Physics Exploration Homework Supplement P110-4.pdf

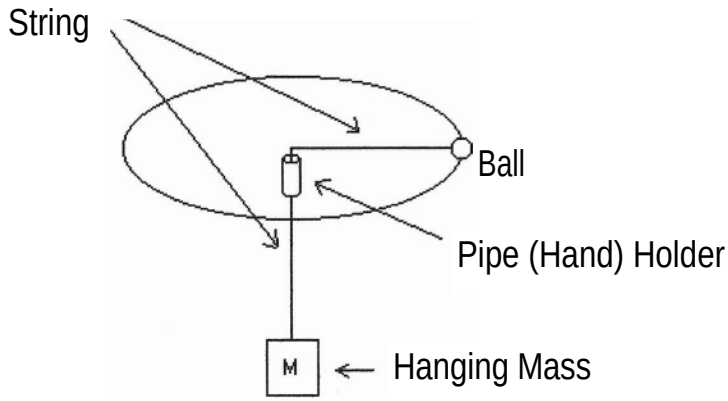
Circular Motion and Centripetal Acceleration: Ball and String Experiment

Go to the Physics Exploration Center. Enter through the resource room 311/312 Thaw Hall.

Answer the following question before you start the exploration problem:

(1) A ball of mass m is tied to a mass less string which is threaded through a pipe (holder). Attached to the other end of the string is a mass M. The ball is rotated in a horizontal circle of radius r at constant speed v. If the speed v is increased to 2v

(a) The radius of the circle must decrease and so must the period.
(b) The radius of the circle must increase and so must the period.
(c) The radius of the circle must increase but the period remains constant.
(d) The radius of the circle must decrease but the period remains constant.
(e) The radius of the circle remains constant but the period increases.



Go to the demonstration which has a ball attached to the end of a string. Attach a 1 kg mass to the other end of the string and rotate the ball in a horizontal circle of radius 0.5 meter (blue mark on the string). Here are tips on how to accomplish this without hurting yourself: Hold the pipe (holder) in one hand (DO NOT hold the string in your hand while rotating the ball to ensure that the tension is the same as the hanging weight), and the 1 kg mass in the other hand. Start the circular motion and adjust the speed such that the radius of the circle in which the ball is rotating is 0.5 meter (when the holder will roughly be touching the blue mark on the string). At this point, let go of the 1 kg mass from the other hand but continue to rotate the ball by holding the pipe at the blue mark.

(a) Is the ball is undergoing circular motion at constant speed if the radius is kept fixed at 0.5 meter (blue mark)?

(b) Calculate the speed *v* of the ball by measuring the period T. To be reasonably accurate, measure the time for 20 revolutions using the stop watch. Then, divide it by 20 to find the period. Once you know T (and the radius is known to be 0.5 meter), find the speed of the ball in circular motion.

(c) Predict what will happen to the radius of the circle if you increase the speed keeping everything else the same. Justify your answer. Is it consistent with your answer to question (1) above? Now increase the speed compared to part (b), what happens to the radius of the circle? Reconcile any discrepancies in your prediction and observation.

(d) Make the speed such that the radius of the circle becomes 0.75 m (red mark). Calculate the speed of the ball in this case by measuring the period.

(e) How do the speed and period in case (d) compare with case (b)? Rationalize your findings (For example, if the period and speed have both become larger in case (d) compared to case (b), does it make sense intuitively? Explain.).

(f) Which force provided the centripetal acceleration necessary to keep the ball moving in a circle?

(g) Predict whether you will have to increase or decrease the speed of the ball to keep it moving in a 0.5m radius circle at constant speed if the hanging mass is decreased to 500 grams from 1 kg. Justify your answer. Now, change the attached mass to 500 gram and repeat part (b) (Find the speed of the ball for a radius of 0.5 m, the blue mark). Is the speed larger in this case compared to case (b) when the mass was 1 kg? Justify your answer based upon your understanding of uniform circular motion.

Now answer the following question. Refer back to your exploration as needed:

(h) Which force provides the centripetal acceleration necessary to keep your car moving around a curve at constant speed?

(i) If the radius of the curve and the force keeping your car along the curve remain constant, what will happen if you keep increasing the speed of your car? Explain your reasoning.
(j) If the speed of your car and the force keeping your car along the curve remain constant, what will happen if you make turns around curves with smaller and smaller radius? Explain your reasoning.