Journal of Physics Special Topics

An undergraduate physics journal

P2_1 "Home stretch, baby!"

E. Coleman, T. Nottingham, S. Robinson and K. Zimolag

Department of Physics and Astronomy, University of Leicester, Leicester, LE1 7RH

November 15, 2018

Abstract

In the opening scene of the 2003 film "2 Fast 2 Furious" [1], a car jumps over another car after racing over an open bascule bridge. We investigate whether the second car, leaving the bridge after the first car and at a greater velocity can jump over the first car and end up ahead. We found that the second car leaves the bridge 0.11 s after the first, and jumps a distance of 110 m, which is 24 m more than the jump distance of the first car combined with the distance the first car travels after landing, within the time the second car is in the air.

Introduction

During the first race of "2 Fast 2 Furious" [1], Brian's (Paul Walker) Nissan Skyline (car 2) jumps over Slap Jack's (Michael Ealy) Toyota Supra (car 1), after racing over a bascule bridge (one that opens up for passage of boat traffic). The Supra leaves the bridge first with the Skyline following shortly after, but at a higher velocity, allowing it to jump over the first car and win the race.

We used the length and height of a fifth generation Nissan Skyline GT-R (4.6 m and 1.36 m respectively) [2], to estimate the length and height of the open bridge, to allow us to calculate the angle at which the cars leave the bridge.

We estimated the ramped section of the bridge to be 20 m long and open to a 5 m height. Furthermore, we approximate the cars as particles in projectile motion with no air resistance.

Using a scene from the film which shows the speedometers of the cars right before the ramp, which display 120 km/h and 160 km/h for the Supra and the Skyline respectively, we estimated the velocities of the cars leaving the bridge to be 33 ms $^{-1}$ and 44 ms $^{-1}$ for car 1 and car 2 respectively. Furthermore, we assume that car 2 is 5 m behind at the moment car 1 leaves the bridge and that both cars land perfectly and carry on driving.

Method

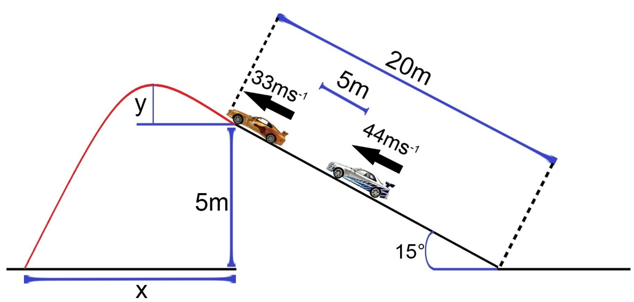

Figure 1: A diagram portraying the bridge jump (car 1 in front at 33 ms $^{-1}$ and car 2 behind at 44 ms $^{-1}$) all the approximated measurements.

First we calculated the angle at which the bridge is raised in order to obtain the vertical and horizontal components of the velocities. Therefore using Eq. (1) below, where the angle of the ramp is θ, the estimated length, l, is 20 m, and the height, h, is 5 m, we found the angle to be 15 °.

$$\theta = \arcsin(h/l) \tag{1}$$

With this angle, we found the velocity components using:

$$v_x = v\cos\theta, v_y = v\sin\theta, \tag{2}$$

where v is the velocity of the car at take-off, v_x and v_y are the components of the velocity in the x and y directions respectively, and θ is the angle of the bridge. ($v_x = 32$ ms $^{-1}$ and $v_y = 8.5$ ms $^{-1}$ for car 1, $v_x = 43$ ms $^{-1}$ and $v_y = 11$ ms $^{-1}$ for car 2).

The time taken to reach top of trajectory after leaving the bridge, taking g as the gravitational acceleration (9.81 ms $^{-1}$), is found by:

$$v_{yf} = v_y - gt_1 \tag{3}$$

where v_{yf} is the velocity in the y direction at the top of the trajectory, and t_1 is time to reach the top of the trajectory [3]. We found t_1 to be 0.87 s for car 1 and 1.1 s for car 2.

Then we calculated the height of highest point of the trajectory using:

$$y_1 = v_y t_1 - \frac{1}{2}gt_1^2 \tag{4}$$

where y_1 is the difference in height between the top of the bridge and the top of the trajectory (distance y in Fig (1)) [3]. We calculated this to be 3.7 m for car 1 and 6.2 m for car 2.

Combining this height with the height of the bridge we got the total distance the car falls, y_t. We then found the time it takes to fall, t_2 using:

$$y_t = v_{yf}t_2 + \frac{1}{2}gt_2^2 \tag{5}$$

[3]. We calculated t_2 to be 1.3 s for car 1 and 1.5 s for car 2. This then allowed us to get the total time of flight for both cars, t_f to be 2.2 s and 2.6 s respectively. Then, using these times we calculated (using Eq. (6)) the total horizontal distances travelled by the cars in the air (distance x in Fig (1)).

$$x = v_x t \tag{6}$$

where x is the horizontal distance, v_x is the horizontal velocity and t is time. We found these to be 70 m for car 1 and 110 m for car 2.

Since car 1 spends less time in the air, it lands first and therefore travels some distance on the ground before car 2 lands. Furthermore, car 2 left the bridge some time after car 1. We worked out this time to be 0.11 s (using rearranged Eq. (6)). Following this, we worked out the distance travelled on the ground by car 1 using the combined time of 0.51 s (the difference in times of flight and the delay between jumps) with the horizontal velocity (using Eq. (6)) to be 16 m.

Therefore, the total distance covered by car 1 at the time of car 2 landing was 86 m.

Conclusion

In this investigation, we calculated the trajectories of two cars with different speeds and starting positions. Using the time of flights and the ranges, we investigated whether the faster car in the rear would overtake the slower car in front during their consecutive jumps over a raised bridge.

From our results we found that car 2 did indeed overtake car 1 from the jump, landing 24 m in front.

In reality, the suspension of both cars would be severely damaged upon impact, the oil pans and exhaust system would be damaged and the cars would be unable to carry on driving let alone finish the race. To expand on this in the future, the impulse on landing could be calculated.

References

[1] `https://www.imdb.com/title/tt0322259/` [Accessed 3 October 2018]

[2] `https://en.wikipedia.org/wiki/Nissan_Skyline_GT-R#Fifth_generation_(1999%E2%80%932002)` [Accessed 4 October 2018]

[3] P. A. Tipler, *Physics for scientists and engineers, sixth edition*, p.71-76.