

Name \_\_\_\_\_

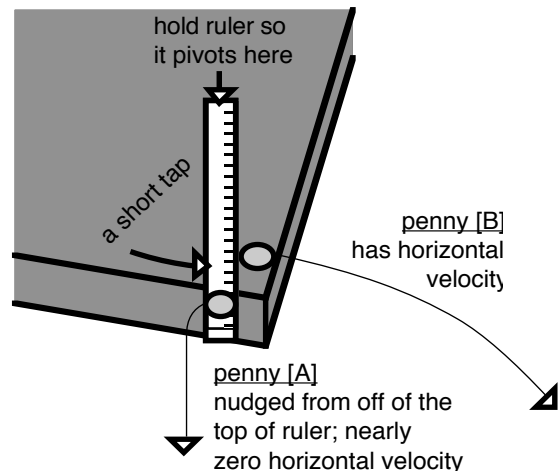
## Acceleration of Gravity and Freefall: Two Penny Trick

- A. The two penny trick. Hit two pennies off of the table, as shown in the figure below. Which penny hits the ground first (listen carefully!)?

Do this again, but give one of the pennies even more horizontal velocity, while still making the other penny fall straight down. How does the result change if at all?

- B. Analysis of the two penny trick, using the method of graphical analysis. Record your group's results for (1)-(2) on a sheet of graph of paper.

- Draw one set of coordinate axes. On these axes draw three graphs showing only the vertical velocity  $v_y$ , for pennies [A], [B], and [C] (the second penny with even more horizontal velocity). Measure and record the height of the table with respect to the floor  $y_{initial} = \text{___ m}$ . This is the initial height of the pennies at  $t = 0$  seconds, and each falls down to the  $y = 0$  m floor at  $t = \text{___ seconds}$  (when? measure this with a stopwatch). Also verify this using your velocity graph.



According to your graph, the pennies hit the floor at  $t = \text{___ seconds}$ .

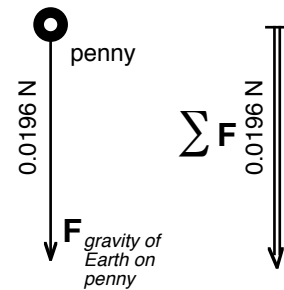
- On the same *horizontal*  $v_x$  velocity graph, draw the motion for pennies [A], [B], and [C], which all initially start at  $x = 0.0$  m at  $t = 0$  seconds, and each falls down to the  $y = 0$  m floor at
  - $x[A] = \text{___}$  (measure how far), and  $t = \text{___ seconds}$  (when?).
  - $x[B] = \text{___}$  (measure how far), and  $t = \text{___ seconds}$  (when?).
  - $x[C] = \text{___}$  (measure how far), and  $t = \text{___ seconds}$  (when?).
 Use this information to draw the three graphs.

- C. Challenge question. Discuss this and record it on the bottom of the page.

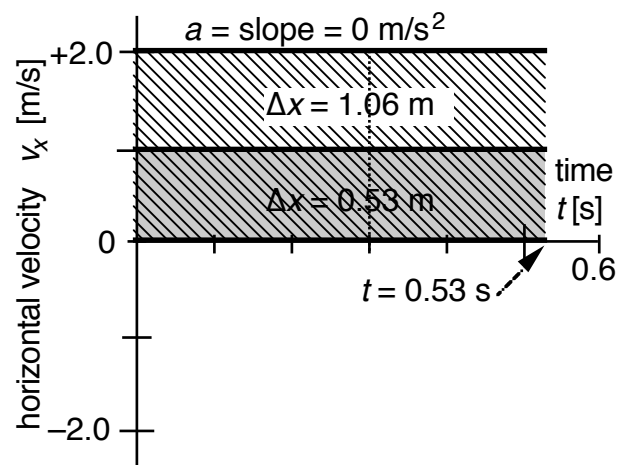
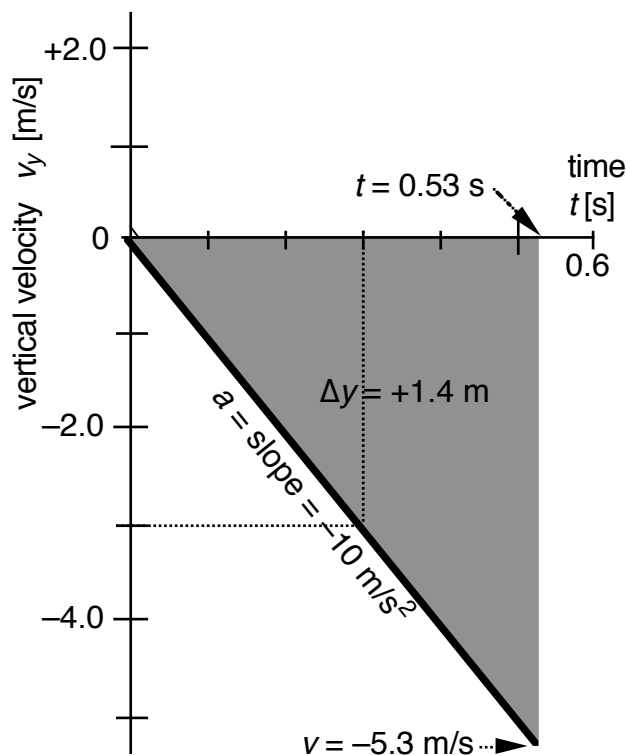
- Explain why the velocity graphs look the way they do. Explain the differences between the vertical and horizontal velocity graphs.

### Activity Cycle 8.2.5: TA instructions

1. All three pennies have the same force diagram and same net force vector. Students may still try to incorporate the  $\perp$  contact force of the ruler and/or the table on the pennies, even though we are interested in the pennies *after* they have been hit and lost contact with the ruler and the table. Even if these forces aren't on the students' diagrams, prompt them with questions like, "Where's the  $\perp$  contact force of the ruler?" and see if they are comfortable and confident with not having that force acting on the pennies as they fall.



- 2-3. The graphs are shown below. Note that all three pennies have the same vertical  $v(t)$  graph.



4. Due to the orthogonality of  $x$  and  $y$  directions, all three pennies have the same net force in the  $y$  direction, *and* all have the same initial  $y$  conditions (no initial vertical velocity). Thus they will have the same vertical  $v(t)$  graph. All three pennies have the same net force in the  $x$  direction as well, *but* have the *different* initial  $x$  conditions (various amounts of initial horizontal velocity). Thus they will have different horizontal  $v(t)$  graphs, but at least their slopes will all be the same.