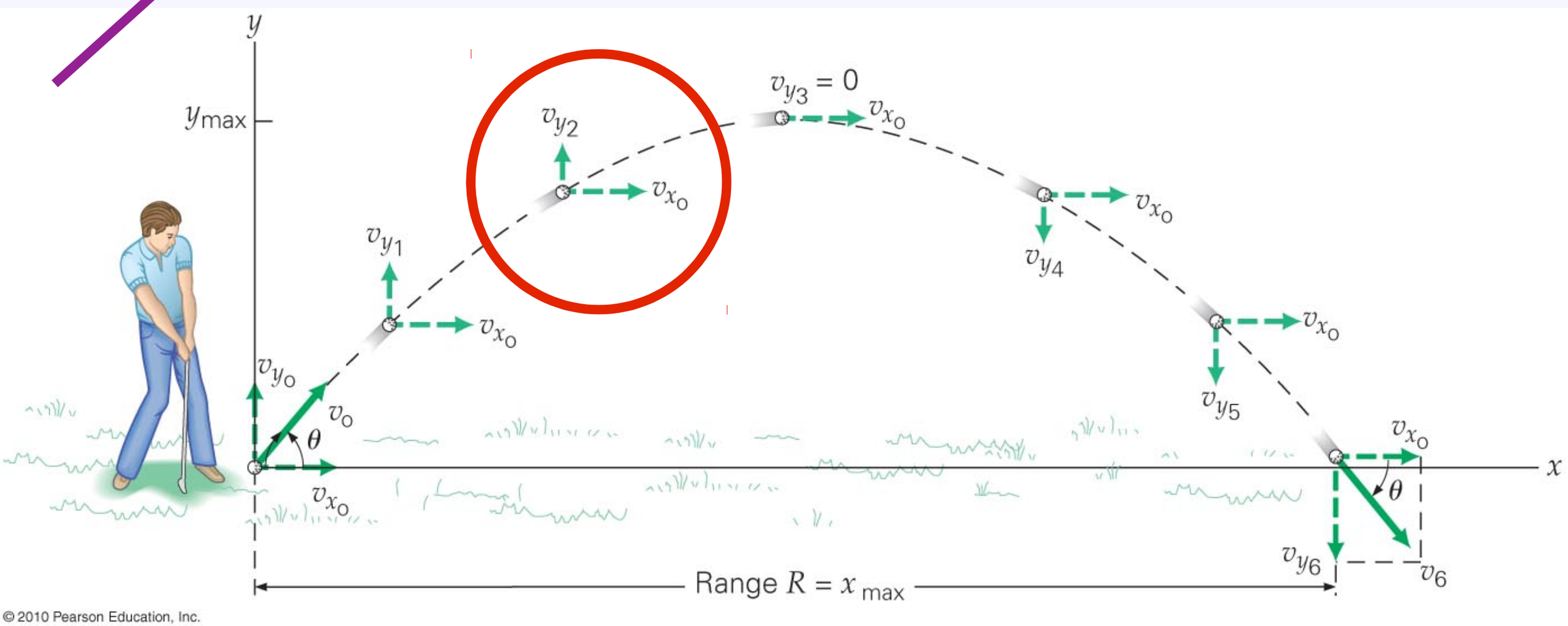
Which is the *acceleration* at the circled time?

A

B

C

D



Clicker question #2c

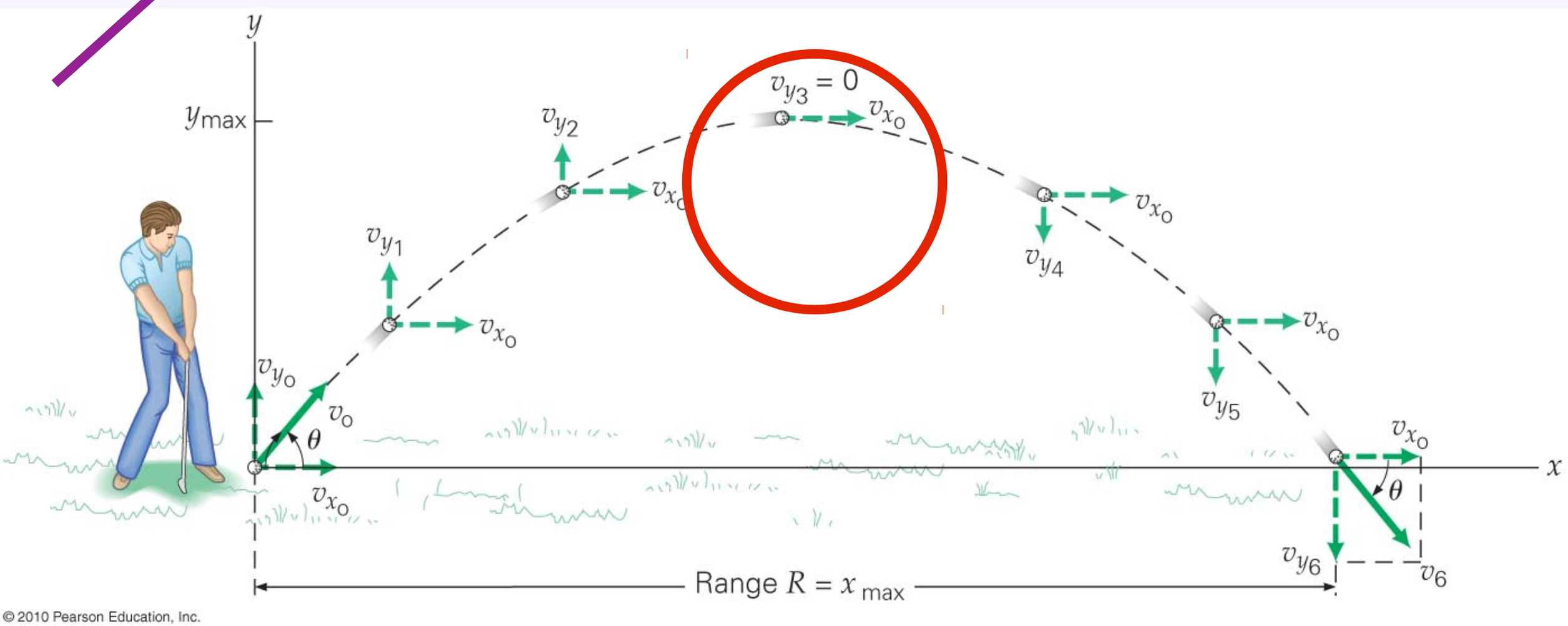
Which is the *acceleration* at the circled time?

A

B

C

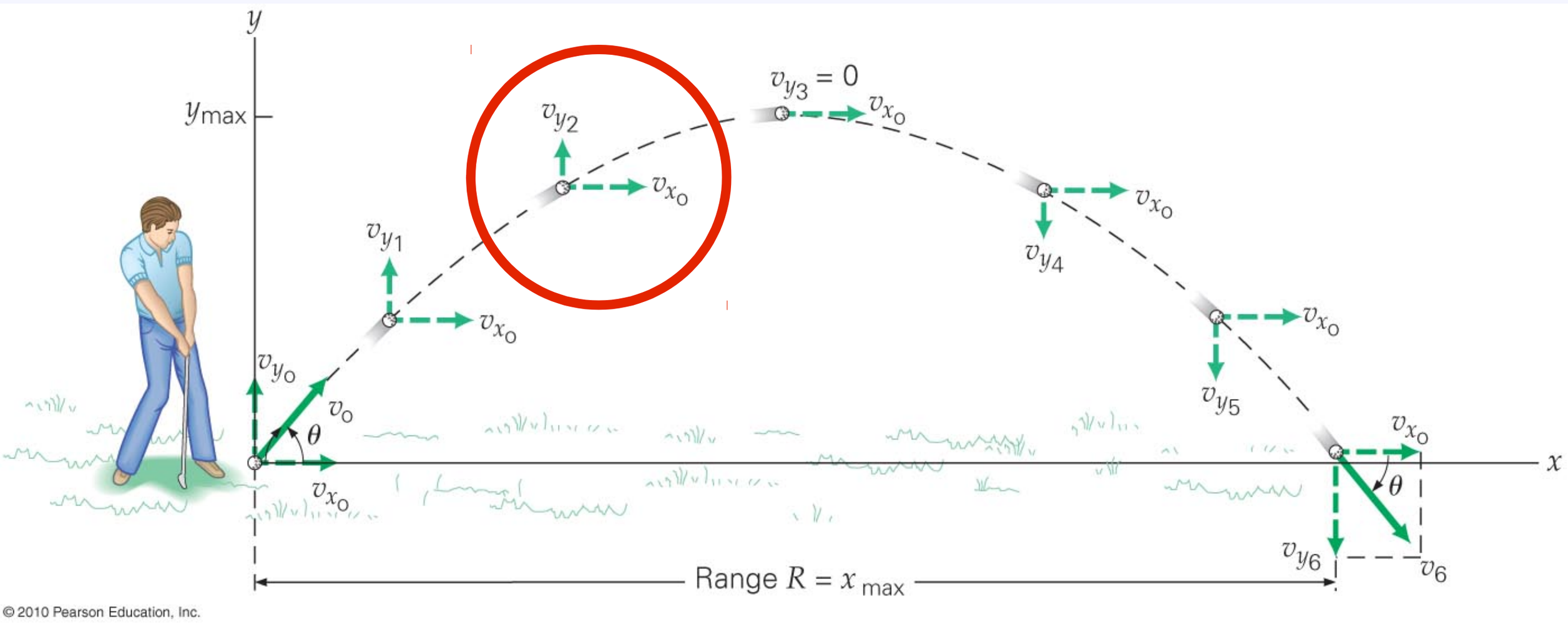
D



Clicker question #2d

What is the x *component of the velocity* at the circled time?

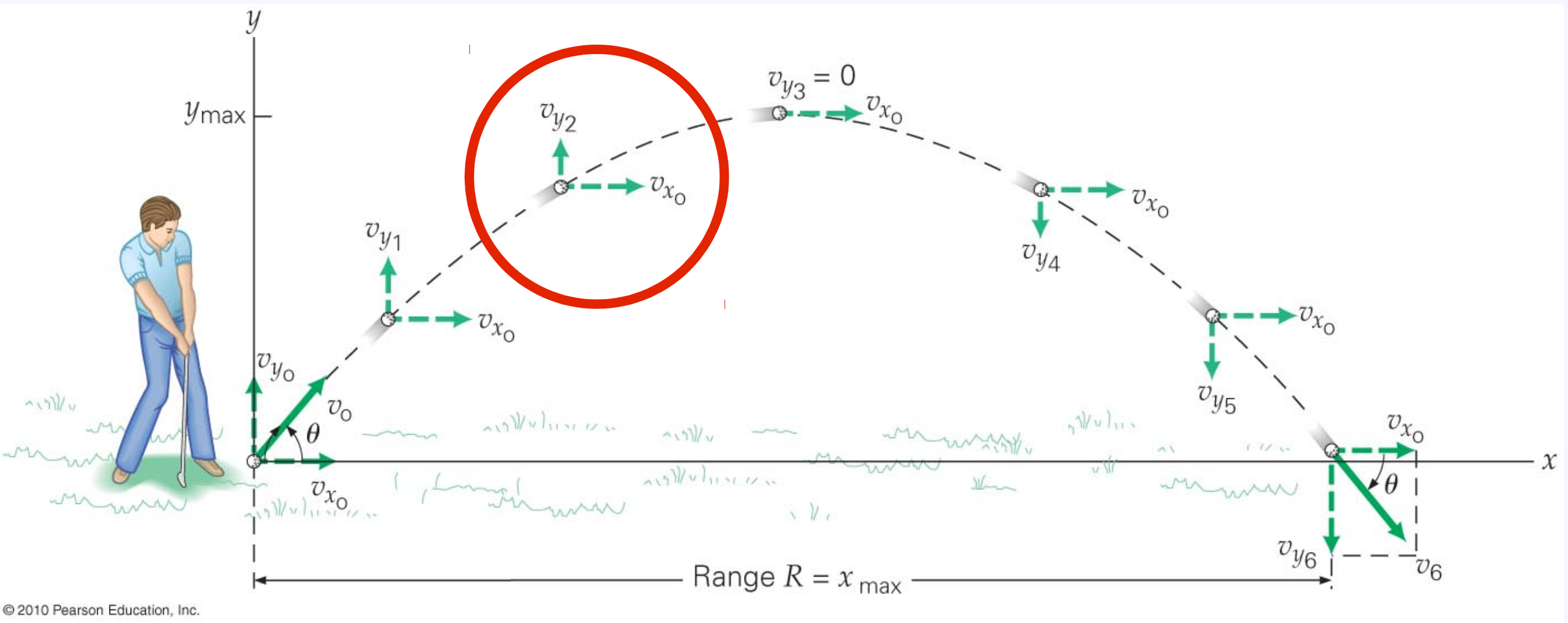
A → B ↓ C ↑ D ←



Clicker question #2e

What is the y *component of the velocity* at the circled time?

