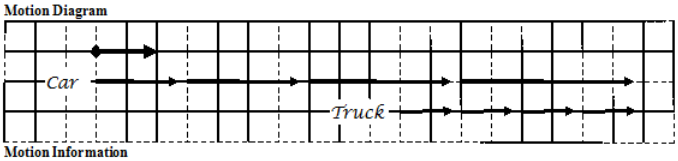
I-48

The driver of a car traveling at 16 m/s sees a truck 20 m ahead traveling at a constant speed of 12 m/s. The car starts without delay to accelerate at 4.0 m/s² in an attempt to rear-end the truck. The truck driver is too busy talking on his cellular phone to notice the car.

Motion Diagram



Motion Information

Object: *Car*		Object: *Truck*	
Event 1: *Car begins to accelerate.*	Event 2: *Collision!*	Event 1: *Car begins to accelerate.*	Event 2: *Collision!*
$t_1 = 0\ s$	$t_2 =$	$t_1 = 0\ s$	$t_2 =$
$r_1 = 0\ m$	$r_2 =$	$r_1 = 20\ m$	$r_2 =$
$v_1 = 16\ m/s$	$v_2 =$	$v_1 = 12\ m/s$	$v_2 =$
$a_{12} = +4\ m/s^2$		$a_{12} = 0\ m/s^2$	

Mathematical Analysis

At first glance, there appear to be six unknowns in the motion table. This should concern you since you only have four equations (the two kinematic equations applied to the car and the same two applied to the truck). However, since the car and truck collide at event 2, t_2 and r_2 for the car and truck must be equal at this event. Thus, the only four variables are t_2, r_2, v_{2Car}, and v_{2Truck}. These can be determined by the four kinematic equations. Specifically, set the position equation for the car equal to the position equation for the truck and solve for t_2:

$$r_{2Car} = r_{2Truck}$$

$$0 + 16(t_2 - 0) + \frac{1}{2}(4)(t_2 - 0)^2 = 20 + 12(t_2 - 0) + \frac{1}{2}(0)(t_2 - 0)^2$$

$$16t_2 + 2t_2^2 = 20 + 12t_2$$

$$0 = 20 - 4t_2 - 2t_2^2$$

Using the quadratic formula, $t_2 = 2.32\ s$. Plugging this back into either position equation yields,

$$r_{2Car} = 0 + 16(2.32 - 0) + \frac{1}{2}(4)(2.32 - 0)^2$$

$$r_{2Car} = 47.9m$$

Solving the two velocity equations gives:

$$v_{2Car} = 16 + 4(2.32) \qquad v_{2Truck} = 12 + 0(2.32)$$

$$v_{2Car} = 25.3m/s \qquad v_{2Truck} = 12m/s$$