Spring 2014

PHYS-2010

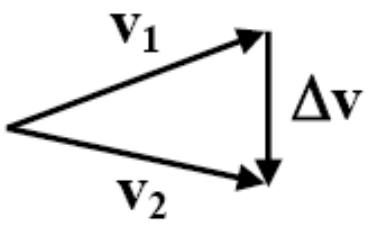
Lecture 10

Clicker Question

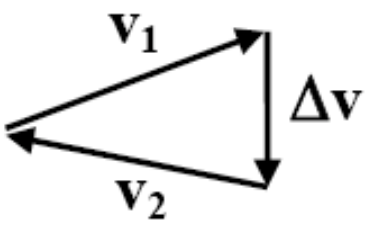
Room Frequency BA

Which diagram below correctly depicts the equation $\vec{v}_1 + \Delta\vec{v} = \vec{v}_2$?

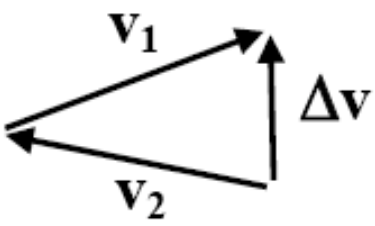
A)



B)



C)



D) all three (A,B,C) are correct

E) None (A,B,C) are correct

Clicker Question

Room Frequency BA

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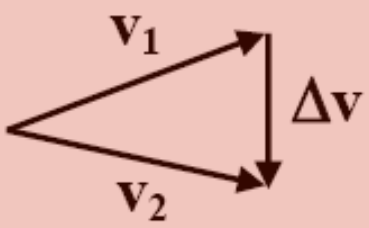
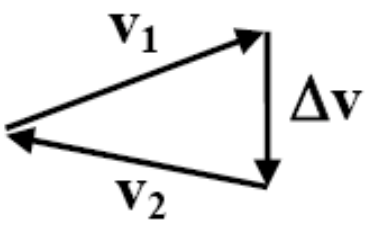
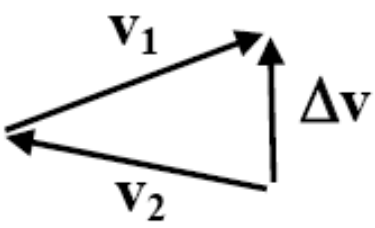
A)



B)



C)



D) all three (A,B,C) are correct

E) None (A,B,C) are correct

Announcements

- Finish reading Giancoli Chapter 3.
- **CAPA # 4** is due next Tuesday.
- **No Written homework** this week!
- **Midterm Exam 1** is tomorrow, Thur, Feb 6, 7:30-9:15 PM.
- Exam seating:
  - if your TA is Rosemary Wulf or Andrew Hess, your exam is here, G1B30.
  - if your TA is Jake Fish or Clarissa Briner, your exam is next door, G1B20.
- More details about the exam are on the course website:

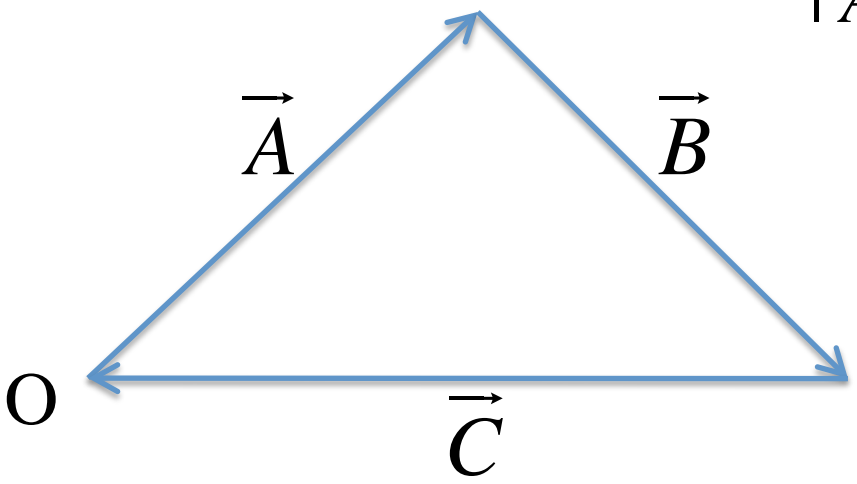
http://www.colorado.edu/physics/phys2010/phys2010_sp14/exams.html

Clicker Question

Room Frequency BA

An object travels from point O back to point O in 1 hour along an equilateral triangle in which each side is 10 km as follows:

$$|\vec{A}| = |\vec{B}| = |\vec{C}| = 10 \text{ km}$$



What is the object's **average speed** around the loop?

