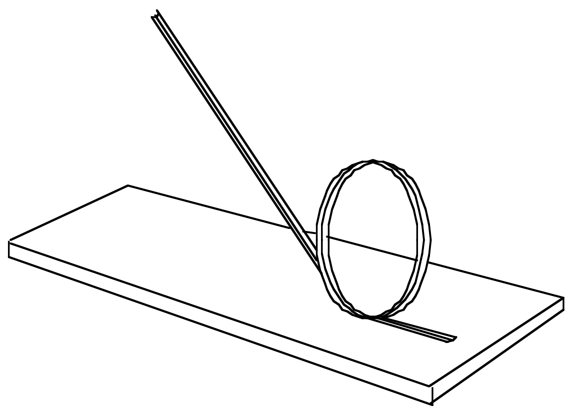
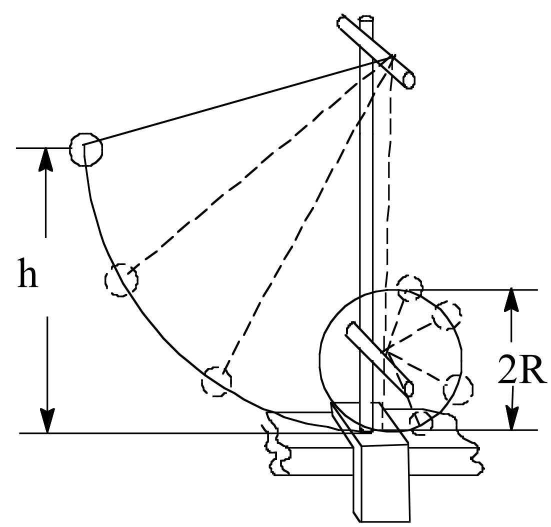
PE to Closed Vertical Loop Pendulum

A popular demonstration consists of a closed metal track that begins with an incline and continues through a vertical loop, A small metal ball is located on the vertical incline at a position that will allow the ball to roll down the track and around the loop without leaving the track..



This track looks something like illustrated on the left. The complete apparatus can be quite expensive . The least expensive I have seen is from xUmp for $30. There are many references on the web explaining how to use this apparatus as well as equipment supply houses that can supply it. Below is a discussion on how an easy equivalent demonstration can be done with a pendulum.

The simple equivalent of the track is illustrated on the right. Firmly attach a vertical ring-stand rod to a table top. Clamp a horizontal rod to hold the top of the pendulum string to the top of the vertical rod and attach another horizontal rod near the bottom to abruptly change the length of the pendulum. For easy future measurement, have the length of the pendulum be level with the top of the table (although the pendulum will swing in front of the table.) Adjust the bottom rod to produce a convenient radius for the bob to swing after the string strikes it., The object is to repeatedly swing the pendulum to find the height where the string just does not slack when the bob reaches the top of the smaller circle. Apply conservation of energy to the original PE at h to the combined PE and KE when the bob reaches the top of the circle just with no slack in the string. See argument at right.



$PE_h = PE_{2R}$ + KE at top of circle or
$mgh = mg2R + 1/2mv^2$
If the tension of the string is 0 at 2R then only mg supplies the centripetal force or, $mg = mv^2/R$
From the above we get $½ mv^2= 1/2mgR$
Finally: $mgh = mg2R + ½ mgR$
Which reduces to $h=5/2 R$