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A police car is traveling at a velocity of 20.0 m/s due south on I-15 when a roadster zooms by at a constant velocity of 45.0 m/s. After the roadster passes the police car it takes the policeman 2.00 s to check the speed of the roadster on his radar gun and hit the accelerator. The police car then takes off after the roadster at a constant 5.00 m/s² acceleration.

A. [16 pts.] Setting $t_0 = 0$ at the instant the police car starts accelerating and x_0 (police car) = 0, how long does it take the police car to catch the roadster?

POLICE CAR
 $x_{op} = 0$
 $x = ?$
 $v_{op} = 20.0 \text{ m/s}$
 $v_p = ?$
 $a_p = 5.00 \text{ m/s}^2$
 $t = ?$

ROADSTER
 $x_{or} = 50.0 \text{ m}$
 $x_R = ?$
 $v_{or} = 45 \text{ m/s}$
 $v_R = 45 \text{ m/s}$
 $a_R = 0$

$$x_{or} = (45 \text{ m/s} - 20 \text{ m/s})(2.00 \text{ s}) = 50.0 \text{ m}$$

$$x_R = x_{or} + v_{or}t + \frac{1}{2}a_R t^2 = 50 \text{ m} + (45 \text{ m/s})t$$

$$x_p = x_{op} + v_{op}t + \frac{1}{2}a_p t^2 = (20 \text{ m/s})t + (2.5 \text{ m/s}^2)t^2$$

SET $x_p = x_R$

$$50 \text{ m} + (45 \text{ m/s})t = (20 \text{ m/s})t + (2.5 \text{ m/s}^2)t^2$$

$$(2.5 \text{ m/s}^2)t^2 - (25 \text{ m/s})t - 50 \text{ m} = 0$$

$$t = \frac{25 \pm \sqrt{(25)^2 + 500}}{5} = \frac{25 \pm 33.5}{5}$$

$t = 11.75, -1.81 \text{ s}$

SELECT
 $t = 11.75$

B. [8 pts.] How far did the police car travel from the moment the policeman hit the accelerator to the instant the police car caught the roadster?

DISTANCE POLICE CAR TRAVELLED IS x_p

$$x_p = (20 \text{ m/s})t + (2.5 \text{ m/s}^2)t^2$$

$$= (20 \text{ m/s})(11.75) + (2.5 \text{ m/s}^2)(11.75)^2$$

$x_p = 576 \text{ m}$

C. [8 pts.] At the instant the police car caught the roadster, what was the velocity of each vehicle?

$v_R = 45.0 \text{ m/s}$

$v_p = v_{op} + a_p t = (20 \text{ m/s}) + (5.00 \text{ m/s}^2)(11.75)$

$v_p = 78.5 \text{ m/s}$

WOW!