Calculating the Motion of a Projectile—KEY

Instructions:

Use the simulation to complete this activity.

1. Click *Shoot Ball* to release the ball from the tennis ball gun.
2. Measure the distance from the base of the wall to where the ball landed based on the mark. This will be your distance (Δd_x). Record the distance in your data table.
3. Check the timer in the simulation and record the time in your data table.
4. Repeat steps 1–3 until you have completed 10 trials.
5. To review your data, click *View Data*.

SAMPLE DATA

Trial	Distance, Δx (m),	Time, t (s)
1	~~3.37~~	~~1.02~~
2	4.93	1.23
3	4.15	1.12
4	3.86	1.08
5	4.05	1.11
6	~~5.24~~	~~1.27~~
7	4.73	1.20
8	5.12	1.26
9	4.29	1.14
10	5.10	1.25
Averages	**Δd_x = 4.53**	**t = 1.17**

6. Discard the highest and lowest values for distance and time. Calculate the average distance and time for the remaining trials. Record the data in your notebook or journal.

Problem solving:

Use the data recorded in the table above to complete the calculations.

1. In the space below, calculate the horizontal velocity of the tennis ball using the average distance and average time from the data collected. Use the formula $v_x = \frac{\Delta x}{t}$ to solve this problem.

   Given: $\Delta d_x = 4.53$ m
   $t = 1.17$ s

   $$v_x = \frac{\Delta x}{t} \qquad v_x = \frac{4.53\ m}{1.17\ s} \qquad \boldsymbol{v_x = 3.87\ m/s}$$

2. Calculate the acceleration due to gravity (a_y) using the average time from the data table. Use the formula $\Delta d_y = v_i + \frac{1}{2} a_y t^2$. When $v_i = 0$, use $\Delta d_y = \frac{1}{2} a_y t^2$.

   Given:
   $\Delta d_y = 5.95$ m
   $t = 1.17$ s

   $$\Delta d_y = \frac{1}{2} a_y t^2 \qquad a_y = 2d_y/t^2 \qquad a_y = 2(5.95\ m)/(1.17\ s)^2$$

   $$\boldsymbol{a_y = 8.69\ {}^{m}/_{s^2}}$$

3. Use the average time (t_{avg}) and the calculated values for vertical acceleration (a_y) to calculate the vertical velocity (v_y).

   Given: $t = 1.17$ s
   $a = 8.69$ m/s^2

   $$v_y = a\ x\ t \qquad v_y = 8.69\ m/s^2\ x\ 1.17\ s$$

   $$\boldsymbol{v_y = 7.43\ m/s}$$

4. Compare the calculated vertical acceleration with the accepted acceleration due to gravity. If you performed the simulation using real materials, what could account for the difference?

   Given: Calculated value = 8.69 m/s^2 Accepted value = 9.81 m/s^2

   Student answers will vary. The difference between the calculated and accepted values are commonly explained by air resistance, holding gun at angle, and/or reaction time or errors in timing.