Projectile Simulation

Purpose:
The purpose of this activity is to analyze the nature of a projectile's motion and to explore a variety of questions regarding projectile motion.

Procedure and Questions:

1. Navigate to the Projectile Simulator page and experiment with the on-screen buttons in order to gain familiarity with the control of the animation. The launch speed, launch height and launch angle can be varied by using the sliders or the buttons. A trace of the object's motion can be turned on, turned off and erased. The vector nature of velocity and acceleration can be depicted on the screen. The animation can be started, paused, continued, single-stepped or *rewound*. And finally, the time of flight, the horizontal displacement, and height are displayed during the course of the animation.

   After gaining familiarity with the program, use it to answer the following questions.

Section 1: For Horizontally Launched Projectiles: Raise the launch height to about 50 meters and adjust the launch angle to 0 degrees. Conduct several trials to answer the following questions.

2. Use the language of mathematics to describe the path or trajectory of a projectile.

3. During the course of a trajectory, is the horizontal component of the velocity a constant or a changing value? ___________________ If it is a changing value, then describe its changes (increasing, decreasing, or ...).

4. During the course of a trajectory, is the vertical component of the velocity a constant or a changing value? ___________________ If it is a changing value, then describe its changes (increasing, decreasing, or ...).

5. Describe the acceleration of a projectile - direction, constant or changing magnitude, etc. Be complete.

6. As a projectile falls vertically, it also travels horizontally. Is the distance which it falls vertically effected by its horizontal velocity? _______________ In the space below, display some collected data which clearly support your answer. Discuss how your data provide support for your answer.

7. A classic mind-bender: If a ball is dropped from rest from an elevated position at the same instant that a second ball is launched horizontally (from the same height), then which ball will hit the ground first? Assume the balls behave as projectiles.

Section 2: For Angle Launched Projectiles: Return the launch height to ground level. Conduct several trials to answer the following questions.

8. Consider questions 2-5 in the previous section of this lab (horizontally launched projectiles). Would launching a projectile at an angle effect any of the answers which you provided earlier? Consider path or trajectory, horizontal velocity (v_x), vertical velocity (v_y) and acceleration. Be thorough and organized as you answer your questions.

9. At what point in the projectile's trajectory is the velocity vector entirely horizontal (i.e., the vertical component of velocity is zero)? __________ If necessary, slow the simulation down using the Pause and Single Step (>>) buttons.

10. **TRUE** or **FALSE**:

    The acceleration of projectile is 0 m/s/s at the peak of the trajectory.

    Identify the evidence which supports your answer.

11. Pick a launch speed and angle and compare the time required for the projectile to rise to the peak of its trajectory to the time for the projectile to fall from the peak of its trajectory. The **Single Step** button and the **Vector** display can be used to assist in your *measurements*. Repeat for other launch angles if necessary. Describe your findings.

12. For a fixed launch velocity, what launch angle (between 0 and 80 degrees) maximizes the time of flight for an angle launched projectile? In the space below, display some collected data which clearly support your answer.

Set the launch speed to 30 m/s and the launch height to 0 meters. Fill in the table below to investigate the effect of launch angle on horizontal displacement.

Launch Angle (deg)	**Horizontal Displacement (m)**
10	
20	
30	
40	
45	
50	
60	
70	
80	

13. Based on the data collected above, which launch angle provides the maximum *range* (horizontal displacement) for a projectile.

14. Describe any other obvious observations which you could make from the inspection of the above data.

Summary Statement:
Discuss the motion of a projectile in terms of the changes (or lack of changes) in its horizontal and vertical motion parameters. Comment on such quantities as horizontal velocity (v_x), vertical velocity (v_y), horizontal acceleration (a_x), and vertical acceleration (a_y). Do a great job!