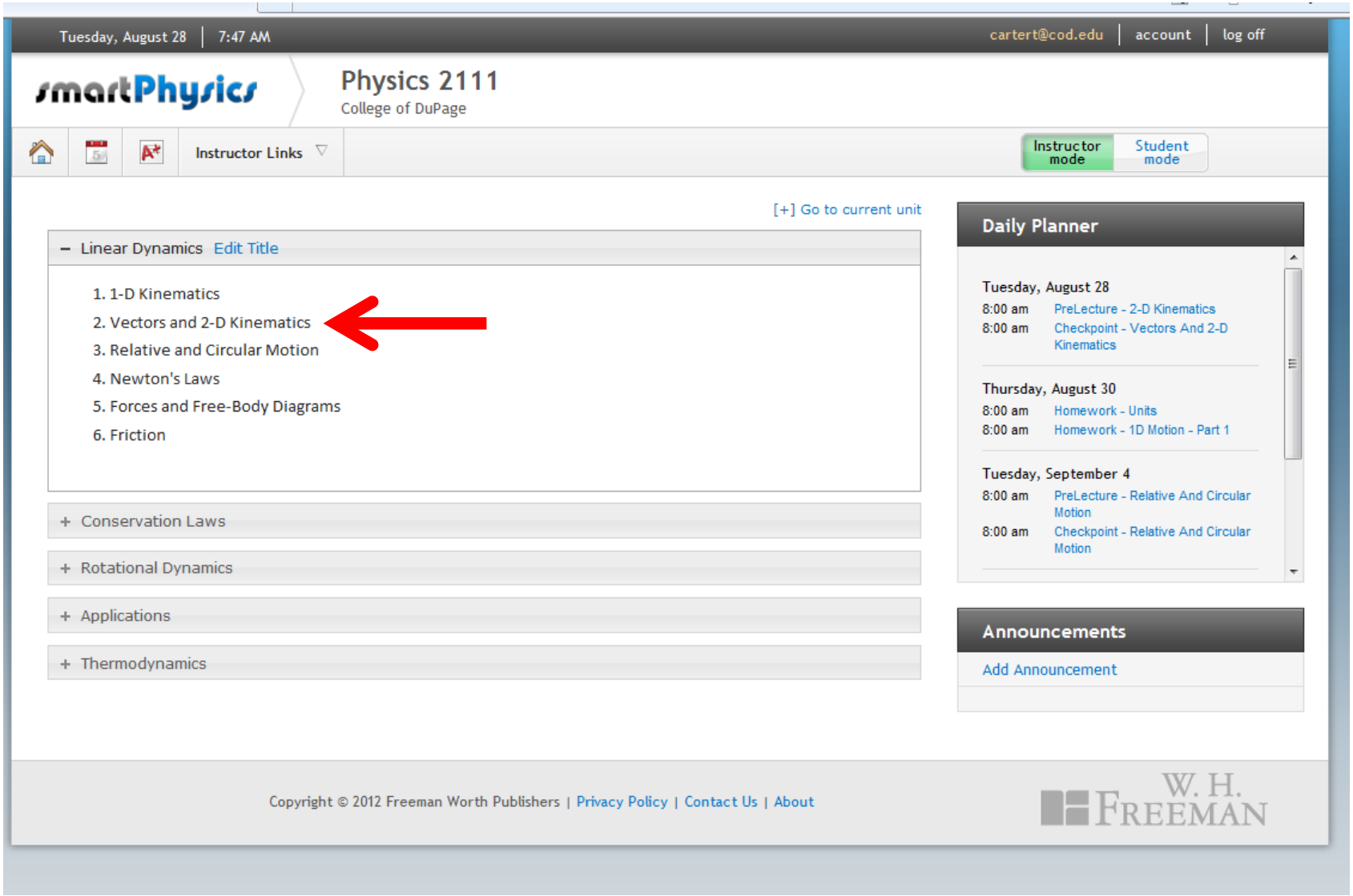
Physics 2111
Unit 2

Unit Concepts:

a) Vectors
b) 3D Motion
c) Projectile motion

Where we are…….


Tuesday, August 28 | 7:47 AM
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Physics 2111
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[+] Go to current unit
Linear Dynamics Edit Title
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
Thermodynamics
Daily Planner
Tuesday, August 28
8:00 am PreLecture - 2-D Kinematics
8:00 am Checkpoint - Vectors And 2-D Kinematics
Thursday, August 30
8:00 am Homework - Units
8:00 am Homework - 1D Motion - Part 1
Tuesday, September 4
8:00 am PreLecture - Relative And Circular Motion
8:00 am Checkpoint - Relative And Circular Motion
Announcements
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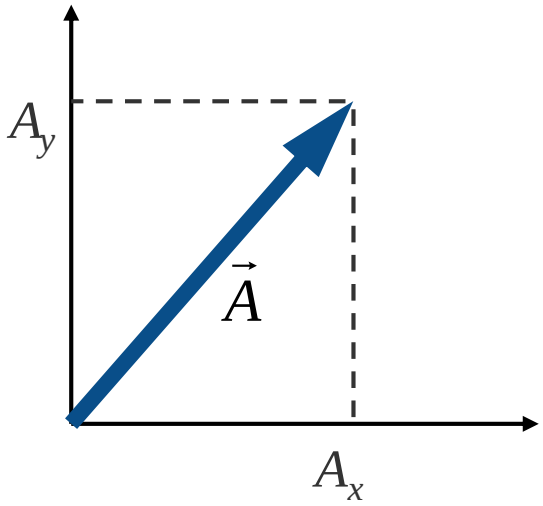
W. H. FREEMAN

Vectors



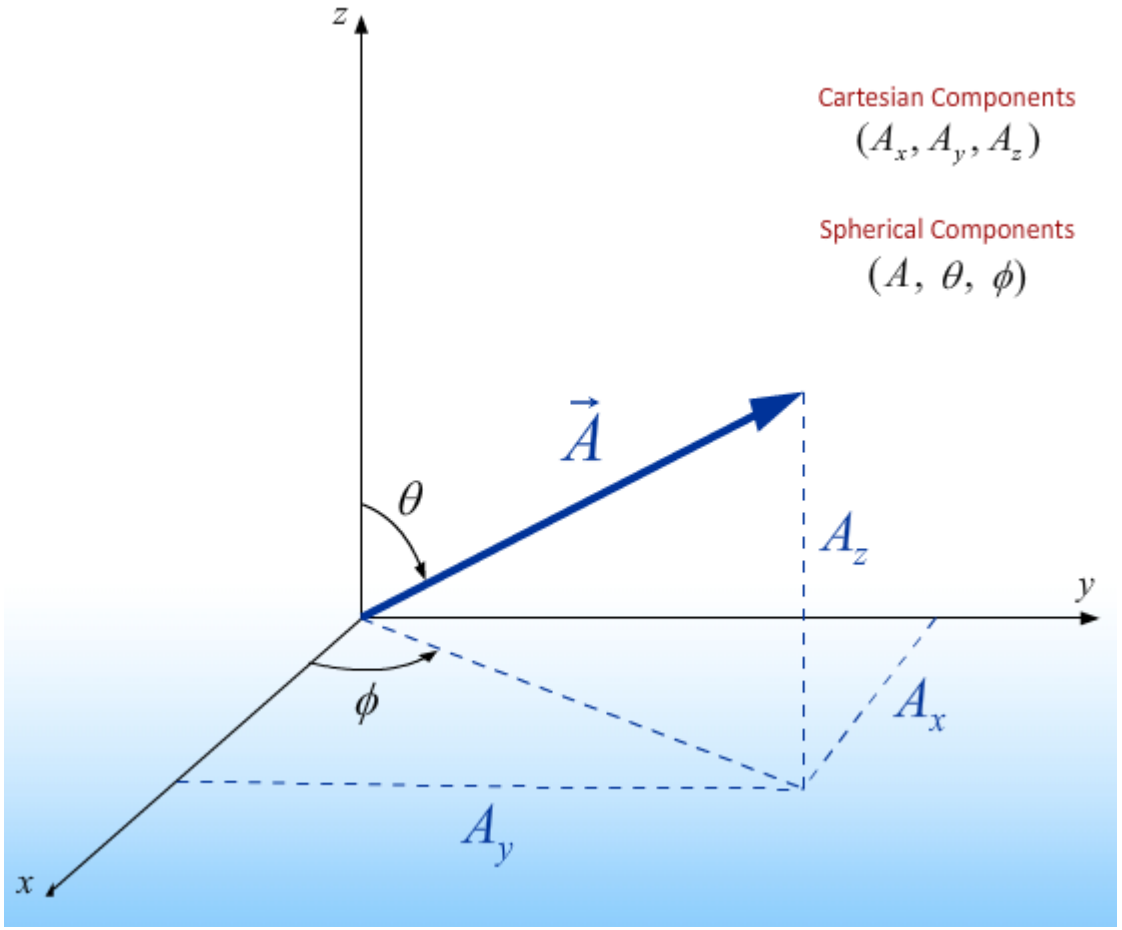
Think of a vector as an arrow.

