**Projectile Motion Practice Problems** Breadcrumbs….

1. A projectile is launch from ground level to the top of a cliff which is 195 m away and 155 m high. If the projectile lands on top of the cliff 7.6 s after it is fired, find the initial velocity of the projectile (magnitude and direction). With what velocity does it land on the cliff (magnitude and direction)? Had the projectile passed the pinnacle of the trajectory when it landed on the cliff? What was the highest altitude obtained by the projectile? **a. 63.1 m/s at 66 b. 30.7 m/s at –33c. Yes, b/c vy <0 d. 170 m.**
	* Draw a picture and visualize the problem. Label your picture with data where possible.
	* Identify the type of problem….general projectile
	* List the variables for general projectile problems
	* Read the problems again to identify given information and place in your variable list. Remember to include special values like -9.81 m/s2 for vertical acceleration, or 0 m/s vertical velocity at the top of a trajectory, remember vectors pointing down are negative.
	* Plan your strategy:
	* Part a) asks for the magnitude and direction of the initial velocity. That means, vx and uy are the components you need. Solve for those values using x = vxt or a suvat equation.

Switch vx and uy  back into magnitude and direction.

* + Part b) asks for the magnitude and direction of the final velocity. So do the same as before for vx and vy.
	+ Part c) Is about vy. If it lands still moving up, + vy, then it didn’t reach the top of the trajectory. If it lands moving down, –vy, then it did reach the top
	+ Part d) Highest point is NOT part of the trajectory for the first three parts. So you need a new suvat. You can solve this question using only the y dimension.
1. At serve a tennis player aims to hit the ball horizontally. What minimum speed is required for the ball to clear the 0.90 m high net about 15.0 m from the server if the ball is “launched” from a height of 2.50 m? Where will the ball land if it just clears the net? Will it be “good” in the sense that it lands within 7.0 m of the net? How long will it be in the air? **a. 26.3 m/s b. 3.8 m past the net c. Yes, good. d. 0.714 s**
	* Draw a picture and visualize the problem. Label your picture with data where possible.
	* Identify the type of problem….horizontal launch
	* List the variables for general projectile problems
	* Read the problems again to identify given information and place in your variable list. Remember to include special values like -9.81 m/s2 for vertical acceleration, or 0 m/s initial vertical velocity, remember vectors pointing down are negative.
	* Plan your strategy:
	* Part a) asks for minimum speed initially. That means, vx Use x=vxt and/or suvat equations.
	* Part b) asks for landing location if just clears. That’s the x dimension. Needs a new suvat and xvt because it’s a different trajectory. Complete using your answer from a) and solve for x.
	* Part c) Is about x from b) compared to 7.0 m beyond the net.
	* Part d) You will have already calculated this for part b).
2. A ball is thrown horizontally from the roof of a building 45.0 m tall and lands 24.0 m from the base. What was the ball’s initial speed? What was it’s final velocity (magnitude and direction)? How much time did the ball spend in the air? **a. 7.92 m/s b. 30.7 m/s at –75c. 3.03 s**
	* Draw a picture and visualize the problem. Label your picture with data where possible.
	* Identify the type of problem….horizontal launch
	* List the variables for general projectile problems
	* Read the problems again to identify given information and place in your variable list. Remember to include special values like -9.81 m/s2 for vertical acceleration, or 0 m/s initial vertical velocity, remember vectors pointing down are negative.
	* Plan your strategy:
	* Part a) asks for initial speed. That means, vx Use x=vxt and/or suvat equations.
	* Part b) asks magnitude and direction of the final velocity. Find the components vx and vy. then turn them into magnitude and direction.
	* Part c) You’ll have that from part a) already.
3. A football is kicked at ground level with a speed of 18.0 m/s at an angle of 35.0 to the horizontal. How much later does it hit the ground? How far away from the kicker does it land? What is the maximum height obtained by the ball? **a. 2.10 s b. 31.0 m c. 5.41 m**
	* Draw a picture and visualize the problem. Label your picture with data where possible.
	* Identify the type of problem….Range equation possible, may need general projectile
	* Part b) asks about the Range. Find that first.
	* Parts a) and c) asks about the full trajectory and half of the trajectory. If you just use the half trajectory you can multiply the time and distances by 2 to get the data for the full path.
	* List the variables for general projectile problems for the half trajectory using the Range result of part b)
	* Read the problems again to identify given information and place in your variable list. Remember to include special values like -9.81 m/s2 for vertical acceleration, recall initial and final velocities in the y dimension are opposites for the whole motion and 0 m/s at the top, remember vectors pointing down are negative.
	* Part c) asks maximum height. That’s y when vy = 0.
	* Part a) The time for the half path was found in part c) so time for the full path is twice that.
4. A ball thrown horizontally at 22.2 m/s from the roof of building lands 36.0 m from the base of the building. How tall is the building? How much time does the ball spend in the air? With what velocity does it hit the ground (magnitude and direction)? **a. 12.9 m b. 1.62 s c. 27.3 m/s at –36**
	* Draw a picture and visualize the problem. Label your picture with data where possible.
	* Identify the type of problem….horizontal launch
	* List the variables for general projectile problems
	* Read the problems again to identify given information and place in your variable list. Remember to include special values like -9.81 m/s2 for vertical acceleration, or 0 m/s initial vertical velocity, remember vectors pointing down are negative.
	* Plan your strategy:
	* Part a) asks height of building which is positive. While the displacement y is negative. Their magnitudes are equal.
	* Part b) asks for the time which you will have from part a)
	* Part c) asks for the magnitude and direction of the final velocity. So find vx and vy and convert them into magnitude and direction.
5. An athlete executing a long jump leaves the ground at a 28.0 angle and travels 7.80 m. What was the takeoff speed? If this speed were increase by just 5% how much longer would the jump be?

