PHY230: Centripetal Acceleration and Centripetal Force

Experimental Measurement of centripetal Acceleration:

1. Detach the bob from its support strings and determine its mass. Record that here.
   M=

2. Hang the bob from its cross-arm support by the strings that support it. Do not attach the spring to the bob. It should hang straight down. The post mounted to the base is the position pointer. It should be in the position closest to the rotating shaft. If it is not, move it there. Now loosen the screw holding the cross arm in place so that you can adjust its position until the tip of the box is exactly over the pointer. The tip of the bob should be close to, but not touching, the tip of the pointer. Measure and record the distance R from the center of the rotating shaft to the pointer and tip of the bob. Record that here with units.

   R=

3. Attach the spring to the bob and the rotating shaft. Twirl the rotating shaft with your fingers. Practice until you can produce a steady rotational speed that gets the bob over the pointer and practice keeping that speed steady. Once you are ready, measure the total time needed from 25 complete revolutions with the bob at the radius R. Keep the rotational speed as constant as possible the whole time. Record the time required for 25 revolutions. Repeat two more times.

Trial	Time for 25 rotations in seconds	Period in seconds
1		
2		
3		
Average		

4. What is the circumference of the circle in which the bob moves? (Refer back to question #2). Show work.

5. What is the average speed of the bob based on your three trials? Show work.

6. What is the centripetal acceleration of the bob? (Show work)

Experimental Measurement of Spring Force I

7. Draw a free body diagram for the bob as it rotates. Draw an arrow showing the direction of the acceleration for the spinning bob.

8. What is/are the centripetal force(s) in this case?

9. Apply Newton's second law to your free body diagram to write an algebraic equation that includes the centripetal acceleration.

10. Given your value of the centripetal acceleration and mass of the bob, what is the value of the force exerted by the spring? (Show your work).

Experimental Measurement of Spring Force II

11. With the bob standing still, attach a string to the side of the bob opposite the spring. Run the string over the pulley and attach a mass hanger to the other end. Add slotted masses to the hanger until the bob is again just over the pointer. Record the mass added here. Don't forget to include the mass of the hanger.

    M=

12. Draw a free body diagram for the bob in this situation. Draw a free body diagram for the hanging mass.

13. Apply Newton's second law to the free body diagram for the hanging mass to write an algebraic equation that includes the tension in the string. Apply Newton's second law to the free body diagram for the bob to write an algebraic equation that includes the tension in the string and spring force.

14. Calculate the tension in the string.

15. Calculate the force exerted by the spring when the bob is over the pointer.

16. Compare this calculated spring force to the force you found in #10 based on the centripetal acceleration measurement. What is your percent difference?

Discussion Questions

17. Does the centripetal force pull the bob in toward the center of the rotating rod or push it out, away from the center shaft?

18. What would happen to the bob if you tried to spin it in a circle and there were no centripetal force from the spring?

19. **If there is more than 30 minutes left in lab**……Repeat step 3 for a different value of R.

R=

Trial	Time for 25 rotations in seconds	Period in seconds
1		
2		
3		
Average		

20. What is your calculated centripetal acceleration in this case? Show work.

21. What is the force exerted by the spring (the centripetal force) in this case? Show work.

22. Repeat step 11. Record the mass here. What is the force exerted by the spring calculated based on the tension in the string now? Show work.

23. What is the percent difference in these two measurements of the spring force? Show work.