(An object having both magnitude and direction)

The object is the same no matter how we chose to describe it

Vectors in 3D

A vector can be defined in 2 or 3 (or even more) dimensions:

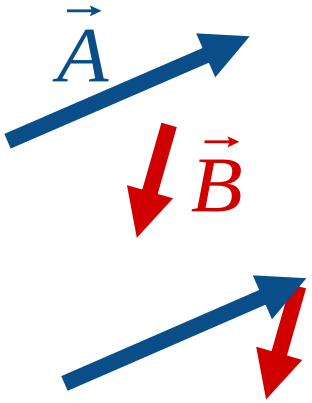


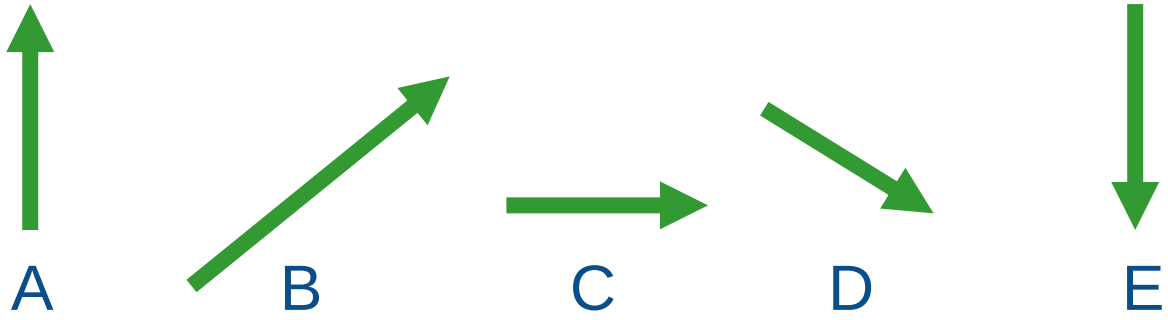
Unit Vector Format

$A_x \hat{i} + A_y \hat{j} + A_z \hat{k}$

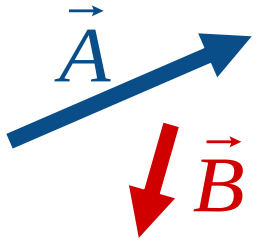
Question

Vectors $\vec{A}$ and $\vec{B}$ are shown to the right.
Which of the following best describes $\vec{A} + \vec{B}$

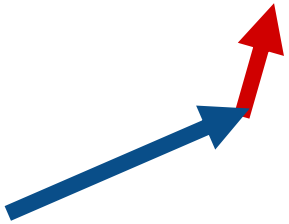


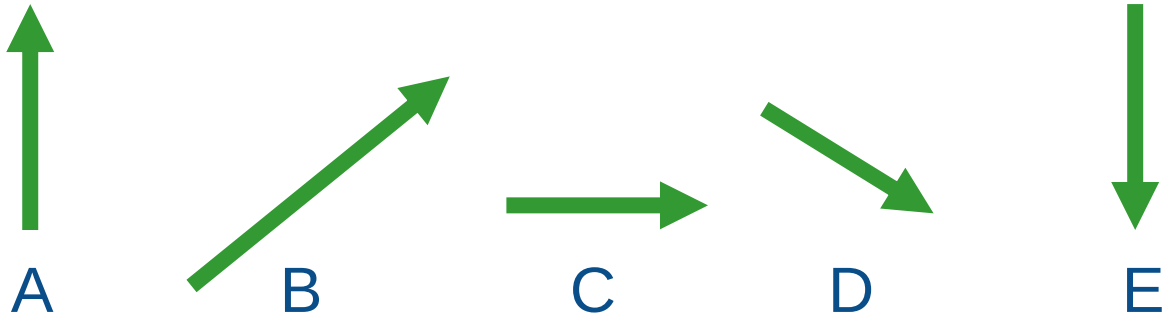


Question



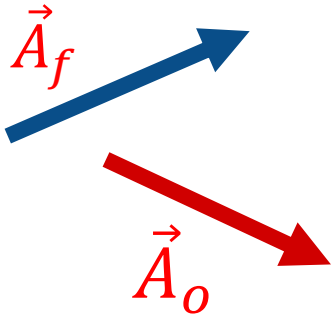
Vectors $\vec{A}$ and $\vec{B}$ are shown to the right.
Which of the following best describes $\vec{A} - \vec{B}$





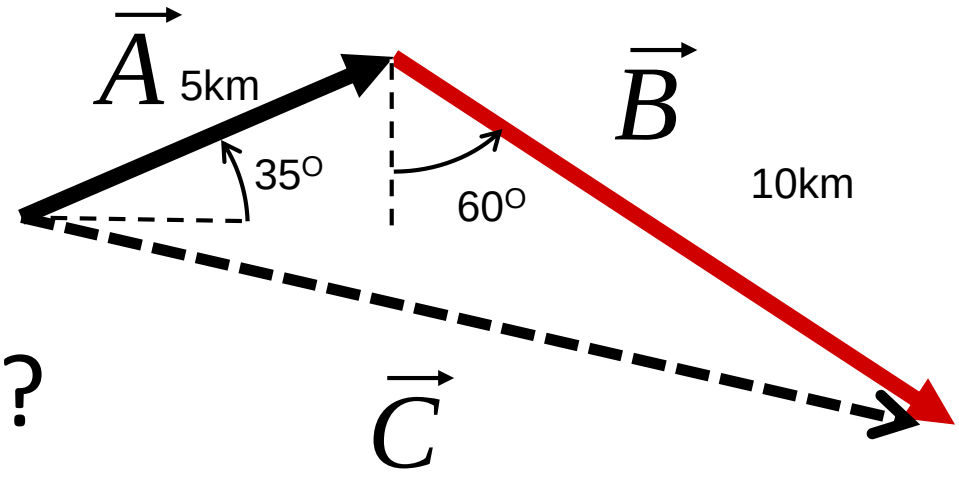
Question

Vectors $\vec{A}_o$ and $\vec{A}_f$ are shown to the right.
Which of the following best describes $\Delta\vec{A}$?



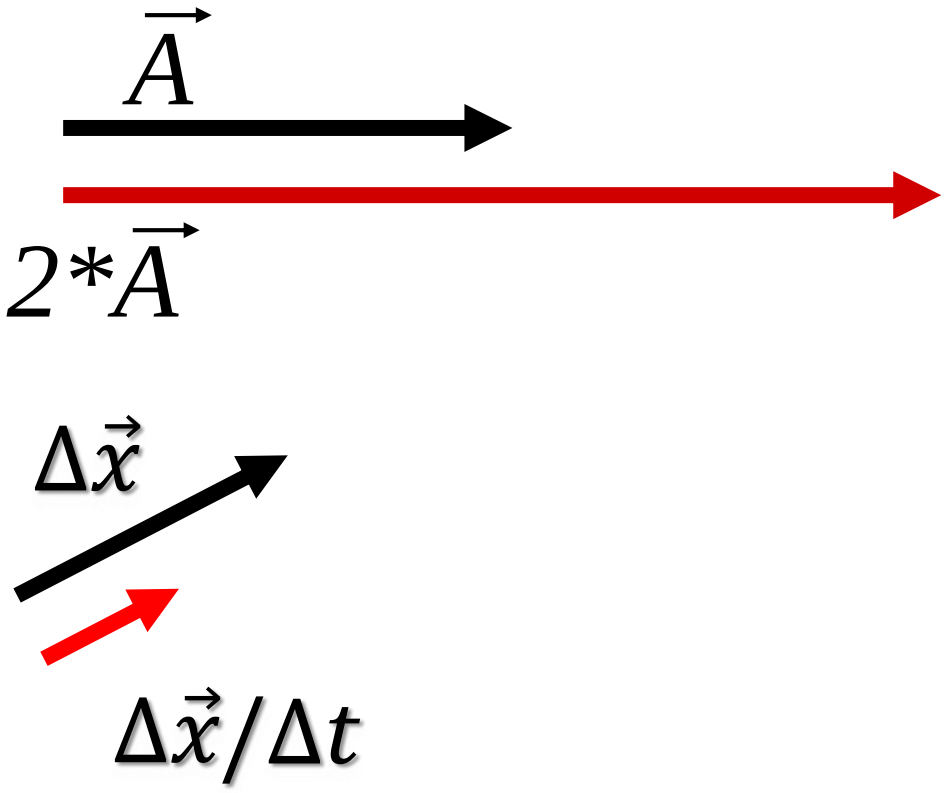
Example 2.1 (Vector Addition)

