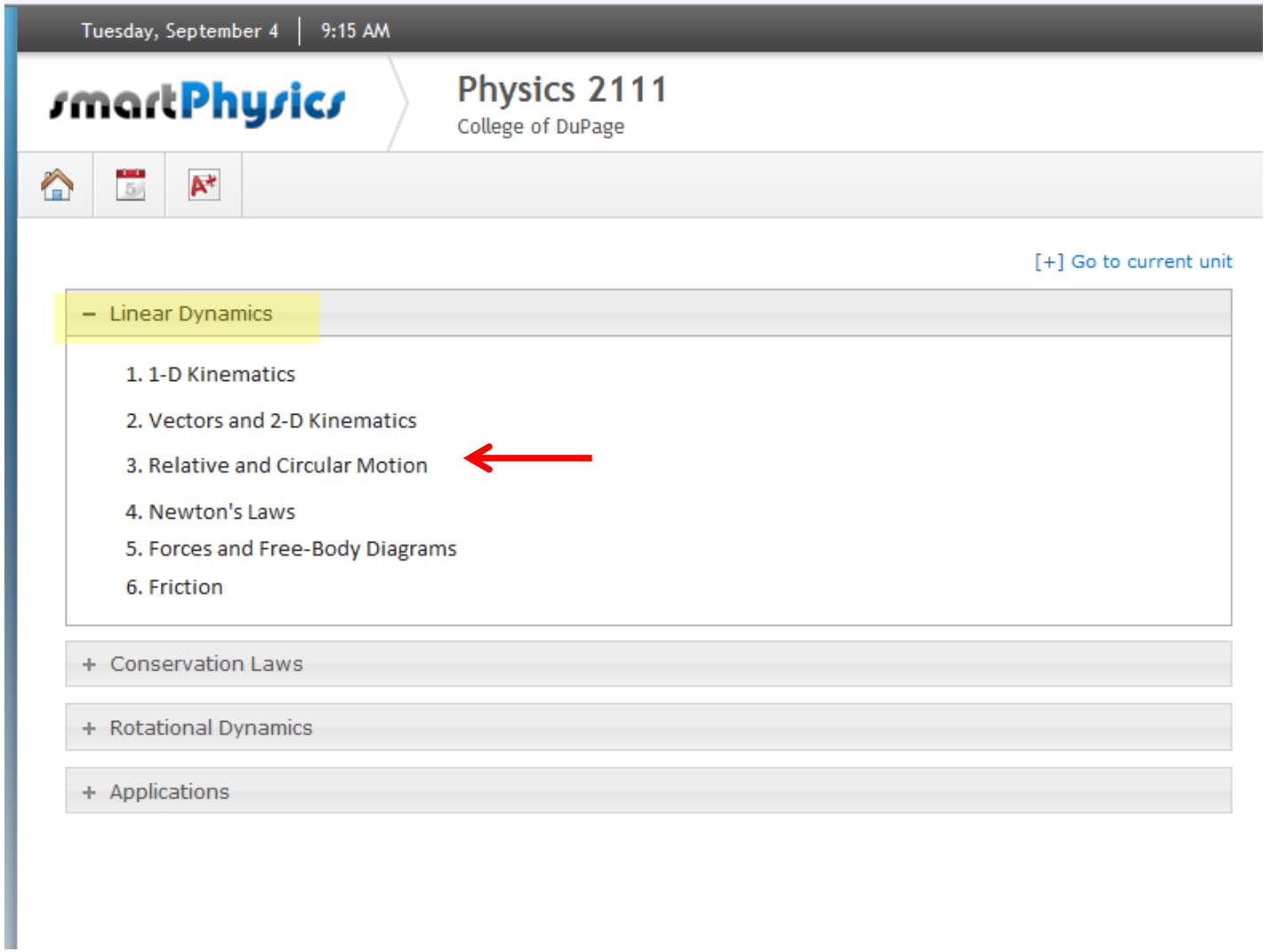
Physics 2111
Unit 3

Unit Concepts:

a) Circular Motion

b) Relative motion

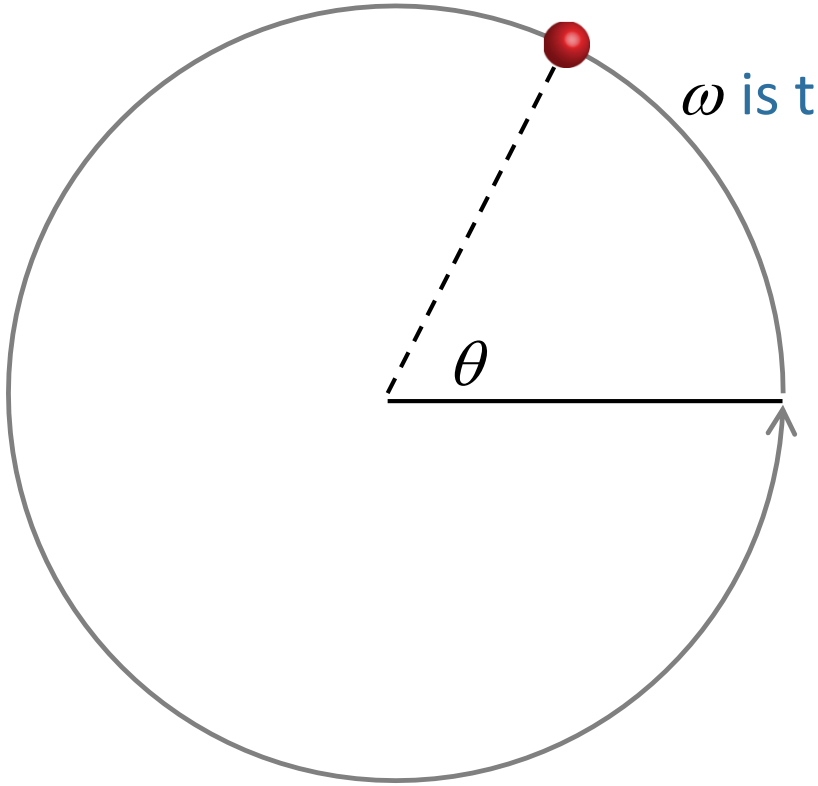
Where are we?


Tuesday, September 4 | 9:15 AM
smartPhysics
Physics 2111
College of DuPage
[+] Go to current unit
− Linear Dynamics
1. 1-D Kinematics
2. Vectors and 2-D Kinematics
3. Relative and Circular Motion
4. Newton's Laws
5. Forces and Free-Body Diagrams
6. Friction
+ Conservation Laws
+ Rotational Dynamics
+ Applications

Circular Motion

Another example of 2D motion….let's define some things…..

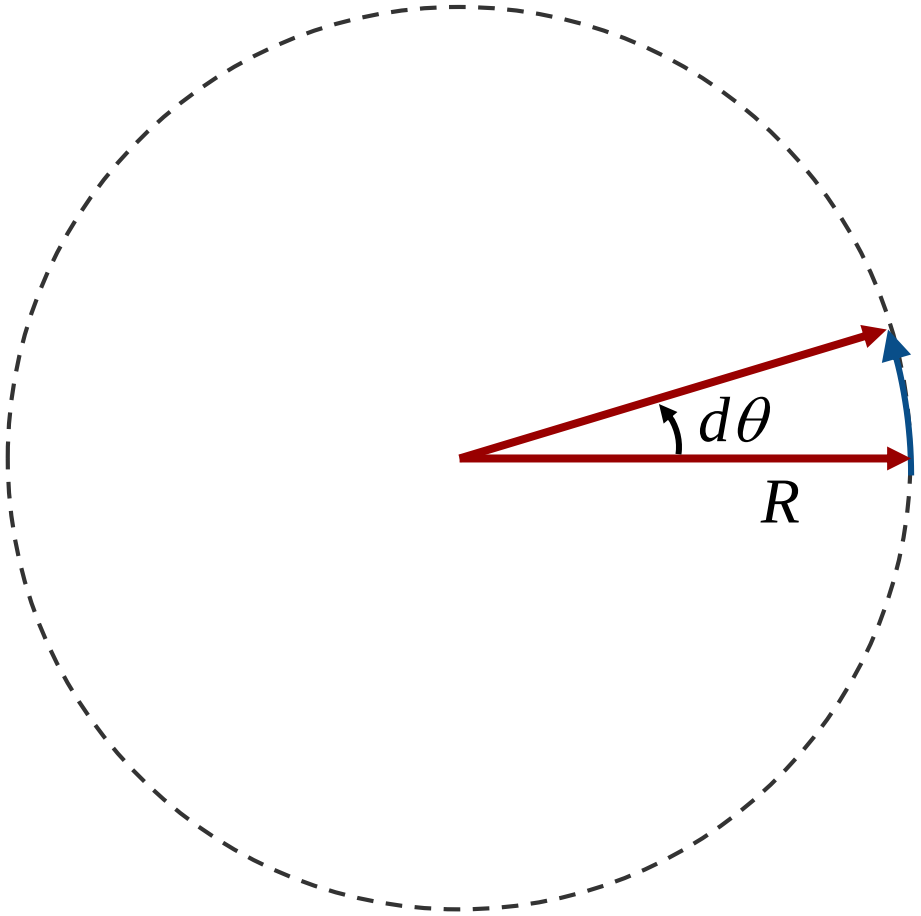
$$\Delta\Theta = \Delta S/R$$



ω is the rate at which the angle θ changes:

$$\omega = \frac{d\theta}{dt}$$

Circular Motion



Another way to see it:

$$v\,dt = R\,d\theta \qquad v = R\frac{d\theta}{dt}$$

$$v = R\omega$$

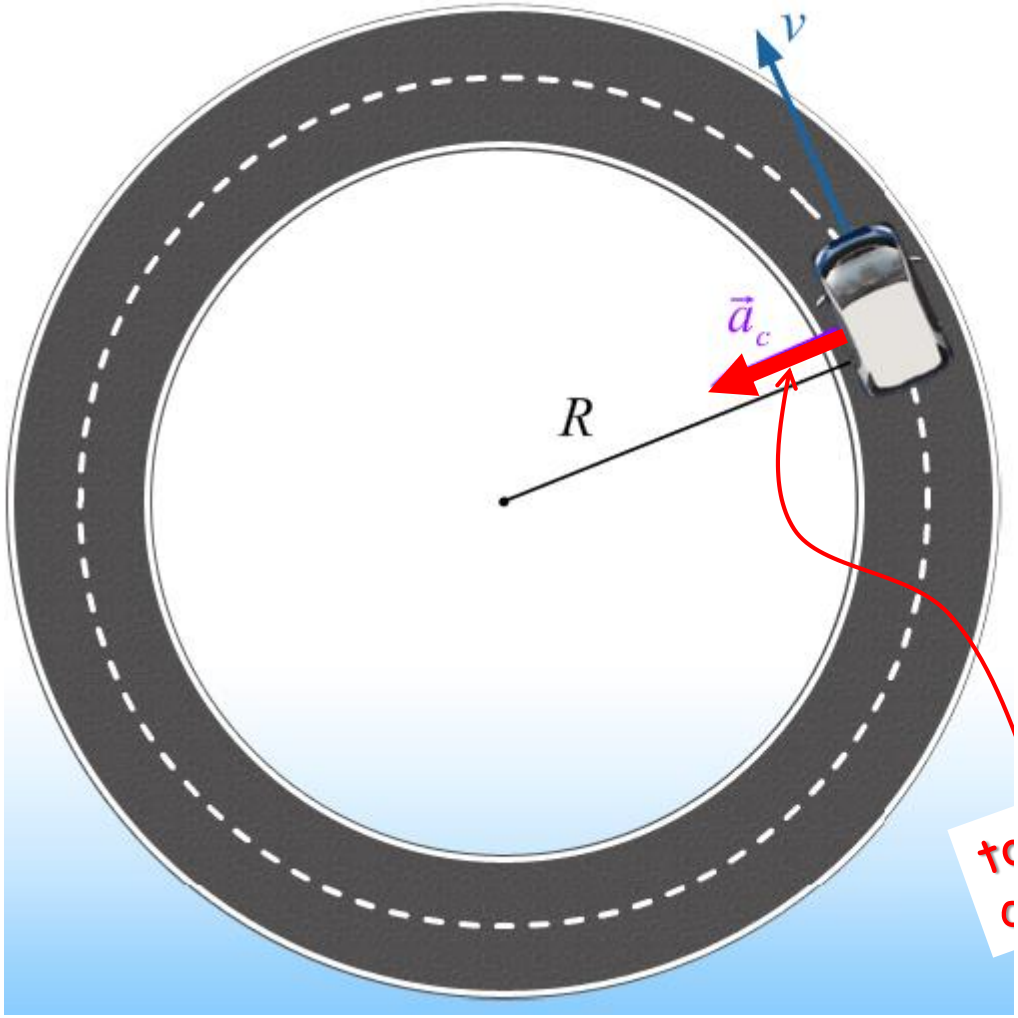
$$v = \omega R$$

Once around:

