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/s². 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, \( t_1 = 0.5 \text{ s} \)
- Segment 2: slowing down at \( a = -6 \text{ m/s}^2 \)

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
\[ v = \frac{x_1}{t_1}, \quad t_1 = 0.5 \text{ s} \]

\[ v = 20 \text{ m/s} \]

\[ x_1 = vt_1, \]

\[ = (20)(0.5) \]

\[ x_1 = 10 \text{ m} \]

Segment 2: Slowing down.

Knowns: \[ v_0 = 20 \text{ m/s} \]
\[ v = 0 \text{ (stops at end)} \]
\[ a = -6 \text{ m/s}^2 \]

Unknown: \( (x - x_0) = x_2 \)

Don't care about \( t \).

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

\[ v^2 = v_0^2 + 2ax_2 \]

\[ 0 = v_0^2 + 2ax_2 \]

\[ 2ax_2 = -v_0^2 \]

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

Total distance is \( d = x_1 + x_2 = 10 \text{ m} + 33.3 \text{ m} \)

\[ d = 43.3 \text{ m} \]
less than 50 m.
So yes, you can stop the car in time to avoid hitting the cat. Yay!