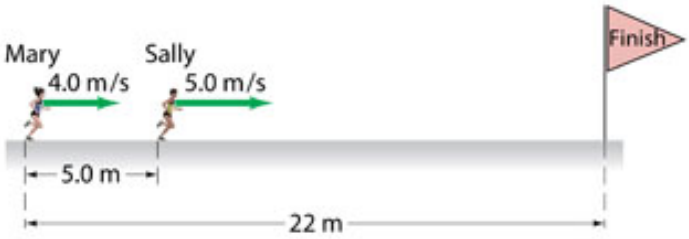
Answer on Question #62140, Physics / Mechanics | Relativity

Mary and Sally are in a foot race. When Mary 22m from the finish line, she has a speed of 4.0m/s and is 5.0m behind Sally, who has a speed of 5.0m/s. Sally thinks she has an easy win and so, during the remaining portion of the race, decelerates at a constant rate of 0.50m/s^2 to the finish line. What is the speed when Mary reach to the finish line?

Solution:



Find how long it takes Sally to reach the finish line.

$$x = (v_0))(t) + (1/2)at^2$$

$$22 - 5\,m = (5.0\,m/s)(t) + (1/2)(-0.50\,m/s^2)t^2$$

$$0.25t^2 - 5t + 17 = 0$$

$$t = 5 \pm \frac{\sqrt{(-5)^2 - 4(0.25)(17)}}{2 \cdot (0.25)}$$

Solve for t.

t = 15.7 or 4.34 seconds

t = 4.34 seconds.

We want the smaller answer -- the other answer is the time it would take to pass the finish line, change direction, and cross the finish line again.

$$t = 4.34\,s$$

What constant acceleration does Mary now need during the remaining portion of the race, if she wishes to cross the finish line side-by-side with Sally?

Since time for Sally equals times for Mary. Reuse t= 4.34s.

Find the acceleration Mary would need.

$$x = (v_0))(t) + (1/2)at^2$$

$$22\,m = (4.0\,m/s)(4.34\,s) + (1/2)(a)(4.34\,s)^2$$

$$a = +0.493\ m/s^2$$

What is the speed when Mary reach to the finish line?

$$v = v_0 + at$$

$$v = (4\,m/s) + (0.493\ \mathrm{m/s^2})(4.34\ s) = 6.14\,m/s$$

Answer: $6.14\,m/s$