$$v = \Delta x / \Delta t = 2\pi R / T$$

$$\omega = \Delta\theta / \Delta t = 2\pi / T$$

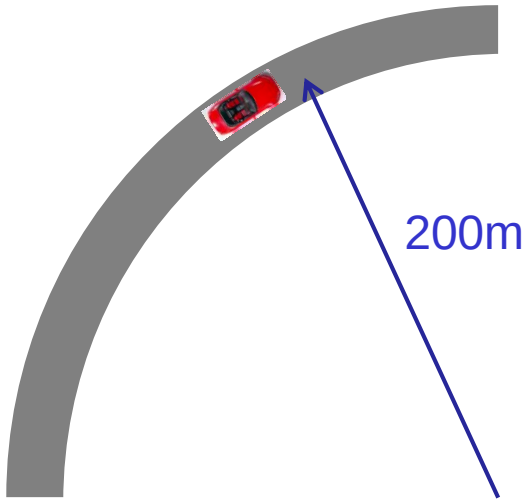
Centripetal Acceleration



Angular Velocity

$$\omega = \frac{v}{R}$$

Example 3.1 (Going around corner)



If you went around a curve with a radius of 200m at a constant velocity of 15m/sec, what would the magnitude of your acceleration be?

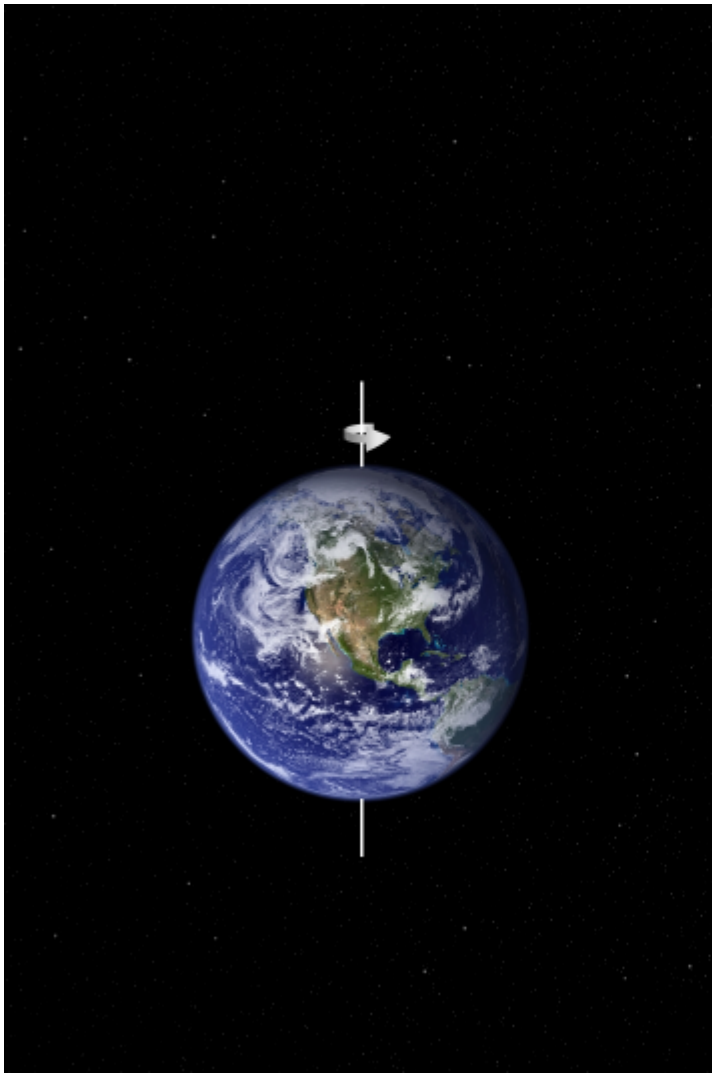
What if your velocity were 30m/sec?

What is the radius were 100m?

Example 3.2 (Merri-go-round)