A) 0 km/h
B) 10 km/h
C) 20 km/h
D) 30 km/h
E) 40 km/h

s = distance traveled/elapsed time
= 30 km/1 hr = 30 km/h

Clicker Question

Room Frequency BA

An object travels from point O back to point O in 1 hour along an equilateral triangle in which each side is 10 km as follows:

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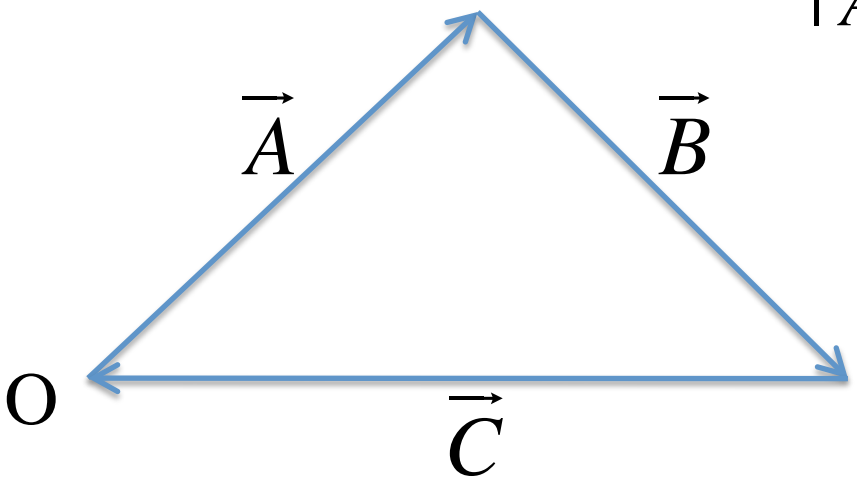


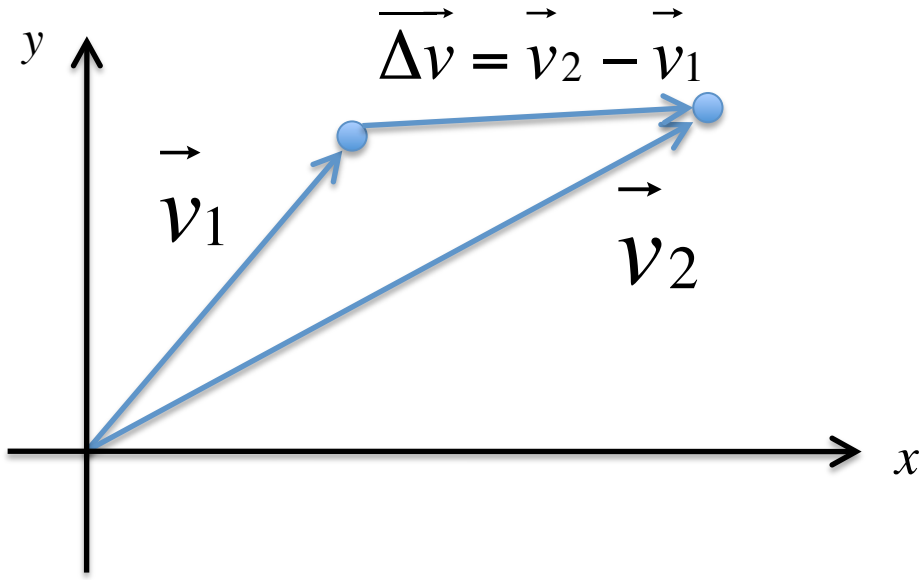
What is the magnitude of the object's **average velocity** around the loop?

A) 0 km/h
B) 10 km/h
C) 20 km/h
D) 30 km/h
E) 40 km/h

v = displacement/elapsed time
= 0 km/1 hr = 0 km/h

Kinematics in 2D: Use of Vectors

Consider the two "velocity vectors" that specify the velocity of a blue ball at two points in time (t_1 and t_2) in a chosen (x,y) Reference Frame:



In 1D:

$$a = \frac{\Delta v}{\Delta t} = \frac{\text{change in velocity}}{\text{elapsed time}}$$

In 2D:

$$\vec{a} = \frac{\overrightarrow{\Delta v}}{\Delta t} = \frac{\text{change in velocity}}{\text{elapsed time}}$$

Note: in 2D:

(1) **Acceleration is a vector.**

(2) Direction of acceleration is determined entirely by the change in velocity.