$$\vec{A}+\vec{B}=\vec{C}$$



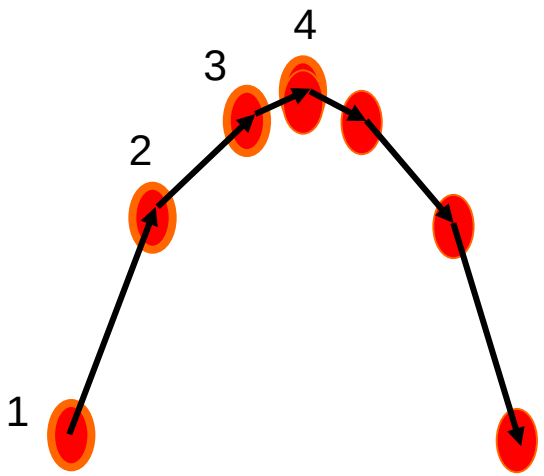
What is vector $\vec{C}$?

Vector times a scalar



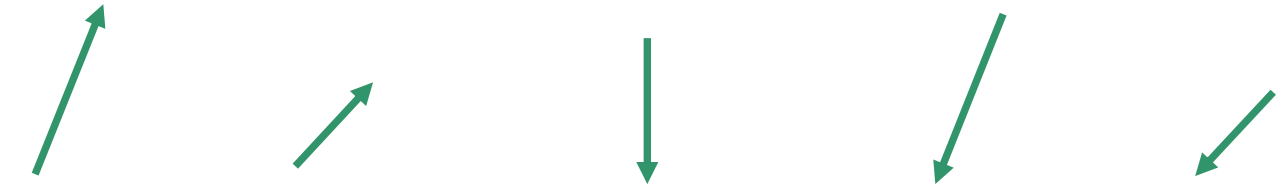
Average velocity vector is in the same direction as the change in position vector.

Question



The figure to the left is the motion diagram to a ball being tossed into the air by someone's right hand and caught by her left hand.

Which of the below vectors best represents change in velocity, ΔV, at time 2?



(A) (B) (C) (D) (E)

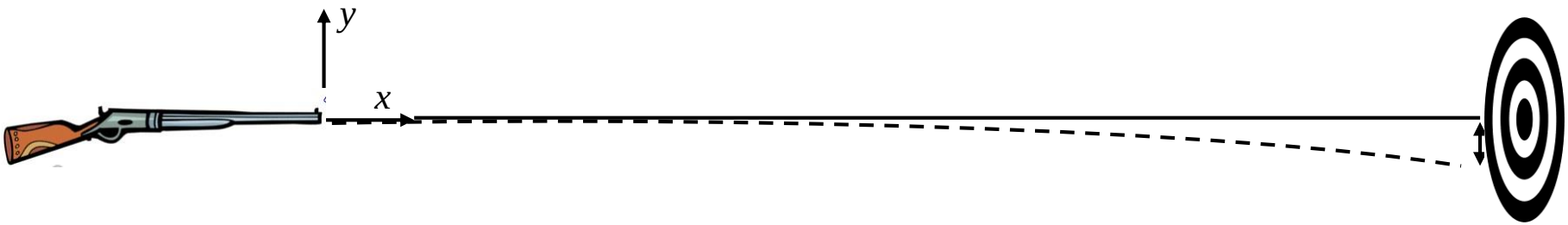
KEY POINT:

Motion in each direction is independent

Kinematic Equations with Constant Acceleration

x-component	y-component	z-component
$a_x = \text{constant}$	$a_y = \text{constant}$	$a_z = \text{constant}$
$v_x = v_{o_x} + a_x t$	$v_y = v_{o_y} + a_y t$	$v_z = v_{o_z} + a_z t$
$x = x_o + v_{o_x} t + \frac{1}{2} a_x t^2$	$y = y_o + v_{o_y} t + \frac{1}{2} a_y t^2$	$z = z_o + v_{o_z} t + \frac{1}{2} a_z t^2$

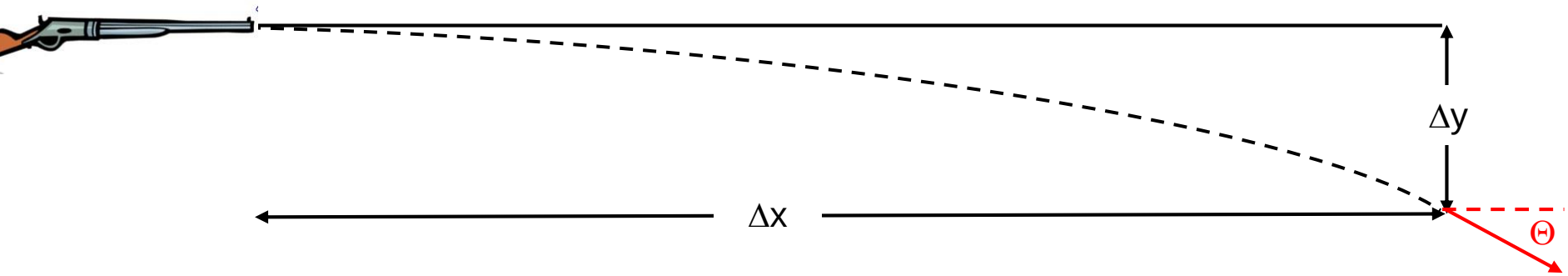
Example 2.4 (Rifle Range)



A rifle is shot horizontally at target on the range 100m away. If the bullet comes out of the muzzle at 975m/sec, how far will it drop before it hits the target?

What is the angle the bullet makes with the horizontal when it hits the target?

Question



How can we find the final angle with the horizontal?

a) $v_y/v_x = \tan\Theta$

b) $\Delta y/\Delta x = \tan\Theta$

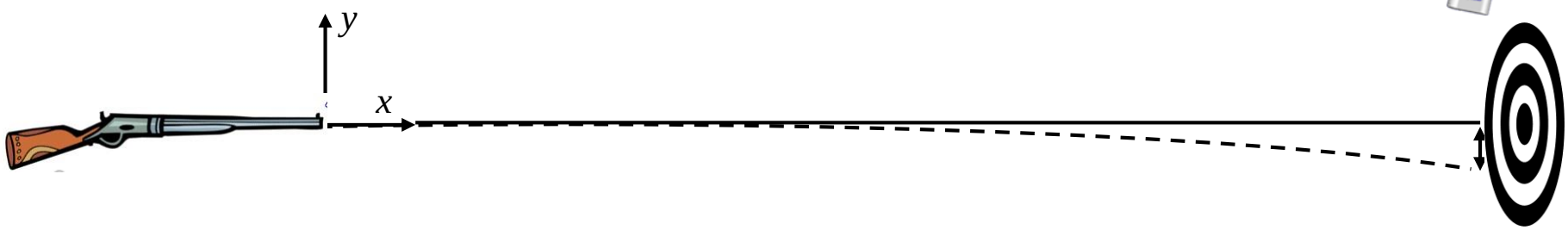
c) $\Delta y * \sin\Theta = \Delta x$

d) $\Delta x * \sin\Theta = \Delta y$

e) $\Delta x * \cos\Theta = \Delta y$

$$\frac{\Delta y}{\Delta x} \approx \frac{v_y}{v_x}$$

Question



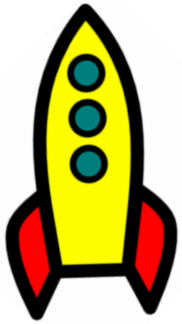
Let's say the rifle is shot a second time at target on the range 200m away instead of 100m away. What can we about the distance it will drop this second time?

a) It will drop a greater distance the second time

b) It will drop the same distance as before.

c) It will drop a smaller distance the second time.

