Answer on Question 68683, Physics, Mechanics, Relativity

Question:

Car cruise down an expressway at $25\ m/s$. Engineers want to design an interchange for a deceleration of $-2.0\ m/s^2$ over 3.0 s.

a) What velocity will cars have at the end of the approach?

b) What minimum approach length will satisfy these requirements?

c) What maximum velocity could a car entering the interchange have and still be able to exit at the intended velocity? (Assume an extreme deceleration of four times the usual rate.)

Solution:

a) We can find the velocity of the car at the end of the approach from the kinematic equation:

$$v = v_0 + at,$$

here, $v_0 = 25\ m/s$ is the initial velocity of the car, v is the velocity of the car at the end of the approach, $a = -2.0\ m/s^2$ is the deceleration of the car and t is the time.

Then, we get:

$$v = v_0 + at = 25\ \frac{m}{s} + \left(-2.0\ \frac{m}{s^2}\right) \cdot 3.0\ s = 19\ \frac{m}{s}.$$

b) We can find the minimum approach length that will satisfy these requirements from the kinematic equation:

$$d = v_0 t + \frac{1}{2} a t^2 = 25\ \frac{m}{s} \cdot 3.0\ s + \frac{1}{2} \cdot \left(-2.0\ \frac{m}{s^2}\right) \cdot (3.0\ s)^2 = 66\ m.$$

c) We can find the maximum velocity of the car from the kinematic equation:

$$v^2 = v_0^2 + 2ad,$$

$$v_0 = \sqrt{v^2 - 2ad} = \sqrt{\left(19\ \frac{m}{s}\right)^2 - 2 \cdot \left(-8.0\ \frac{m}{s^2}\right) \cdot 66\ m} = 38\ \frac{m}{s}.$$

Answer:

a) $v = 19\ \frac{m}{s}$.

b) $d = 66\ m$.

c) $v_0 = 38\ \frac{m}{s}$.