Early E. C.: / 1
Total HW Points Unit 3: / 20
Total Lab Points Unit 3: / 40
Unit 3 Apps.: / 5
Late, Incomplete, No Work, No Units Fee? Y / N

Unit 3 – Motion & Two Dimensional Kinematics

Essential Fundamentals of Motion and Two Dimensional Kinematics

1. The horizontal component of a projectile's velocity is constant.

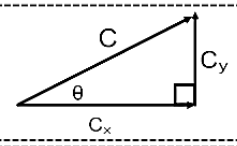
Add More!!

Link to Algebra

In Unit 3, the following equations will be used. Isolate the indicated variables.

AP Equations

In-Class Equations



Vector Analyses

$C_y = C \sin\theta$ Vector Decomp.

$\theta =$

$C_x = C \cos\theta$

$C =$

$\theta = \tan^{-1}\left(\frac{C_y}{C_x}\right)$ Angle Formula

$C_x =$

$C_y =$

$hypotenuse = \sqrt{x^2 + y^2}$ Distance Formula (From Pythagorean)

$x =$

$y =$

$x = v_{x_0} t$ x-Position Equation

$t =$

$y = v_{y_0} t - \frac{1}{2} g t^2$ y-Position Equation

$v_{y_0} =$

$v_{x_0} = v_0 \cos\theta$ Initial X-Velocity Equation

$v_0 =$

$\theta =$

$v_{y_0} = v_0 \sin\theta$ Initial Y-Velocity Equation

$v_0 =$

$\theta =$

$v_y = v_{y_0} - gt$ Y-Velocity at Time = t Equation

$t =$

$t_u = \frac{v_{y_0}}{g}$ Time-to-Top Equation

$v_{y_0} =$

$Range = \frac{v_0^2 \sin 2\theta}{g}$ Range Equation

$v_0 =$

$\theta =$

$y_{max} = v_{y_0} t_u - \frac{1}{2} g t^2$ Why Max? Equation

$v_{y_0} =$

$t = \sqrt{\frac{2y}{g}}$ Free Fall Time Equation

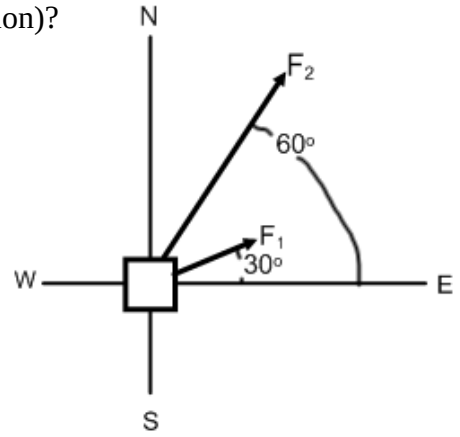
$y =$

Possible 3.1 Pts.: 4
Late, Incomplete, No work, No Units Fee: - 1 - 2 - 3
Final Score: / 4

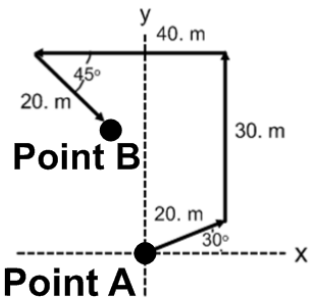
3.1 Problems – Vector Manipulation

Section 3.2 of your book.

1. Two boys are pulling a box across a horizontal floor as shown in the diagram. If F_1 = 50.0 N, and F_2 = 100.0 N, what is the resultant force (magnitude and direction)?



2. A person walks from point A at the origin to point B as shown in the following figure. What is the person's displacement (magnitude and direction) relative to point A? Hint: break up the journey into four parts, and add the component magnitudes together.



Possible 3.2 Pts.: 5
Late, Incomplete, No work, No Units Fee: - 1 - 2 - 3
Final Score: / 5

3.2 Problems – Components of Motion – Two Dimensional Kinematics

Section 3.1 of your book.

1. A. An airplane climbs at an angle of 15^o with a horizontal component speed of 200 km/h. What is the plane's actual speed?

   B. For the previous problem, what is the magnitude of the vertical component of its velocity?

2. A ball rolls at a constant velocity of 1.25 m/s at an angle of 35^o below the + x-axis in the fourth quadrant. If the ball is at the origin at t = 0, what are its coordinates (x,y) 1.65 s later?

3. A. A particle moves along the x axis in the positive direction at a speed of 3.0 m/s. Upon reaching the origin, the particle receives a continuous constant acceleration of 0.75 m/s^2 in the positive y-direction. What is the (x, y) position 4.0 s later?