Example 2.5 (Space Rocket)



A rocket in drifting sideways in space at a rate of 50m/sec. If fires its engine for 2seconds giving it an acceleration of 20m/sec^2 for those two seconds. 10 seconds after it starts its engine, what is its position?

Projectile Motion

Horizontal

$$a_x = 0$$

$$v_x = v_{o_x}$$

$$x = x_o + v_{o_x} t$$

Vertical

$$a_y = g$$

$$v_{fy} = v_{oy} + gt$$

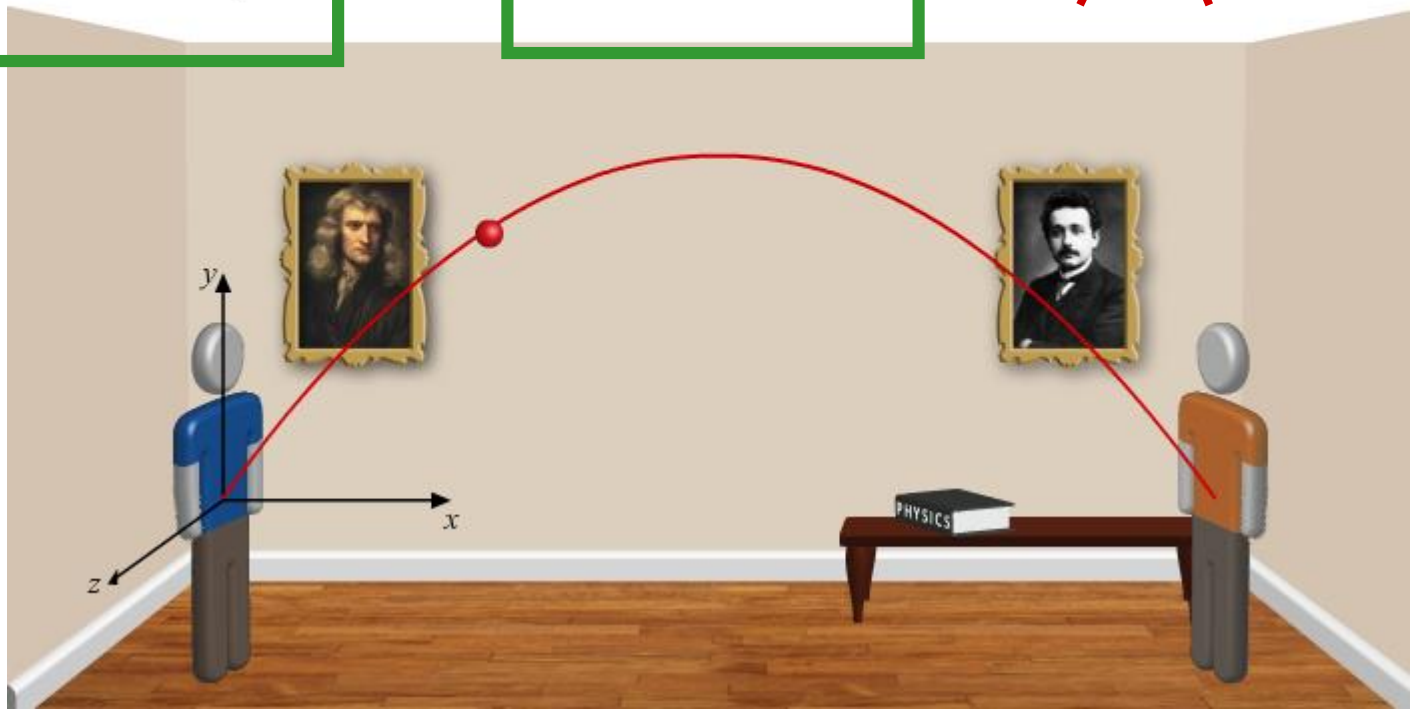
$$y_f = y_o + v_o t + \tfrac{1}{2} g t^2$$

Boring

~~$a_z = 0$~~

~~$v_z = 0$~~

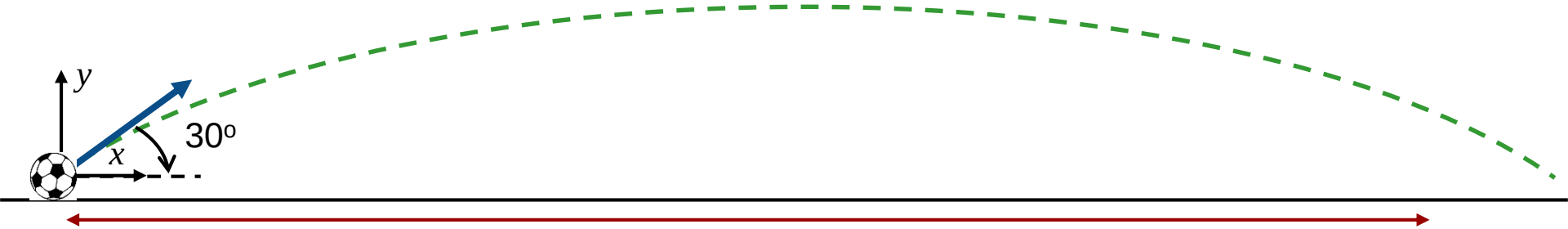
~~$z = z_o$~~



Is g = + 9.81 m/sec^2 or – 9.81 m/sec^2?

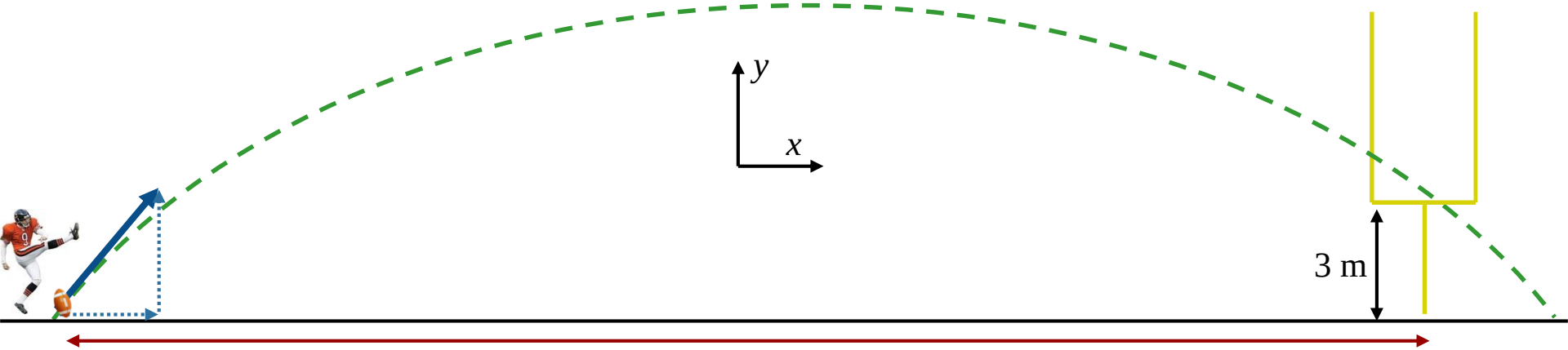
Example 2.5 (Soccer Ball)

A soccer ball is kicked at an initial velocity of 20m/sec at 30^o above the horizontal. Where will it land?

