AP Physics 1 Name: _____

Unit 1: 2D Kinematics Test Period: _____

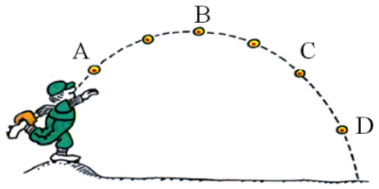
Part 1: Multiple Choice - Choose the answers that best answers the questions below. If an exact answer is not present, chose the closest available answer. (4 points each)

1. _____An object is at rest. Three forces are exerted are exerted on the object. One force is directed 10 N due south, and another is 10 N directed due east. Which of the following forces, when added to the other two, would make the total force be equal to zero?

   A) $10\sqrt{2}$ N, directed northwest
   B) $10\sqrt{3}$ N, directed northwest
   C) $10\sqrt{2}$ N, directed southeast
   D) $10\sqrt{3}$ N, directed southeast

2. ____ Tim Tebow throws a baseball that travels a parabolic path as shown. At which of the following points is the speed of the baseball a maximum?

   A) A B) B C) C D) D



3. ____ A machine launches a tennis ball at an angle of 25° above the horizontal. The ball returns to ground level. Which changes would necessarily decrease the time the ball is in the air?

   A) Decrease the launch angle and increase the ball's initial speed.
   B) Increase the launch angle and decrease the ball's initial speed.
   C) Increase the launch angle and keep the ball's initial speed the same.
   D) Decrease the launch angle and keep the ball's initial speed the same.

4. _____ During football practice, a football is kicked with a speed of 22 m/s at an angle of 60.0° above the ground. At that instant, an observer rides past the football in a car that moves with a constant speed of 11 m/s in the same horizontal direction that the football travels. According to the observer in the car, the ball will:

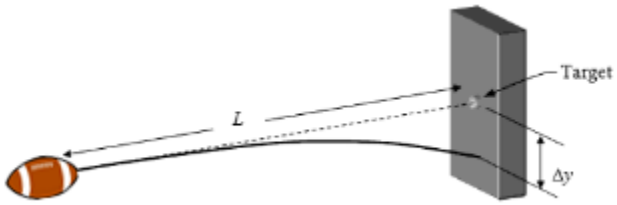
   A) follow a parabolic path.
   B) follow a path that is straight up and down in the *y* direction.
   C) follow a path that is hyperbolic in the x-direction.
   D) follow a straight line that is angled with respect to the *x* direction.

5. ____ A projectile is launched with speed v at angle of 30° above the horizontal. It travels a horizontal distance D before hitting the ground. Suppose the projectile had instead been launched at the same speed, v, but an angle of 60° above the horizontal. What would the new horizontal distance traveled by the projectile be?

   A) $D/2$ B) $D/4$ C) D D) 2D

6. ____ At t = 0 a paintball is shot out of a paintball gun horizontally off a 1000 m tall cliff. At the same time, a paintball is released from rest (dropped from the same height). Ignoring air resistance, which paintball strikes the ground with a higher speed?
   A) The paintball shot from the gun.
   B) The paintball released from rest.
   C) Both paintballs hit the ground with same speed.
   D) The answer depends on the initial velocity of the paintball fired from the paintball gun.

7. _____A football is aimed at a target on the wall a distance L away from the throwing position, from which the football is launched horizontally. Because of gravity, the bullet strikes the wall a distance Δy below the mark as suggested in the figure.



If the distance L was half as large and the football had four times initial velocity, how would Δy be affected?

   A) Δy will double.
   B) Δy will be half as large.
   C) Δy will be four times larger.
   D) Δy will be one fourth as large.

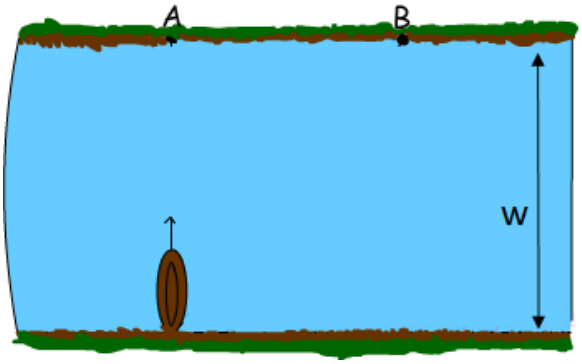
8. _____A ball is kicked from the ground an initial speed v at an angle g above the horizontal. Which of the following best describes the magnitudes of the velocity and acceleration of the ball when it reaches the highest point of its trajectory?

