Q1. A speeding motorist zooms through a 50 km/h zone without noticing a stationary police car. The police officer immediately heads after the speeder, accelerating at 2.5 m/s2 (i.e. the speeder and the cop start at the same starting point). The officer catches up to the speeder 350 m down the road (i.e. the speeder and the cop arrive at the same point 350 m from where the speeder first passes the cop).

Assuming that the speeder is going at a constant speed, answer the following:

a) Sketch three motion graphs of the situation: the acceleration chart, the velocity chart and the position chart. Please put both the lines describing the speeder and the officer's motion on the same chart and label the lines using "cop" and "speeder" and the equation of the lines.

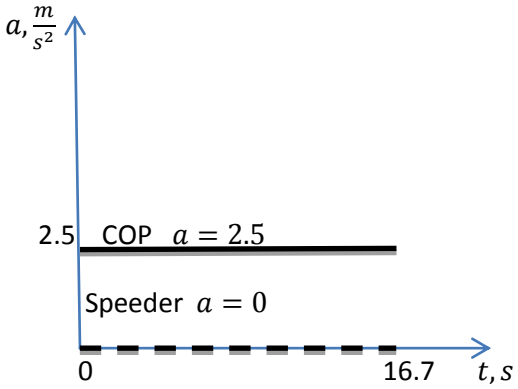
b) Give the general expression for the position of the police officer with respect to time. How long does it take the police officer to catch up to the speeder (seconds)?

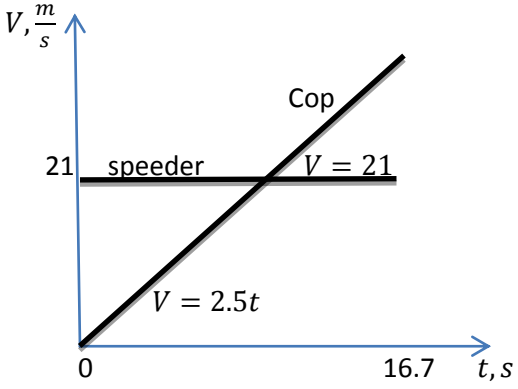
c) Give the general expression for the position of the speeder with respect to time. Given the information you know what is the velocity of the speeder (km/h)? Was the speeder breaking the speed limit?

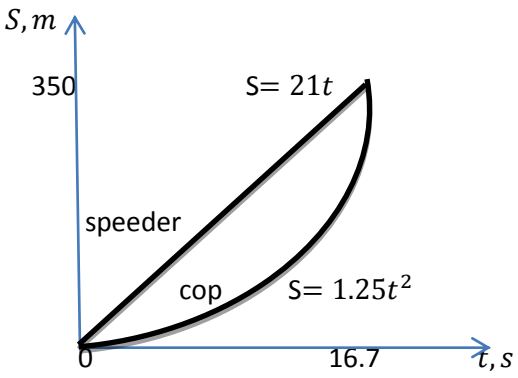
d) Give the general equation for the velocity of the police officer? How fast is the police officer going when he catches up to the speeder (km/h)?

Solution

a)







b) $S_{cop} = \frac{at^2}{2} = 2.5\frac{t^2}{2} = 1.25\ t^2;\ 350 = 1.25\ t_1^2 \gg t_1 = \sqrt{\frac{350}{1.25}} = 16{,}7\ s$

c) $S_{speeder} = vt = 21\ t\ ;\ v = \frac{S_{cop}}{t_1} = \frac{350}{16{,}7} = 21\frac{m}{s} = \frac{21}{3.6}\frac{\text{km}}{\text{h}} = 5{,}8\frac{\text{km}}{\text{h}} < 50\frac{\text{km}}{\text{h}}$

So the speeder wasn't breaking the speed limit.

d) $v = at = 2.5\ \text{t}\ ;\ \text{v}_{\text{cop}} = 2.5 * 16{,}7\ \frac{m}{s} = 11.6\ \frac{\text{km}}{\text{h}}$