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How Many Pairs of Running Shoes Would Sonic Need?

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Abstract

This paper describes and calculates the number of pairs of running shoes that Sonic would need while completing the original 1991 version of the game *Sonic the Hedgehog* if he did not have his Power Sneakers. Calculations show that only one pair of running shoes would be needed, as the total distance ran in the entire game is 6.17 km. As running shoes are suggested to be replaced every 500 km in order to ensure effective shock absorption, it is concluded that Sonic would only need a single pair of regular running shoes.

Introduction

The first *Sonic the Hedgehog* game, commonly referred to as *Sonic 1*, was released in 1991 for the Sega Genesis console [1]. The player controls a hedgehog named Sonic and is trying to foil Doctor Robotnik, a scientist who has imprisoned animals and stolen the magical Chaos Emeralds. The game is split into six zones, with each zone having its own unique theme and containing three acts, totalling 18 acts for the game. In order to beat the acts of the 2D side-scrolling platform game, the player must make their way from the left-most to the right-most point of the game on each act. There is a variation of pathways, but a common theme is Sonic running at high speeds and utilising springs, slopes, and loops while avoiding enemies or spikes [2].

Since the game is centred around the premise of Sonic moving quickly, previous studies have found that depending on the iteration of the game, Sonic's speed can range from 10 ms^{-1} to 80 ms^{-1} [3]. For reference, Usain Bolt's fastest speed during his world record 100 m sprint measured at 12.4 ms^{-1} . Many reports, however, do not address the issue of the potential impacts on Sonic's body that running could have. Canonically, his Power Sneakers are nearly friction-proof, so they wear out extremely slowly. A common rule of thumb is that running shoes should be replaced every 500 km, as the shock absorption capabilities of shoes would have worn down enough to begin causing damage to joints and ligaments [4, 5]. Based on in-game information, it is possible to

calculate the distance ran by Sonic during the entire game of *Sonic 1*, and subsequently see how many pairs of running shoes Sonic would need in order to ensure the longevity of his joints.

Parameters of the Problem

Since the game levels are designed to have various pathways for a player take, assumptions need to be made in order to find the distance ran by Sonic:

- Distance travelled will only be calculated for the 18 acts, as there exist 'extra stages' which are not necessary to complete the game.
- Distance is calculated by measuring the total linear distance of ground that Sonic travels over during the shortest possible path to the right-most point of the level, ignoring possible enemies in his way that would impede his running motion.
- Distance travelled while underwater counts, as the game allows running while submerged.
- Potential damage caused to the shoes due to getting wet is ignored.

Calculations

The official height of Sonic in *Sonic 1* is given as 1.00 m [6]. It is then possible to find the relative dimensions of the height of Sonic's sprite to the lengths travelled during each act. For example, for Zone 1 Act 1, Sonic's sprite measured 2.05 cm tall, while the distance travelled was manually measured as 490 cm. So, the total distance travelled is:

$$\frac{2.05 \text{ cm}}{1.00 \text{ m}} = \frac{490 \text{ cm}}{x}$$

$$x = 239 \text{ m}$$

Following a similar calculation for all 18 acts of the game, the total distance travelled equals 6.17 km, as shown in Table 1.

Zone	Act	Act measured length (cm)	Act Actual Length (m)
1	1	490	239
	2	414	202
	3	472	230
2	1	521	254
	2	737	359
	3	775	378
3	1	531	259
	2	572	279
	3	587	286
4	1	737	359
	2	503	245
	3	658	321
5	1	772	377
	2	869	424
	3	1034	504
6	1	1011	493
	2	1097	535
	3	861	420
Total length ran:			6.17 km

Table 1 – The act measured lengths and appropriate actual lengths after conversion using Sonic's sprite and real-life heights for scale [2, 6].

Discussions

Since running shoes should typically be used for 500 km before they are replaced, Sonic clearly would have no problems with joint damage while completing the entire game in a regular pair of sneakers [4, 5]. It should be mentioned that this rule of thumb to replace shoes every 500 km is based upon a model of an average human, who would generally have a greater mass and longer stride length compared to Sonic. While this may affect the calculations due to the changing impact force exerted on the shoe per unit distance, it is extremely likely that even with these factors taken into consideration, this would not affect the overall conclusion that only one pair of running shoes would be needed since the calculated distance of 6.17 km is vastly smaller than the benchmark 500 km. For this reason, these factors regarding the differences in mass and stride length are not taken into consideration.

Conclusion

Using Sonic's actual height, the relative height of Sonic's sprite, and comparing this to the measured lengths travelled during each act, it is found that Sonic covers a total distance of 6.17 km throughout a single playthrough of *Sonic 1*. Since it is suggested that running shoes be replaced after 500 km of use, Sonic would only need one pair of runners to complete the game.

References

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