A) Velocity: 0	Acceleration: g
B) Velocity: $vcos\theta$	Acceleration: g
C) Velocity: v	Acceleration: 0
D) Velocity: 0	Acceleration: 0

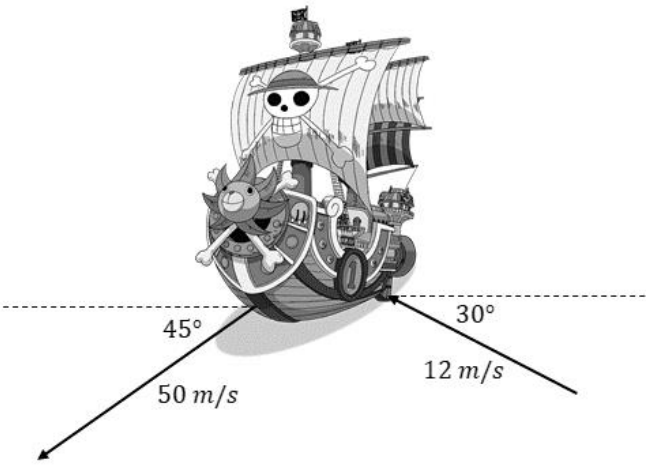
Part 2: Free Response. **You must show all steps** required to arrive at the correct answer for the problem below, including any diagrams. **All answers must be given with correct units.**

9. (16 points)

a) In order to escape an impending physics, Anderson escapes in a boat across a river of width w = 300 m as shown. The river has a current flowing to the east at a speed of 6 m/s. When Anderson reaches the other side of the river, at point B, he has drifted 180 m downstream from point A. How fast does Anderson paddle the boat relative to still water?



b) Sebastian pilots the Thousand Sunny across the ocean in his quest to be king of the pirates. He pilots the boat with a velocity of 50 m/s 45º south of west as shown. There is a strong ocean current pushing on his boat that is direction 30º north of west as shown. What is the resultant velocity of Sebastian's boat?



10. (12 points) An airplane flies at a velocity of 220 m/s directly east over Palm Beach. Genevieve, a passenger on the airplane, runs towards the back of the airplane at 5 m/s. At the same instant, Lauren drives directly west towards the airplane at a speed of 15 m/s.

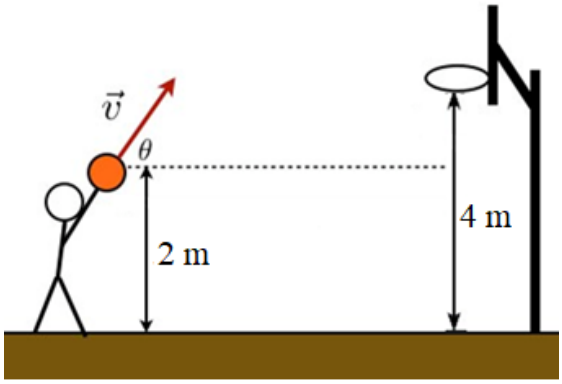
a) Calculate Genevieve's velocity relative to Lauren (how fast Lauren is approaching Genevieve).