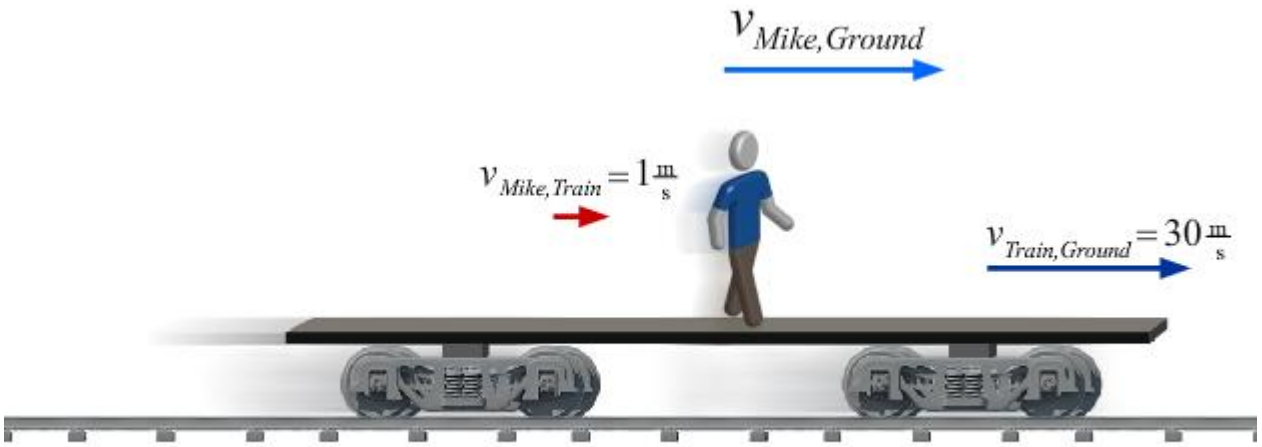
What is the magnitude of your acceleration if you're on a merri-go-round with a radius of 5m that goes around once every minute?

We can ignore this acceleration due to Earth's rotation since its small



Relative Motion

What is the velocity of Mike with respect to the ground?



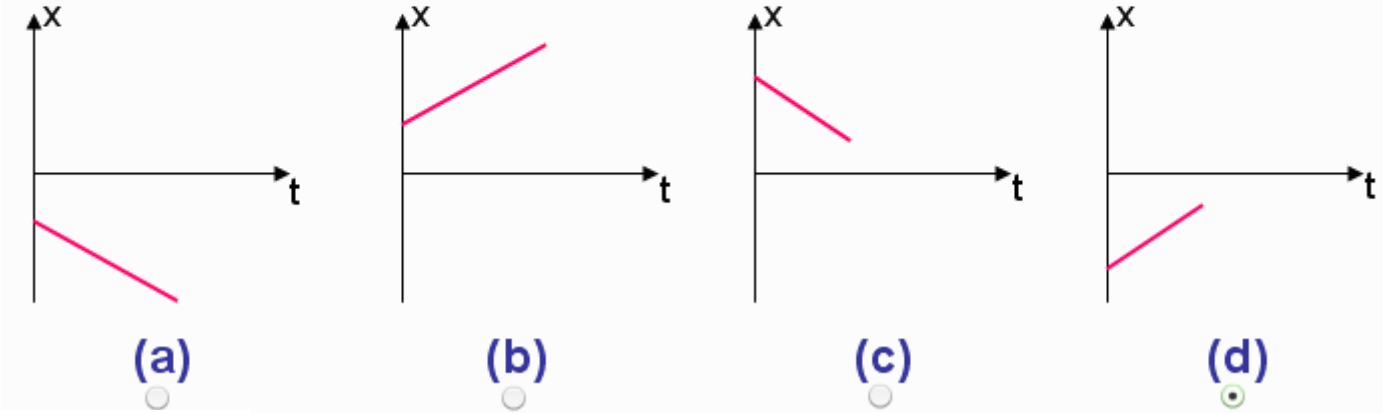
What you just did

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

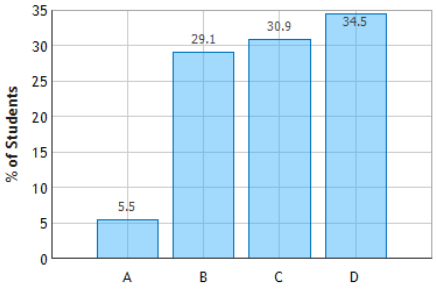
Prelecture 3, Question 1

The diagram shows a snapshot at time t = 0 of two balls on a collision course. At t = 0, the balls are separated by a distance D = 12 m. The green ball moves with constant velocity v_G = 6 m/s due East, while the red ball moves with constant velocity v_R = 2 m/s due West.

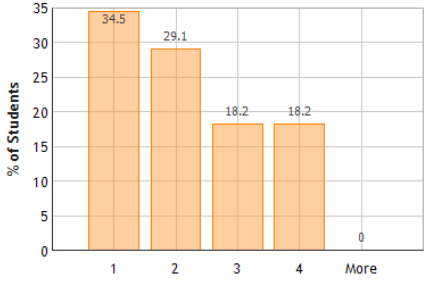
Which of the following graphs correctly describes the motion of the green ball in the reference frame of the red ball? Take the origin to be the position of the red ball and the positive direction to be East.