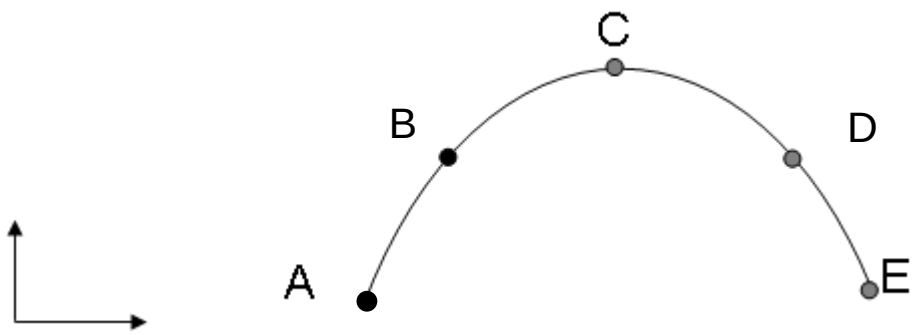


Example 2.6 (Field Goal)

A field goal kicker can kick the ball 20 m/s at an angle of 30 degrees w.r.t. the ground. If the crossbar of the goal post is 3m off the ground, from how far away can he kick a field goal?



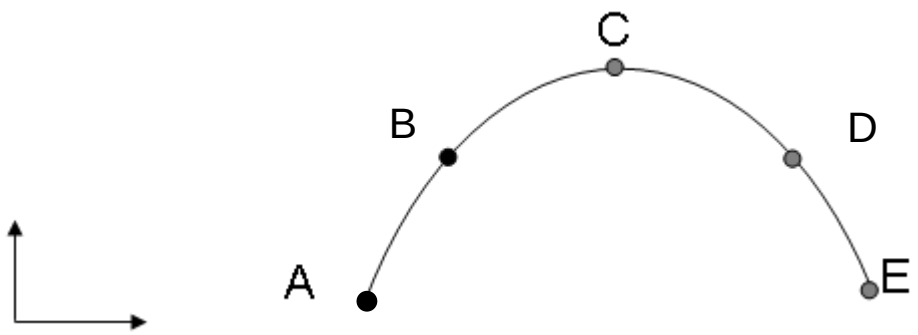
Question



The diagram to the left represents the parabolic trajectory of a soccer ball as it moved from point A to point E. What is the direction of the velocity of the ball at point C?

A. To the right
B. To the left
C. Velocity is zero
D. Down and to the left
E. Straight down

Question

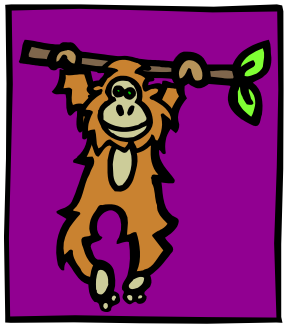


The diagram to the left represents the parabolic trajectory of a soccer ball as it moved from point A to point E. What is the direction of the acceleration of the ball at point B?

A. Up and to the right
B. Down and to the right
C. Up and to the left
D. Down and to the left
E. Straight down

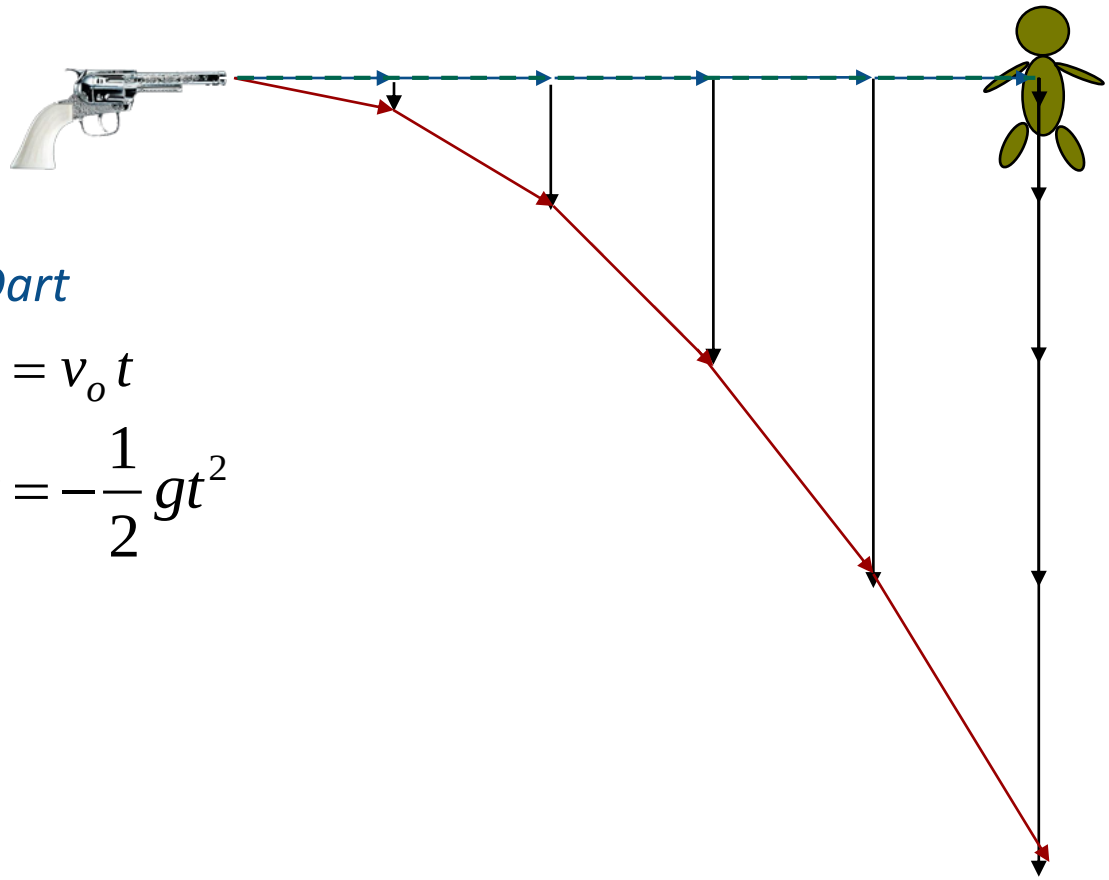
Monkey Troubles

You are a vet trying to shoot a tranquilizer dart into a monkey hanging from a branch in a distant tree. You know that the monkey is very nervous, and will let go of the branch and start to fall as soon as your gun goes off. In order to hit the monkey with the dart, where should you point the gun before shooting?