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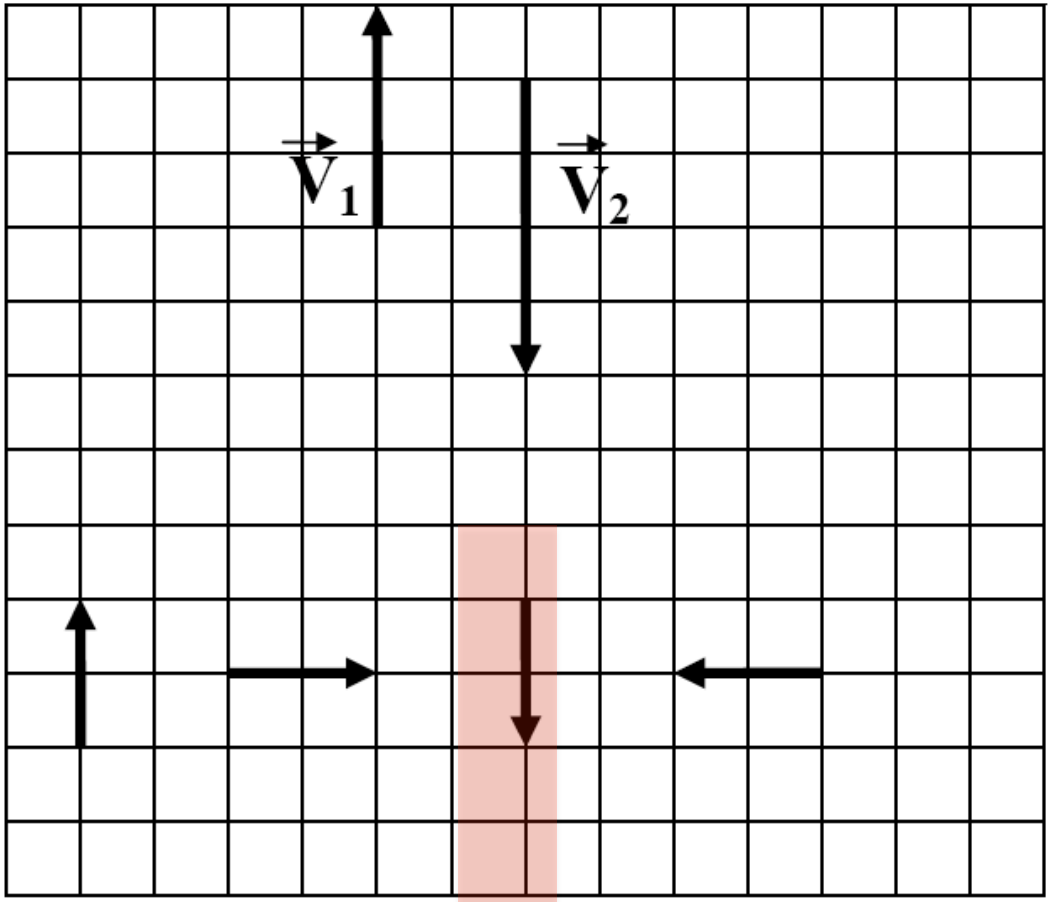
Room Frequency BA

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.

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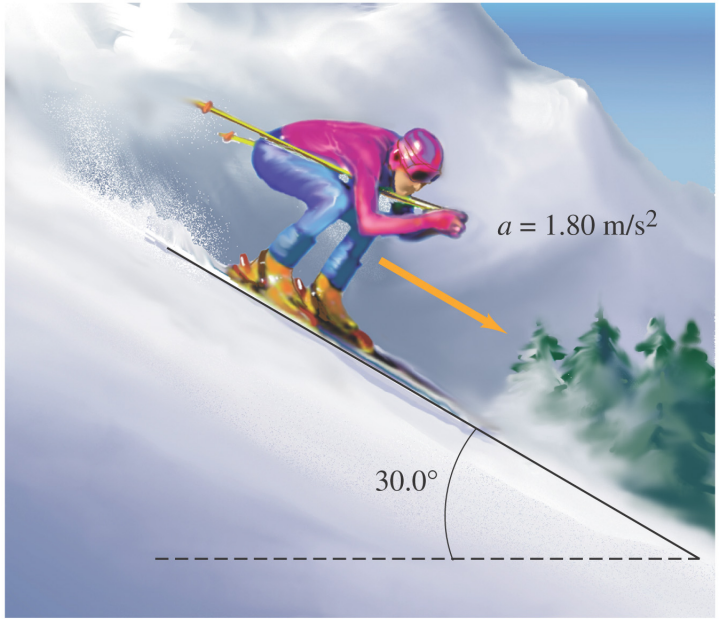
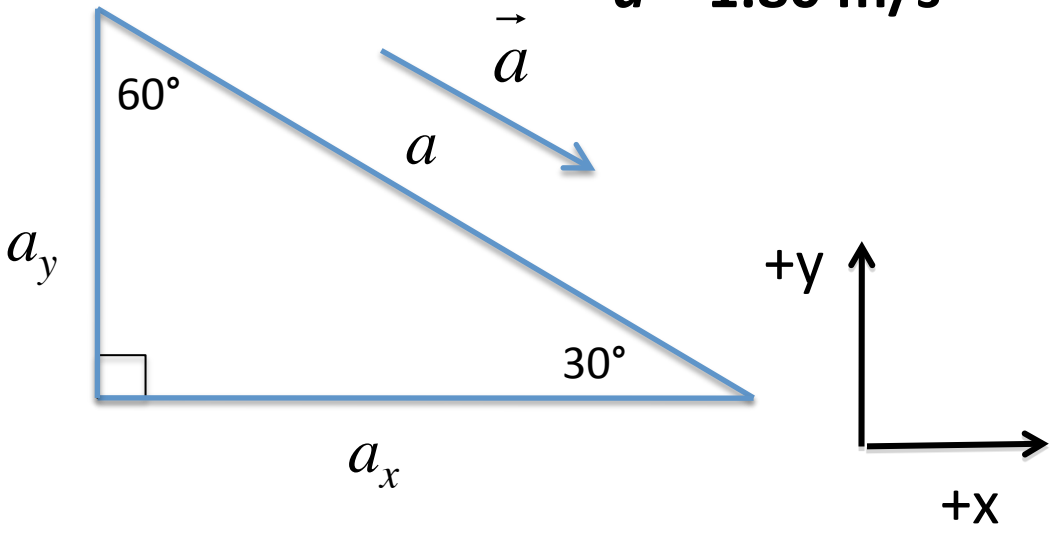
What is the vertical-component of acceleration of the skier?



