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A3_4 King of the Swingers

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Abstract

The idea of swinging on a vine as a means of travel within a jungle is one that has been used in a variety of contexts; while the physical act may be difficult to do, modelling the action as a mass on the end of a pendulum the value for the average horizontal ground velocity has been calculated. Within films and books, this action has been used for many years; the chase scene from the movie 'Indiana Jones and the Kingdom of the Crystal Skull' is one such film. From investigating this scene the average horizontal ground velocity of Shia la Beouf is found to be 15.3 ms^{-1}.

Introduction

In the 2008 film 'Indiana Jones and the Kingdom of the Crystal Skull' there is a scene in which one of the main characters, played by Shia La Beouf, gets flung into the air from a jeep during a car chase through the Amazon jungle. He is then trapped in the canopy above them until he sees monkeys swinging on vines as a means of transport. Using this idea, he then swings on the hanging vines to successfully catch up to the jeeps again. It is clear in this scene that he takes a shorter, more direct route through the trees to meet up with them. But just how fast could he have travelled on the vines in order to catch up with them? The model of him swinging as a mass on the end of a pendulum is used to test this idea.

Theory

For the model of the swing, we have assumed the vine to act as a pendulum with a mass on the end of it. We have assumed that the mass of the vine is negligible and that, on the first swing, the mass will reach the same height as when it was released. The period for large amplitude oscillations of a pendulum is given by the approximation

$$T = T_0[1 + \frac{1}{4}sin^2(\frac{1}{2}\Theta) + \frac{1}{4}(\frac{3}{4})^2 sin^4(\frac{1}{2}\Theta) + ...], \tag{1}$$

where Θ is the angular amplitude and T is the oscillation time period, also using

$$T_0 = 2\pi\sqrt{\frac{L}{g}} \quad [1]. \tag{2}$$

Here, L is the length of the vine and g is the acceleration due to gravity. The approximation has been taken to the third order for this model as, due to the assumptions already made, there is no need to use a more accurate order.

Velocity

We can now calculate the average horizontal velocity of the person using

$$v_{avg} = \frac{s}{t}, \tag{3}$$

where s is the horizontal distance and t is the time. Using trigonometry, the length of s can be

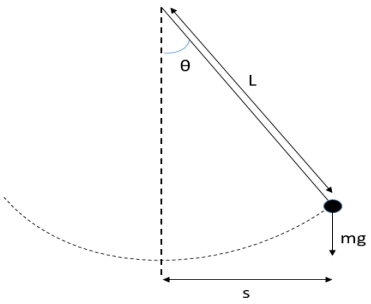

Figure 1: Exhibiting the forces acting on a mass at the end of a pendulum at an angular displacement of θ and the horizontal distance travelled s.

found to be $s = Lsin(\Theta)$. The period of oscillation is for a distance of $4s$ as it is the time for a complete swing forward and backward. This then gives the average horizontal velocity of the swinger to be

$$v_{avg} = \frac{4s}{T}. \tag{4}$$

The period of oscillation is dependent on the length of the vine and so, using the location of the film's chase scene to be the Amazon, the height of the trees used was 25 m [2]. Allowing for this height to include the canopy, an area they would not be able to swing through, the maximum length of the vine was chosen to be 20 m. By using Eq. (1) and Eq. (2), the average horizontal velocity was found by varying the initial angular displacement and vine length. This was then plotted on a graph to compare and find the maximum velocities for each combination. Figure 2 clearly shows that larger initial displacements and vine lengths increase the average horizontal velocity. For the scenario in the film, taking the length to be 20 m and the initial angular displacement to be 70^o, the velocity was found to be 15.3 ms^{-1}. Comparing this to the apparent velocity of the jeeps in the scene, which we have assumed to be approximately 40 kmh^{-1} or 11.1 ms^{-1}, we show that it would be possible to catch up with the jeeps, in theory.

Conclusion

To conclude, while Hollywood usually does a good job of ignoring physics when it comes to

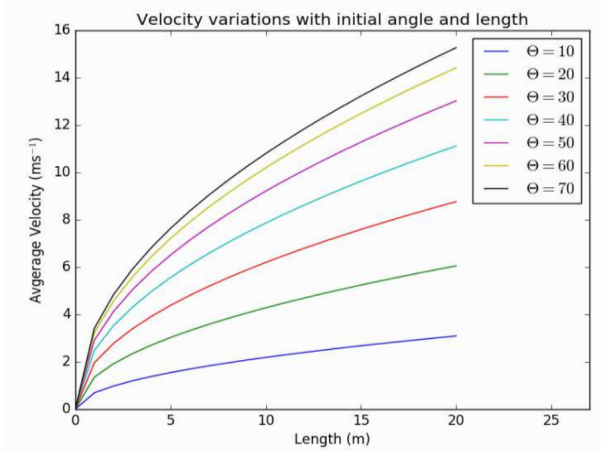

Figure 2: Showing the average horizontal velocity against vine length with varying initial angular displacements in degrees.

action sequences, swinging on a vine as a means of travel seems at least plausible. Certainly, with Shia taking a shorter and more direct route, the ability for him to catch up doesn't seem too far fetched. With future work taking into account the mass of the vine and also air resistance, the accuracy of the average horizontal ground velocity value could be improved.

References

[1] Tipler, P. and Mosca, G. (2008). Physics for scientists and engineers. New York: W. H. Freeman. Sixth Edition, pg 473

[2] `https://www.earthmagazine.org/article/map-reveals-height-worlds-forests` [Accessed 20 October 2017]