A) Right at the monkey
B) Below the monkey
C) Above the monkey

Shooting the Monkey…



Dart

$$x = v_o t$$

$$y = -\frac{1}{2} g t^2$$

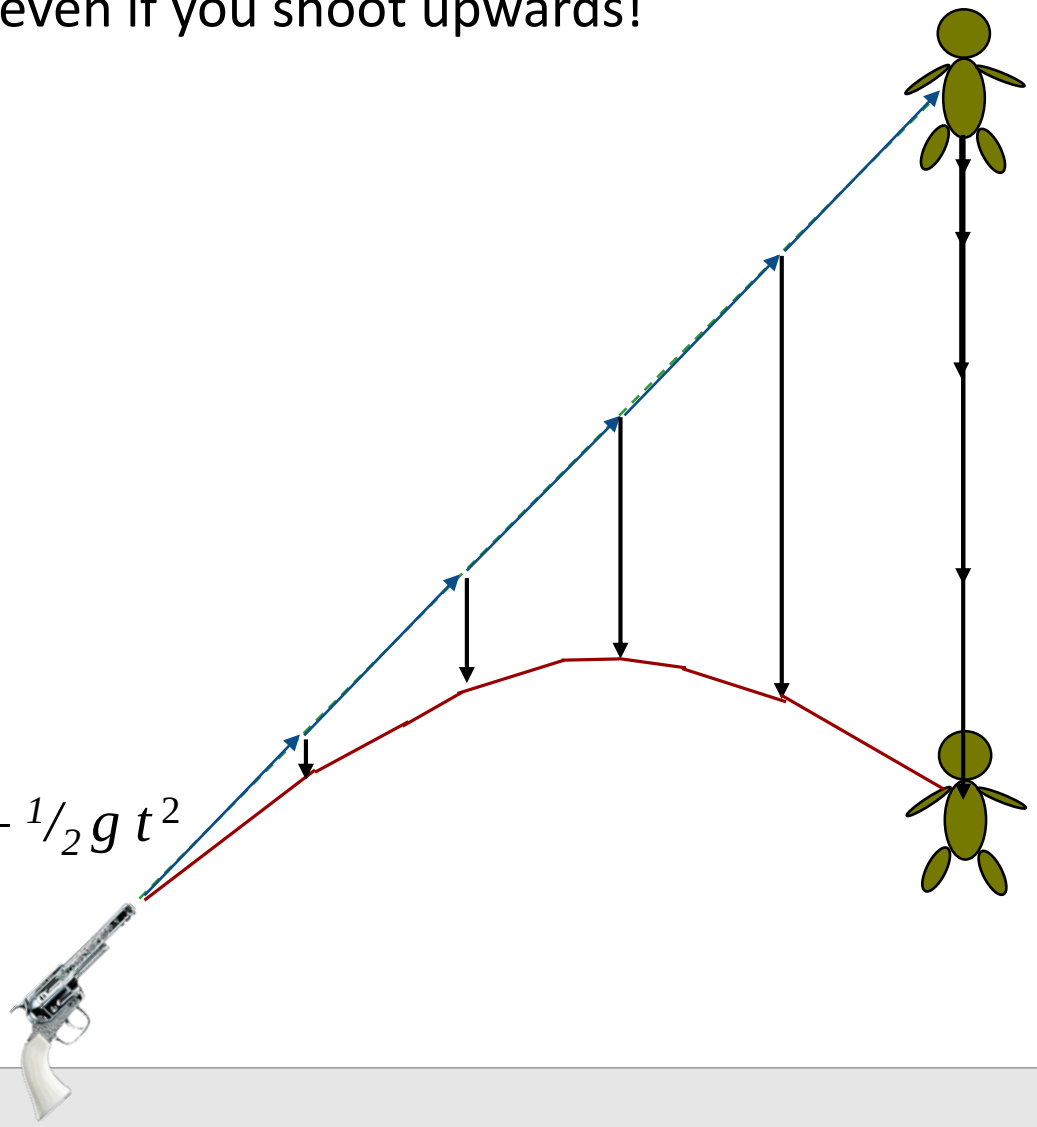
Monkey

$$x = x_o$$

$$y = -\frac{1}{2} g t^2$$

Shooting the Monkey…

Still works even if you shoot upwards!

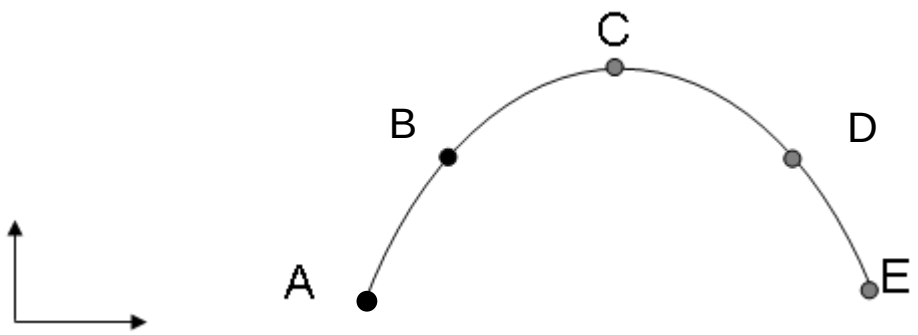


$y = y_o - {}^1/_2 g\, t^2$

$y = v_{oy}\, t - {}^1/_2 g\, t^2$

Dart hits the monkey

Question



A soccer ball is kicked such that its total velocity is 5m/sec. The horizontal component of its velocity is 4m/sec and the vertical component is 3m/sec. At the point where it reaches its highest point above the ground, its total velocity is:

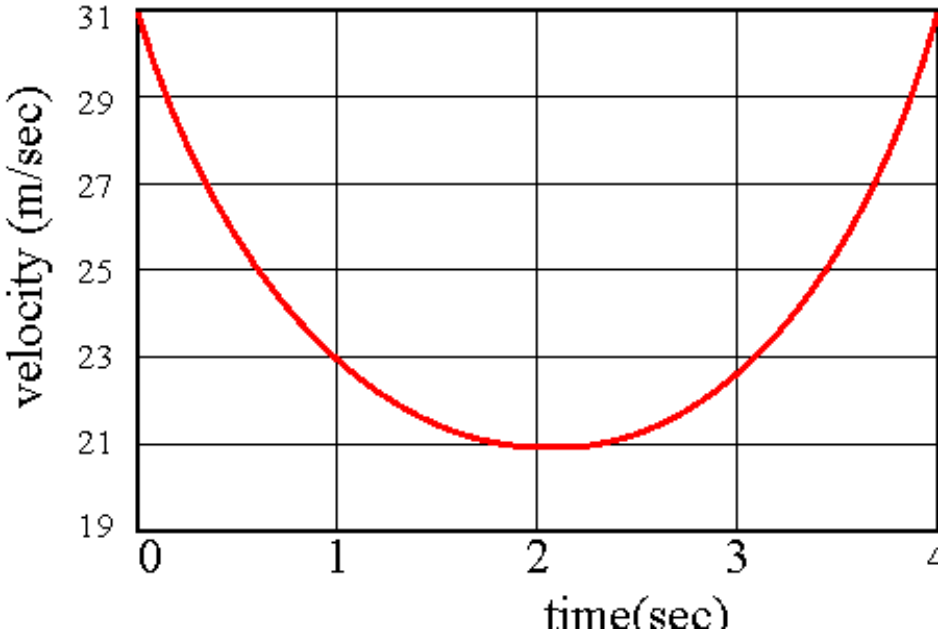
A. 5 m/sec
B. 0 m/sec
C. 3m/sec
D. 4 m/sec
E. none of the above

Example 2.7 (Golf on Lgis)

Having aced her physics class, a student gets a cool summer job with NASA that involves playing golf on distant planets. For the first drive on the 4th hole on the planet Lgis, the total velocity of her ball is as plotted below. The ball lands at the same vertical level at which it starts. Along with being distant, the planet Lgis is airless, so we can ignore air resistance.

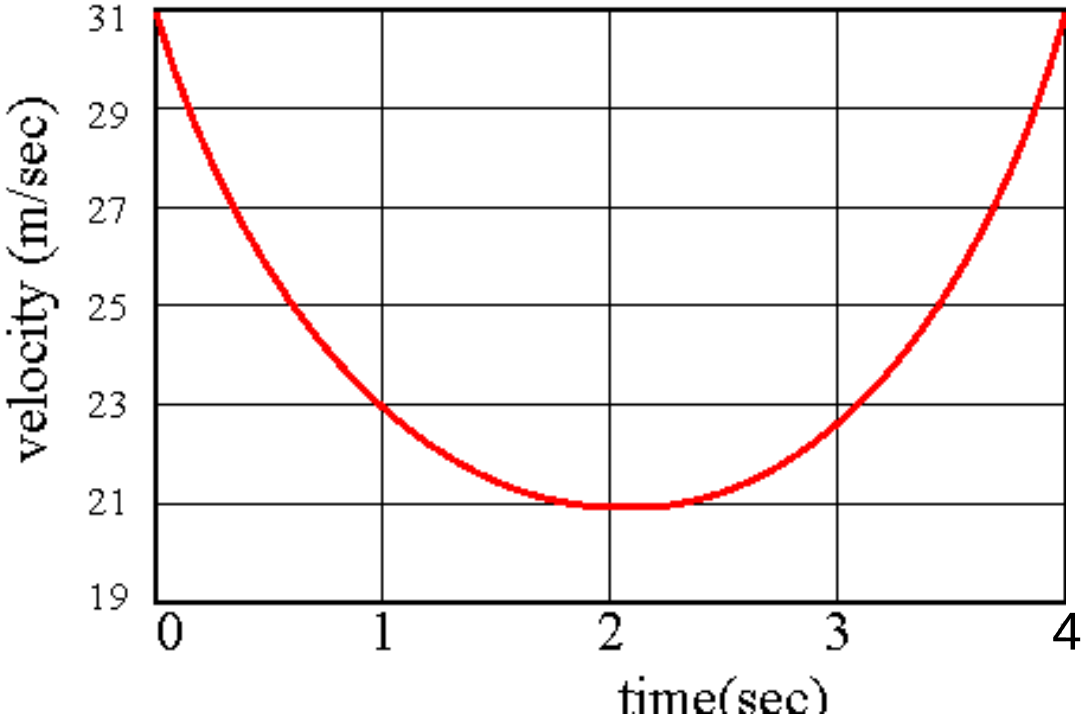
How far does the ball travel horizontally in it's flight?