a = 1.80 m/s²



What is the vertical component of a

A) 1.55 m/s²

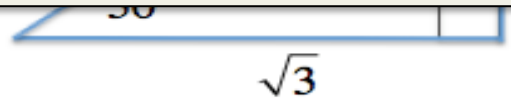
B) -1.55 m/s²

C) 0.9 m/s²

D) -0.9 m/s²

$$a_x = a\cos 30^\circ = 1.8\left(\frac{\sqrt{3}}{2}\right) m/s^2 = 1.55 m/s^2$$

$$a_y = -a\sin 30^\circ = -1.8\left(\frac{1}{2}\right) m/s^2 = -0.9 m/s^2$$



Motion in > 1D

• Position, displacement, velocity, and acceleration vectors. Distance traveled is a scalar.

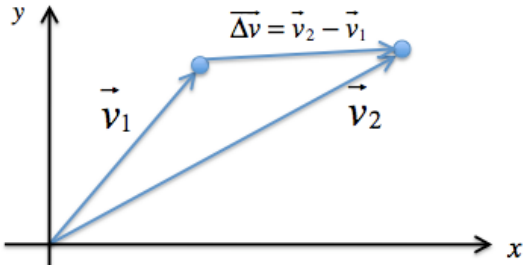
• Addition and subtraction of vectors – needed to define velocity and acceleration:

$$s = \frac{\text{distance traveled}}{\text{elapsed time}} \qquad \vec{v} = \frac{\overrightarrow{\Delta R}}{\Delta t} = \frac{\text{displacement}}{\text{elapsed time}} \qquad \vec{a} = \frac{\overrightarrow{\Delta v}}{\Delta t} = \frac{\text{change in velocity}}{\text{elapsed time}}$$

Speed | Velocity | Acceleration

$$\overrightarrow{\Delta R} = \vec{R}_2 - \vec{R}_1 \qquad \overrightarrow{\Delta v} = \vec{v}_2 - \vec{v}_1$$