   B. What is the magnitude and direction of its displacement (what straight line distance did it go)?

Possible 3.3 Pts.: 4
Late, Incomplete, No work, No Units Fee: - 1 - 2 - 3
Final Score: / 4

3.3 Problems – Projectile Motion (Part 1)

Section 3.3 of your book.
Wizard Challenge Alert!

1. A cannon fires a projectile with a muzzle velocity of 185 m/s at an angle of 55°.
   A. How long does the projectile take to reach the top of its arc?
   B. How high up is it at the top?

2. An artillery crew fires a cannon at an angle of 56° with a muzzle velocity of 330 m/s. How far will the cannonball travel before it hits the ground assuming it's on level ground?

3. A. A wheeled car with a spring-loaded cannon fires a metal ball vertically. If the vertical initial speed of the ball is 5.0 m/s as the cannon moves horizontally at a speed of 0.75 m/s, how far from the launch pad will the ball fall back into the cannon?

   B. From the previous problem, describe what would happen if the cannon were accelerating.

3.4 Problems – Projectile Motion Part 2

Section 3.3 of your book.

Wizard Challenge Alert!

Possible 3.4 Pts.: 3
Late, Incomplete, No work, No Units Fee: - 1 - 2 - 3
Final Score: / 3

1. A ball rolls horizontally with a speed of 7.6 m/s off the edge of a platform. If the ball lands 8.7 m from the point on the ground directly below the edge of the platform, what is the height of the platform?

2. A convertible travels down a straight, level road at a speed of 23 km/h. A person in the car throws a ball with a speed of 7.6 m/s forward at an angle of 37^{o} to the horizontal. Where is the car when the ball lands? Hint: determine how long the ball is in the air first.

3. A good-guy stuntman is being chased by bad guys on a building's level roof. He comes to the edge and runs straight off to the level roof of a lower building 4.0 m below and 5.0 m away. What is the minimum speed the stuntman needs to clear the gap?

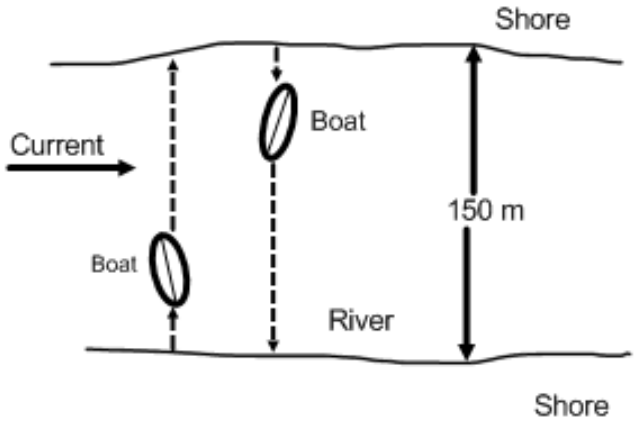
Possible 3.4 Pts.: 4
Late, Incomplete, No work, No Units Fee: - 1 - 2 - 3
Final Score: / 4

3.5 Problems – Relative Velocity
Section 3.4 of your book.

1. A. While you are traveling in a car on a straight, level interstate highway at 90. km/h, another car passes you in the same direction; its speedometer reads 120 km/h. What is your velocity relative to the other driver?

   B. What is the other car's velocity relative to you?

2. A boat that travels at a speed of 6.75 m/s in still water is to go directly across a river and back, according to the following diagram. The current flows at 2.50 m/s. At what angle must the boat be steered?



3. For the previous problem, how long does the boat take to make the round trip?

AP Physics 1	3.1 Lab - Launcher Design Challenge
Reminder: Update Table of Contents	Correction Credit: Half

Lab Overview:

Your team must build a launcher with materials from our physics construction sets. At launch time, you'll compare your launcher's distance to that of the other students in the class, and make calculations of your launcher's velocity.

