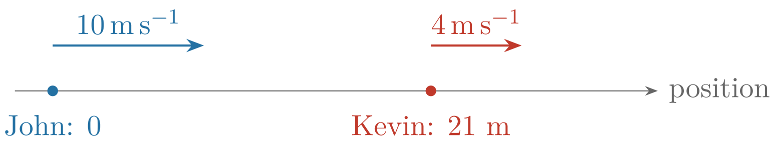
Part (c)

Game plan: We measure both positions from John's starting point and use one clock. Kevin starts accelerating one second later, so we must account for that first second separately.

Step 1: Set up the positions at the start

Let t be the time in seconds after John starts accelerating, and take forwards as positive.



$t = 0$: John starts accelerating; Kevin waits until $t = 1$.

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$$s = ut + \frac{1}{2}at^2.$$

John's position is

$$x_J = 10t + \frac{1}{2}(2)t^2 = 10t + t^2.$$

Step 2: Allow for Kevin's one-second delay

During the first second, Kevin travels $4(1) = 4$ m. He is therefore at position $21 + 4 = 25$ m when he starts accelerating.

For $t \geq 1$, his acceleration has acted for $t - 1$ seconds:

$$\begin{aligned} x_K &= 25 + 4(t-1) + \frac{1}{2}(4)(t-1)^2 \\ &= 25 + 4t - 4 + 2t^2 - 4t + 2 \\ &= 23 + 2t^2. \end{aligned}$$

There is no earlier meeting: during $0 \leq t \leq 1$, the gap is $21 - 6t - t^2$, which decreases from 21 m to 14 m and stays positive.

Step 3: Equate the positions

When one passes the other, their positions are equal:

$$\begin{aligned} 10t + t^2 &= 23 + 2t^2, \\ t^2 - 10t + 23 &= 0, \\ t &= \frac{10 \pm \sqrt{100 - 92}}{2} = 5 \pm \sqrt{2}. \end{aligned}$$

Both times are greater than 1, so both are valid for Kevin's position formula.

Step 4: Identify which cyclist passes the other

For $t \geq 1$, $v_J = 10 + 2t$ and $v_K = 4 + 4(t-1) = 4t$. Thus $v_J - v_K = 10 - 2t$.

At $5 - \sqrt{2}$, John is faster and passes Kevin. At $5 + \sqrt{2}$, Kevin is faster and passes John.

Final Answer

$\boldsymbol{t = 5 - \sqrt{2} \approx 3.59}$ **s and** $\boldsymbol{t = 5 + \sqrt{2} \approx 6.41}$ **s**, measured from when John starts accelerating.