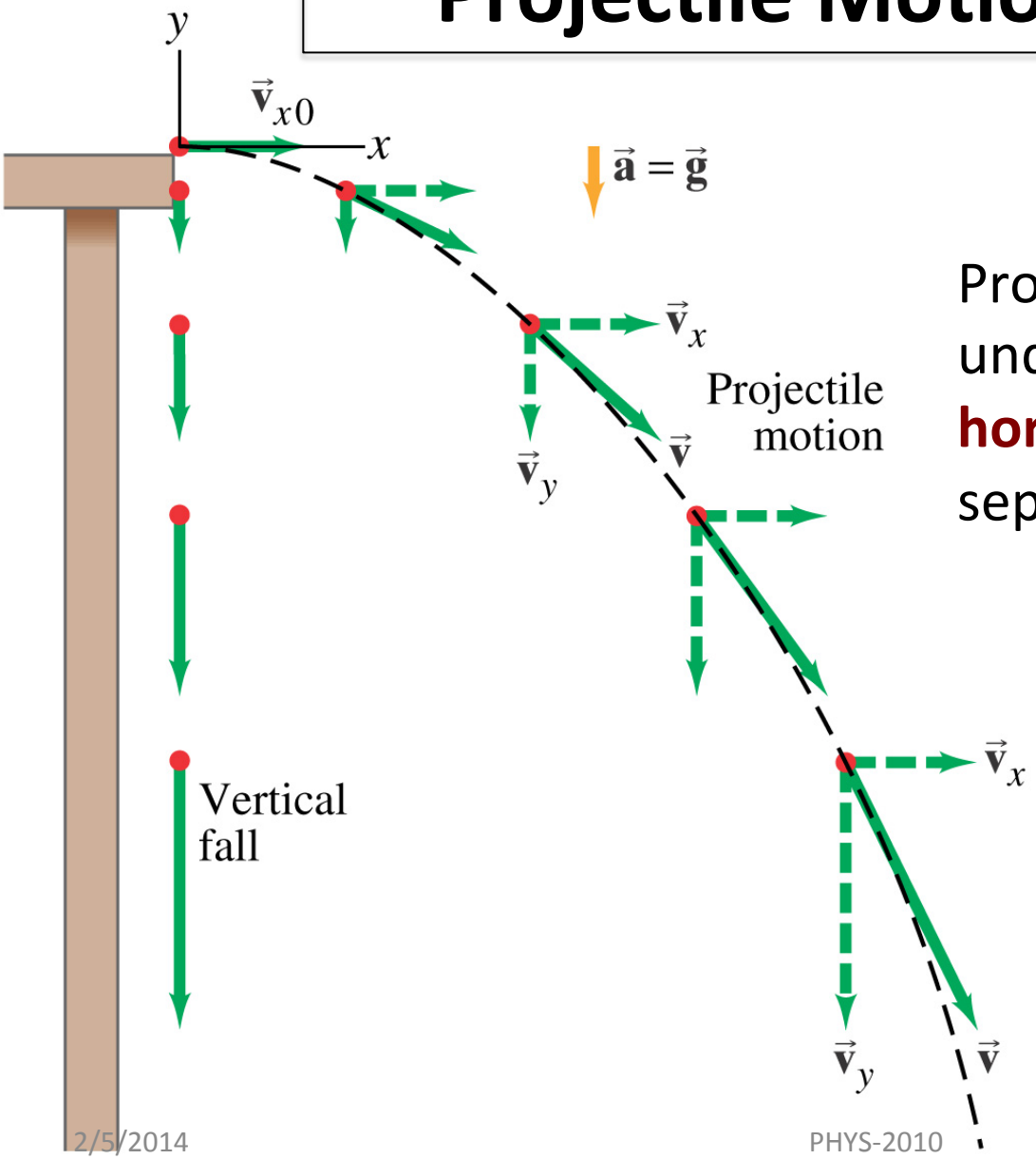
- Be able to deal with velocity and acceleration as vectors:
  - find its components from its length and direction;
  - find its length and direction from its components;
  - add and subtract them graphically & using components.



Projectile Motion in 2D

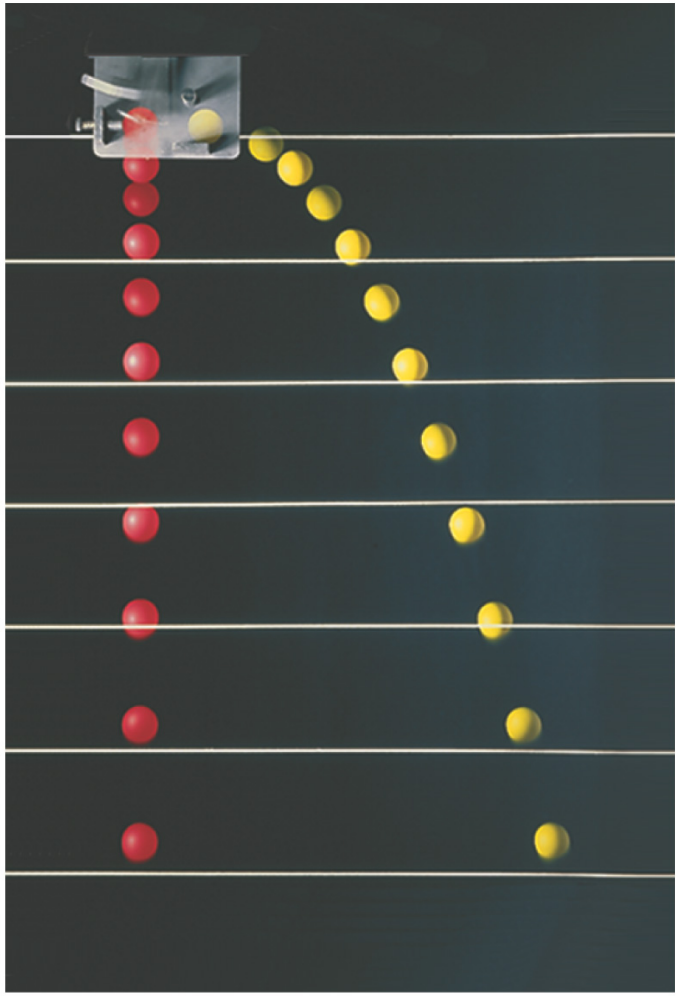
A projectile is an object moving in two dimensions under the influence of Earth's gravity; its path is a parabola.