What is the free-fall acceleration rate on Lgis?



QUESTION

The below plot represents the total velocity of a golf ball during it's entire flight. What is the *initial* horizontal velocity of the golf ball?



A. 31 m/sec
B. 21m/sec
C. 10 m/sec
D. 0 m/sec
E. We can't tell from this graph

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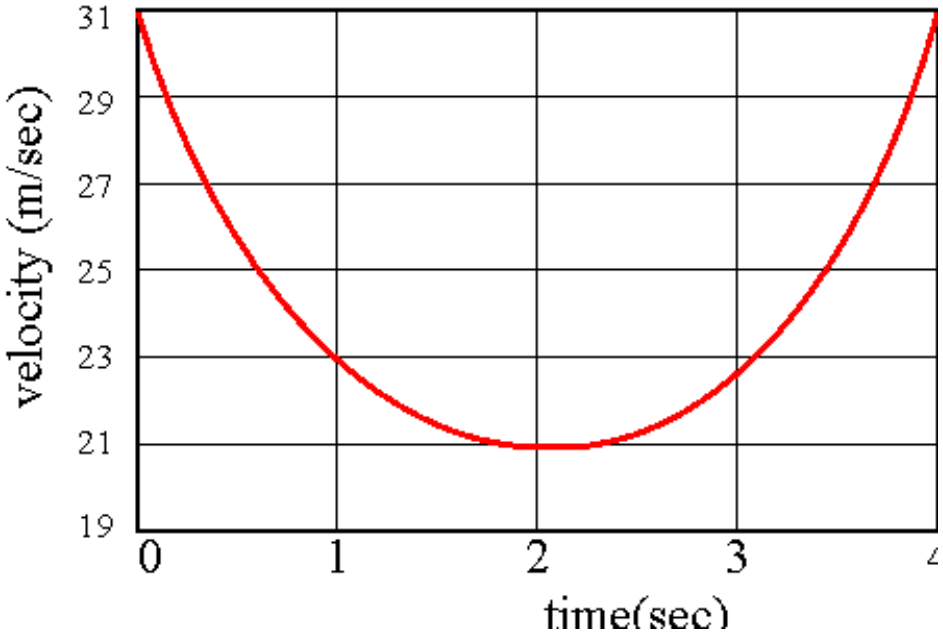
How far does the ball travel horizontally in it's flight?

a) 42m
b) 62m
c) 84m
d) 95m
e) 102m



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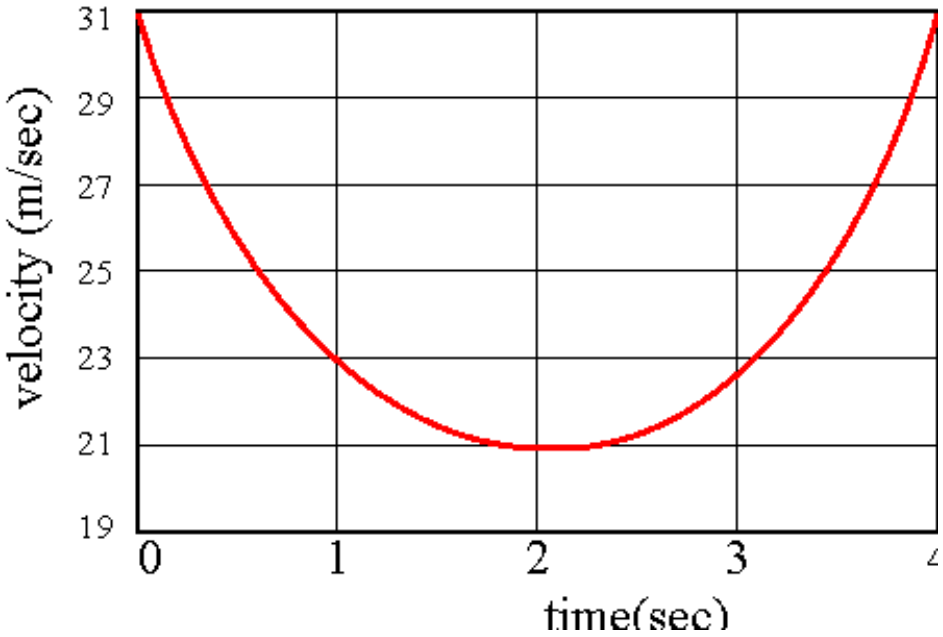

What is the golf ball's initial vertical velocity?

a) 10.0m/sec
b) 11.4m/sec
c) 21.0m/sec
d) 22.8m/sec
e) 31.0m/sec

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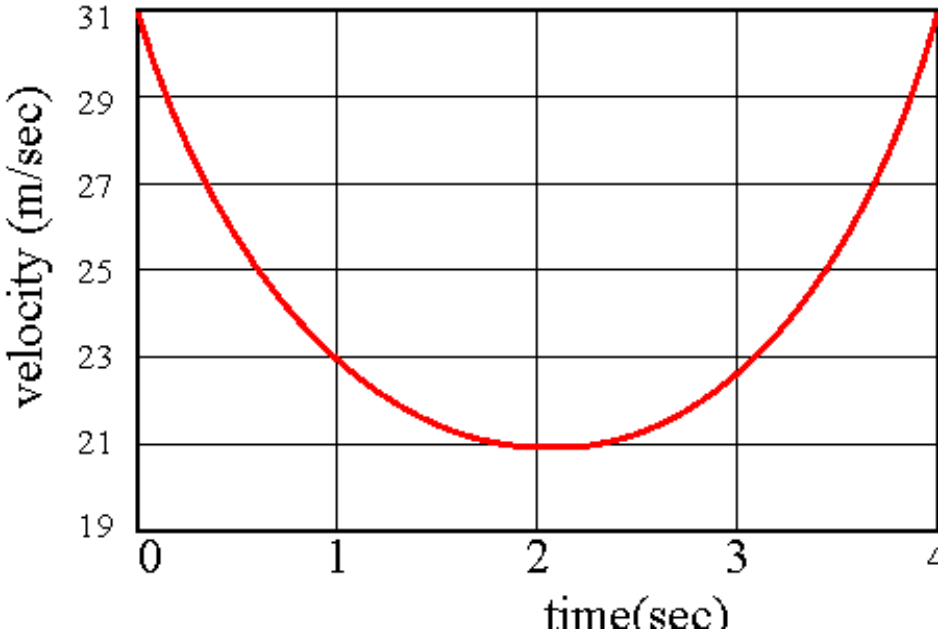
How long does it take the golf ball to reach its highest point?

