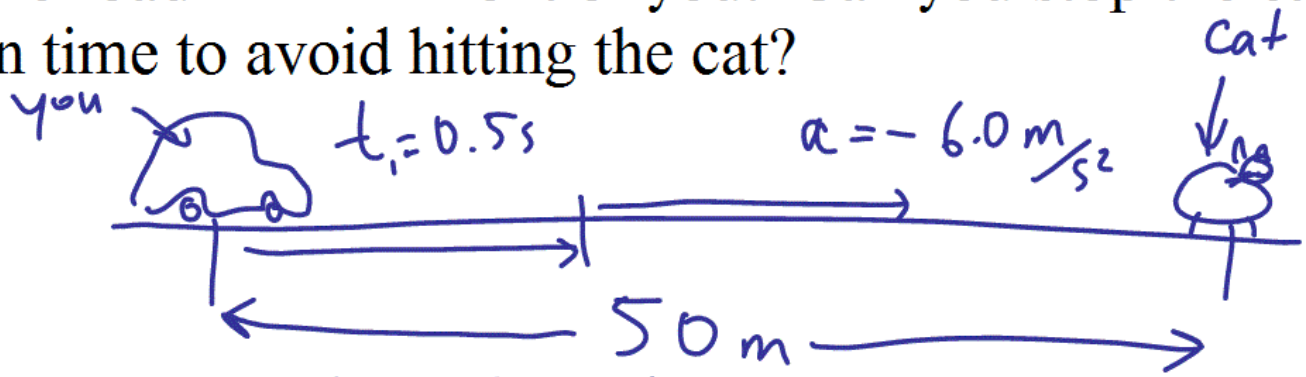
Example: Can you stop your car in time to save the cat?

You have a reaction time of 0.50 s, and the maximum deceleration of your car is 6.0 m/s^2. You are driving at 20 m/s when suddenly you see a cat in the road 50 m in front of you. Can you stop the car in time to avoid hitting the cat?



2 segments of motion:

Segment 1: constant velocity, $t_1 = 0.5$ s

Segment 2: slowing down at $a = -6$ m/s^2

1. $x = x_0 + \left(\frac{v_0 + v}{2}\right)t$ Does not contain a! (but you know it's constant)
2. $v = v_0 + at$ Does not contain position!
3. $x = x_0 + v_0 t + \frac{1}{2}at^2$ Does not contain v_f!
4. $v^2 = {v_0}^2 + 2a(x - x_0)$ Does not contain t!

5th eq. if $a = 0$, $v = v_0 = \frac{x - x_0}{t}$

Segment 1: constant velocity

$v = \frac{x_1}{t_1}$ $\quad t_1 = 0.5\ s$

$v = 20\ m/s$

$x_1 = v t_1$

$= (20)(0.5)$

$x_1 = 10\ m$

Segment 2: slowing down.

Knowns: $v_0 = 20\ m/s$

$v = 0$ (stops at end)

$a = -6\ m/s^2$

Unknown: $(x - x_0) = x_2$

Don't care about t.

Use eq. (4): $v^2 = v_0^2 + 2a(x - x_0)$

$v^2 = v_0^2 + 2a x_2$

$0 = v_0^2 + 2a x_2$

$2a x_2 = -v_0^2$

$x_2 = \frac{-v_0^2}{2a} = \frac{-(20)^2}{2(-6)} = 33.333\ m$

Total distance is $d = x_1 + x_2 = 10\ m + 33.3\ m$

$\rightarrow d = 43.3\ m$

less than 50 m.
So yes, you can stop the car in time to avoid hitting the cat. Yay!