Materials:

1 – Base Plate
4 – Threaded Base Attachment Brackets
4 – Long Rods (threaded)
2 – Medium Rods (unthreaded)
2 – Short Rods (unthreaded)
6 – 90º Skew Connectors (wing nuts)
1 – 90º Skew Connectors (nut / hook)
2 – 90° Perp. Connector (wing nuts)
1 – Piece of Paper (8½ " X 11")
20 cm Masking Tape
1 m string.
1 Rubber Band
1 Ping Pong Ball

Launcher Lab (3.1) Guide		
Table of Contents, Title/Date, Detailed Synopsis, Two Purposes		/ 2
Performance: 8 Floor Tiles		1 2 3 4
Mission 1: Large Detailed Drawing	Full Page:	/ 1
	Labeled:	/ 1
	Dimensions:	/ 1
	To Scale:	/ 1
Mission 2: Calculations	Work Shown:	/ 2
	Correct Value:	/ 2
Question 1: Improvements		/ 3
Question 2: Calc. Errors		/ 3
Extra Credit:	Farthest:	+ 1
	12 Floor Tiles:	+1
Late Lab Fee		- 4
Total:		**/ 20**

Launcher Rules:

1. Only components in the plastic bucket may be used, and you don't have to use all of them.
2. There is risk of potential eye injury from flying objects, no horseplay allowed.
3. Device will be activated by letting go of the mechanism: no pushing allowed.
4. Deformation/destruction of metal materials is grounds for grade reduction/disqualification.
5. The projectile is only a naked ping pong ball.

Timeline:

_____/_____ – Introduce lab; brainstorm designs. Dismantle launchers by class' end.

_____/_____ **–** Build launcher and be ready to launch after 40 minutes. Launch projectiles. Dismantle launchers. Finish calculations and questions.

Competition Day:

1. Teams must be ready to go after thirty minutes. I will set the launch order.
2. All teams must observe the other teams' launches.
3. Launches will be in the hallway, from the double doors heading north.
4. Launchers will be on the ground during launch.
5. Each team will have three launches.
6. Distance is measured from the last point of contact with the ball to the first point of contact with the ground, and we will measure your launcher's angle for calculation purposes.

Performance Points:

Ping pong ball goes 8 floor tiles. One point per tile cleared.
+ 1 E.C. – Launcher goes more than 12 floor tiles. + 1 E.C. – Launcher that fires the farthest.

Mission 1:

Make a large, detailed drawing of your launcher in your Lab Notebook (one full page). Your drawing should be well labeled with dimensions of the major parts for full credit. It should also attempt to be to scale.

Mission 2:

Calculate the launch velocity of your ball, based on its distance traveled and its launch angle. Show all work for your calculation for full credit. To simplify calculations, assume that your start and end heights are equal.

Questions: Rephrase and answer in complete sentences for full credit.

1. How would your improve your launcher in the future?

2. What are some errors that your launch velocity calculation may have?

AP Physics 1	3.2 Lab - Shoot For Your Grade	
Reminder: Update Table of Contents		Correction Credit: Half

Lab Overview:

Students calculate the exact location a projectile lands, when launched from a standard classroom launcher. Proximity to the target will determine your grade!

Materials:

Standard Classroom Launcher.

Mission 1: (6 Points)

Use the classroom launcher at a three different angles to calculate its muzzle velocity (speed of launch): 25°, 40°, and 60°. You will have to take three trials at these angles to determine an average muzzle velocity. Be sure to record all data you gather in a table, and show all calculations for this part in your Lab Notebook.

Check your work carefully, I will evaluate launch velocities that seem egregious.

Shoot for your Grade Lab (3.1) Guide		
Table of Contents, Title/Date, Detailed Synopsis, Two Purposes		/ 2
Mission 1: Muzzle Velocity Calculation	25° Calculation	/ 2
	40° Calculation	/ 2
	60° Calculation	/ 2
	Accurate Calcs.	/ 2
Mission 2: Target Acquired?	Bullseye!	/ 8
	Close?	0 2 4 6
Question 1: Improvements		/ 4
Late Lab Fee		- 4
Total:		**/ 20**

Mission 2: (8 Points)

I will give you a specific angle of launch, and after you've calculated how far the ball will go, we'll set up the target down range. If you hit the bull's eye on one of your launches, you can get full credit.

Questions: Rephrase and answer in complete sentences for full credit.

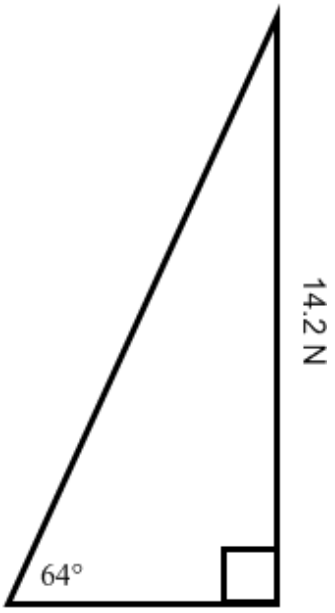
1. Did you hit the target? What could you do better in the future to hit it consistently? What went wrong/right?