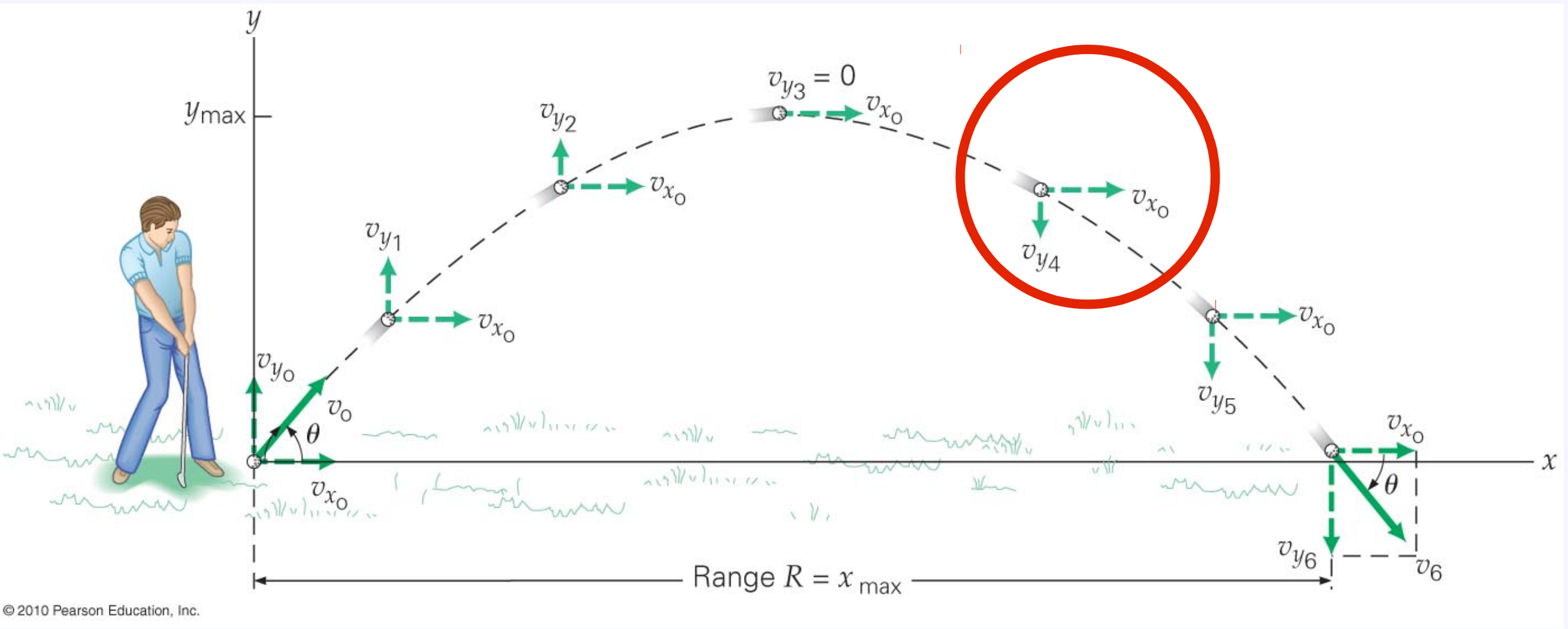
A → B ↓ C ↑ D ←



Clicker question #2f

What is the x *component of the velocity* at the circled time?

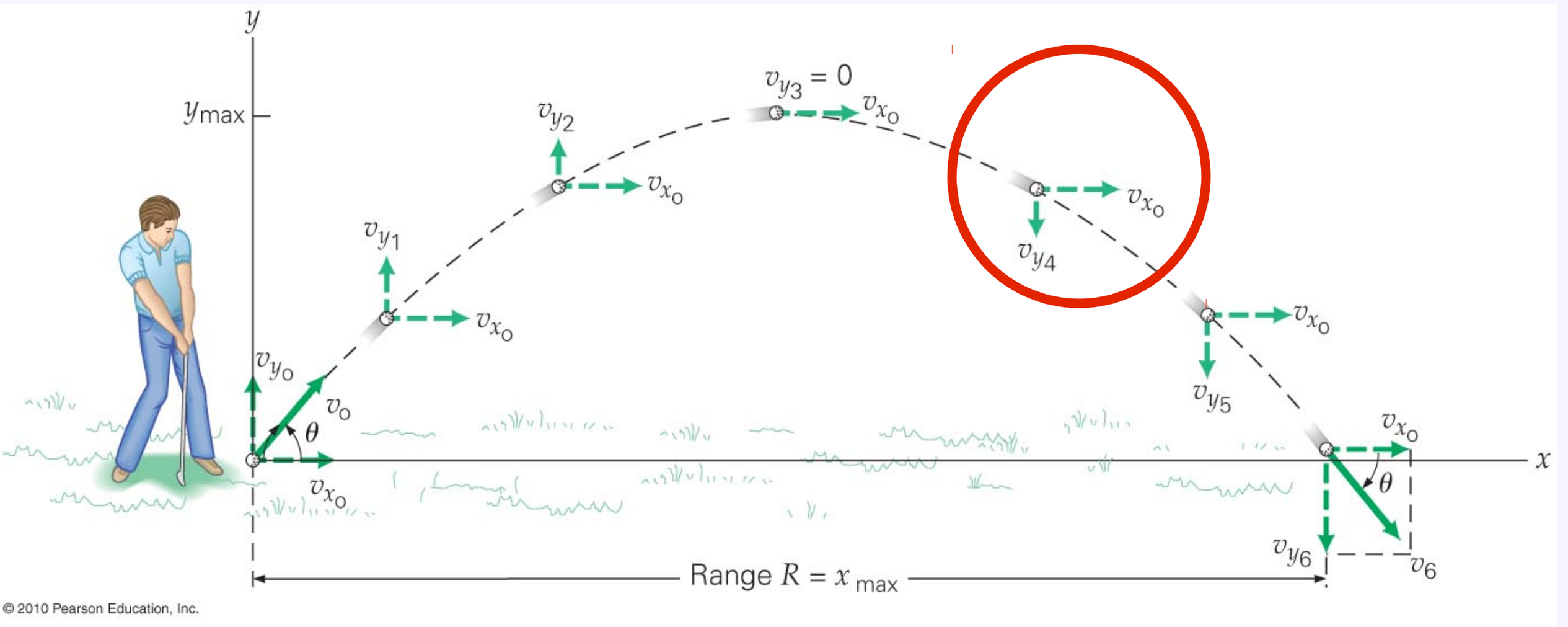
A → B ↓ C ↑ D ←



Clicker question #2g

What is the y *component of the velocity* at the circled time?

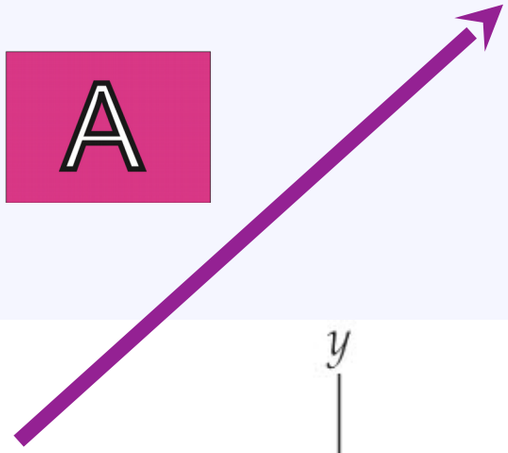
A → B ↓ C ↑ D ←



Clicker question #2h

Which is the *velocity* at the circled time?

