

Question #57994, Physics / Mechanics | Relativity

A bicycle racer sprints at the end of a race to clinch a victory. The racer has an initial velocity of 11.5 m/s and accelerates at the rate of 0.650 m/s² for 7.00 s. What is his final velocity? The racer continues at this velocity to the finish line. If he was 300 m from the finish line when he started to accelerate, how much time did he save? One other racer was 5.00 m ahead when the winner started to accelerate, but he was unable to accelerate and traveled at 11.7 m/s until the finish line. How far ahead of him (in meters and in seconds) did the winner finish?

Solution:

a) Final velocity of the racer:

$$v_f = v_0 + at_{acc};$$

$$v_f = 11.5 + 0.650 \times 7 = 16.05 \text{ m/s}$$

b) Distance traveled by racer during acceleration:

$$d_{acc} = v_0 t_{acc} + \frac{at_{acc}^2}{2};$$

$$d_{acc} = 11.5 \times 7 + \frac{0.650 \times 7^2}{2} = 96.43 \text{ m};$$

Distance traveled by racer with final velocity:

$$d_{fv} = d - d_{acc};$$

$$d_{fv} = 300 - 96.43 = 203.57 \text{ m};$$

Time, spent to travel d_{fv} :

$$t_{fv} = \frac{d_{fv}}{v_f};$$

$$t_{fv} = \frac{203.57}{16.05} = 12.68 \text{ s}$$

Total time spent to travel 300 m:

$$t_{total} = t_{acc} + t_{fv}$$

$$t_{total} = 7 + 12.68 = 19.68 \text{ s}$$

Time required to travel 300 m with initial velocity:

$$t_{v0} = \frac{d}{v_0};$$

$$t_{v0} = \frac{300}{11.5} = 26.09 \text{ s};$$

Time saved due to acceleration:

$$\Delta t = t_{v0} - t_{total};$$

$$\Delta t = 26.09 - 19.68 = 6.41 \text{ s}$$

c) The second racer was $\Delta d_0 = 5.00 \text{ m}$ ahead from the first one; therefore, he was 295 m from finish.

Distance traveled by second racer till first racer's finish:

$$d_2 = v_2 t_{total};$$

$$d_2 = 11.7 \times 19.68 = 230.26 \text{ m};$$

Distance behind the leader:

$$\Delta d_f = d - \Delta d_0 - d_2;$$

$$\Delta d_f = 300 - 5.00 - 230.26 = 64.74 \text{ m}$$

Time behind the winner:

$$\Delta t_f = \frac{\Delta d_f}{v_2} = \frac{64.74}{11.7} = 5.53 \text{ s}$$

Answer: 16.05 m/s; 6.41 s; 64.74 m; 5.53 s.