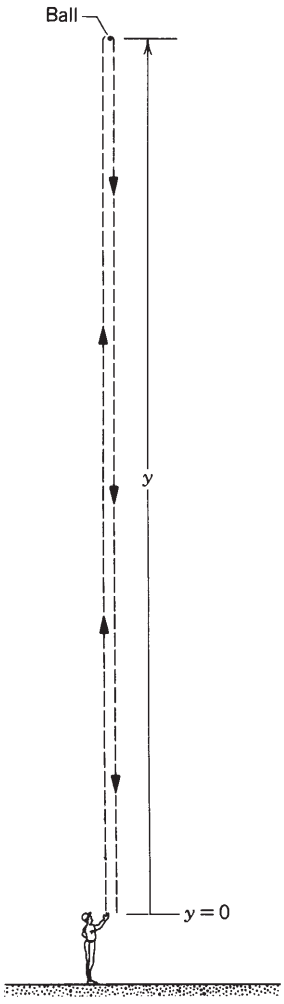
Name _____ Period _____ Date _____

Going Up

Lab 1.5

Purpose

The purpose of this lab is to investigate the motion of an object thrown vertically into the air.



Required Equipment

- Tennis ball
- Timer
- Meterstick

Discussion

In this activity you will find you will use a tennis ball and stopwatch to estimate the height of an object and how fast a ball was thrown upward based on how high it goes in the air. You will also calculate your own hang time. Gravity is no different on the way up as it is on the way down, in other words, objects moving away from the Earth slow at the same rate as objects moving towards the Earth.

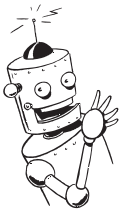
Procedure: (Finding Height)

1. Your instructor will direct you to a location where you will try and find the height of an object using only a tennis ball and a stopwatch.

2. Once you are ready to begin, toss a tennis ball straight up into the air and time its travel up then down. Your objective will be to toss the tennis ball such that it just touches, or comes to the same level as the object you are trying to measure; this may take several practice throws. Only record the total time for the perfect toss.

Data Table A

Location	Time (s)			Velocity Leaving Hand (m/s)	Calculated Height (m)	Height from floor (m)	% Error
	Total Time	Time Up	Time Down				



Calculating the Time Up and Down

3. Since gravity works the same on the way up just as on the way down, the time up is the same as the time down or half the total time. Calculate the time up and down for each location in **Data Table A**.

Half the Total Time: _____

Calculating the Initial Velocity

4. At the very top of it's path the velocity (v_{top}) of the ball is 0 m/s. The starting velocity of the ball is the same as the final velocity of the ball but opposite in direction. To find the starting and ending velocities we use half the total time.

5. Using half the total time, calculate the velocity leaving your hand ($v_{leaving\ hand}$) of the and record in **Data Table A.** For this lab activity make the answer negative.

$$v_f = v_o + gt \longrightarrow v_{top} = v_{leaving\ hand} + gt_{half\ total\ time} \longrightarrow v_{leaving\ hand} = gt_{half\ total\ time}$$

Show your work:

Velocity Leaving Hand: _____

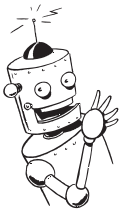
Calculating Height

6. To find the calculated height we will again use only half the total time.

7. Using the half the total time and the velocity at the top equal to 0 m/s, calculate the height and record in the **Data Table A**. Use (9.8 m/s^2) for gravity.

$$\Delta h = v_o t + \frac{1}{2} g(\Delta t)^2 \longrightarrow \Delta h = v_{top} t + \frac{1}{2} a(t_{half\ total\ time})^2 \longrightarrow \Delta h = \frac{1}{2} a(t_{half\ total\ time})^2$$

Show your work:



Calculated Height: _____

8. Since the ball is not release from the floor but instead near the shoulder of the person throwing the ball, measure and record the shoulder height of the person releasing the ball in meters.

Shoulder height: _____

9. By adding the shoulder height to the calculated height you will get the height from the floor to the object. Add the shoulder height to the calculated height and record in **Data Table A.**

Show your work:

Height from Floor _____

10. Get the actual height from your instructor.

Actual Height _____

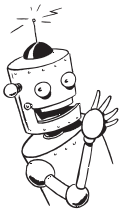
Percent Error

11. Get the actual height(s) from your teacher and calculate the percent error. Record the percent error in your data table.

$$\%\ \text{error} = \left(\frac{\text{Calculated Height - Actual Height}}{\text{Actual Height}}\right) \times 100$$

Show your work:

Percent Error: _____



Procedure: (Finding Hang Time)

12. In this part of the activity each person in the group will stand next to a wall, jump into the air, and record how high they jumped. In **Data Table B** you will record **all** group members data.

Data Table B

Name	Jump Height (m)	Take off Velocity (m/s)	Landing Velocity (m/s)	Hang Time (s)

Calculating the Initial and Final Velocities

13. At the very top of your jump, your velocity (v_{top}) is 0-m/s.

14. Calculate your landing velocity ($v_{landing}$). Use (9.8 m/s^2) for gravity.

$$v_f^2 = v_o^2 + 2g\Delta h \longrightarrow v_{landing}^2 = v_{top}^2 + 2g\Delta h_{jump\ height} \longrightarrow \boxed{v_{landing} = \sqrt{2g\Delta h_{jump\ height}}}$$

Show your work:

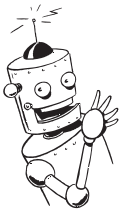
15. Because gravity works the same on the way up as it does on the way down, the Take Off Velocity ($v_{take\ off}$) is the same as the Landing Velocity ($v_{landing}$)but opposite in sign. Record Take Off Velocity ($v_{take\ off}$) as negative in your **Data Table B.**

Calculating Hang Time

16. Use the formula bellow to calculate the total hang time. Use (9.8 m/s^2) for gravity.

$$v_f = v_o + g\Delta t \longrightarrow \boxed{t_{hang\ time} = \frac{(v_{landing} - v_{take\ off})}{g}}$$

Show your work:



Hang Time: _____