Period:

Date: \_\_\_\_\_

## Free Fall, Hang Time, and Projectile Motion Worksheet

 $d = d_i + v_i \cdot t + \frac{1}{2} \cdot a \cdot t^2$ 

Hang Time:  $time_{up} = time_{down}$ 

 $time_{total} = 2 \cdot time_{up}$ 

 $v_f = v_i + a \cdot t$ 

These equations can be used to solve for the motion in the x-direction and y-direction. In projectile motion, **t** is the same for both the x-direction and y-direction.

Use the Kinematic Equations above to solve the problems on this worksheet.

## NO WORK – NO CREDIT

# Free Fall

- 1. A rock falls off of a cliff initially at rest. The rock is in the air for a total of 3.1 seconds before it hits the ground.
  - a. How fast is the rock going before it hits the ground?
  - b. How high up was the rock before it hit the ground?

- 2. A student catches a can of soda dropped from some unknown height by Mr. Fineman. If the can was dropped from rest, and it is traveling at 8.9 m/s before it arrives in the student's hand...
  - a. How long was the can in free fall for?
  - b. From what height was the can of soda dropped?

- 3. An acorn falls from rest from the top of a 19 m tall oak tree.
  - a. How long does it take for the acorn to fall to the ground?
  - b. How fast is the acorn going before it hits the ground?

Hang Time (remember – the final velocity at the top of an object's trajectory is 0 m/s)

4. What speed must you toss a baseball straight upwards at so that it takes 5 seconds to return to you?

- 5. If a firework on the Fourth of July is fired upwards from the ground with an initial speed of 200 m/s...
  - a. What is the total time the rocket spends ascending towards the sky?
  - b. How high up from the ground does the rocket travel?
- 6. If Kobe Bryant has a vertical leap of 1.35 m, then...
  - a. What speed does he leave the ground at?
  - b. What is his total hang time?

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### **Projectile Motion (Horizontally Fired)**

- 7. Mr. Fineman rolls a tennis ball off of his desk. If his desk is 1 m tall, and the tennis ball is rolling off of his desk at a speed of 1.6 m/s...
  - a. How long will it take for the tennis ball to hit the ground?
  - b. How far away from Mr. Fineman's desk will the tennis ball land on the ground?
- 8. A paintball is fired horizontally from a tower 45 m above the ground. If the paintball gun fires paintballs at 90 m/s...
  - a. How long does it take for the paintball to hit the ground?
  - b. How far away from the tower will the paintball land?
- 9. You and your friends build a confetti cannon to be used at VHS football games. You can adjust the *initial firing speed* of the cannon depending on how far away you want people to get showered with confetti. If the cannon is mounted at the top of the snack bar hut at a height of 7 meters tall, and you want to hit the football team as they enter onto the field while they are 20 meters away from the cannon, what speed does the cannon need to fire at in order to properly shower the football team with confetti? (Assume the confetti comes out in one big batch.)

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#### **Projectile Motion (Fired with an Angle)**

Feel free to use the shortcuts Mr. Fineman teaches on 10/30/14

- 10. A long jumper leaves the ground with an initial speed of 9.5 m/s at an angle of 22° from the ground. Determine:
  - a. The x-component and y-component of the jumper's velocity.
  - b. The time it takes for the long jumper to reach her maximum height of her jump.
  - c. The maximum height off of the ground the long jumper achieves.
  - d. The total time the long jumper spends in the air (hang time)
  - e. How far away does the long jumper land?

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- 11. Bo Duke and Luke Duke from the *Dukes of Hazard* drive their car, *"The General Lee"* off of a ramp over a gorge. If their car is traveling at a speed of 30 m/s when it leaves a ramp set up an angle of 37° from the ground...
  - a. What is the x-component and y-component of *The General Lee*'s velocity?
  - b. How much time does it take for the car to reach the maximum height of its jump?
  - c. How high off of the ground will the car reach?
  - d. What is the total hang time of the car?
  - e. What is the maximum size of the gorge the Duke boys could clear?

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- 12. A snowball launcher set up on the ground launches a snowball at a speed of 25 m/s at an adjustable angle.
  - a. What firing angle would you need to set the snowball launcher at to hit a target
    25 meters away?

b. What firing angle would you need to set the snowball launcher at to his a target 50 meters away?

c. What is the hang time of a snowball if it were fired at an angle of 40°?