Projectile Motion in 2D



Projectile motion can be understood by analyzing the **horizontal** and **vertical** motions separately.

Is the *y* motion independent?

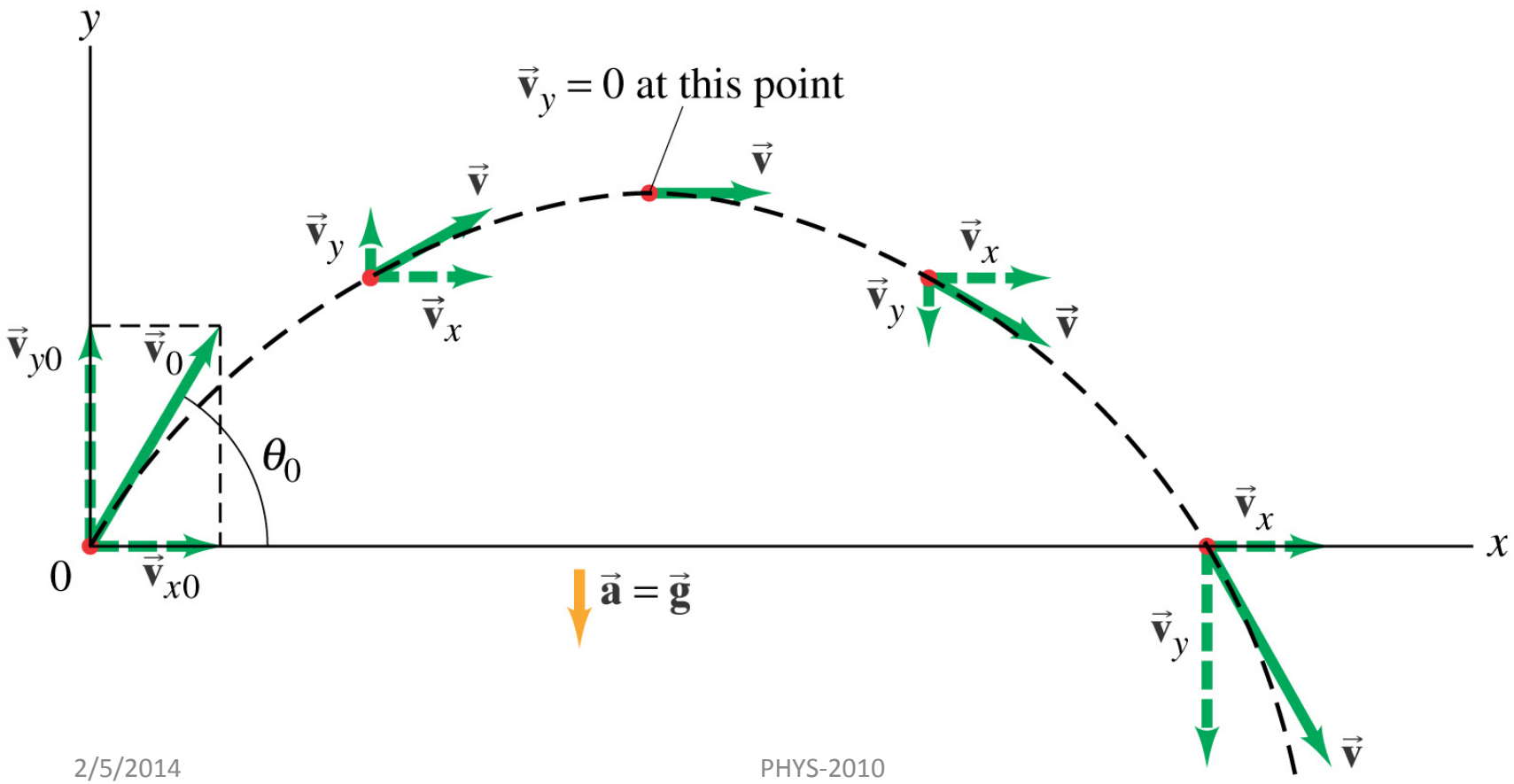


- *x*-direction: constant velocity;
- *y*-direction: constant acceleration *g*.

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.