First Answer Choice Distribution (N = 55)



Number of Submissions for Correct (N = 55)

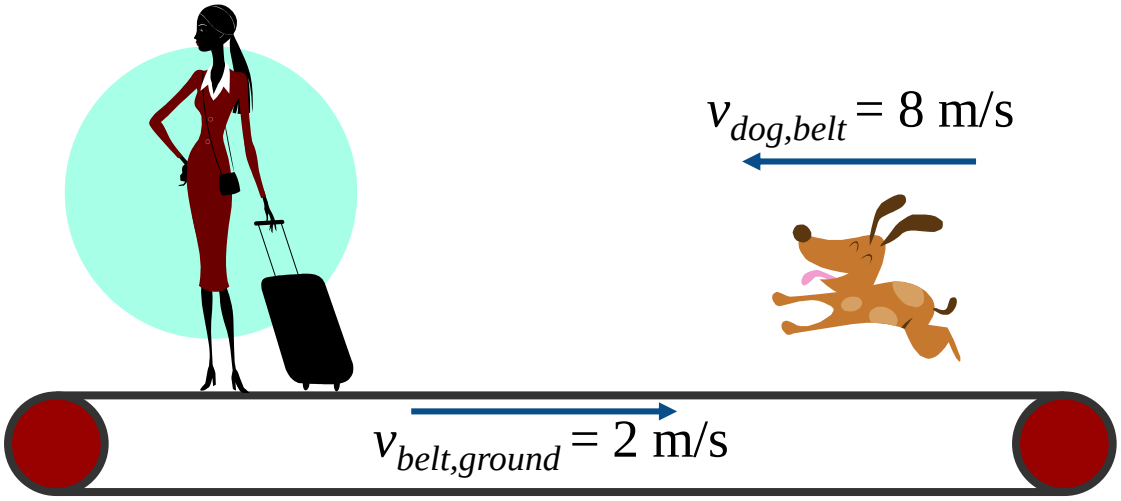


nit

Checkpoint

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

What is the magnitude of the speed of the dog relative to the girl?

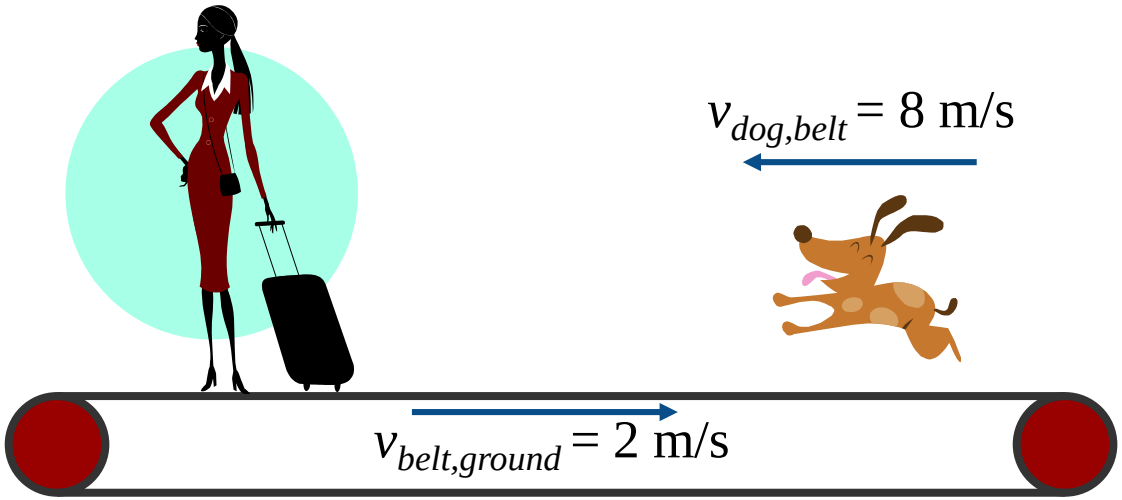


A) 6 m/s B) 8 m/s C) 10 m/s

Checkpoint

A girl 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.

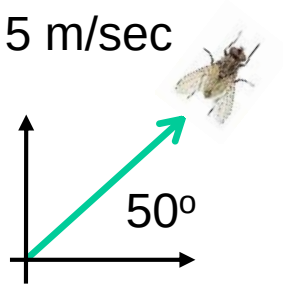
What is the magnitude of the speed of the dog relative to the ground?