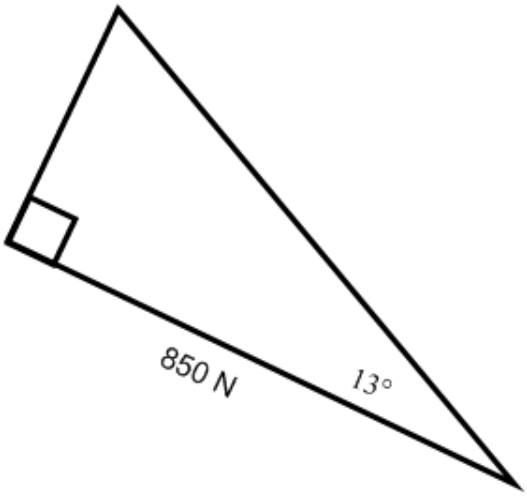
AP Physics 1	Extra Credit Trigonometry Problems	
Name:	E.C.:	1 2

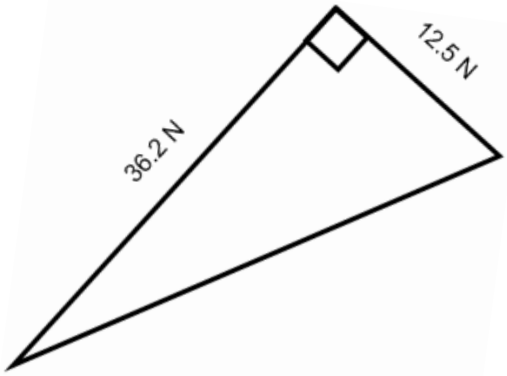
The ancient Greeks realized the power of triangular relations thousands of years ago, and since then, mathematicians, scientists, engineers, students, and wizards have been using them to design brilliant things and solve difficult problems.

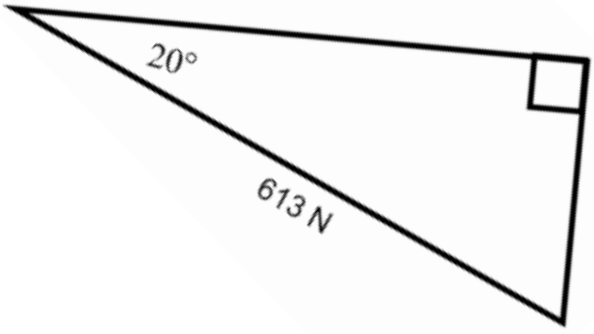
Extra Credit Problems: Use your AP resources or notes. Your points will be added dire3ctly to the assessments category of your grade.

Use trigonometric ratios to determine the angles and sides of the following right triangles. The symbol N in these problems represents the Newton, a unit of force. It is a vector quantity.









AP Physics 1	Unit 3 - Motion & Two Dimensional Kinematics				
Application Problems, AP Test Preparation Questions					
Presentation Points:	/ 5	Late Fee:	-2	Completion (Booklet Check)	/ 5

Your grade on this problem set will depend on the presentation you provide for your problem, and whether they are complete when you submit your Booklet at the end of the Unit.

1. A cannon fires a projectile with a velocity of 385 m/s at an angle of 75.0^{o}. What are the x and y components of velocity?

2. How high does a bullet travel after leaving the barrel of a rifle at 225 m/s with an angle of 66.0° above the horizontal?

3. How far does the bullet in the previous problem travel if it lands at the same elevation?

4. Holly intends to swim to a point straight across a 125 m wide river that flows at 1.25 m/s. If she can swim 2.50 m/s in still water, at what angle must she swim upstream to achieve her goal?

5. A cannon fires a projectile with a muzzle velocity of 225 m/s at an angle of 78.5^{o}. What is the projectile's location (x,y) after 18.5 seconds?

6. A pickup truck moves 25 m/s eastward. A guy in the back throws a baseball in what to him is the southwest (225^{o}) direction at 28 m/s (with respect to the truck). A stationary person (with respect to the car) would see the ball moving HOW FAST in WHAT DIRECTION? (Hint: this is a vector addition problem.)

7. Misty throws a stone horizontally from the roof edge of a 50.0 meter high dormitory. It hits the ground at a point 60.0 m from the building. How fast did she throw the stone?

Unit 3 Practice AP Multiple Choice Questions

The following problems (multiple choice and free response) are designed to train you to take the AP Physics 1 test in the spring, and will be scored at the end of the Unit – based on completion and accuracy.