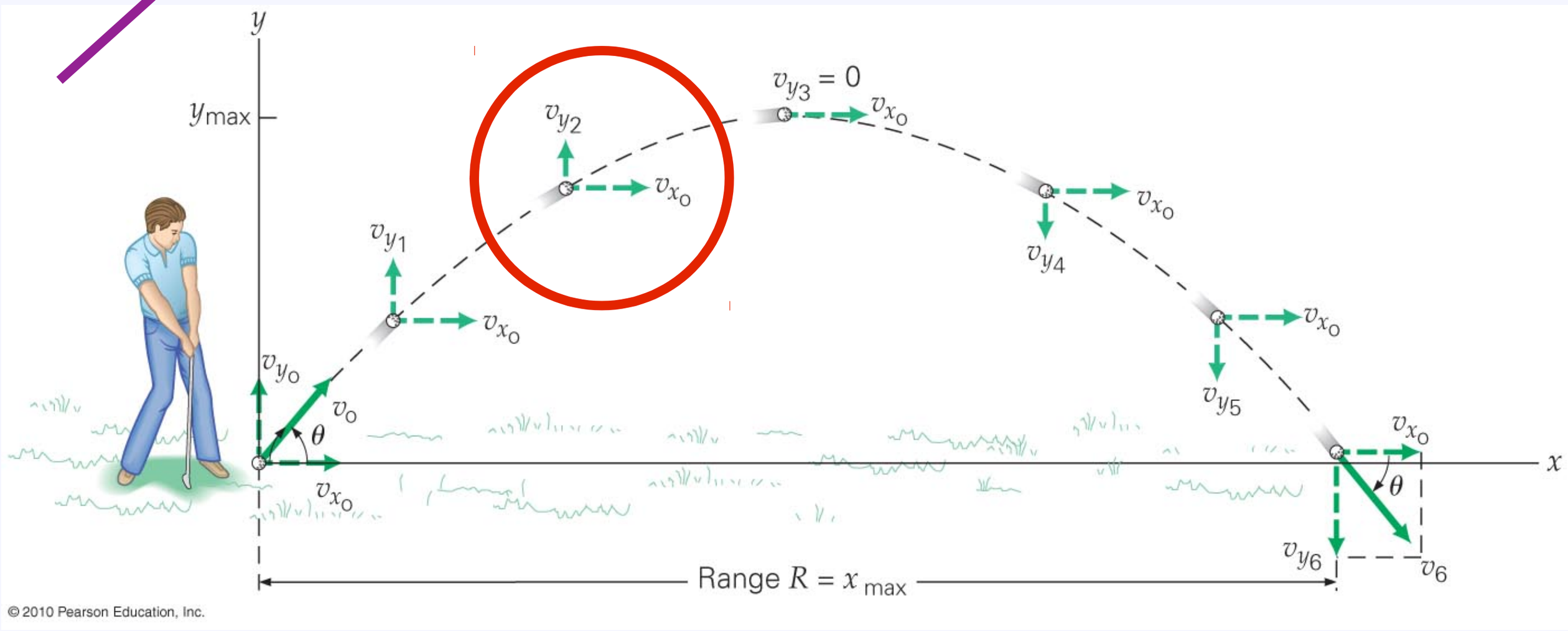
A



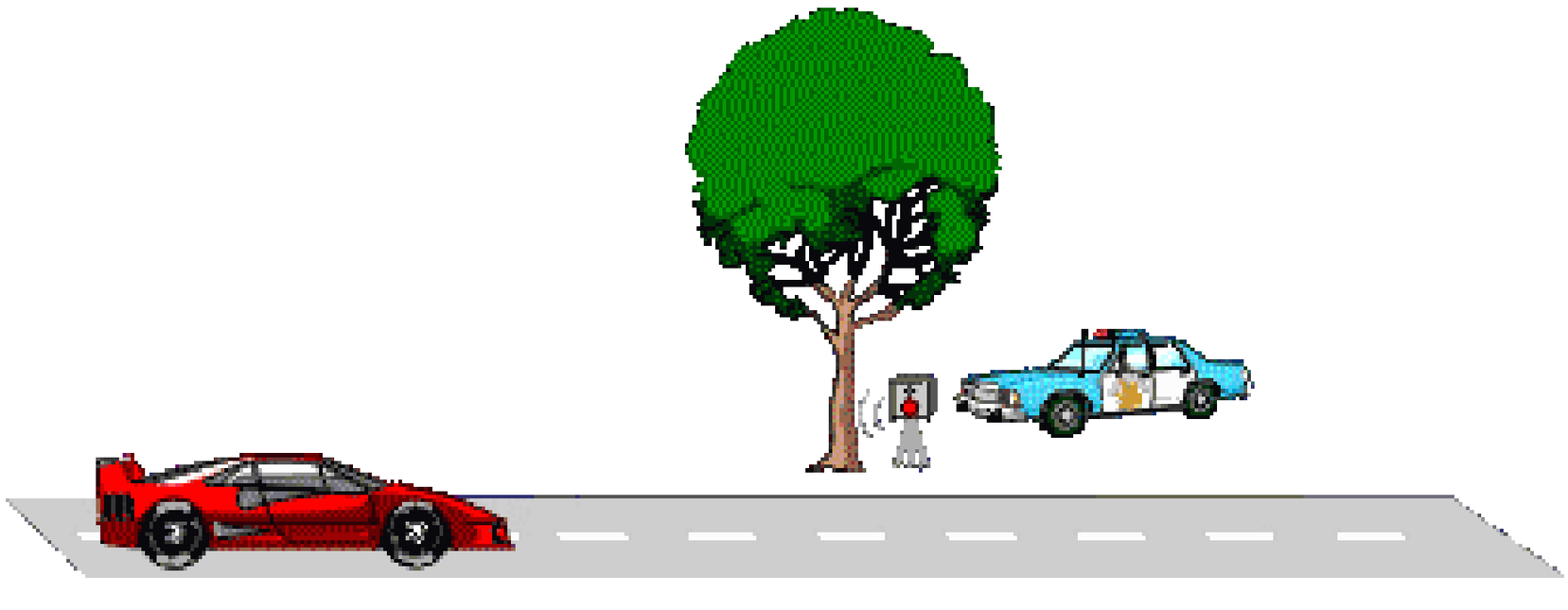
B

C

D

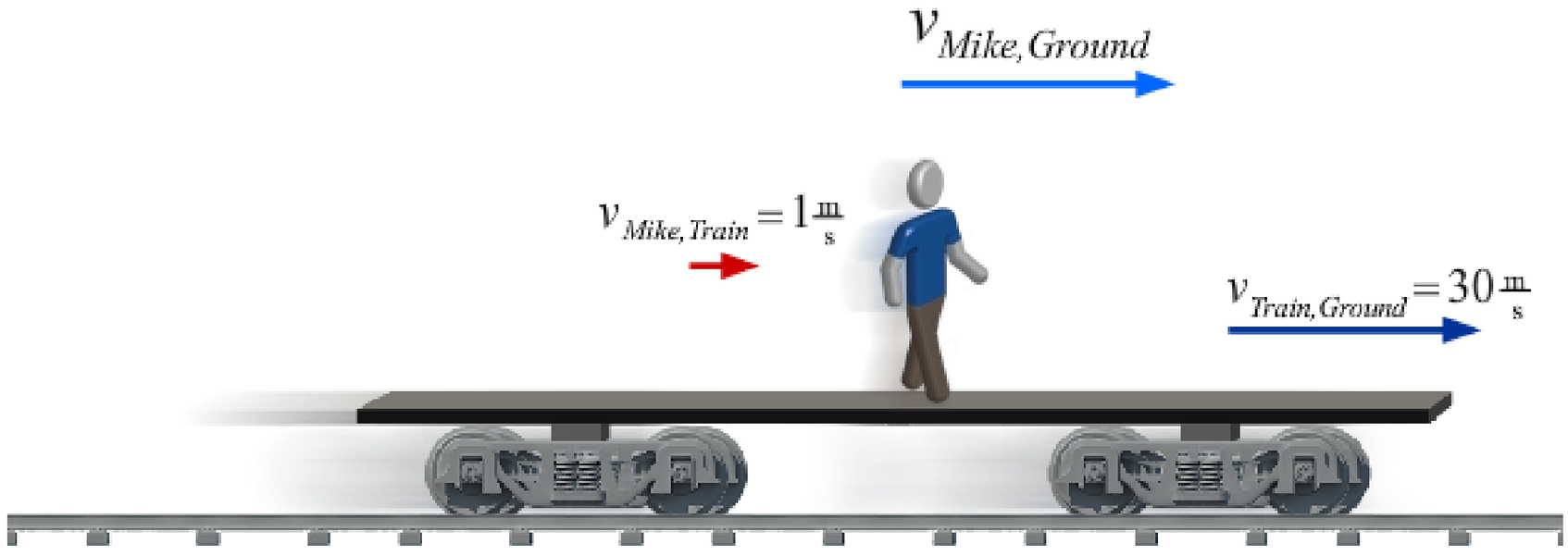


Relative Motion



- Relative motion means the velocity of a particle depends on the **reference frame** of the **observer**
- Reference frame is the physical object to which we attach our **coordinate system**
- **e.g.** seeing a plane fly by vs. being on the plane

Relative Motion



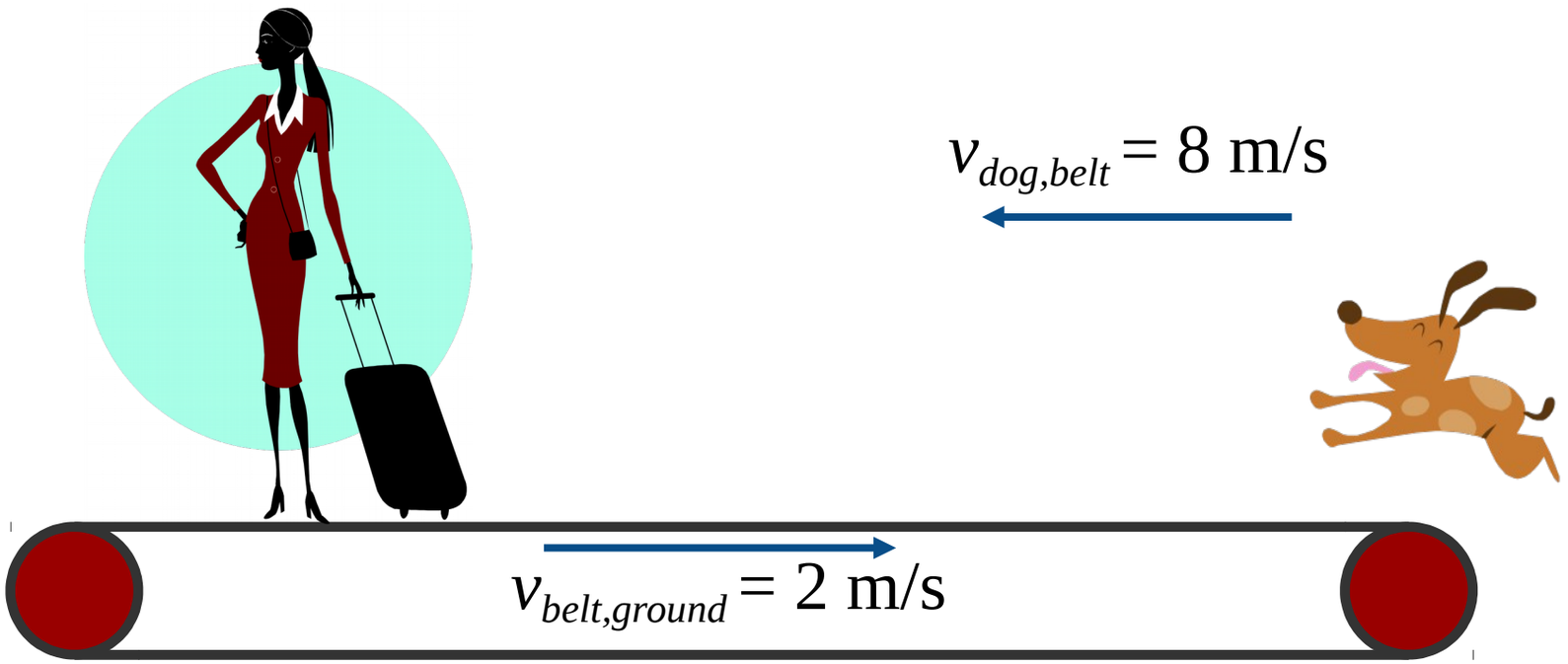
$$v_{Mike,Ground} = v_{Mike,Train} + v_{Train,Ground}$$

$$\vec{v}_{ac} = \vec{v}_{ab} + \vec{v}_{bc}$$

Clicker Question #2

A woman stands on a moving sidewalk that moves to the right at $2\ \mathrm{m/s}$ relative to the ground. A dog runs toward the girl in the opposite direction along the sidewalk at a speed of $8\ \mathrm{m/s}$ relative to the sidewalk.

What is the speed of the dog relative to the ground?



A) 6 m/s B) 8 m/s C) 10 m/s

Clicker Question #3

A man starts to walk along the dotted line painted on a moving sidewalk toward a fire hydrant that is directly across from him. The width of the walkway is 4 m, and it is moving at 2 m/s relative to the fire-hydrant. If his walking speed is 1 m/s, how far away will he be from the hydrant when he reaches the other side?

