One Dimensional Kinematics

Kinematic Equations - Solutions

Practice Problems

1. Solve the following.
   a. A race car can reach a velocity of 75.0 m/s in 3.72s. What is the acceleration of the car?
   $v_0=0$, $v=75$, $t=3.72$, $a=$
   $v=v_0+at$
   $a=(v-v_0)/t$
   $a=(75-0)/3.72=20.2 m/s^2$
   b. How far would the same car travel when slowing down from 75.0 m/s to 48.1m/s in 5.11s?
   $v_0=75$, $v=48.1$, $t=5.11$, $x=$
   $x=½(v+v_0)t$
   $x=½(75+48.1)(5.11)=314m$
   c. If the car slams on the brakes while traveling at 48.1m/s and takes a distance of 63.8m to stop, what was it's acceleration?
   $v_0=48.1$, $v=0$, $x=63.8$, $a=$
   $v^2=v_0^2+2ax$
   $v^2-v_0^2=2ax$
   $a=(v^2-v_0^2)/2x$
   $a=(0^2-48.1^2)/2(63.8)=-18.1 m/s^2$
2. A train can accelerate at 5.00 m/s^2 and can brake at -3.00m/s^2.
   a. If the train is traveling at 15.0m/s how long would it take to come to a stop?
   $v_0=15$, $v=0$, $a=-3$, $t=$
   $v=v_0+at$
   $t=(v-v_0)/a$
   $t=(0-15)/-3=5.00s$
   b. What distance would it travel in that period of time?
   $v_0=15$, $v=0$, $a=-3$, $x=$
   $v^2=v_0^2+2ax$
   $v^2-v_0^2=2ax$
   $x=(v^2-v_0^2)/2a$
   $x=(0^2-15^2)/2(-3)=37.5m$
   c. How far would the train travel when accelerating from a velocity of 13.5m/s for 17.2s?
   $v_0=13.5$, $t=17.2$, $a=5$, $x=$
   $x=v_0t+½at^2$
   $x=(13.5)(17.2)+½(5)(17.2)^2=972m$
3. A car is 10.0m behind a truck and both are traveling at 20.0m/s. The car has a maximum acceleration of 1.20m/s^2. The driver decides to pass the truck and wishes to pull back into the lane when they are 10.0m ahead of the truck. If the truck has a length of 15.0m, how far will the car have traveled before it can pass the truck?
   Two separate objects so each must be treated with its own kinematic equation.
   The truck is traveling at a constant velocity so (T for truck).
   $v_T=x_T/t_T$
   $x_T=v_Tt_T$
   The car is accelerating, $a=1.2$, $v_{0c}=20.0$, $x_c=$, $t_c=$
   We use time because the time period of both is the same

$t_T=t_c=t$
$x_c=v_{0c}t+½at^2$
With two equations we need to reduce our variable to 2, one is t
The car must travel the distance to the truck, the length of the truck and then 10 more meters or 10+15+10=35m further than the truck so
$x_c=x_T+35$
Adding the variables we know the equation for the truck becomes
$20=x_T/t$
For the car
$x_T+35=20t+½(1.2)t^2$
Manipulate the truck equation to solve for x
$x_T=20t$
Combine with the car equation to get
$20t+35=20t+0.6t^2$
Subtract 20t from each side
$35=0.6t^2$
$t=7.64s$

The problem asks for displacement so
$x_c=(20)(7.64)+½(1.2)(7.64)^2=188m$
to confirm, solve for the displacement of the truck and add 35
$x_T=(20)(7.64)=153$
$x_c=153+35=188m$

You could also combine the equations for t
$t=x_T/20$
Combine with the car equation
$x_T+35=20(x_T/20)+½(1.2)(x_T/20)^2$
$x_T+35=x_T+½(1.2)(x_T^2/400)$
$x_T+35=x_T+(0.6x_T^2/400)$
Subtract x_T from both sides
$35=0.6x_T^2/400$
$23333=x_T^2$
$x_T=153$
$x_c=153+35=188m$