1. A stone is thrown horizontally with an initial speed of 10 m/s from a bridge. If air resistance could be ignored, how long would it take the stone to strike the water 80 m below the bridge?
   a. 1 s b. 2 s c. 4 s d. 8 s

2. A soccer ball, at rest on the ground, is kicked with an initial velocity on 10 m/s at a launch angle of 30°. Calculate its total flight time, assuming that air resistance is negligible.
    a. 0.5 s b. 1 s c. 2 s d. 4 s

3. A stone is thrown horizontally with an initial speed of 30 m/s from a bridge. Find the stone's total speed when it enters the water 4 seconds later. Ignore air resistance.
    a. 30 m/s b. 40 m/s c. 50 m/s d. 60 m/s e. 70 m/s

4. Which of the following statements is true concerning the motion of an ideal projectile launched at an angle of 45° to the horizontal?
    a. The acceleration vector points opposite to the velocity vector on the way up and in the same direction on the way down.
    b. The speed at the top of the trajectory is zero.
    c. The object's total speed remains constant during the entire flight.
    d. The vertical speed decreases on the way up and increases on the way down.

Unit 3 Example AP Question – Free Response

Consider a projectile moving in a parabolic trajectory under constant gravitational acceleration. Its initial velocity has magnitude v_0 and its launch angle (with the horizontal) is θ_0.

A. Calculate the maximum height of the projectile.

B. Calculate the range, R, of the projectile.

C. For what value of θ_0 will range be maximized?

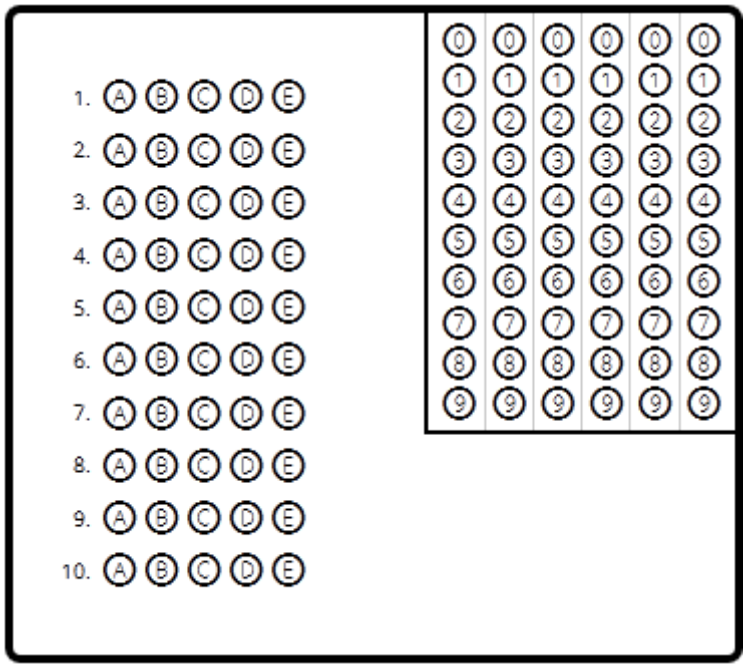
AP Physics 1		Unit 3 Review - Motion & Two Dimensional Kinematics					
Points:	/ 16	Late or Incomplete Fee:	-2 -4 -6	Correction Credit:		Final Score:	

Solve these problems here, THEN enter your responses in the bubble sheet provided. On the due date, I will scan your responses in class, mark which problems you missed, and enter your score in Powerschool.

If you submit your responses on time, you will have one attempt to correct errors you made (for half credit back).

If you are late, you will only get one attempt, and will only receive half credit for the problems you got right.

Each question is worth two points.



1. A student walks 500.0 m north, then 200.0 m east, then 300.0 m south, then 400.0 m west. What is his resultant displacement (distance AND direction)?

A) 282.8 m, 90^{O} or due North
B) 282.8 m, 315^{o} or 45^{o} East of South
C) 282.8 m, 135^{o} or 45^{o} North of West
D) 282.8 m, 105^{o} or 15^{o} North of West

2. A person shoveling snow exerts a downward force on her shovel of 30.0 N at an angle of 30.0° below the horizontal. What are the horizontal and vertical components of the force she exerts?