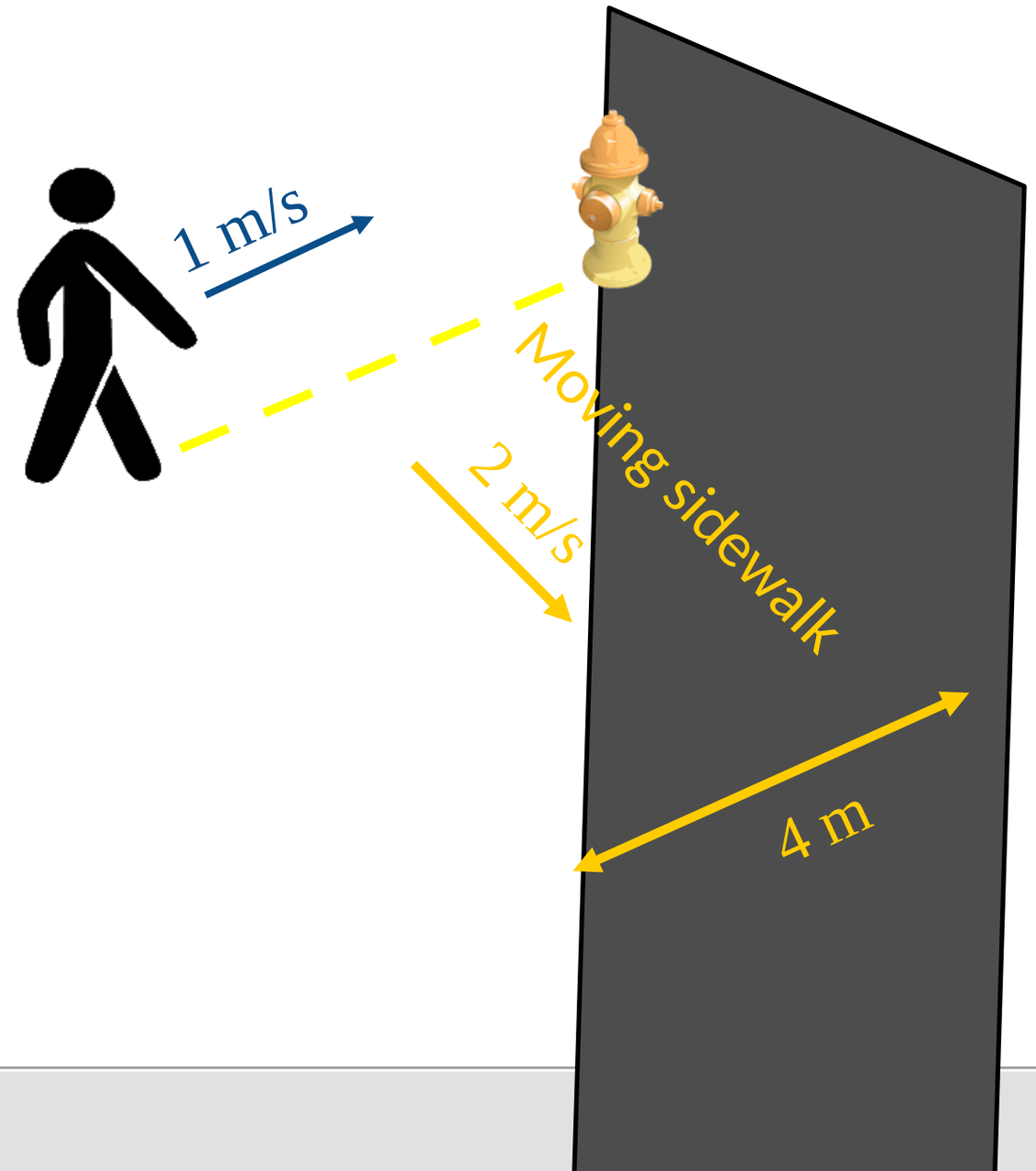
A) 2 m

B) 4 m

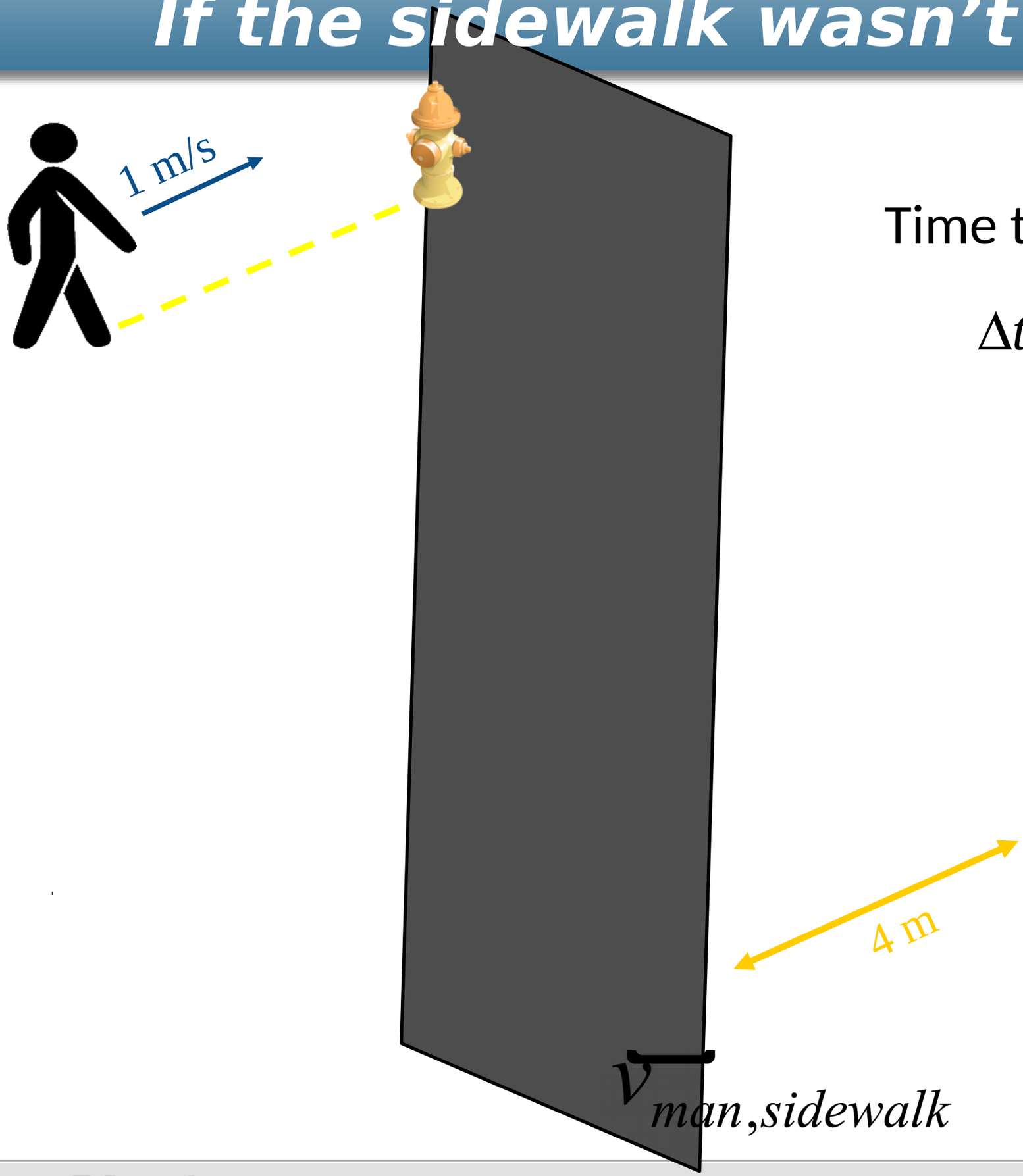
C) 6 m

D) 8 m

E) 0 m



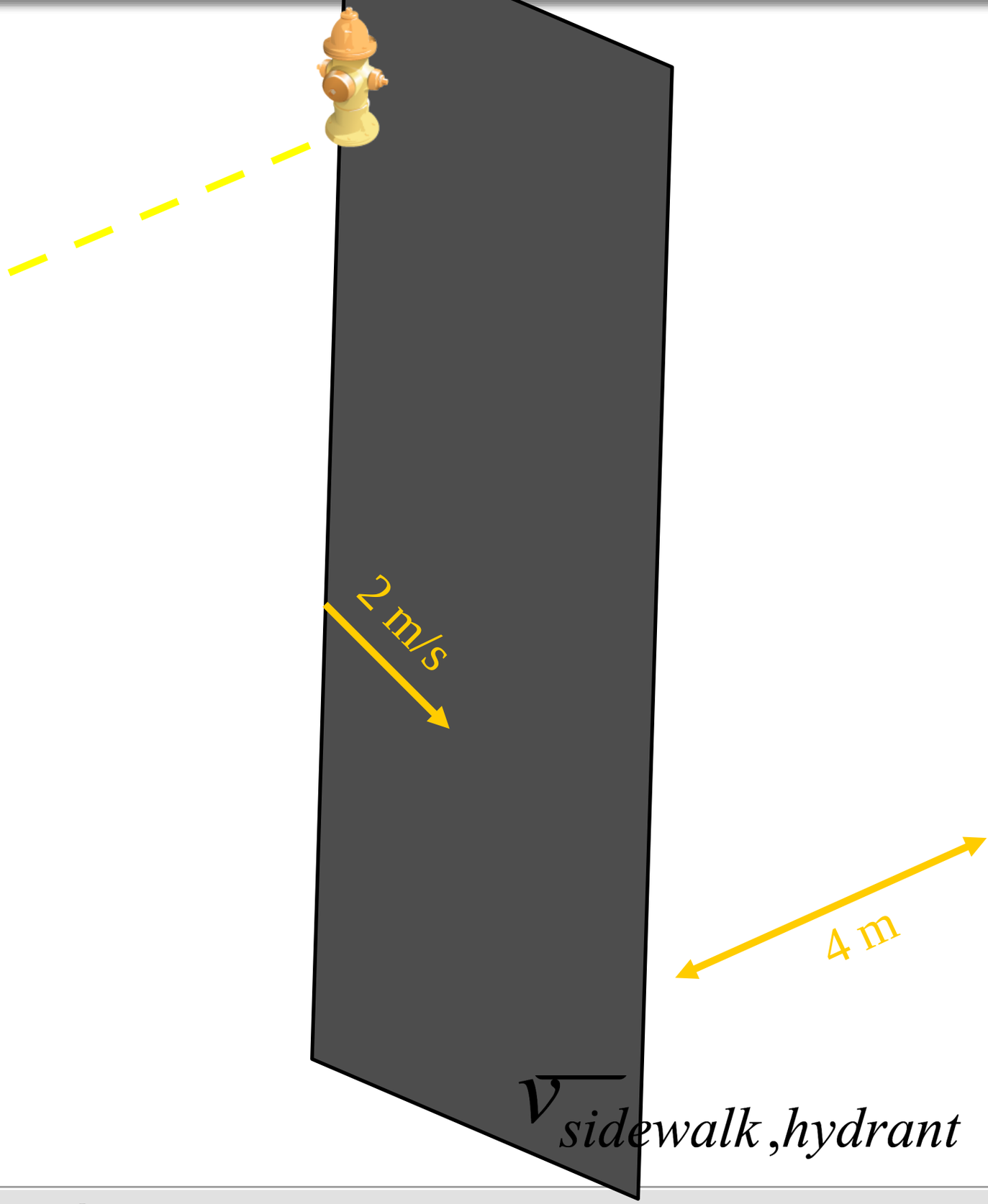
If the sidewalk wasn't moving:

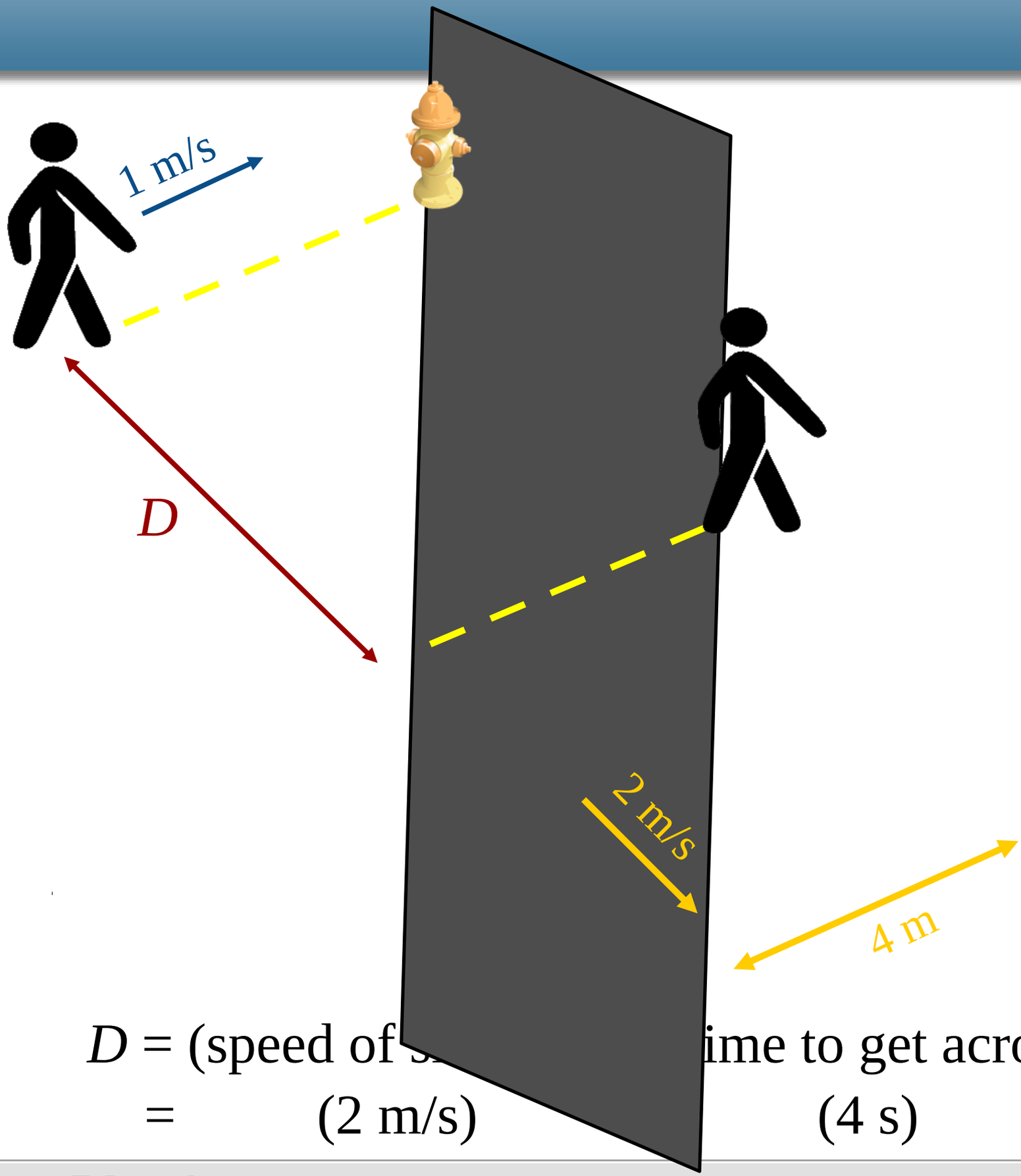


Time to get across:

$$\Delta t = \text{distance} / \text{speed}$$
$$= 4\text{m} / 1\text{m/s}$$
$$= 4\text{ s}$$

