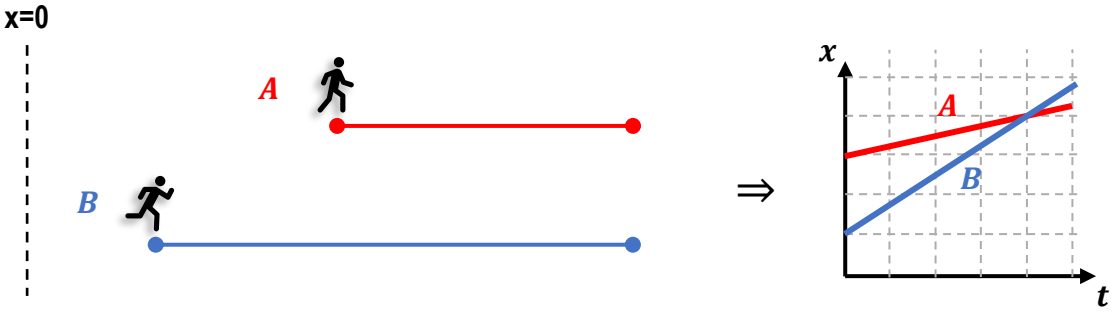
CONCEPT: SOLVING "CATCH UP" OR "OVERTAKE" PROBLEMS

● When one object "catches up to" or "overtakes" another, they are at the same _____ at the same _____!



EXAMPLE: Two cars are driving along the same road. Car A is at x = 0 at t = 0s and drives at constant 50 m/s. At the same time, Car B is 280 meters ahead and drives at a constant 36 m/s. **(a)** When does Car A catch up to Car B? **(b)** At what position (in meters) do the two cars meet?

CATCH & OVERTAKE PROBLEMS
1) Draw Diagram, list known variables
2) Write objects' **full** position eq's: x_A & x_B $x_A = x_{0A} + v_{0A}t_A + \frac{1}{2}a_A t_A^2$ $x_B = x_{0B} + v_{0B}t_B + \frac{1}{2}a_B t_B^2$
3) Set position eq's equal → $x_A = x_B$
4) Solve for t, any additional variables

MOTION EQUATIONS	
When a = 0	When a **NOT** = 0
$v = \frac{\Delta x}{\Delta t}$ **OR** $x = x_0 + vt$	(1) $v = v_0 + at$
	(2) $v^2 = {v_0}^2 + 2a\Delta x$
	(3) $\Delta x = v_0 t + \frac{1}{2}at^2$ **OR** $x = x_0 + v_0 t + \frac{1}{2}at^2$
	(4) $\Delta x = \left(\frac{v_0 + v}{2}\right) t$

PRACTICE: A police car at rest is passed by a speeder traveling at a constant 36 m/s. The police officer takes off in hot pursuit, accelerating at a constant 2.00 m/s^2. **(a)** How long does it take for the police officer to overtake the speeder. **(b)** Calculate the speed of the police car at the overtaking point.

CATCH & OVERTAKE PROBLEMS

1) Draw Diagram, list known variables

2) Write objects' **full** position eq's: x_A & x_B

$$x_A = x_{0A} + v_{0A}t_A + \frac{1}{2}a_A t_A^2$$

$$x_B = x_{0B} + v_{0B}t_B + \frac{1}{2}a_B t_B^2$$

3) Set position eq's equal → $x_A = x_B$

4) Solve for t, any additional variables

MOTION EQUATIONS

When a = 0	When a NOT = 0
$v = \frac{\Delta x}{\Delta t}$	(1) $v = v_0 + at$
	(2) $v^2 = {v_0}^2 + 2a\Delta x$
OR	(3) $\Delta x = v_0 t + \frac{1}{2}at^2$ OR $x = x_0 + v_0 t + \frac{1}{2}at^2$
$x = x_0 + vt$	(4) $\Delta x = \left(\frac{v_0 + v}{2}\right)t$

EXAMPLE: You drop a watermelon off the Empire State Building, 320 m above the sidewalk. Superman flies by at the instant you release the watermelon, heading straight down at a constant 35.0 m/s, because gravity doesn't matter when you're Superman. However, the watermelon does accelerate. How fast is the watermelon going when it passes Superman?

CATCH & OVERTAKE PROBLEMS

1) Draw Diagram, list known variables

2) Write objects' **full** position eq's: x_A & x_B

$$x_A = x_{0A} + v_{0A}t_A + \frac{1}{2}a_A t_A^2$$

$$x_B = x_{0B} + v_{0B}t_B + \frac{1}{2}a_B t_B^2$$

3) Set position eq's equal → $x_A = x_B$

4) Solve for t, any additional variables

MOTION EQUATIONS

When a = 0	When a NOT = 0
$v = \frac{\Delta x}{\Delta t}$ OR $x = x_0 + vt$	(1) $v = v_0 + at$
	(2) $v^2 = {v_0}^2 + 2a\Delta x$
	(3) $\Delta x = v_0 t + \frac{1}{2}at^2$ OR $x = x_0 + v_0 t + \frac{1}{2}at^2$
	(4) $\Delta x = \left(\frac{v_0 + v}{2}\right)t$