a) 1sec
b) 1.5sec
c) 2sec
d) 3sec
e) 4sec



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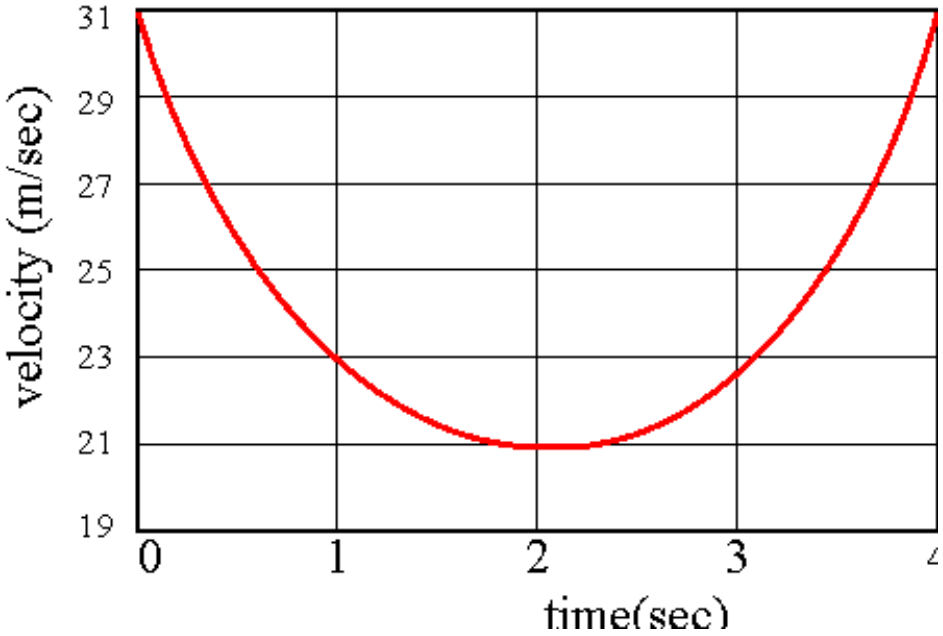
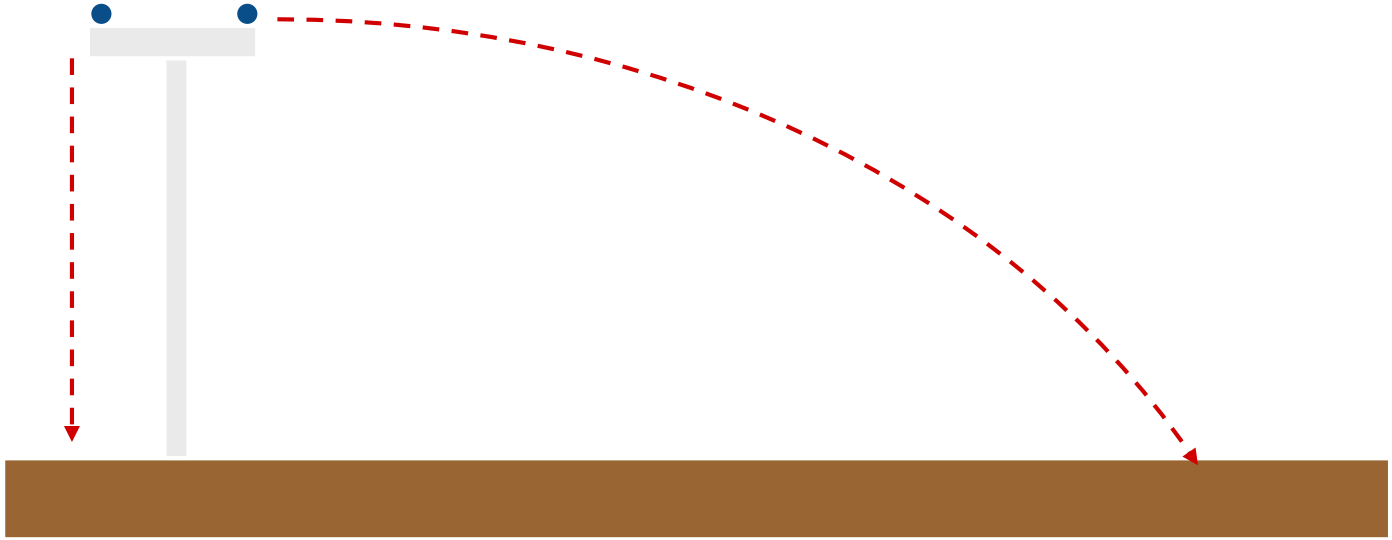


What is the free-fall acceleration on Lgis?

a) 10.0m/sec^2
b) 11.4m/sec^2
c) 21.0m/sec^2
d) 22.8m/sec^2
e) 31.0m/sec^2

Question

In the check point question about dropping the two marbles, what determined how long each marble was in the air?



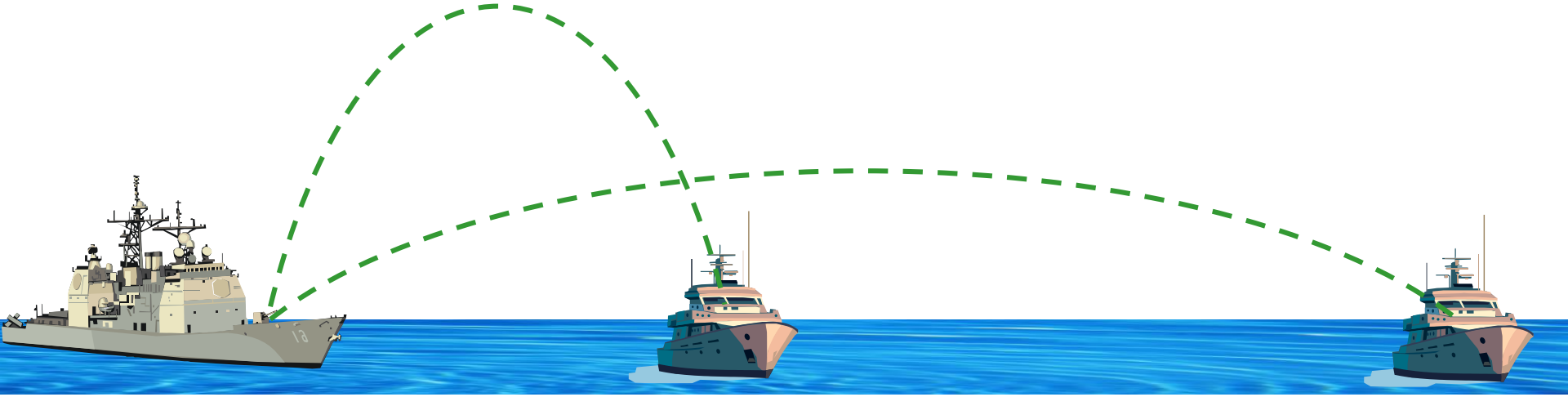
A) How far the marble dropped in the vertical direction.

B) How far the marble moved in the horizontal direction.

C) How far it moved in both the horizontal and vertical directions.

Checkpoint 2

A destroyer simultaneously fires two shells with the same initial speed at two different enemy ships. The shells follow the trajectories shown. Which ship gets hit first?



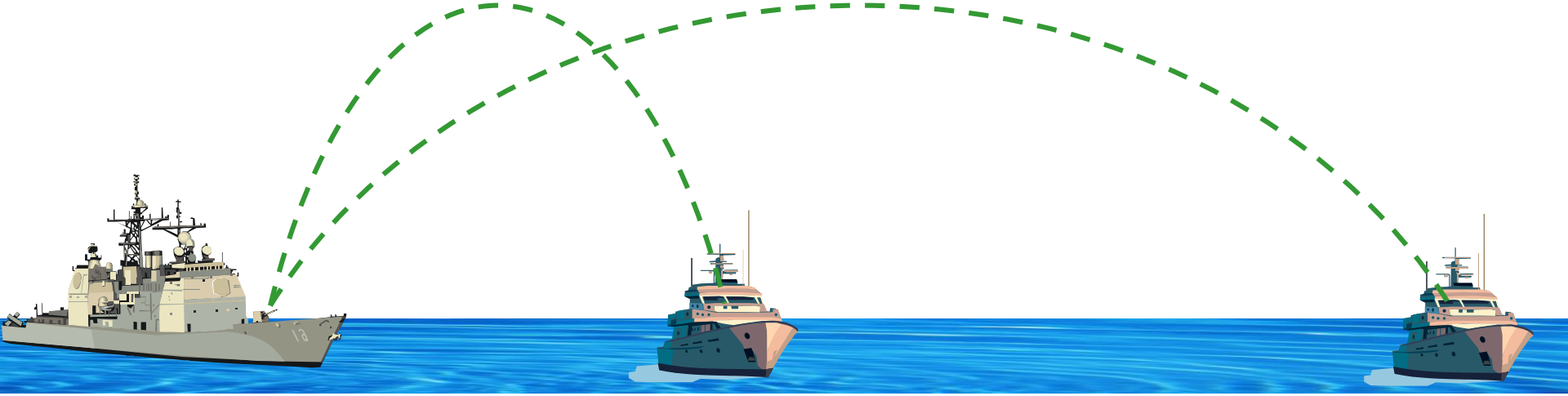
A) Enemy 1

B) Enemy 2

C) They are both hit at the same time

Checkpoint 3

Now lets say the destroyer fires two shells with *different initial* speeds at two different enemy ships. The shells follow the trajectories shown. Which enemy ship gets hit first?



Destroyer Enemy 1 Enemy 2

A) Enemy 1

B) Enemy 2

C) They are both hit at the same time