Name _____   **Honors Physics**
Mr. Dove   **Based on Chapter 6**

Unit 3: Projectile Motion

Essential Questions:

- What are the horizontal and vertical accelerations for a projectile?
- What is the initial vertical velocity for a projectile fired horizontally?
- Does the horizontal speed for a projectile ever change? Why or why not?
- What is the vertical speed of a projectile at its maximum height?
- What is the first step when dealing with a projectile fired at an angle?
- What is the path of a projectile called?
- At what angle can a projectile be fired to give it maximum range? Maximum height?
- Projectiles fired at complementary angles (sum of angles equal 90) give the same…what?

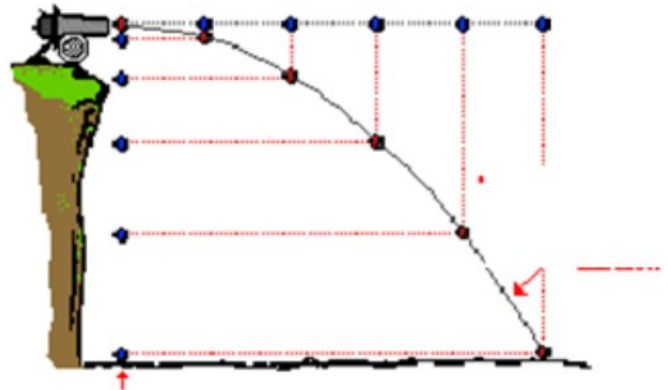## I.   Horizontal Projectiles (Case 1 Projectiles)

A. What is a projectile:

- **An object that has only _____ acting on it**

- **All _horizontally_ fired objects , regardless of _____, if fired from the same height, will**

  _____

B. Properties of Horizontal Projectile Motion:

- Horizontal projectile motion is free fall with an initial horizontal velocity

- Horizontal and vertical motions are completely _____ of each other.

	Horizontal Motion (X Component)	Vertical Motion (Y Component)
Forces		
Acceleration		
Velocity		

C. Horizontal Projectile Motion Problem Solving Strategies

1. Draw a diagram and identify which direction (x and y) you want to be positive (we always use _____ and to the _____ is positive)
2. Create a horizontal (x) and vertical (y) table and break all given values and what you want to find into these two components.
3. Remember general information:

A) a_y = _____ - the projectile experiences a _____ downward acceleration

B) a_x = _____ - the object does not accelerate in the horizontal component ($v_{ix} = v_{fx}$)

C) If fired **horizontally**, v_{iy} = _____

## D. Horizontal Projectile Examples
1. A physics student from Pittsford throws a ball thrown horizontally from the top of a building with a speed of 8 m/s. The student, wishing to test her knowledge, measures the height of the building to be 15 m.

A) What is the ball's acceleration in x and y components?

B) What is the ball's initial vertical (y) velocity?

C) How long does it take for the ball to hit the ground?

D) How far away did the ball land from the building?
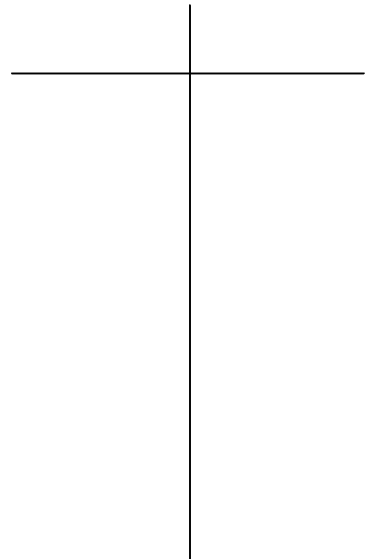
2. A plane drops a package on a friendly village. The plane is traveling 240 m/s. The package took 20 s to hit the ground.
A. What was the package's initial velocity?

B. What was the plane's altitude when it released the package?

C. How far away from where the plane originally dropped the package did it land?

E. <u>Horizontal Projectile Whiteboard Problems</u>

1. You are at a circus and you see a stunt man climb up 20 meters into a cannon. He gets fired horizontally out of the cannon and lands 150 m away. A) How long was stunt man in the air for? B) What was his velocity when he came out of the cannon?

