# Sizzle and Slice
## Work, Energy, and Projectile Motion

In this activity, you are presented with a challenge: predict the landing position of a mass by determining the speed of the mass at the moment it is released from the string. Use your knowledge of kinematics and the law of conservation of energy to make your prediction.

A pendulum mass is supported on a thread and held above the equilibrium position by a string, as shown in Figures 1 and 2. A razor blade is attached to the apparatus at the pendulum's equilibrium point. A second thread holding the pendulum to one side will be burned, allowing the bob to swing down to the bottom of the arc. When the pendulum passes its equilibrium point, the razor cuts the thread and detaches the mass, which then becomes a projectile.

Work with your lab group to develop and implement a procedure for predicting the landing point of the mass. Consider the measurements you will need to perform before burning the string. You should also consider the uncertainty in these measurements and how they will determine the uncertainty in your prediction of the final landing position.

### PURPOSE

In this activity, you will derive an equation to predict the exact landing position of the projectile, perform the experiment, and see how close the result is to your expectations.

### MATERIALS

*Each lab group will need the following:*

calculator, TI® graphing
2 clamps, right angle
clamp, single buret
2 clamps, table
matches
meter stick
paper, carbon
paper, copy
projectile target
razor blade, single-edged
ring stand
2 rods to fit table clamps (1 m)
ruler, clear metric
scissors
tape, masking
thread
weight, 200–500 g
weight, 50 g
weights, fishing, 1 oz

## EQUIPMENT SETUP

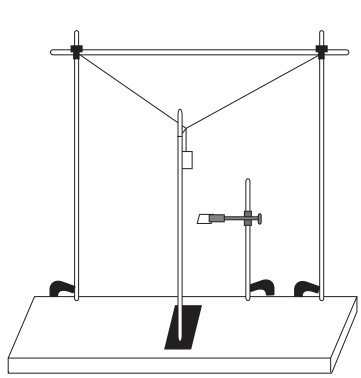

*Figure 1: Back view*

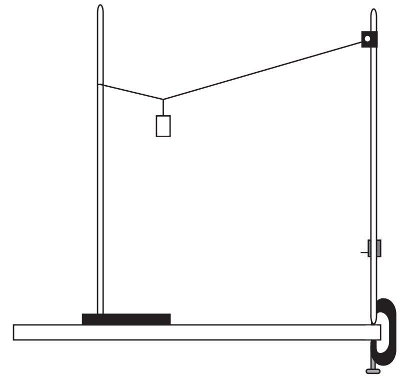

*Figure 2: Side view*

## PROCEDURE

1. Set up the pendulum apparatus as your teacher instructs using the provided diagrams. You may wish to make the length of the string about 2 m to facilitate adjustments. Pull the string up until the length of the pendulum is about 50 cm from the point where it will be tied to the setup. Tie the pendulum to the string and adjust the position of the razor blade such that it will cut the string about 1 cm above the weight. The pendulum mass itself must be suspended from a single thread so that the razor blade can cut it easily.

2. Measure the appropriate variables and derive an equation to predict the landing position of the projectile. Record your calculations and reasoning in the Data and Observations portion of your student answer page.

3. Place the target and carbon paper (carbon side down) at the predicted landing position on the floor.

4. Release the pendulum by burning the string that is holding the pendulum mass at its launch angle. Your teacher will check your apparatus and provide you with a match or butane lighter. Do not test the apparatus before your teacher is watching. The string should be burned a few centimeters above the pendulum. You will shoot for your grade.

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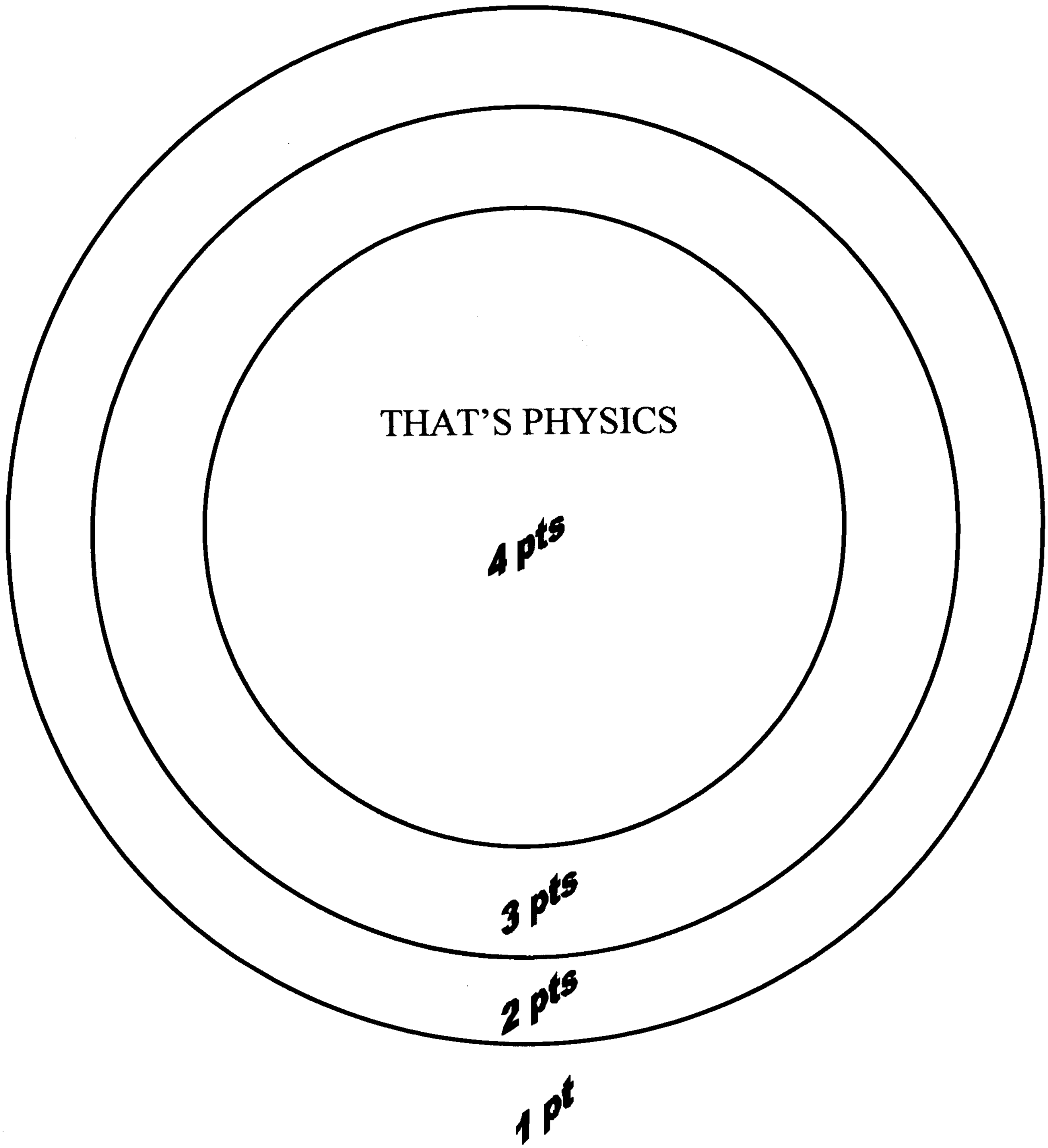
### DATA AND OBSERVATIONS