Just the sidewalk:

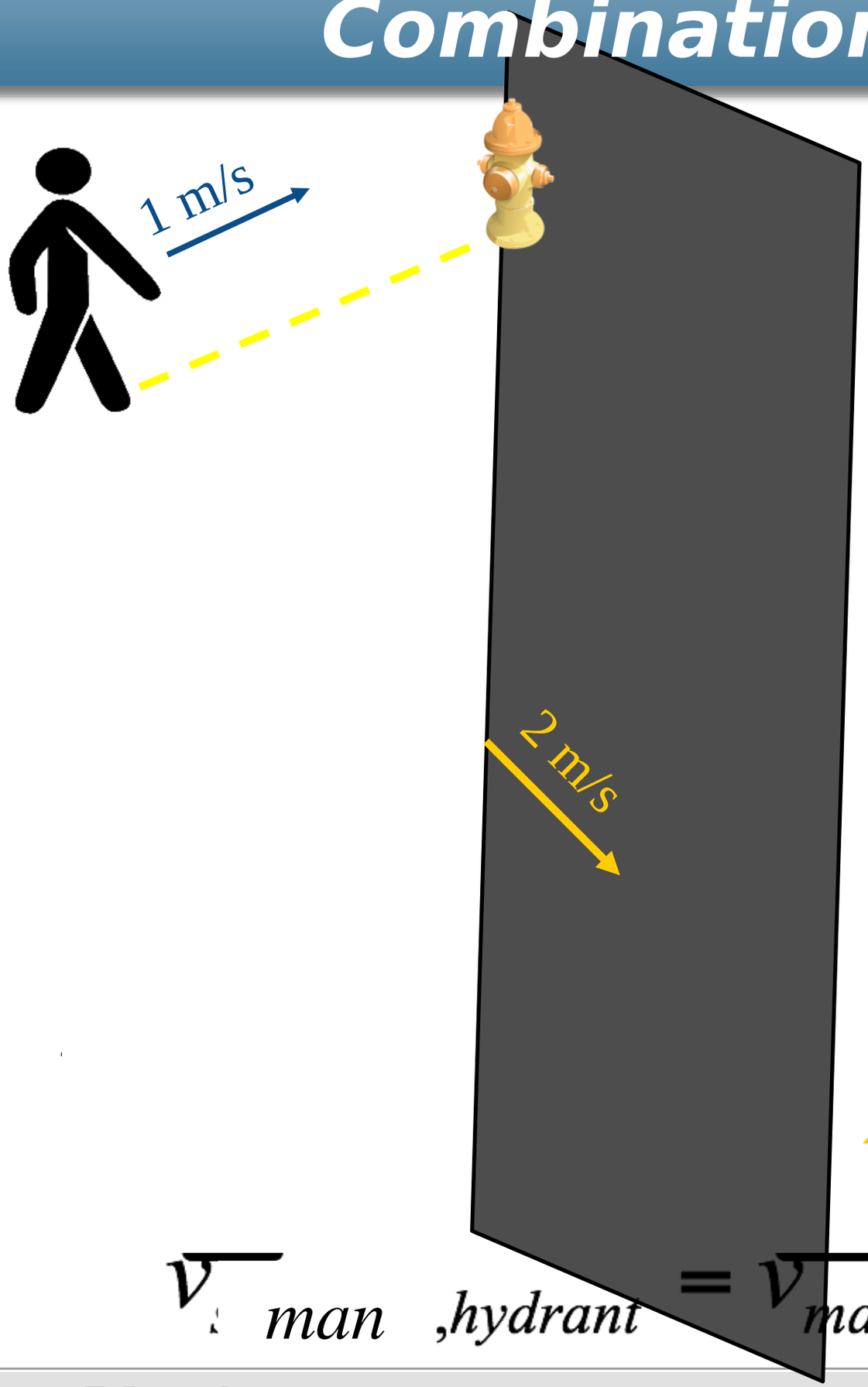


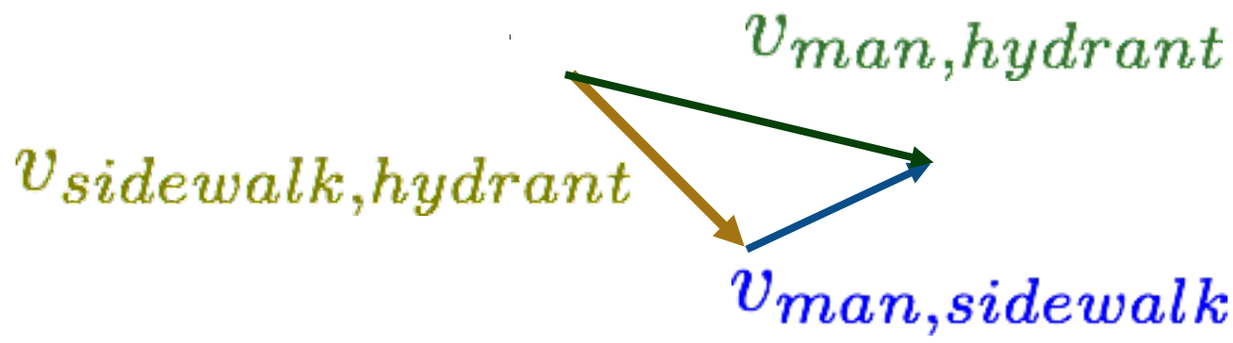


D = (speed of s… ime to get across)

= (2 m/s) (4 s) = 8 m

Combination of motions:



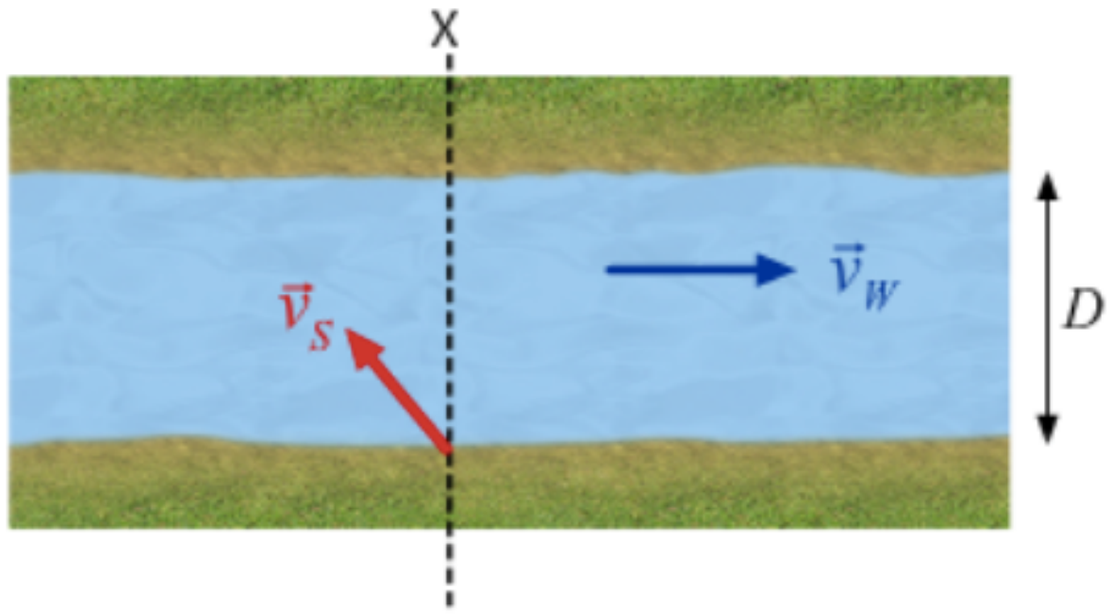


$$\vec{v}_{man,hydrant} = \vec{v}_{man,sidwalk} + \vec{v}_{sidewalk,hydrant}$$

Clicker Question #4

A swimmer wishes to swim across the stream as shown. She knows she can maintain a constant speed $v_S = 0.4$ m/s with respect to the water. The water in the stream moves with speed $v_W = 0.5$ m/s as shown.

Which of the following statements is true?



A She will not be able to cross the stream since $v_S < v_W$.

B She will be able to cross the stream but since $v_S < v_W$, she will never be able to reach any point upstream of X, but will be able to reach point X by choosing an appropriate heading.

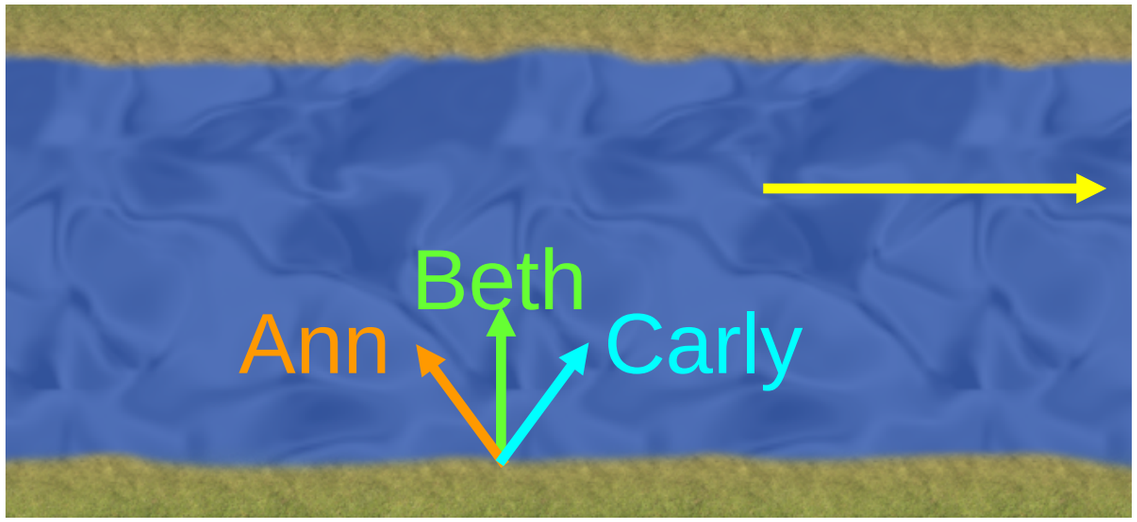
C She will be able to cross the stream but since $v_S < v_W$, she will never be able to reach point X, no matter what heading she chooses.