2. An arrow is shot at a target 20 m away. The arrow is shot with a horizontal velocity of 60 m/s. A) How long is the arrow in the air for? B) How far does the arrow drop as it approaches the target?

3. A stone is thrown off a cliff with a horizontal speed of 15 m/s.
A) If the stone's final vertical speed is 40 m/s, how tall was the cliff?
B) How long is the stone in the air for?
C) How far from the base of the cliff does the stone hit the ground?
D) What is the stone's horizontal speed right before it hits the ground?

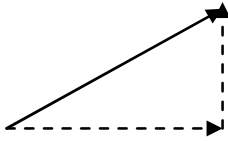## II.   <u>Projectiles at Angles (Case 2 Projectiles)</u>

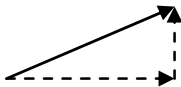### A. <u>Vector Components</u>
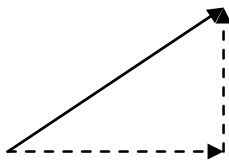
**Equations (see reference tables)**:

Examples:

1. If the initial velocity of an object is 30 m/s at 30 degrees. What are the initial horizontal and vertical components of the projectile?

2. If the initial horizontal velocity of an object is 22 m/s and it is fired at an angle of 13 degrees, what is its initial speed?

3. If the initial vertical velocity of an object is 100 m/s and it is fired at an angle of 15 degrees, what is its initial speed?
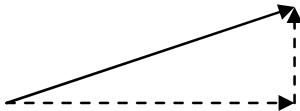
B. **Properties of Projectiles Fired at an Angle**

- Trajectory –

- The projectile travels with **constant** _____ and

    constant _____

- At the maximum height, _____ velocity equals _____

Shape of that path for a projectile fired at an angle:

	Horizontal (X) Motion	Vertical (Y) Motion
Horizontal Velocity:		**Vertical Velocity:**
Horizontal Acceleration:		**Vertical Acceleration:**
Only Equation:		**Maximum Height:**

C. Projectiles at Angles Example
A tennis ball is lobbed at 30° to the horizontal at +10 m/s from a height of 0 m.
a) What is the initial velocity in the horizontal and vertical directions?

b) How long does the tennis ball to reach the maximum height in its path?

c) What is the total time the ball was in the air for?

d) What distance (range) does the tennis ball travel?

e) What is the ball's maximum height?

f) If the angle of the ball decreased, what will happen to the 1) flight time, 2) range, 3) max.height?

D. Projectiles at Angles Whiteboard
A 5 kg cannon ball is fired with a velocity of 75 m/s at an angle of 40° from the horizontal.
    A) Determine the horizontal and vertical components of the initial velocity.
    B) What is the "hang time" of the cannon ball?
    C) What is the range of the cannon ball?
    D) What is the cannon ball's maximum height above the ground?
    E) What is the cannon ball's **speed** at its maximum height?
    F) What are the cannon ball's horizontal and vertical components of its velocity 3 seconds in to the flight?
    G) What is the **acceleration** 1 second into its flight?

E. **Symmetry in Angles for Projectiles**

- View the animation Mr. Dove shows to you.
- How does the range of a projectile compare when fired at 30 degrees as opposed to a projectile fired at 60 degrees?

- What angle gives you the maximum range?

Conclusions:

- Projectiles fired at _____ gives maximum _____

- Projectiles fired at _____ (add up to 90 degrees) give

  the _____

F. **Extra Problems**

1. A ball rolls off a cliff with a speed of 15 m/s.

   A. If the ball falls for 3.5 s and hits the ground. What is the balls final vertical velocity?

   B. What is the height of the cliff it rolled off at?

   C. How far away did the ball travel horizontally during its flight?

2. A projectile is fired at an angle of 60 degrees at 150 m/s on level ground.

   A. What was the maximum height of the projectile?

   B. How long did it take to reach its maximum height?

   C. What was the projectiles total time in the air?

   D. What was the range of the projectile?