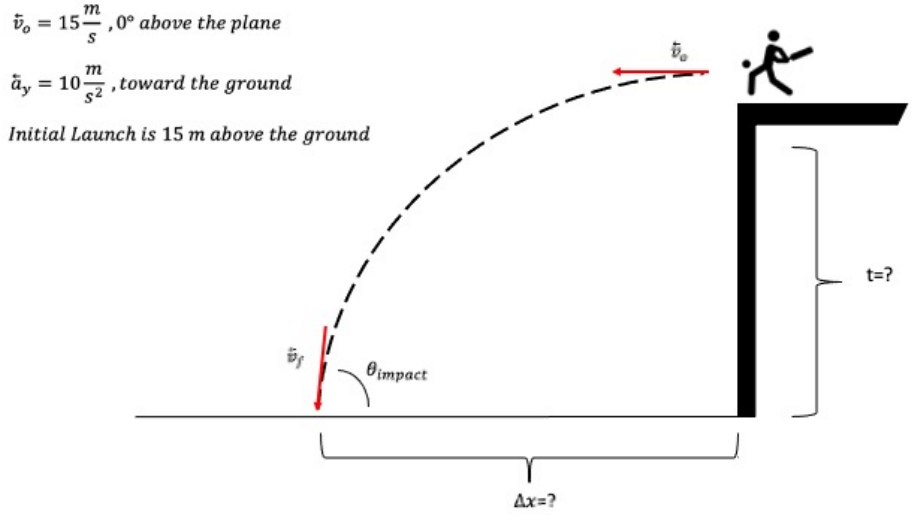
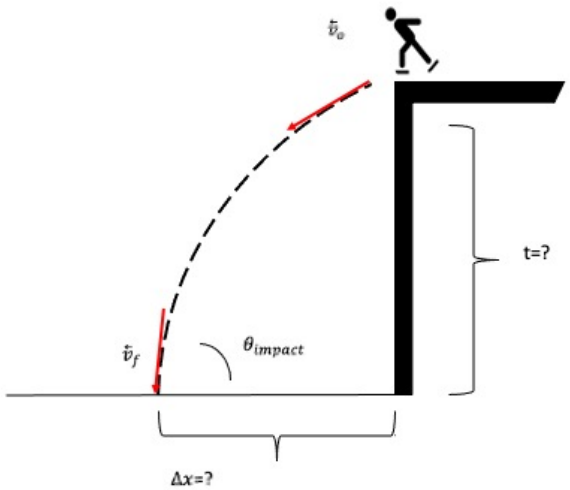
Group Problem Set 7: Using 2D Kinematics

1. Complete the calculations below for the following 3 setups. It may be helpful to report your answers in a table.
   (a) What is the initial velocity in component form?
   (b) How long does it take for the projectile to hit the ground?
   (c) What is the final velocity in the y direction?
   (d) What is v_f in component form?
   (e) What is the magnitude of the final velocity?
   (f) What is the angle of impact?
   (g) How far from the wall will the projectile travel?
   (h) Compare the distance and time based on initial angle for all 3 cases and order smallest to largest.
   (i) Compare angle of impact and final velocity for all 3 cases and order smallest to largest.
   (j) Draw the acceleration vector throughout the flight for all 3 cases.
   (k) Draw the velocity vector throughout the flight for all 3 cases.



$\vec{v}_o = 15\frac{m}{s}$, 30° *below the plane*



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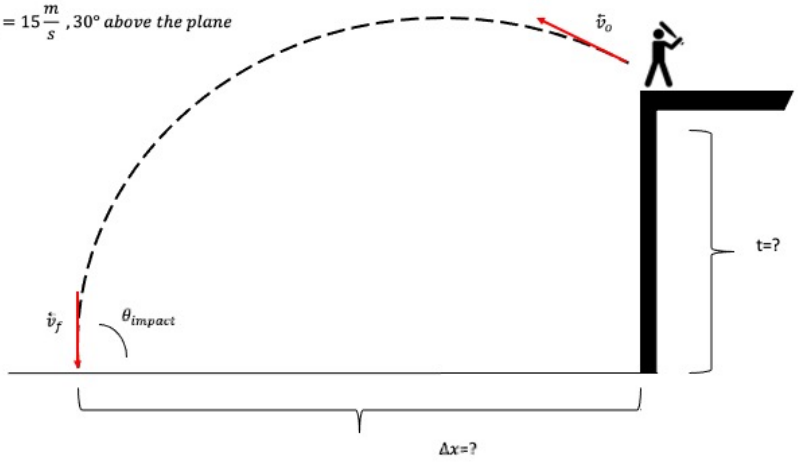
$\vec{v}_o = 15\frac{m}{s}$, 30° *above the plane*



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2. Now, looking back at all of your data from problem 1. Answer the following questions (using setup numbers 1, 2 or 3) for the best orientation in each case.

   (a) If you wanted the ball to go the highest?

   (b) If you wanted the ball to go the furthest?

   (c) If you wanted the ball to have the shallowest impact?

   (d) If you wanted the ball to have the fastest velocity on impact?

   (e) If you wanted your ball to survive the impact?

3. Start by watching the video game clip (bus jumping a sink hole) and answer the following questions using the information below. A US standard school bus is 14.7 m long. A semi truck is 22.75 m long. The sink hole in the video is approximately the length of a semi, 22.75 m.

   (a) Using what you know about the acceleration due to gravity during free fall and predict whether there is a velocity that the school bus must go to clear the pot hole and land on the ground.

   (b) If the school bus is launched from a ramp, what is the optimal angle for the bus to be launched, such that it travels the furthest at any given velocity?

   (c) If the bus is launched from this angle from a ramp that sits 4 meters off the ground, what is the minimal velocity required for the bus to clear the sink hole?

   (d) The average school bus has an average velocity of 54.48 mph. Would this be fast enough to clear the sink hole? Where does the school bus land?

   (e) What does the height of the ramp need to be such that the bus exactly clears the sink hole?