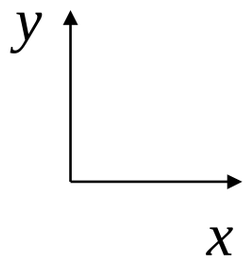
Clicker Question #5a

Three swimmers can swim equally fast relative to the water. They have a race to see who can swim across a river in the least time. Relative to the water, Beth swims perpendicular to the flow, Ann swims upstream at 30 degrees, and Carly swims downstream at 30 degrees.

Who gets across the river first?

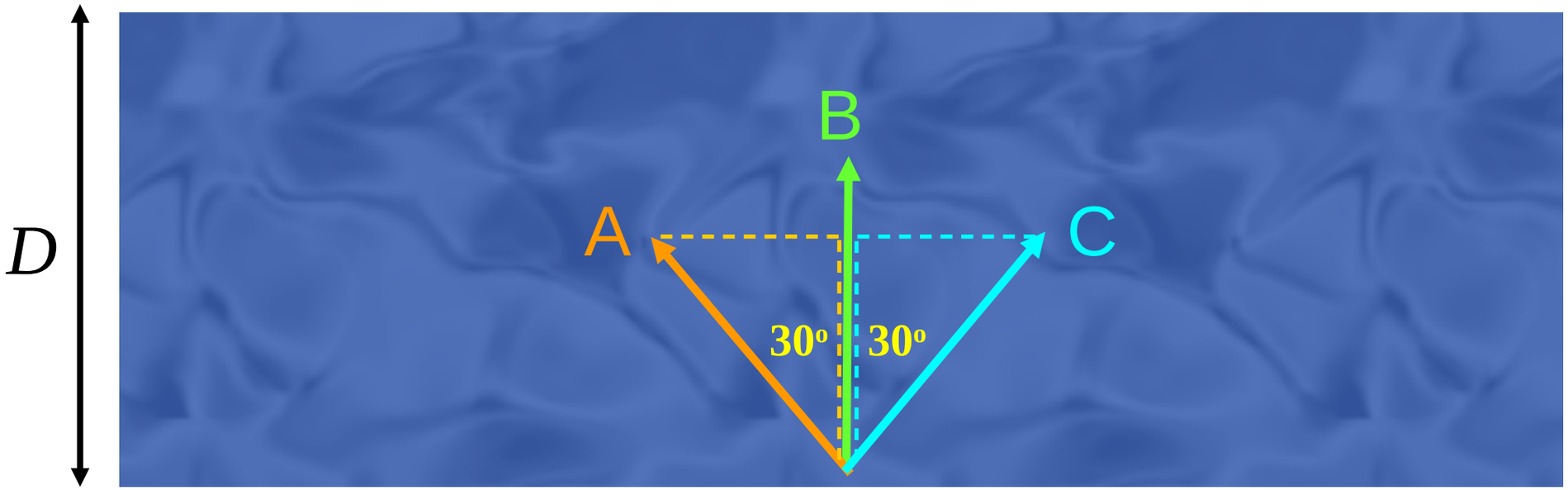
A) Ann B) Beth C) Carly

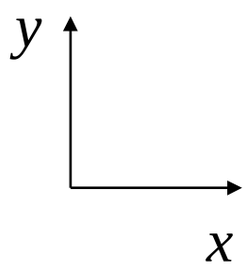




Look at just water & swimmers

Time to get across = D / V_y





$$V_{y,Beth} = V_o$$

$$V_{y,Ann} = V_o \cos(30^o)$$

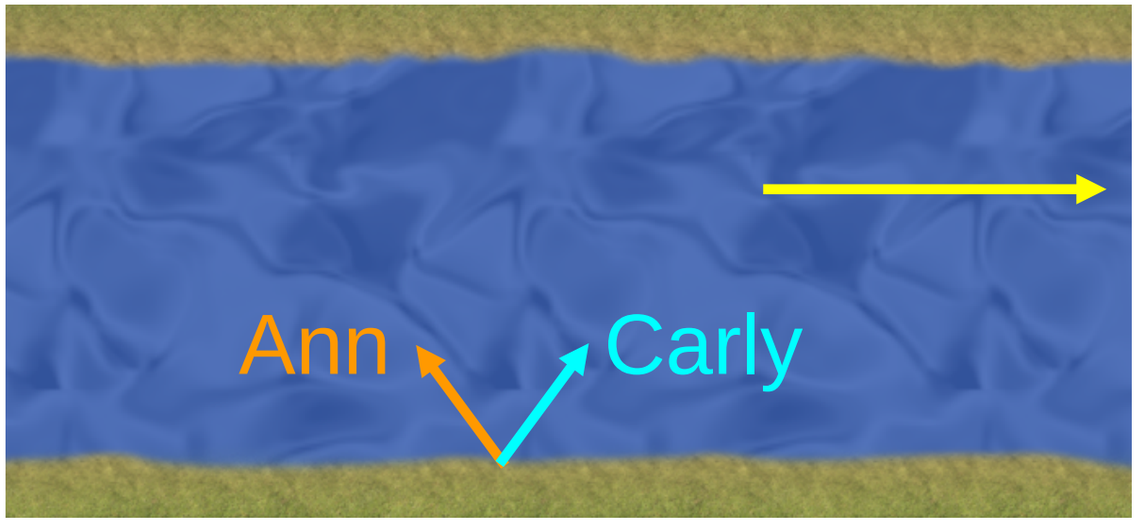
$$V_{y,Carly} = V_o \cos(30^o)$$

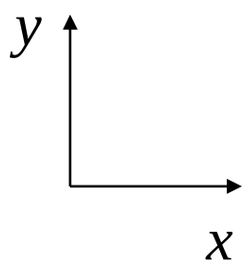
Clicker Question #5b

Three swimmers can swim equally fast relative to the water. They have a race to see who can swim across a river in the least time. Relative to the water, Beth swims perpendicular to the flow, Ann swims upstream at 30 degrees, and Carly swims downstream at 30 degrees.

Who gets across the river second?

A) Ann B) Carly C) Both same





What angle to get straight across river?

Extra slides

Clicker question #5

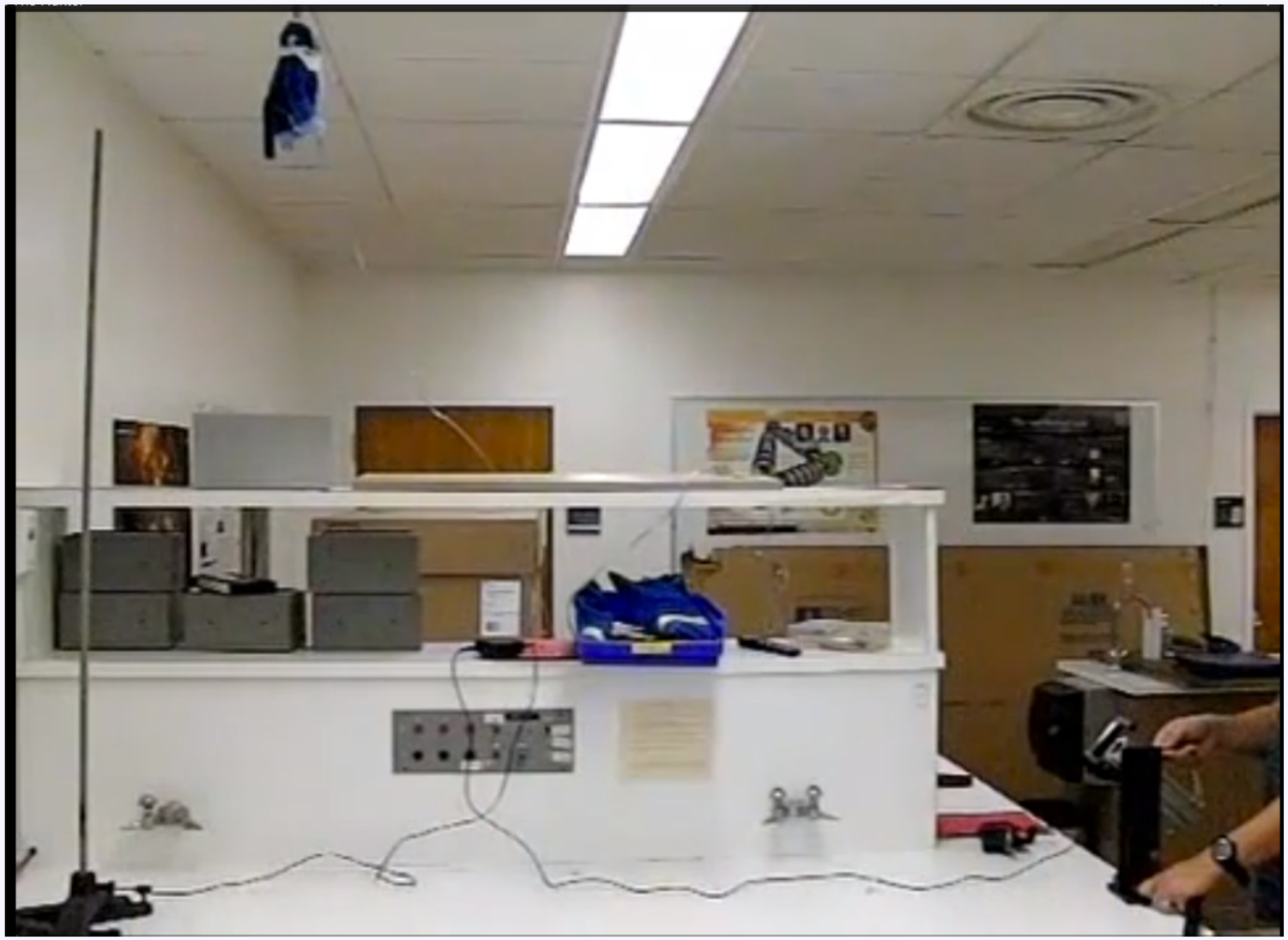
"Monkey shoot" The monkey starts falling when the gun fires. What angle θ should you aim to hit the monkey?