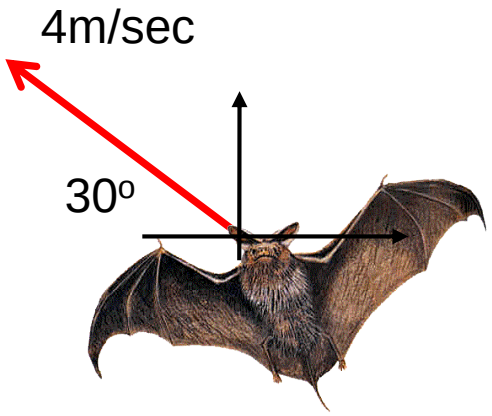


A) 6 m/s B) 8 m/s C) 10 m/s

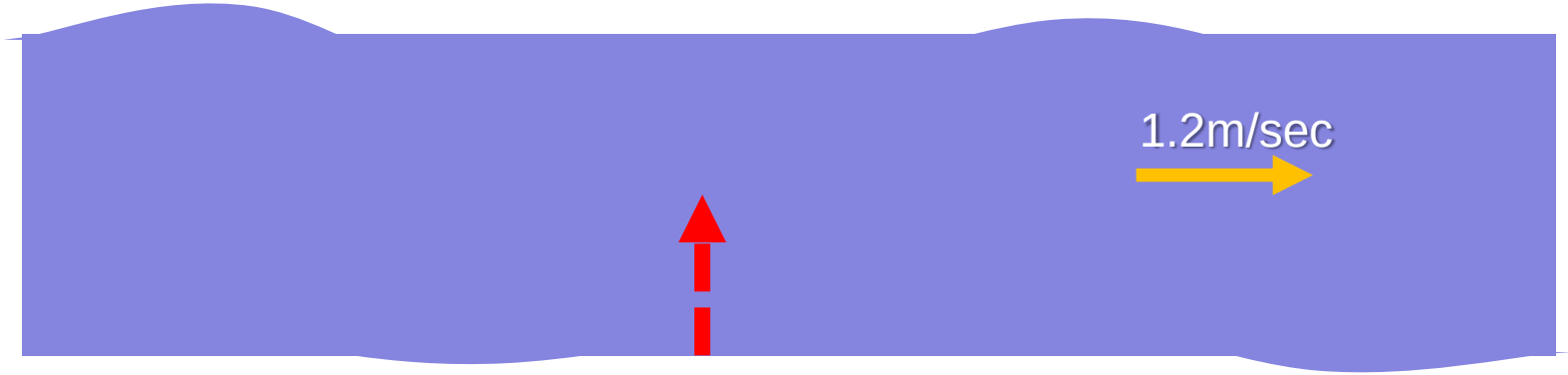
Example 3.3 (Hungry Bat)

A hungry bat detects lunch: an insect buzzing around. The velocities of the bat and of the insect with respect to the ground are shown.





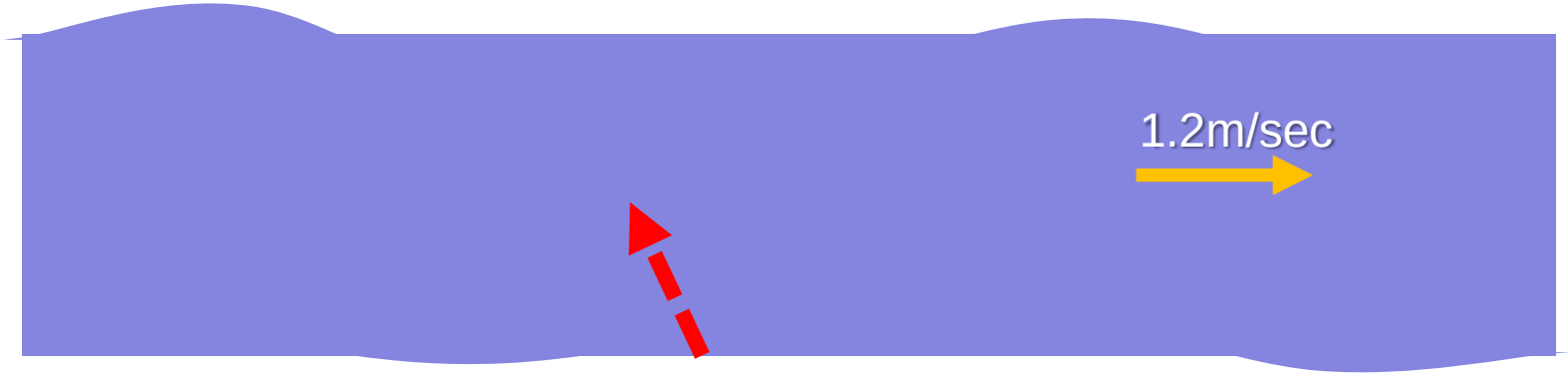
What is the velocity of the insect with respect to the bat?