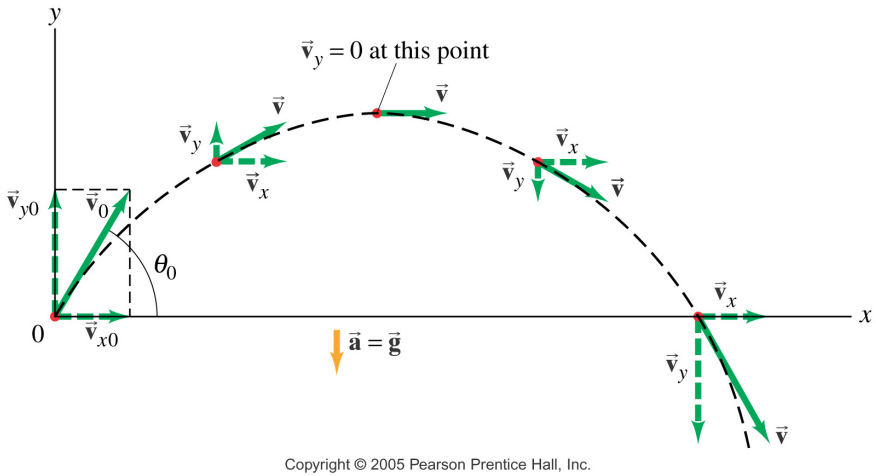
Initial horizontal and vertical velocity

If an object is launched at an initial angle of θ_0 with the horizontal, the analysis is similar except that the initial velocity has **vertical & horizontal** components.



Clicker Question

Room Frequency BA

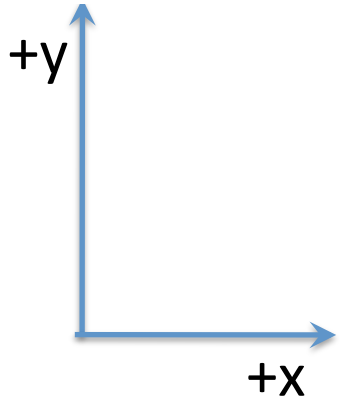


Vertical (y-direction)

Horizontal (x-direction)

$a_y = ?$

$a_x = ?$



What is the acceleration in the *y* and *x* directions?

A) $a_y = 0$ $a_x = 0$

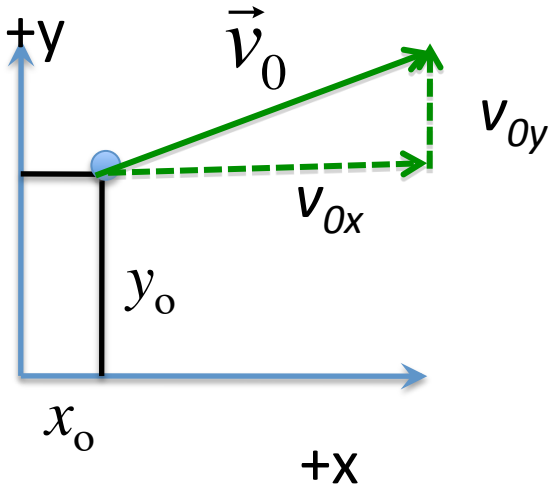
B) $a_y = -g$ $a_x = -g$

C) $a_y = 0$ $a_x = -g$

D) $a_y = -g$ $a_x = 0$

E) Insufficient information to answer.

General Initial Conditions



Vertical ***y*-direction**	**Horizontal** ***x*-direction**
$a_y = -g$	$a_x = 0$
y_0	x_0
v_{0_y}	v_{0_x}

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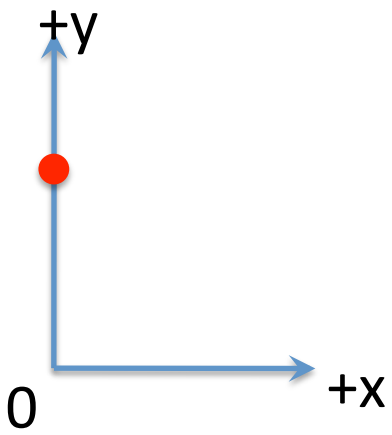
Room Frequency BA



Vertical y-direction	Horizontal x-direction
$a_y = -g$	$a_x = 0$
y_0	x_0
v_{0_y}	v_{0_x}

Assume you have an object whose initial position is on the *y*-axis on the top of a hill of height *h* above the origin. What's x_0 and y_0?

