LAB 6. WORK AND KINETIC ENERGY

Introduction

You will displace a hanging weight sideways from its rest position and measure the greatest speed it reaches in its swing. You will then relate the speed to the height change of the swinging weight.

Lab activity

Supplies

Rod clamp. String, hanging mass, tape timer, ticker tape, meter stick, Vernier calipers, masking tape

Procedure

1. Measure the diameter *d* of the rod using the Vernier calipers.
2. Clamp the rod clamp to a table leg.
3. Hang the weight by the string from the support rod so that it does not touch the ground. Use a different string length from the other groups in the class.
4. Place a piece of masking tape on the floor directly underneath the center of the hanging weight and draw a mark on the tape to show the exact position directly underneath the center of the resting weight.
5. Measure and record the distance *r* from the hanger rod to the bottom of the weight.
6. Place a piece of masking tape on the floor between the tape timer and the mark showing the rest position of the hanging weight. Mark a spot on the tape. Measure and record the horizontal distance between this mark and the resting position of the hanging weight.
7. Tape a piece of ticker tape to the bottom of the hanging weight. Run the ticker tape through the tape timer between the carbon paper and the metal plate.
8. Pull the weight sideways toward the tape timer, so that the center of the bottom of the weight is directly over the mark you made in step 6. Use a plumb line to find exactly where to hold the weight.
9. Pull the slack out of the ticker tape.
10. Turn on the tape timer to 40 Hz.
11. Release the weight so that it pulls the ticker tape through the timer as it swings.
12. Remove the ticker tape.
13. Lay the ticker tape on a table. Find the marks made on the tape by the timer, and measure the distance between each successive pair of marks. Find the maximum speed *v* of the pendulum from the largest pair separation. (The timer makes marks every 0.025 s.)
14. Repeat steps 7-13 for three runs from that starting position.
15. Go back to step 6 and set a different release point for the weight. Repeat your three measurements from this new release point. Repeat for a total of five release points.

Data Processing

1. Calculate the distance from the center of the support rod to the bottom of the hanging weight.
2. For each release point, use trigonometry to find how much higher h (off the floor) the bottom of the hanging weight is at the release point compared to the resting position.
3. Make a plot of maximum speed v vs. height h.
4. Make a plot of the square of speed v^2 vs. height h.
5. Fit the v^2-h plot with a proportional fit (one-parameter linear fit, equation $v^2 = Ah$).
6. Use the fit equation to calculate the expected v^2 for each h.
7. For each measured v, calculate the "residual" $s = v^2 - Ah$.
8. Make a residuals plot s vs. h.

Lab report

Include the raw data and the graphs (v-h, v^2-h, s-h) that you made. Answer the following questions.

- What appears to be the relation between the maximum speed of the swinging weight and the height through which it drops?
- Theoretically, what should be the relation?
- Does the model appear to adequately describe the data?
- What effects or influences might cause the data to diverge from the model?