1. Use what you know about projectile motion to predict the landing distance for your projectile. Show you reasoning and calculations.

2. Place the target on the floor at your predicted location. Call your teacher to witness your trial before you burn the string.

3. Mark you target with the resulting spot and attach to your lab report.


THAT'S PHYSICS
4 pts
3 pts
2 pts
1 pt

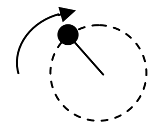
## ANALYSIS QUESTIONS

1. If a ball tied to the end of a string moves around in a vertical circle as shown, does the tension force of the string tend to:

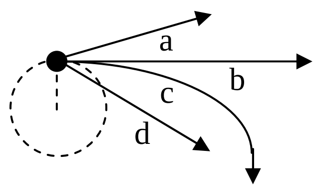
   a. Increase the speed of the object?

   b. Decrease the speed of the object?

   c. Not affect the speed of the object?



2. If the string were to suddenly break, which of the following best describes the subsequent motion of the ball?

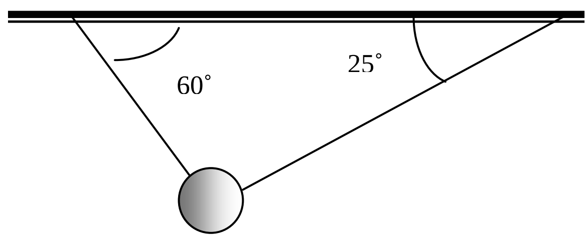



3. How close was your touchdown to the expected point? What are some possible reasons for any difference?

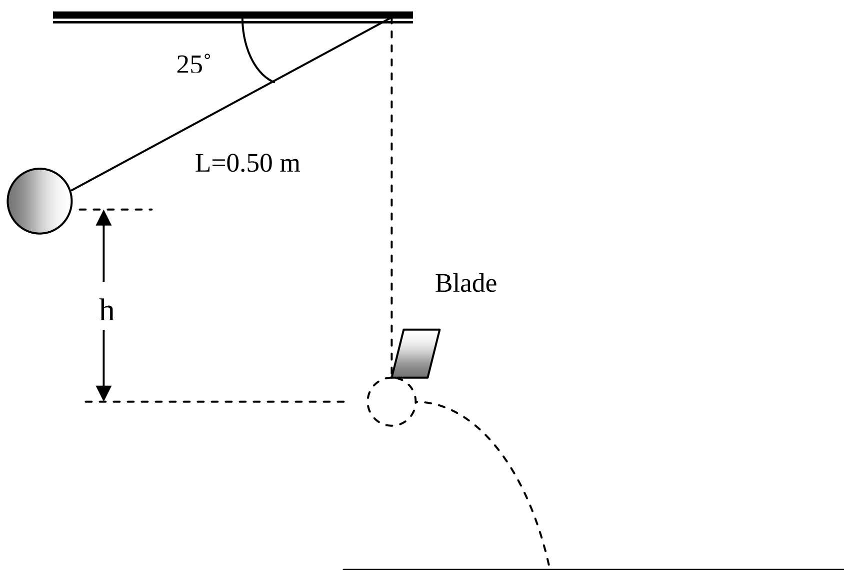
4. Was mechanical energy conserved for the motion? Justify your answer.

Use the following diagrams to answer questions 5–7. Show all your equations and work.

A ball of mass 0.50 kg hangs from two strings at the angles shown. The longer string is 0.50 m long.




The shorter string is cut, and the longer string swings from a height *h* above the lowest point of the swing.




At the instant the ball passes through its lowest point, the string is cut by a razor blade at a height of 1.20 m above the floor.

5. Determine the tension in each string.

6. Determine:
   a. The height *h* from which the ball is dropped.

   b. The potential energy at the height *h*.

   c. The speed of the ball as it passes through its lowest point.

7. Determine:
    a. The time the ball is in the air.

    b. The horizontal distance the ball travels before striking the floor.

    c. The kinetic energy of the ball just before striking the floor.