A) $x_0 = h$, $y_0 = h$

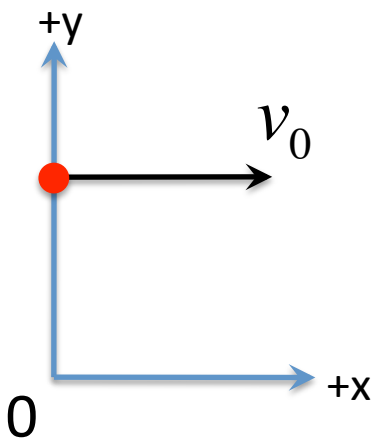
B) $x_0 = 0$, $y_0 = h$

C) $x_0 = 0$, $y_0 = 0$

D) $x_0 = h$, $y_0 = 0$

Clicker Question

Room Frequency BA



Vertical y-direction	Horizontal x-direction
$a_y = -g$	$a_x = 0$
y_0	x_0
v_{0_y}	v_{0_x}

Consider an object fired **horizontally** from the top of a hill to the right with a speed of v_0. What will the initial velocities in the *x* and *y* directions be?

$A)\ v_{x_0} = v_0,\ v_{y_0} = 0$

$B)\ v_{x_0} = v_0,\ v_{y_0} = v_0$

$C)\ v_{x_0} = 0,\ v_{y_0} = v_0$

$D)\ v_{x_0} = -v_0,\ v_{y_0} = 0$

$E)\ v_{x_0} = -v_0,\ v_{y_0} = v_0$

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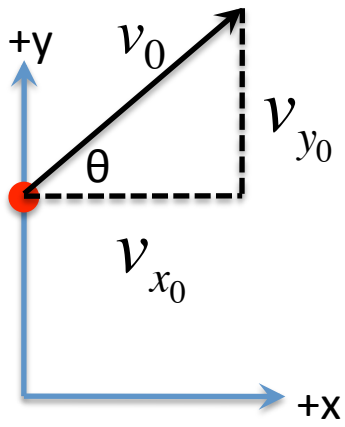
Room Frequency BA



Vertical
y-direction

$a_y = -g$

y_0

v_{0_y}

Horizontal
x-direction

$a_x = 0$

x_0

v_{0_x}

Consider an object fired at an angle θ from the horizontal from the top of a hill to the right with a speed of v_0. What will the initial velocities in the *x* and *y* directions be?

A) $v_{x_0} = v_0 \cos\theta, \quad v_{y_0} = 0$

B) $v_{x_0} = v_0 \sin\theta, \quad v_{y_0} = 0$

C) $v_{x_0} = v_0 \cos\theta, \quad v_{y_0} = v_0 \sin\theta$

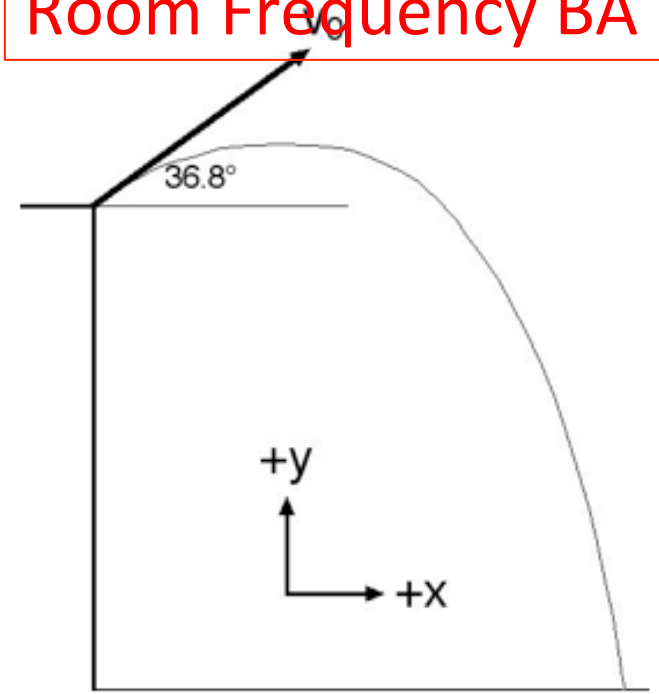
D) $v_{x_0} = v_0 \sin\theta, \quad v_{y_0} = v_0 \cos\theta$

E) $v_{x_0} = -v, \quad v_{y_0} = v$

Clicker Question

Room Frequency BA

A group of physics students shoot a water balloon from the top of Stearns East residence hall toward the President's house. Initial velocity is $v_0 = 50$ m/s at an angle of 36.8°.



The components of initial velocity are:

$A)\ v_{0x} = +40m/s \quad v_{0y} = +30m/s$

$B)\ v_{0x} = +30m/s \quad v_{0y} = +40m/s$

$C)\ v_{0x} = +40m/s \quad v_{0y} = -30m/s$

$D)\ v_{0x} = +30m/s \quad v_{0y} = -40m/s$

$\sin 36.8^\circ = 0.6$

$\cos 36.8^\circ = 0.8$