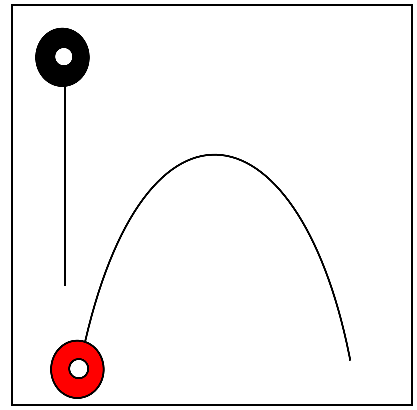
Physics

Projectile Motion

Introduction: In studies of projectile motion, students often question the reality of whether or not horizontal and vertical motions are independent of each other. People often doubt that a bullet dropped hits the ground at the same time as a bullet fired horizontally. This is often demonstrated with two steel balls, one dropped and the other thrown sideways. This lab should convince you this is in fact true. In addition to providing practice in using vector analysis, it will give you some practice in component analysis and in developing equations.



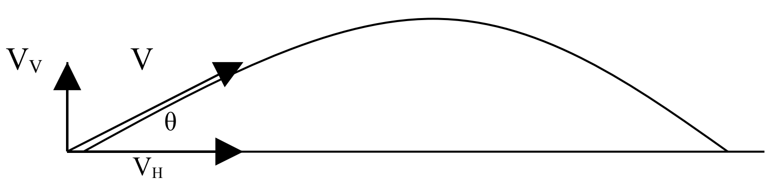
Purpose: To analyze projectile motion and show that horizontal motion is independent of vertical motion.

Equipment: Virtual Air table Program

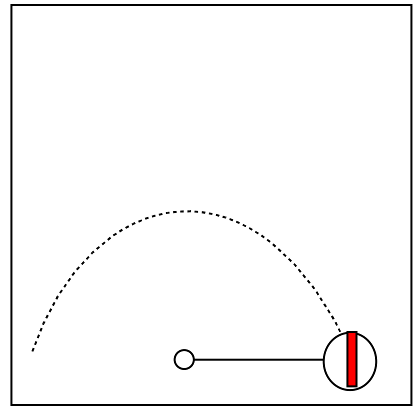
Experiment and Analysis:

1. Load up experiment Projectile.col from the file menu.
2. The black puck is used as a reference to where down is for vector analysis. Be sure the option to see red and black before is checked in the View menu and that the frequency is set at 2 Hz..
3. Hit the start button and then stop when both of the pucks have left the screen of view.
4. Click the "Print Trace" button to print out the Data. Analyze the data as done in class yesterday.
5. Measure the vertical and horizontal components of each velocity vector. i.e. V_V, V_H
6. Plot graphs V_V - t V_H – t. discuss the graphs.
7. Compare the results of the full vector analysis to the results from the component analysis.
8. Compare the results in #7 to the theoretical value the teacher has for you.
9. Discuss errors.

Equation Development:
Try to derive the equation that shows how far an object will go if fired at velocity V at an angle θ and lands at the **same** height. (hint: time is the only thing in common between the vertical and horizontal components)



Vector Analysis of Uniform Circular motion



Procedure:

1. Open up the Virtual Air Table program and load the experiment **Circle.col**
2. Set the timer at 2 Hz and be sure to have the ***Red Before*** option is checked in the ***View*** menu..
3. Start the puck by clicking on the top part of the solid red square. Do it a few times until you have about 12 dots on the page..
4. Hit print Trace button to print out your data and proceed to the analysis. To ensure you get your trace, in the ***File*** menu click ***Who am I*** and type in your name, so your name gets printed on the page.

Analysis: (each member of the group is to do calculations separately. Vector analysis can be done directly on the page.)

5. Using every second point, draw on the position vectors and label them r_0, r_1, etc. (The tail of each vector is drawn from the center of the circle. 8 vectors maximum)
6. Draw the vectors $r_1 - r_0$, $r_2 - r_1$ and label appropriately. i.e. $\Delta r_{0.5}$.
7. Using these displacements, calculate the velocities and determine the accelerations.
8. Measure the radius of curvature of the motion.
9. Measure the angle between the first and last position vector in radians.
10. Using the formula $s = r\theta$, find the actual distance covered by the puck.
11. Using the distance traveled find the speed of the puck.
12. How does the speed compare to the magnitude of the velocities vectors? Explain why this is the same and/or different. Explain which one you would consider to be the actual velocity and determine the percent difference?
13. Calculate the time it would have taken the puck to make one complete circle, this is called the period (T). Explain how you got this.
14. Using the formula $a= v^2/r$ calculate the acceleration.
15. How does this compare to the acceleration found in the vector analysis? Which would you consider to be the more accurate and why? Determine percent error.
16. Using the formula $a = 4\pi^2 r/T^2$, calculate the acceleration and compare it to the previous two accelerations found.
17. Using the a_3 vector, draw the vector onto the tip of the r_3 vector. (Or some other data point that attains the good results) What direction does the acceleration go in?
18. Are the velocity vectors average or instantaneous vectors? Why?
19. Using your answer to the above, draw the $r_{1.5}$ and then draw the $v_{1.5}$ vector on the tip of the $r_{1.5}$. What is the angle between these two vectors?
20. Using what we have found, draw a position, velocity and acceleration vector at the 4^{th} time interval. Sum up the relationships between the angles of these 3 vectors.