Racheal can swim at 2.1 m/sec with respect to the water. If she wants to swim across a river that is 10 meters wide and flows at 1.2m/sec.

If she attempts to swim straight across, how long will it take her?

Where will she be when she reaches the other side?



Now let's say Racheal wants to wind up direction across from where she started.

At what angle should she swim?

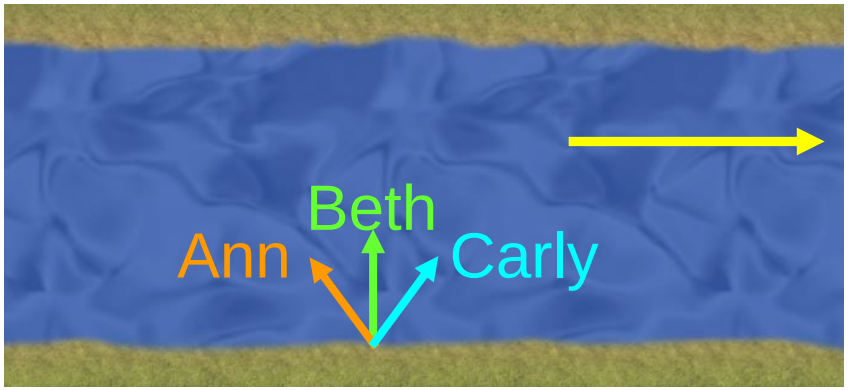
How long does it take her to reach the other side?

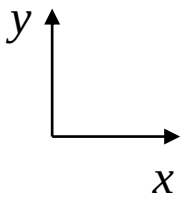
Question

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?

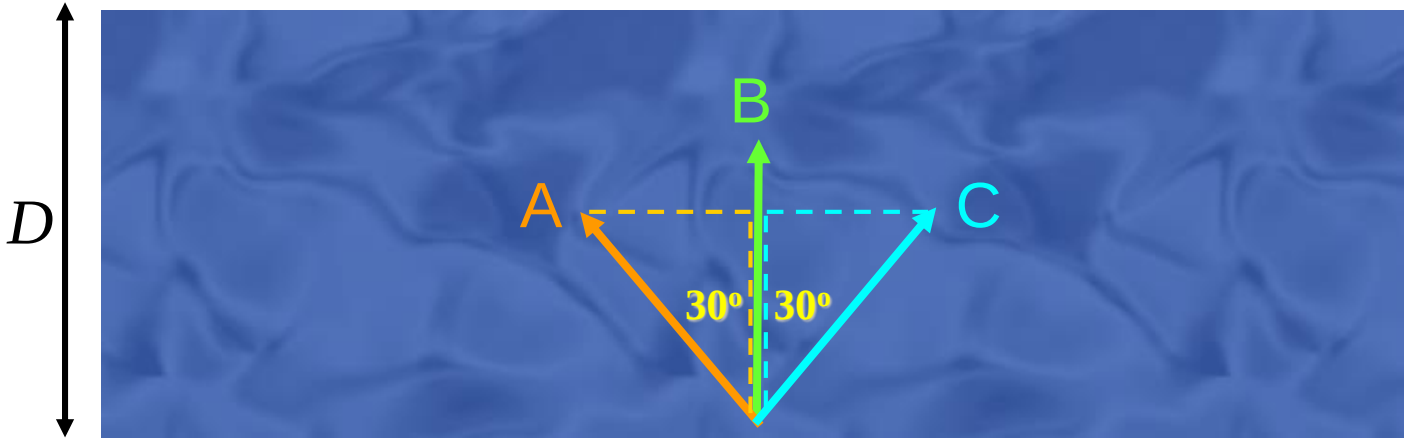
A) Ann B) Beth C) Carly

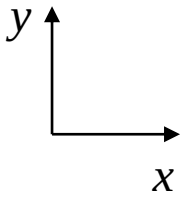




Look at just water & swimmers

Time to get across = D / V_y





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

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

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