**Answer on Question 68262, Physics, Mechanics | Relativity**

**Question:**

A car traveling at a constant speed of 45.0 $m/s$ passes a trooper on a motorcycle hidden behind a billboard. One second after the speeding car passes the billboard; the trooper sets out from the billboard to catch the car, accelerating at a constant rate of 3.0 $m/s^2$. How long does it take her to overtake the car? (ans: 31.0 s).

**Solution:**

Let's write the kinematic equation for the car:

$$x_{car} = x_{0\,car} + v_{car}t,$$

here, $x_{car}$ is the position of the car at any time $t$, $x_{0\,car} = 45\,m$ is the initial position of the car when the trooper begins to move (the car traveled with constant speed $v_{car} = 45.0\ m/s$ for one second, so we can find its initial position), $v_{car}$ is the speed of the car and $t$ is the time.

Let's write the kinematic equation for the trooper:

$$x_{trooper} = x_{0\,trooper} + v_{trooper}t + \frac{1}{2}at^2,$$

here, $x_{trooper}$ is the position of the trooper at any time $t$, $x_{0\,trooper} = 0\,m$ is the initial position of the trooper, $v_{trooper} = 0\ m/s$ is the initial speed of the trooper (since it starts from rest the initial speed will be equal to zero) and $a = 3.0\ m/s^2$ is the acceleration of the trooper.

At time $t$ when the trooper overtake the car its positions are equal, so we can write:

$$x_{car} = x_{trooper},$$

$$x_{0\,car} + v_{car}t = x_{0\,trooper} + v_{trooper}t + \frac{1}{2}at^2,$$

$$x_{0\,car} + v_{car}t = \frac{1}{2}at^2,$$

$$45 + 45t = \frac{1}{2}\cdot 3t^2,$$

$$3t^2 - 90t - 90 = 0,$$

$$t^2 - 30t - 30 = 0.$$

This quadratic equation has 2 roots (since the time can't be negative we choose the positive root):

$$t = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a} = \frac{-(-30) \pm \sqrt{30^2 - 4 \cdot 1 \cdot (-30)}}{2 \cdot 1},$$

$$t = \frac{30 + \sqrt{1020}}{2} = 30.9\ s \approx 31.0\ s.$$

**Answer:**

$t = 31.0\ s.$