A Below the monkey

B Straight at the monkey

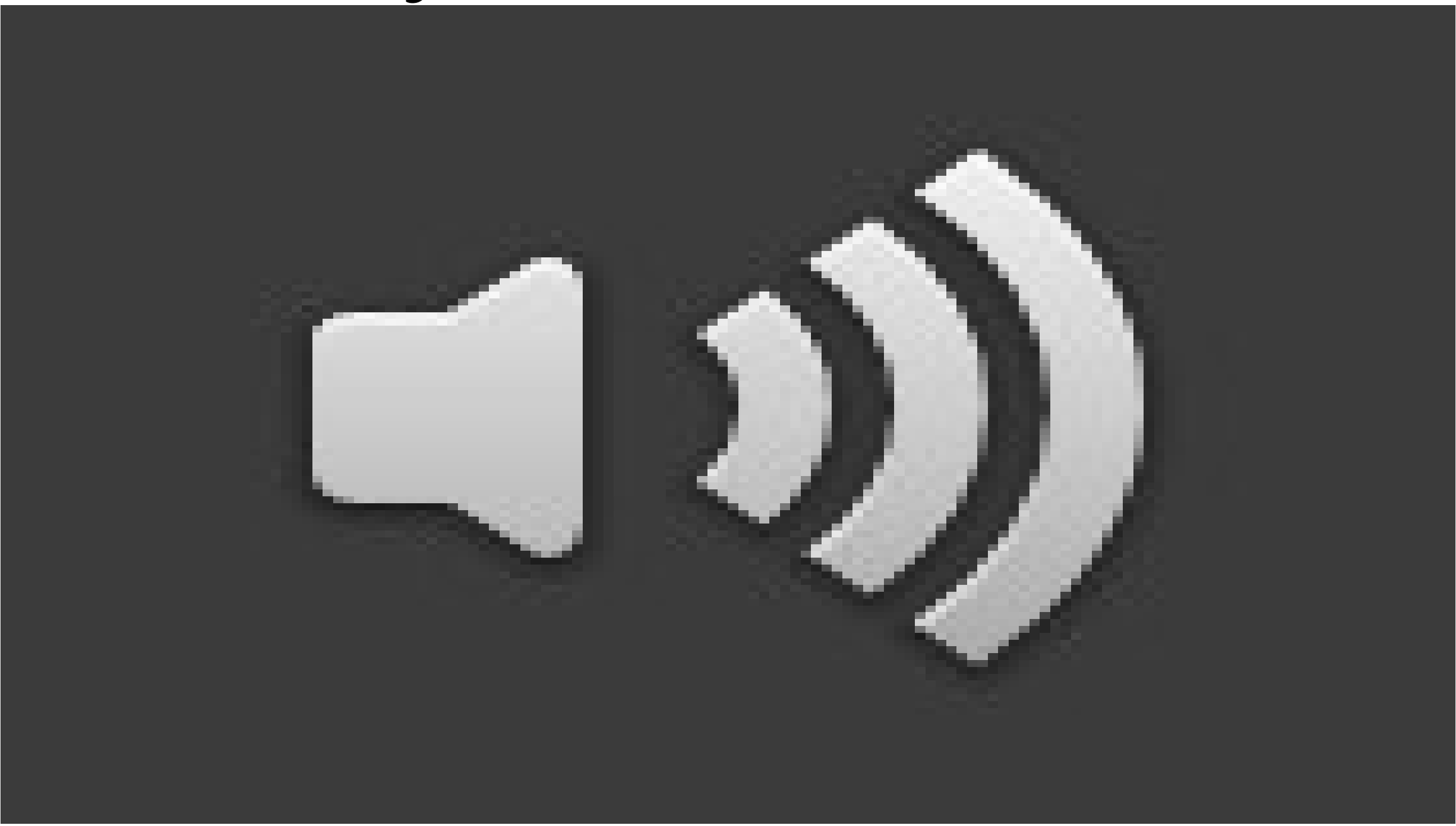
C Above the monkey

D It depends on the dart speed



http://physics.fullerton.edu/department/lecture-demos/93

Monkey shoot



Bonus example

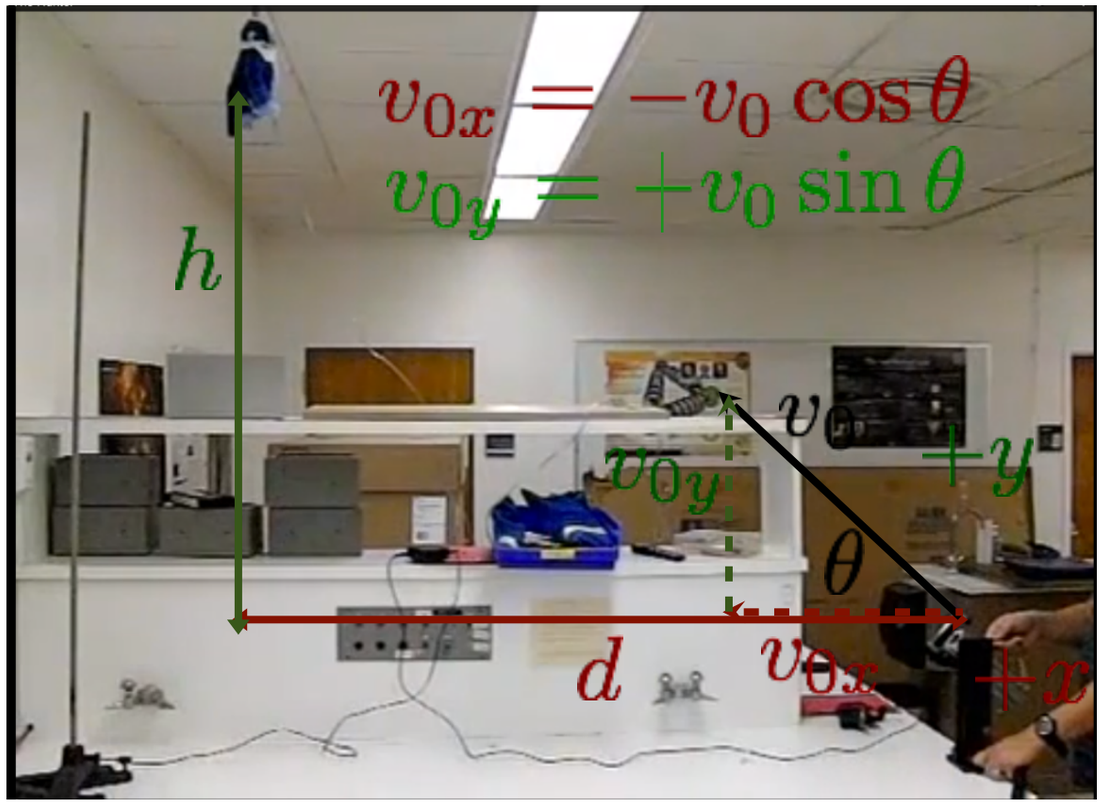
A monkey jumps from a height *h* out of a tree a horizontal distance *d* away at the instant a hunter fires a tranquilizer dart from the ground. At what angle should the hunter aim to hit the monkey?

Given: h d

Goal: θ

Principle: projectile

1. Read the problem
2. Draw a sketch
3. Given? Goal?
4. Brainstorm



Monkey shoot

Given: h d

Goal: θ

Projectile

$$x = x_0 + v_{x0}t + \frac{1}{2}a_x t^2 \qquad y = y_0 + v_{y0}t - \frac{1}{2}gt^2$$

$$v_x = v_{x0} + a_x t \qquad v_y = v_{y0} - gt$$

$$x_M = x_B$$
$$y_M = y_B$$

Monkey

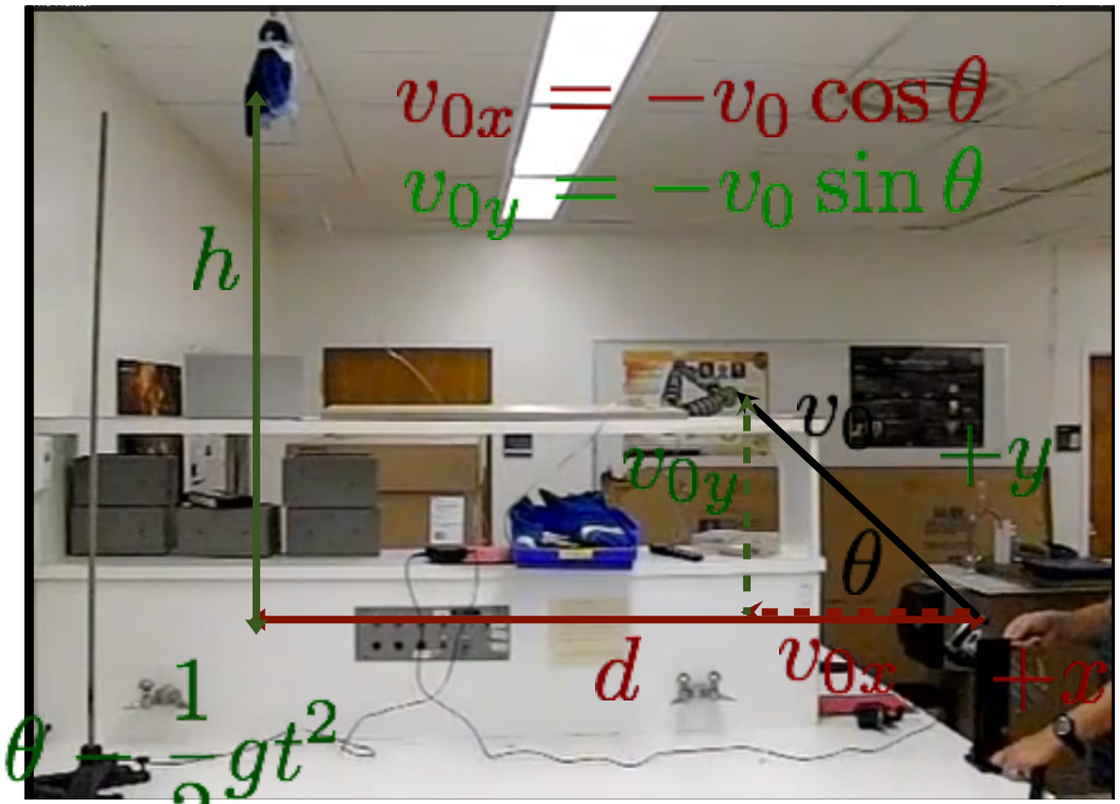
$$x_M = x_{0M} = -d$$

$$y_M = h + v_{0yM}t - \frac{1}{2}gt^2$$

Bullet

$$x_B = x_{0B} - v_{0xB}t = -v_0 t\cos\theta$$

$$y_B = y_{0B} + v_{0yB}t - \frac{1}{2}gt^2 = v_0 t\sin\theta - \frac{1}{2}gt^2$$



Monkey shoot

Monkey

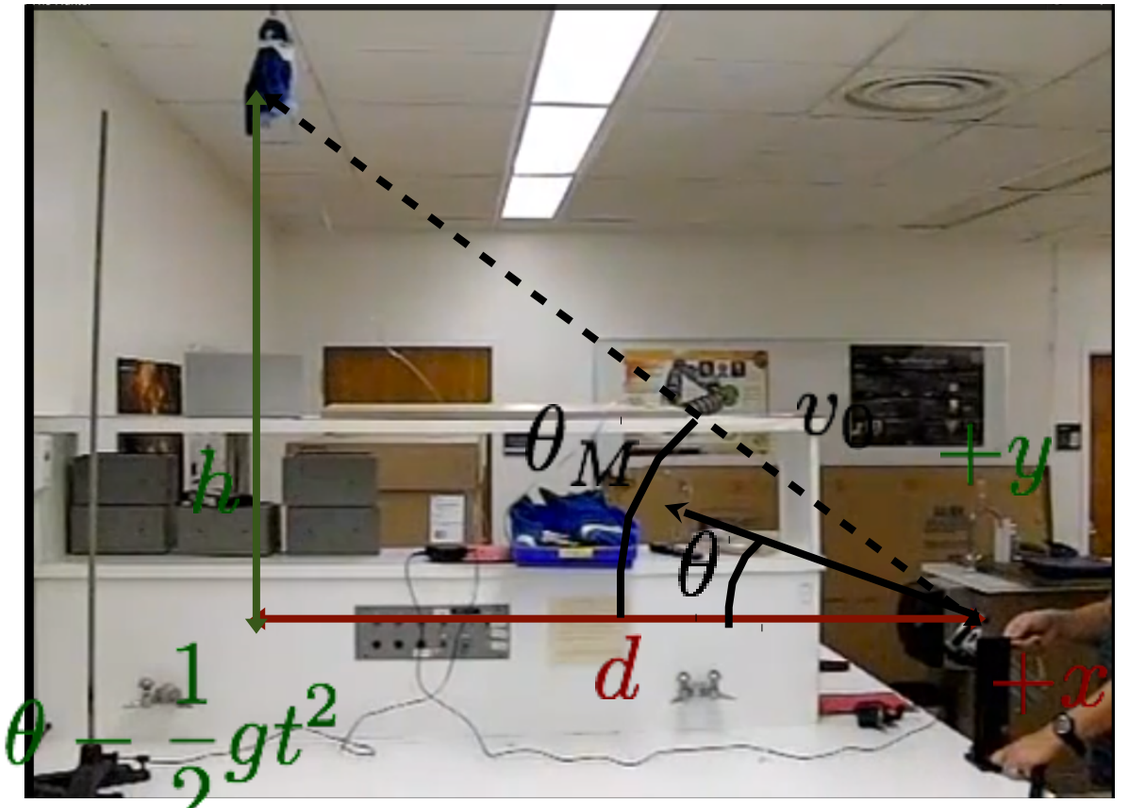
$$x_M = x_{0M} = -d$$

$$y_M = h + v_{0yM}t - \frac{1}{2}gt^2$$

Bullet

$$x_B = x_{0B} - v_{0xB}t = -v_0 t\cos\theta$$

$$y_B = y_{0B} + v_{0yB}t - \frac{1}{2}gt^2 = v_0 t\sin\theta - \frac{1}{2}gt^2$$