A) horizontal = 26.0 N, vertical = 15.0 N
B) horizontal = 26.0 N, vertical = -15.0 N
C) horizontal = -15.0 N, vertical = 26.0 N
D) horizontal = 15.0 N, vertical = 26.0 N

3. A motorboat's speed in still water is 2.0 m/s. The driver wants to go directly across a river with a current of 1.5 m/s. At what angle upstream should the boat be steered?

A) 41^{o} B) 30^{o} C) 15^{o} D) 49^{o} E) 35^{o}

4. What two angles would allow a cannon with a muzzle velocity of 125.0 m/s to hit a target 1,500.0 meters away on level ground?

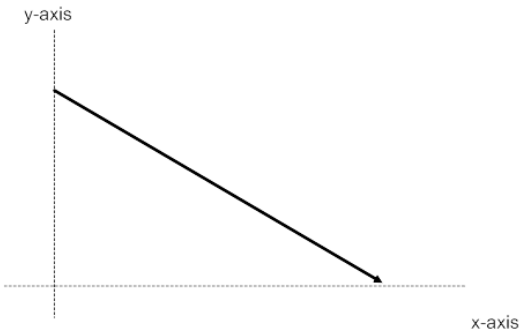
A) 35.17^o and 54.83^o B) 29.45^o and 60.55^o C) 35.17 and 70.34
D) 40^o and 50^o E) 45^o only

5. A ball is dropped from an airplane flying at 60.0 m/s at 300. meters altitude. How far horizontally from the dropping point will the ball land? (Hint: how long does the ball take to land?)

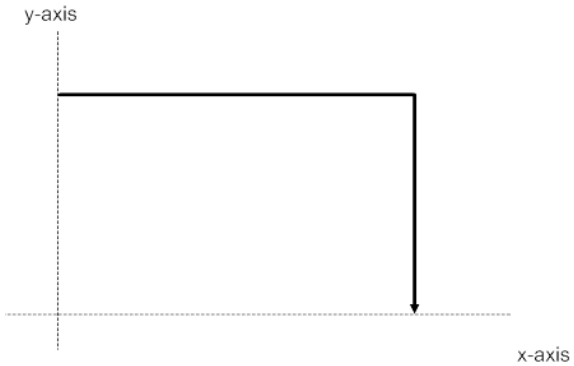
A) 180. M B) 233 m C) 469 m D) 300. m E) 355 m

6. For the previous problem, draw a sketch of the ball's path, and neglect air resistance.

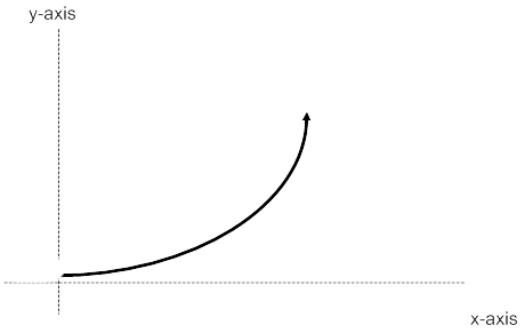
A)



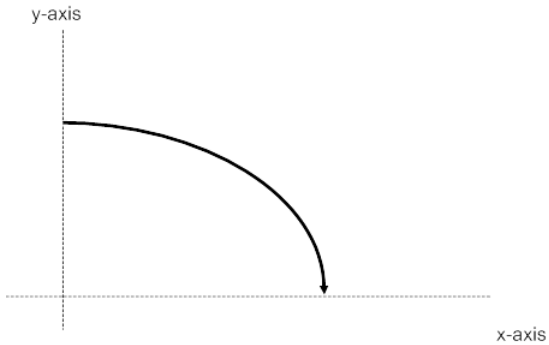
B)



C)



D)



7. How far will a cannonball travel if it is launched on level ground at an angle of 72.0° with an initial velocity of 250. m/s?

A) 3740 m B) 6060 m C) 15.0 m D) 24.2 m E) 4060 m

8. For the previous problem, what are the initial vertical and horizontal components of velocity? Assume that there is no air resistance.

A) vertical = 77.3 m/s and horizontal = 238 m/s B) vertical = 238 m/s and horizontal = 77.3 m/s
C) vertical = 205 m/s and horizontal = 70.0 m/s D) vertical = 250 m/s and horizontal = 72.0 m/s

9. A water rocket takes 5.6 seconds to reach the top of its arc. How fast was it launched to reach this height?

A) 35 m/s B) 40 m/s C) 45 m/s D) 50 m/s E) 55 m/s

10. How high does the rocket in the previous problem go?

A) 154 m B) 140 m C) 145 m D) 138 m E) 161 m