The Virginia Instructors of Physics
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LOOP THE LOOP

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Va. SOL:

PH.5 The student will investigate and understand the interrelationships among mass, distance, force, and time through mathematical and experimental processes.

PH.6 The student will investigate and understand that quantities including mass, energy, momentum, and charge are conserved

National Standards:

CONTENT STANDARD B: As a result of their activities in grades 9-12, all students should develop an understanding of

- Motions and forces
- Conservation of energy and increase in disorder
- Interactions of energy and matter

Topic/Concept

This lab makes use of conservation of mechanical energy and vertical circular motion.

Materials

- Ring stand or vertical lab pole
- Two clamps
- Two cross bars
- String
- Mass set

Safety Considerations

Swinging mass.

Presentation

Photo of the demo will go here.

The student will apply knowledge of vertical circular motion and energy conservation to analyze a vertical loop. This has obvious roller coaster applications.

Loop the Loop

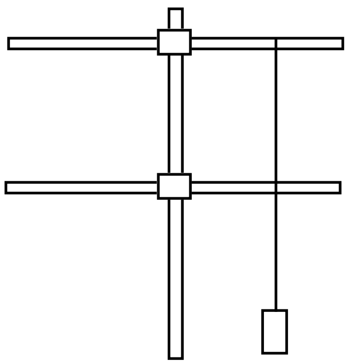
Name______________________________
Period_______

Loop the Loop

SET UP-

Set up three lab poles as shown in figure 1. Tie a string to the top cross bar. Make the string long enough so when a mass is attached to the other end it almost reaches the tabletop. Give yourself a centimeter or two clearance.

Fig. 1



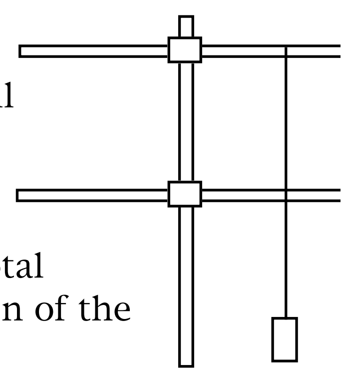
PROCEDURE-

You will hold the mass out the length of the string so the string is parallel with the tabletop. When you release the mass it will "wrap around" the lower cross bar and do a "Loop the Loop". We want to find the critical position for the lower cross bar. In other words, the mass just barely completes the loop around the lower bar while keeping the string "straight" the whole way.

PRELAB QUESTIONS- COMPLETE PRIOR TO DOING THE LAB

A. The lower bar is at the "critical" position in figure 2. Shade in the approximate range the lower bar can occupy and still have the "loop the loop" occur.

Fig. 2



B. If you attach different masses on the string (making sure the total length of the string/mass stays constant) will the "critical" position of the lower bar change?

Loop the Loop

PROCEDURE CONTINUED-

Now do the experiment and find the critical position of the lower bar. Once you have found it measure the height of the top bar, D and the height of the lower bar, d. It is important when measuring these to use the center of the hanging mass as zero height and measure from there. Now calculate the ratio of D/ d and record it here.

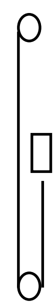
D/d = ________________(numbers)

Now do experiments to find the answers to questions A and B.

POST LAB- **SOLVE ALL OF THESE WITH SYMBOLS ONLY! Make sure to differentiate between D and d.**

What minimum conditions must be met at the moment illustrated in figure 3 for the loop to be completed?

Fig. 3 (this is a side view and the vertical lab pole is not shown)

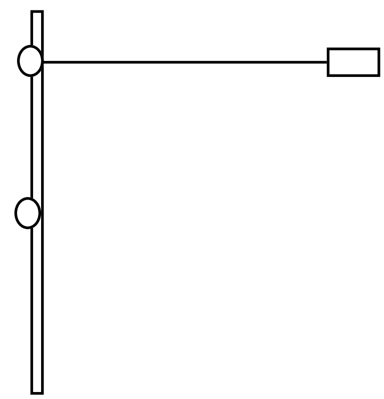


Use these minimum conditions to solve for the minimum speed at this point.

What is the total energy of the mass at the moment illustrated in figure 3? (plug in the value of Vmin from above)

When you hold the mass as shown in figure 4 to start the lab, what is its total energy?

Fig. 4 (this is a side view)



Using conservation of energy, solve for the ratio of the height of the top cross bar to the height of the lower cross bar. D/d (plug in numbers at this point)

Calculate your relative error for this experiment.

Show the algebra line in the calculations that would reveal the answer to the Pre-lab question B.

Explain why the lower bar may occupy any position below the critical position and still "loop the loop".

Teacher Tips Regarding Lab

This lab gives excellent results if you follow these two tips.
1- Hold on to the ring stand and cross bars to stabilize them as much as possible while the mass swings. Any shaking of the apparatus steals energy away from the mass.
2- A “loop the loop” has to make it around the cross bar in a **circle**. Just falling over the top doesn’t count.

Sources & References