Loop the Loop Lab

Teacher's Guide

Topic:

Circular Motion and Satellite Motion

The following information is provided to the student:

Question:
How does the strength of the tension force on a bucket when at the top of a vertical loop compare to the strength of the tension force when at the bottom of the loop?

Purpose:
To determine the *relative* strength of the tension force on a bucket when it is at the top and at the bottom of the vertical loop through which it moves.

A complete lab write-up includes a Title, a Purpose, a Data section, a Conclusion/Discussion of Results and Post-Lab Questions. The Data section should include an organized and informative record of your observations of the tightness of the string around your hand for the two locations. The Conclusion/Discussion should discuss and answer the question raised in the Purpose of the lab. And the Post-Lab Questions section should included the provided page of post-lab analysis questions.

Materials Required:

Bucket (holds 1-3 gallons of water); water; strong string; outdoor space.

Description of Procedure:

Each lab group is given a bucket. The bucket is one-quarter to one-half filled with water. A string is tightly secured to the bucket; a loop is tied into the string at the opposite end. Students place a hand through the loop and wrap a few turns of the string around their hand. Starting with a gentle back-and-forth rocking motion, the students whirl the bucket in a circle and keep whirling. Students make observations of the tightness of the string around their hand at two strategic locations - when the bucket is at the top of the circular loop and when the bucket is at the bottom of the circular loop. They use their observations to draw a conclusion. The post-lab questions involve calculations which further reinforce the concept.

Alternative Materials and Procedure:

Any object which could be tied to the end of a string could be used in place of the bucket of water. Just don't use your mother's fine china (unless you first ask).

Safety Concern:

There is always a higher than usual level of risk associated with working in a science lab. Teachers should be aware of this and take the necessary precautions to insure that the working environment is as safe as possible. While this is truly a fun lab with a strong educational component, students should be cautious of their environment as they swing their bucket in a circle. They should stay clear of trees, windows, people and power lines. Furthermore, they should be cautious of walking on wet surfaces. Student *horseplay* and off-task behaviors should not be tolerated.

The Laboratory

Suggestions, Precautions, Notes:

1. Give considerable thought to the choosing of a suitable location for doing this lab. There is a high likelihood that the surroundings will get wet, maybe even very wet. This lab should not be done indoors. The lab requires space; students will need to spread out so that they are not hitting each other with their buckets.
2. To insure the highest degree of safety, the teacher should take the time in advance of class to tie the string tightly around the bucket and to create a loop in the opposite end for a student to grip it with their hands. Very strong string should be used. The string should be checked between classes. A science teacher can never err on the side of safety; "too safe" is not possible.
3. A gallon of water is a sufficient amount of water to be whirling in a circle. Any more than a gallon could cause considerable shoulder strain for some students.
4. If a string on a bucket breaks, make it into a learning opportunity by having the lab group describe where the bucket was (likely the bottom of trajectory) when the string broke.
5. Some students will be timid about participating. Encourage all to take their turn at the bucket.
6. Monitor safety at all times.

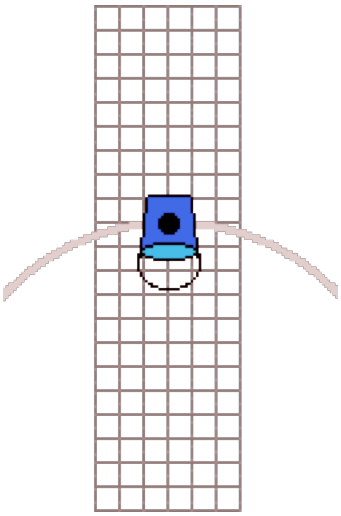
Auxiliary Materials:

The following page is provided to the student for completion and inclusion in the Post-Lab Questions section of their lab notebook.

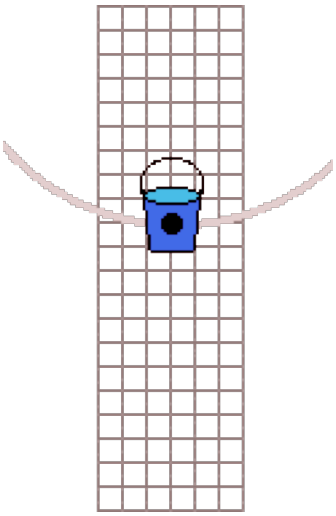
Post-Lab Questions:

1. Construct a free-body diagram showing the forces acting upon the bucket at the top and the bottom of the loop. The size of the force vector should be in proportion to the size of the force. Label each force according to type.

Loop Top



Loop Bottom



2. Use the following information about speed and radius to determine the acceleration, net force and tension force acting on the bucket at the top and the bottom of the loop. Show your work in an organized fashion.

The Laboratory

Loop Top			Loop Bottom		
m = 1.2-kg	R = 1.1 m	v = 4.4 m/s	m = 1.2-kg	R = 1.1 m	v = 6.2 m/s
a = _____ m/s/s			a = _____ m/s/s		
F_{net} = _____ N			F_{net} = _____ N		
F_{tens} = _____ N			F_{tens} = _____ N		

Scoring Rubric:

CG2. Loop the Loop Lab	**Score**
___ Included, labeled and organized all parts of the lab report. ___ Data section included a clear and accurate observations of the relative strength of the tension force for top and bottom positions along a vertical loop. ___ Conclusion/Discussion accurately answers the *question* posed in the Purpose. ___ Post-lab questions were included and answered accurately and completely; FBDs were properly constructed with labeled forces; work was shown on calculations.	____/____

Connections to The Physics Classroom Tutorial:

The following readings are a suitable accompaniment to this lab:

http://www.physicsclassroom.com/Class/circles/u6l1c.cfm

http://www.physicsclassroom.com/Class/circles/u6l1e.cfm

http://www.physicsclassroom.com/Class/circles/u6l2a.cfm

Connections to Minds on Physics Internet Modules:

Sublevels 3 and 4 of the Circular and Satellite Motion module are a suitable accompaniment to this lab:

http://www.physicsclassroom.com/mop/module.cfm