$$-d = -v_0 t\cos\theta$$

$$h - \frac{1}{2}gt^2 = v_0 t\sin\theta - \frac{1}{2}gt^2$$

$$\tan\theta = \tan\theta_M = \frac{h}{d} \Rightarrow \theta = \theta_M$$

$$h = v_0 t\sin\theta$$

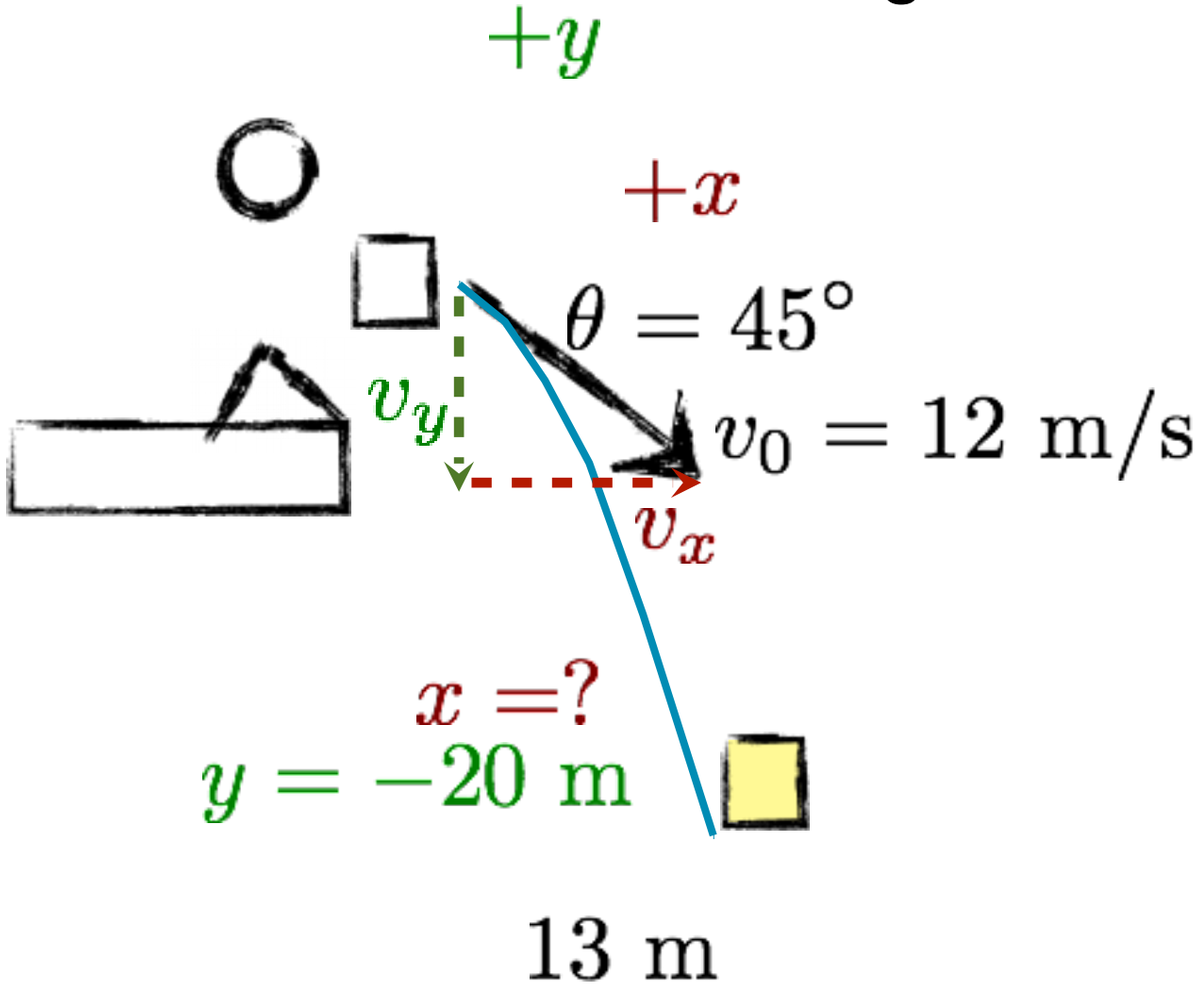
$$d = v_0 t\cos\theta$$

$$\frac{h}{d} = \frac{v_0 t}{v_0 t}\frac{\sin\theta}{\cos\theta} = \tan\theta$$

5. Calculate
6. (Plug in numbers)
7. Reasonable?

Ex. 3.7: stone toss

- A girl on a bridge (height 20 m) throws a stone at 12 m/s, 45° below horizontal. Does the block hit a target on the water that is 13 m from where it goes under the bridge?



Given: $x_0 = y_0 = 0$ $y = -20$ m
$v_0 = 12$ m/s $\theta = 45°$

Goal: $x =?$

Concept: Projectile

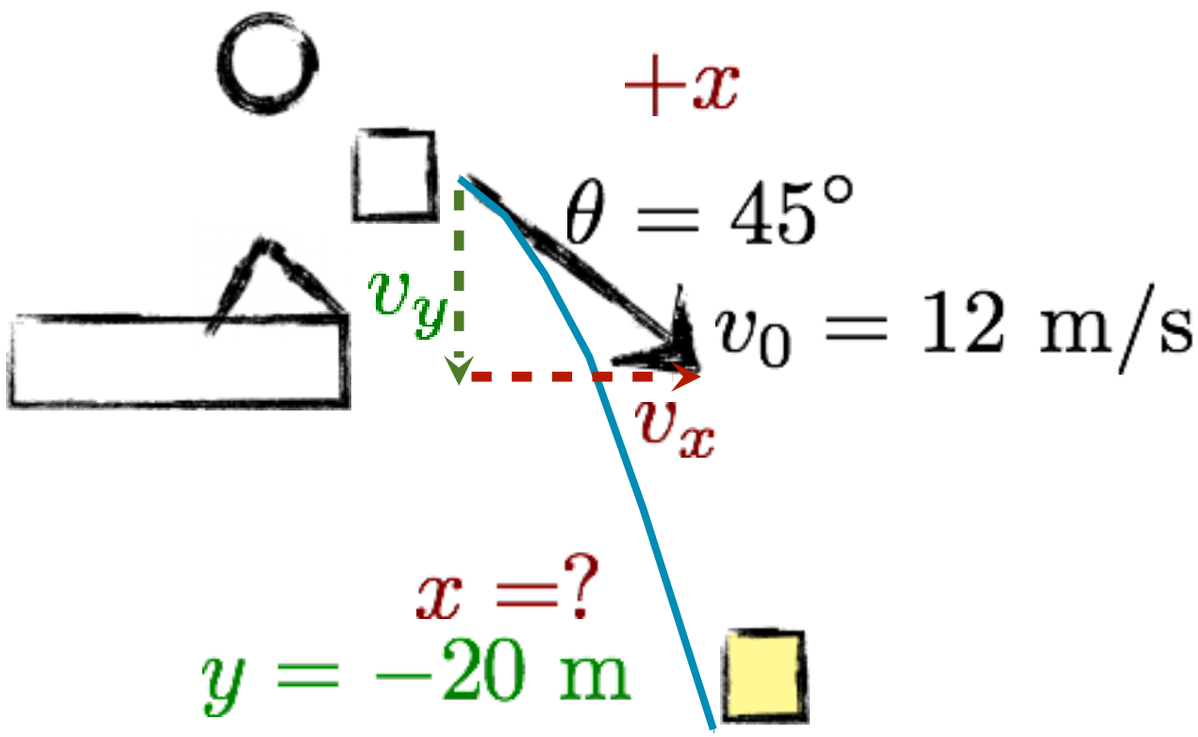
1. Read carefully
2. Draw a sketch
3. Given? Goal?
4. Brainstorm

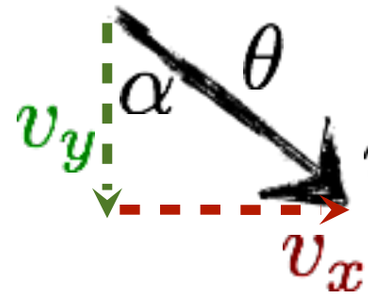
Ex. 3.7

Given: $x_0 = y_0 = 0 \; y = -20 \text{ m}$

$v_0 = 12 \text{ m/s} \quad \theta = 45°$

Goal: $x = ?$ **Concept:** Projectile





$$|v_{0x}|/|v_0| = \sin\alpha$$

$$|v_{0x}| = |v_0|\sin\alpha$$

$$v_{0x} = +v_0\sin\alpha$$

$$|v_{0y}|/|v_0| = \cos\alpha$$

$$|v_{0y}| = |v_0|\cos\alpha$$

$$v_{0y} = -v_0\cos\alpha$$

1. Read carefully
2. Draw a sketch
3. Given? Goal?
4. Brainstorm
5. Calculate

Ex. 3.7

Given: $x_0 = y_0 = 0 \qquad y = -20\ \text{m} \qquad v_{0x} = +v_0 \sin\alpha$

$v_0 = 12\ \text{m/s} \qquad \theta = 45° \qquad v_{0y} = -v_0 \cos\alpha$

Goal: $x = ?$ **Concept:** Projectile

$$x = x_0 + v_{0x}t \qquad t = \frac{x}{v_{0x}} \qquad t = \frac{x}{v_0 \sin\alpha}$$

$$\sin^2 45° = \cos^2 45° = \frac{1}{2}$$

$$\sin^2\alpha = \cos^2\alpha = \frac{1}{2}$$

$$y = y_0 + v_{0y}t - \frac{1}{2}gt^2$$

$$y = y_0 - (v_0 \cos\alpha)\left(\frac{x}{v_0 \sin\alpha}\right) - \frac{1}{2}g\left(\frac{x}{v_0 \sin\alpha}\right)^2$$

$$0 = \left(\frac{g}{v_0^2}\right)x^2 + x + y$$

1. Read carefully
2. Draw a sketch
3. Given? Goal?
4. Brainstorm
5. Calculate

Ex. 3.7

Given: $x_0 = y_0 = 0 \; y = -20 \text{ m}$

$v_0 = 12 \text{ m/s} \quad \theta = 45°$

Goal: $x = ?$ **Concept:** Projectile

$$0 = \left(\frac{g}{v_0^2}\right) x^2 + x + y$$

$$x = \frac{-1 + \sqrt{1 - 4\frac{gy}{v_0^2}}}{2\left(\frac{g}{v_0^2}\right)}$$

$$x = \frac{-1 + \sqrt{1 - 4\left[9.8 \text{ m/s}^2\right]\left[-20 \text{ m}\right] / \left[12 \text{ m/s}\right]^2}}{2\left(\left[9.8 \text{ m/s}^2\right] / \left[12 \text{ m/s}\right]^2\right)} = 11 \text{ m}$$

Target at *x* = 13 m. Stone does not hit target.

Note: book uses different method, rounds differently, gets 12 m (though I get 11 m)

1. Read carefully
2. Draw a sketch
3. Given? Goal?
4. Brainstorm
5. Calculate
6. Plug in numbers
7. Reasonable?

In-class activity - Uniform Circular Motion

A particle undergoes uniform circular motion on a horizontal ***xy*** plane. At time ***t=0 s***, it moves through coordinates ***(3.0 m, 0)*** with velocity ***v =(6 m/s)j***. At ***t=5 s***, it moves through ***(11.0 m, 0)*** with velocity ***v = (-6 m/s)j***. In unit vector notation, what is its acceleration at ***t = 2.5 s***?

solution in WileyPLUS Ch. 4.5, additional sample problems - Uniform Circular Motion