Q- A police car is traveling at a velocity of 18.0 m/s due north, when a car zooms by at a constant velocity of 41.0 m/s due north. After a reaction time 0.900 s the policeman begins to pursue the speeder with an acceleration of 4.00 m/s^2. Including the reaction time, how long does it take for the police car to catch up with the speeder?

The police car will catch up the speeder in a time when both will cover a same distance.

Let the total time taken is t (sec)

The velocity of the speeder's car = 41.0 m/s

Hence the distance covered by him in time t will be given by

S = velocity*time = 41.0*t ---------- (1)

The initial velocity of the police car u = 18.0 m/s

The distance covered by the police car during the reaction time

s_1 = 18.0*0.900 = 16.2 m

The acceleration of the police car a = 4.00 m/s^2
The distance covered by the police car in the remaining time t - 0.900 is given by the second equation of motion [$s = u*t + ½ a*t^2$]

Or $s_2 = 18.0*(t -0.900) + 0.5*4.00*(t -0.900)^2$

Total distance covered by the police car in t sec will be

$s_1 + s_2 = 16.2 + 18.0*(t -0.900) + 0.5*4.00*(t -0.900)^2$

$= 18.0*t + 2*(t -0.900)^2$ ---------- (2)

As after time t the police car catches the speeder hence the distance covered will be the same we have

$s_1 + s_2 = s$
Substituting from equations (1) and (2)

$18.0*t + 2*(t -0.900)^2 = 41.0*t$

Gives $t^2 - 1.8\ t + 0.81 = (41 - 18)\ t/2$

Gives $t^2 - 13.3\ t + 0.81 = 0$

Or $$t = \frac{-(-13.3) \pm \sqrt{(-13.3)^2 - 4*1*0.81}}{2*1} = 13.239\ \text{s}$$

Hence the total time taken by the police car will be 13.239 s.