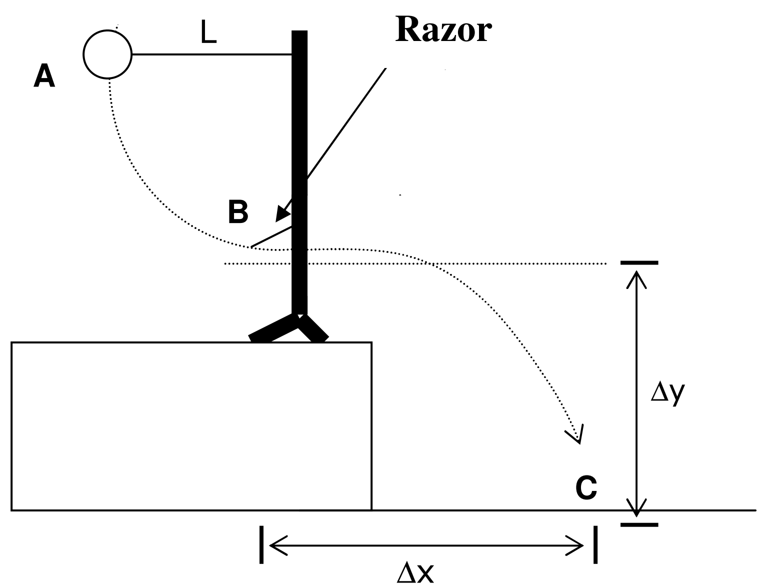
EXPERIMENT: SWINGING LIKE TARZAN

Our hero, the mighty Tarzan, loves to swing from vines. How can you calculate where Tarzan will land after he releases the vine? Does the landing point depend on Tarzan's mass? Does the distance traveled in the horizontal direction depend on the height of the starting point? If so, what is the relationship between the two? How can you calculate the speed at the lowest point of his circular path (just before he lets go of the vine!) since his motion is not uniform?

You are going to answer these questions using the apparatus in the figure. A ball (representing Tarzan) attached to a string will be raised to the horizontal and then released. As it passes through the lowest point of the circular path, a razor blade cuts the string. "Tarzan" will have projectile motion and will land on the floor.

Apparatus



OBJECTIVES

1. The principle of conservation of energy will be used to calculate the velocity of the ball at point B.
2. Apply the projectile motion equations to predict the horizontal landing distance, Δx.
3. Derive an equation relating the landing distance, Δx, to the height of the release point and the length of the string.

MATERIALS

- Ring stand
- Metal Ball
- Fine string
- Sharp razor blade
- tape
- ruler
- meter stick
- plumb bob

PRELIMINARY QUESTIONS

1. Describe the motion of the ball between points A and B in the figure?

2. What is the direction of the velocity vector at point B?

3. What physics principle would be the most appropriate to calculate the velocity at B, knowing the length of the string, L?

4. Describe the motion in the vertical direction from point B to point C.

5. Describe the motion in the horizontal direction between points B and C

PROCEDURE

1) Using the Principle of Conservation of Energy, obtain a relationship between the velocity of the ball at B and the length of the string (L).

2) Using the projectile motion equations, determine a relationship between the velocity of the ball at B, the landing distance (Δx) and the height of the release point (Δy)

3) Attach one end of a piece of string to a metal ball, using tape. Attach the other end of the string to a support beam (connected to a ring stand).
4) Measure the length of the string (L).
5) Attach a razor blade to a piece of cork. *Please be careful handling the razor blade.*
6) Place the blade at the bottom of the ball's circular movement, near the end of the string, so that the string will be cut close to the ball.

7) Measure the height of the release point to the floor, Δy. Enter these data in your table.

8) Calculate the predicted landing distance (Δx). Using a plumb bob, find the vertical position of the release point and mark it on the floor.

9) Measure the landing distance (Δx) from the vertical and mark it on the floor. Place a clean sheet of paper centered on the predicted landing point. Using a paper cup, trace a small circle centered on the predicted landing point.

10) Place either a paper cup on the traced circle OR a piece of carbon paper face down over the paper.

11) Line up your apparatus so the direction of the swing will coincide with the direction of the distance, Δx, you measured. Raise the ball until the string is horizontal. Release the ball.

12) Remove the carbon paper and measure landing distance, Δx

13) Be sure to remove the tape from the metal ball.

Length of string, L	**Height of the release point, Δy**	**Equation used to find Δx**	**Predicted landing distance, $\Delta x_{predicted}$**	**Actual landing distance, Δx_{actual}**	**% Error**

ANALYSIS

1) Calculate the % Error between your predicted and the actual Δx values. Record your value in the above table. In words, described the success of your experiment.

$$\%Error = \frac{\left|\Delta x_{predicted} - \Delta x_{actual})\right|}{\Delta x_{predicted}} \times 100\%$$

2) Calculate the maximum range of landing distances that would be possible for an successful outcome (a land in the cup).

$$Range = \Delta x_{\max imum} - \Delta x_{\min imum}$$

3) Based on your range calculation calculate the acceptable % Range for your prediction.

$$\%Range = \frac{Range}{\Delta x_{predicted}} \times 100\%$$

4) What are the possible sources of error in your experiment?

One Last Thing:

The landing distance, Δx, can be calculated from the length of the string, L, and the release height, Δy, using an elegant equation containing only 8 characters. Derive this equation.

Δx = ... (5 more characters)