b) Genevieve drops a Hello Kitty plushie directly down out of the airplane. Lynn stands at rest on the ground and watches this all go down. Describe the path and calculate the speed of the plushie after falling for 3 seconds according to:

i. Genevieve

ii. Lynn

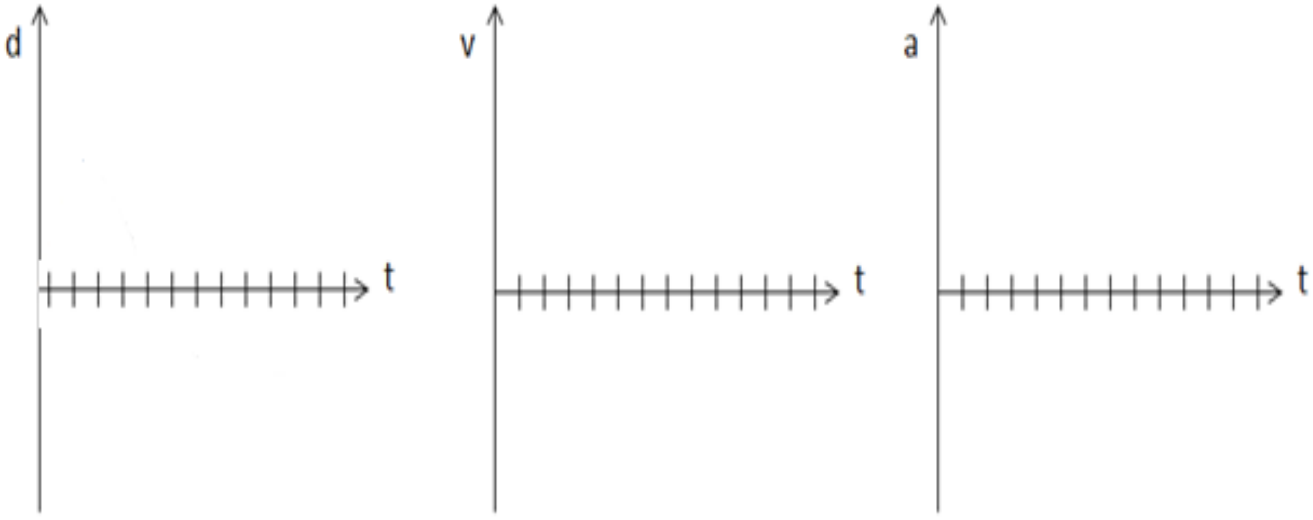
11. (20 points) Jainil throws a basketball that goes directly into a net as shown. Jainil throws the ball at $v = 8$ m/s at an angle of $\theta = 60°$ and at a release height of 2 m as shown. The ball travels downward through the basket at a height of 4 m.



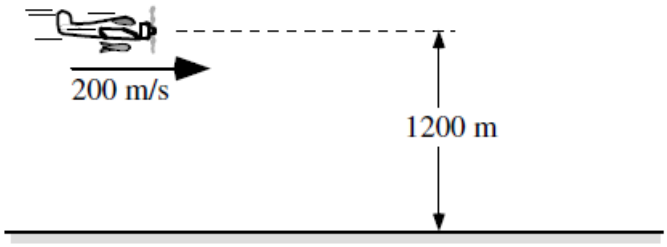
a) Calculate how far away from the basketball Jainil is when he makes the throws the ball.

b) Calculate the maximum height reached by the basketball.

c) Sketch graphs of the displacement, velocity, and acceleration of the ball in the horizontal and vertical directions. Distinguish the graphs by having the x-components be solid lines and the vertical components as dashed lines. Label any maxes and mins.



12. (22 points) An airplane is flying 1200 m above the ground at a speed of 200 m/s. It drops a pumpkin on a target on the ground.

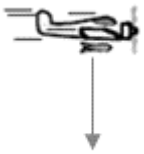


a) Calculate how far from the target the pumpkin must be dropped so that it lands on the target.

b) Calculate the angle the pumpkin's trajectory makes with the ground when it strikes.

c) How would your answer to a) change if the airplane were flying at a downward angle when dropping the pumpkin? Justify your answer qualitatively.

d) Suppose that instead of dropping the pumpkin, the pilot throws the pumpkin downward with an initial downward speed. Steve the student claims "Since the pumpkin is given an initial vertical velocity, it will hit the ground with a greater speed. Since the pumpkin is travelling faster, it will also travel further in the x-direction before hitting the ground.



i. What part of the student's reasoning is correct? Justify your answer.

ii. What part of the student's reasoning is incorrect? Justify your answer.