 **a. 9.61 m/s b. 0.80 m**

* + Draw a picture and visualize the problem. Label your picture with data where possible.
	+ Identify the type of problem….Range problems entirely.
	+ Part a) asks you to solve Range eqn for the initial speed giving all other quantities needed.
	+ Part b) needs 1.05 times your answer to part a) as the new initial speed. Then find Range.
	+ The answer to b) is about how much farther so subtract the distance of the first jump.
1. A hunter aims directly at a target (on the same level) 75.0 m away. If the bullet leaves the gun at a speed of 180 m/s, by how much will it miss the target? At what angle should the gun be aimed so as to hit the target? **a. shot hits 85.2 cm below the target. b. 0.65**
	* Draw a picture and visualize the problem. Label your picture with data where possible.
	* Identify the type of problem….horizontal launch
	* List the variables for general projectile problems
	* Read the problems again to identify given information and place in your variable list. Remember to include special values like -9.81 m/s2 for vertical acceleration, or 0 m/s initial vertical velocity, remember vectors pointing down are negative.
	* Plan your strategy:
	* Part a) asks for the distance missed, or y, which you should expect to be negative.
	* Part b) can be easily found using the Range equation.
2. A shot putter throws the shot with an initial speed of 15.5 m/s at a 34.0 angle to the horizontal. Calculate the horizontal distance traveled by the shot if it leaves the athlete’s hand at a height of 2.20 m above the ground. How much time did the shot spend in the air? With what velocity (magnitude and direction) does the shot hit the ground? What was the maximum height obtained by the shot?

**a. 25.6 m b. 1.99 s c. 16.8 m/s at –40 d. 6.03 m**

* + Draw a picture and visualize the problem. Label your picture with data where possible.
	+ Identify the type of problem….general projectile problem
	+ List the variables for general projectile problems
	+ Read the problems again to identify given information and place in your variable list. Remember to include special values like -9.81 m/s2 for vertical acceleration, or 0 m/s vertical velocity at the top, remember vectors pointing down are negative.
	+ Use the given magnitude and direction information to find the initial vx and uy components.
	+ Plan your strategy:
	+ Part a) asks for the distance x. It may be easier to find vy before finding t, especially since you need to find it anyway for part c)
	+ Part b) asks for the time you’ll have found during part a)
	+ Part c) asks magnitude and direction of the final velocity. Find the components vx and vy. then turn them into magnitude and direction.
	+ Part d) asks about the maximum height. The max height is not part of the trajectory from parts a)-c). So you need a new xvt/suvat. Use the 0 for the final vertical velocity and the initial components. Find y. Then add the height of the shot initially to find the height at the top.