Name: _____

Class Period: _____

Physics:

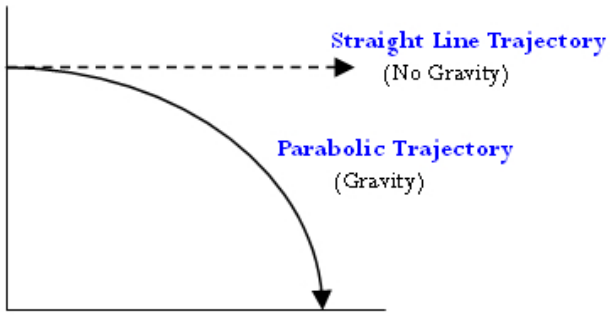
Problem Set – Two-Dimensional Kinematics

**Set calculator to degrees*

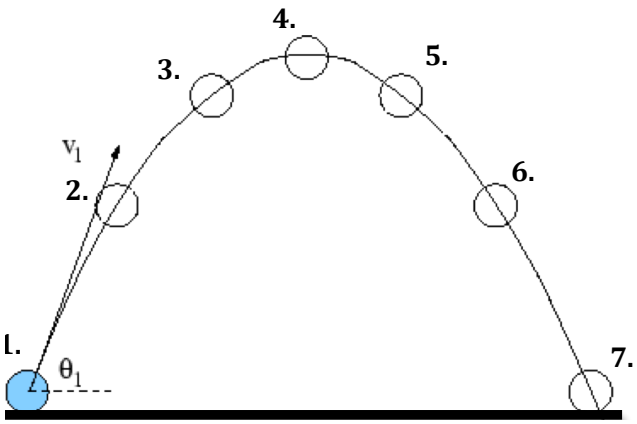
Conceptual Ideas

1. What are things that can ALWAYS be assumed with projectile motion?

2. For the ½ Projectile shown below, please answer the following
   A. What kind of velocity does a ½ projectile have at the beginning of its motion?
   B. What happens to the velocity in the y-direction as the objects moves?



3. The full projectile below has an initial velocity of 16.8 m/s directed at an angle of 56.0°.



   A. What are the values of the velocity in the x- and y- direction at the initial point (point #1)

   B. What are the values of the velocity in the x- and y- direction at the highest point (point #4)

   C. What happens to the x-velocity throughout the course of the projectile's movement?

   D. What happens to the y-velocity throughout the course of the projectile's movement?

4. In one of our very first demonstrations with projectile motion, an apparatus was used to launch one ball out as a projectile, while allowing another to fall from the exact same height. Which hit the ground first? Why?

5. How is a ½ projectile different from a full projectile?

6. How does the launch angle affect the trajectory of a projectile?

For the problems below – identify whether the problems involved a full or ½ projectile

7. Little Johnny is kicking rocks from the top of a bridge down into the water below. Little Johnny gives the rock a horizontal velocity of 3.50 m/s and it lands in the water a horizontal distance of 5.40 m away from where Little Johnny is standing.
   Projectile Type: _____
   A. How long does it take for the rock to hit the water below?
   B. How high is Little Johnny standing above the water?

8. A baseball player is hitting fly balls. A ball is hit with an initial velocity of 24.0 m/s at an angle of 57.0° above the horizontal.
   Projectile Type: _____
   A. What are the x- and y- components of the initial velocity?
   B. To what maximum height will the ball rise?
   C. What will be the time of flight for the ball?
   D. At what horizontal distance from home plate will the ball land?

9. A cannonball is launched with an initial velocity of 141 m/s at an angle of 50.0°, follows the curved path of a projectile, and hits a balloon at the **very top** of its path.
   Projectile Type: _____
   A. What are the x- and y- components of the initial velocity?
   B. What are the x- and y- components of the cannonball's velocity when it strikes the balloon?
   C. The acceleration the cannonball has when it strikes the balloon. Consider – what kind of acceleration is involved with projectile motion?

10. A car drives horizontally off a cliff that is 51.0 m high. The police at the scene of the accident noted that the point of impact was 138 m from the base of the cliff. What were the x- and y- components of the initial velocity?
    Projectile Type: _____

11. If Jack is nimble and Jack is quick and Jack jumped over a candlestick with a velocity of 5.00 m/s at an angle of 30.0° with respect to the ground, did Jack burn his feet on a 0.250 m tall candle?
    Projectile Type: _____

Physics: Two-Dimensional Kinematics
Problem Set – Numerical Answers

Conceptual Questions:

1. Things true for all projectiles:
   - The only acceleration is gravity, so $a_y = -9.8\ m/s^2$.
   - The acceleration in the x-direction is zero, $a_x = 0\ m/s^2$.
   - The velocity in the x-direction is constant. $v_{ox} = v_{fx} = v_x$
   - Time is the same whether measured in the x- or y-direction

2. A.) No initial velocity in the y-direction ($v_{oy} = 0$ m/s). The only initial velocity is horizontal (v_x)
   B.) The y-velocity increases, object moves faster in a negative direction

3. A.) $v_x = 9.39$ m/s, $v_{oy} = 13.9$ m/s
   B.) $v_x = 9.39$ m/s, $v_y = 0$ m/s
   C.) Velocity in the x-direction remains constant
   D.) Velocity in the y-direction slows down on the way up, is zero at the very top, increases in velocity on the way down

4. They hit at the same time. If they begin from the same height, gravity will accelerate them both at the same rate, therefore, whether shot outwards or straight down, they hit the ground at the same time.

5. A ½ and full projectile differ in shape most obviously. The ½ is only the second half of a full projectile. The initial velocities are different. The initial velocity for a full projectile must be broken apart into x- and y- components. For the ½, the y-velocity always begins at 0 m/s leaving the object with only x-velocity initially. Finally, the placement of y = 0 m is always where the object begins its motion.

6. Smaller launch angles give shallower trajectories, emphasizing the x-direction. Larger launch angles will give steeper trajectories that emphasize y-motion.

Mathematical Questions:

7. ½ Projectile
   A. t = 1.54 s
   B. y = -11.6 m or the bridge is 11.6 m tall

8. Full Projectile
   A.) $v_x = 13.1$ m/s, $v_{oy} = 20.1$ m/s
   B.) y = 20.6 m
   C.) t = 4.10 s
   D.) x = 53.7 m

9. Full Projectile
   A.) $v_x = 90.6$ m/s, $v_{oy} = 108$ m/s
   B.) $v_x = 90.6$ m/s, $v_y = 0$ m/s
   C.) The only acceleration in projectile motion is gravity, so $a_y = -9.8\ m/s^2$

10. ½ Projectile $v_x = 42.7$ m/s, $v_{oy} = 0$ m/s

11. Full Projectile
    He jumps to a maximum height of 0.319 m, so nope, no burns today!