Investigation 3: The swinging trapeze

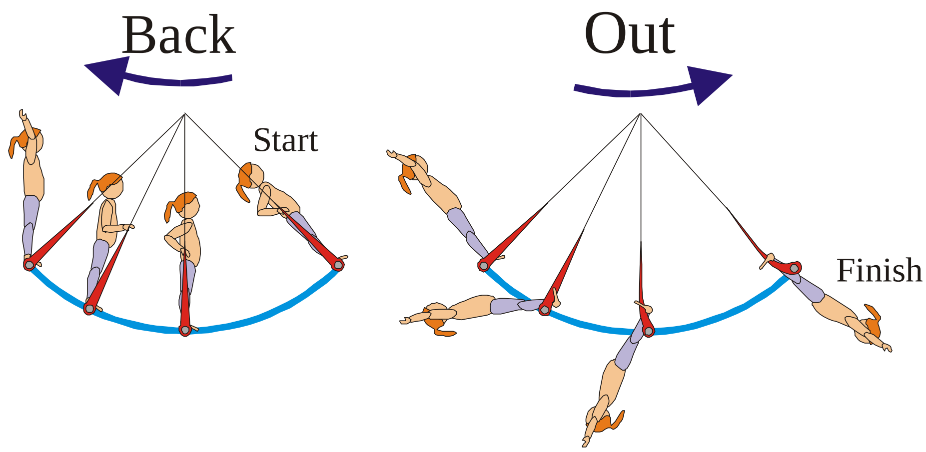
We have now discussed various ways to change the swing, but have ignored the movement of the performer. By moving his body or by adopting a position for a trick, the performer can vary the length of the pendulum and therefore change the period of his swing as shown in the previous investigation.

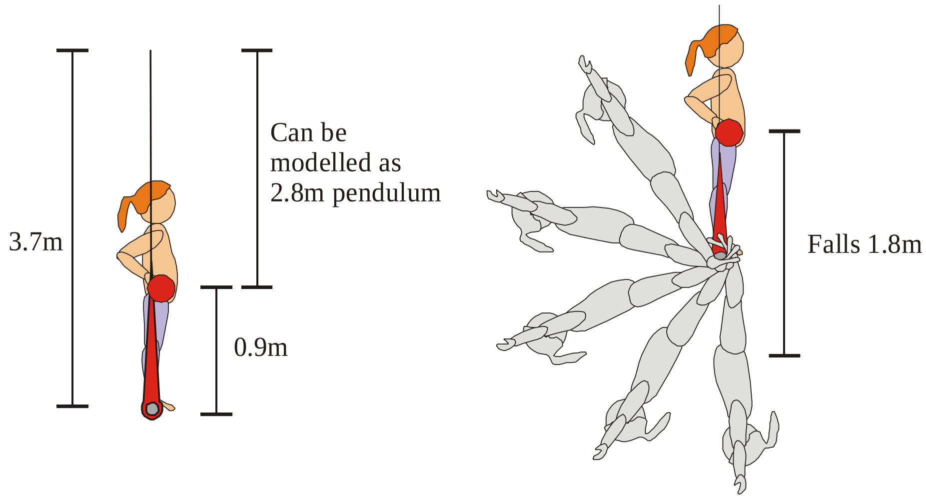
A good and easy to understand example of this is found on the swinging trapeze (although all the same principles apply to flying). The swinging trapeze is a much simpler version of the flying trapeze. More often than not, there is no safety net and the performer is secured only with a safety line. The main difference between the two is that on the swinging trapeze, the performer has to produce the swing himself, rather than generating swing by stepping off a high platform.

The Standing Seats-Off

This trick, best described by a diagram, involves the performer first standing on the bar, and ending up hanging underneath it from his/her feet.

We will examine this trick because it involves a very large change in the length of the pendulum, and also a very large change in speed.



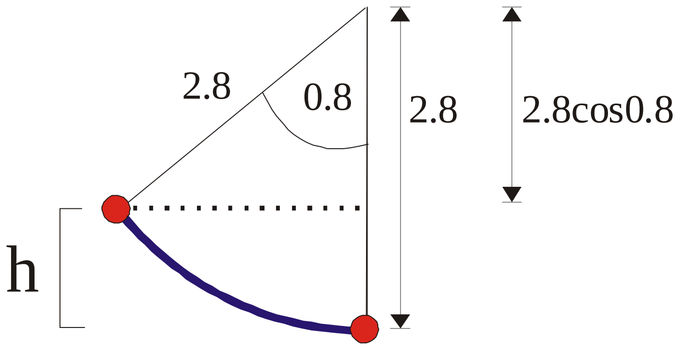


When we first examine this trick, it is easy to think that the (intuitive) change in speed comes as a result of the change in length of the pendulum, as the man falls underneath it. We must remember that the equation for speed has no term for length in it ($v^2=2gh$) and therefore it cannot be this that causes the acceleration.

When swinging, standing on the bar, the system follows the original principal of a change from PE to KE, as described in Investigation 1. When the man falls back, he converts his PE to KE, which is then added to the KE he would already have had at that point in his swing.

We will assume that the angle of swing (θ) is approx. 0.8 radians (50 degrees), although of course this could be considerably larger for a high level artist.

What is his original maximum speed?



$$v = 2gh$$

$$v = 2 \times 9.8 \times (2.8 - (2.8 \times \cos 0.8))$$

$$v = 4.1ms\text{-}1$$

PE at top is $mgh = 70 \times 9.8 \times (2.8 - (2.8 \times \cos 0.8))$ (ignore mass of bar)

PE = 582J therefore KE at bottom is 582J

What is his maximum speed after he falls?

Man falls a total distance of 1.8m, therefore he loses how much PE?

PE = mgh = 70 x 9.8 x 1.8 = 1234.8J

This is all converted to KE (assume no air resistance)

$\frac{1}{2}mv^2 = 1234.8 + 582 = 1816.8$J

$v^2 = 51.9ms^{-1}$

$v = 7.2ms^{-1}$

This is a huge increase in speed (the performer has nearly doubled his original speed). Therefore this shows another way that the performer can vary the speed of his swing; moving his body to increase or decrease his energy. This is a theme we will return to when we investigate advanced swinging.