A person left a wallet at a restaurant and the waiter is trying to return it to him. The person has a 40 m head start and is walking at a constant 5 m/s. The waiter starts from rest and accelerates at 1 m/s/s.

a) How long will it take the waiter to catch up to the person?
b) At what position will that happen?

What do we know about the moment when the waiter catches up with the person?

They will be at the same position.

(Even though their changes in position will be different.)

Turning the Change in Position Equation into a Position Equation

$$\Delta x = v_0 t + \frac{1}{2} a t^2$$

Turning the Change in Position Equation into a Position Equation

$$\Delta x = v_0 t + \tfrac{1}{2} a t^2$$

$$x - x_0 = v_0 t + \tfrac{1}{2} a t^2$$

$+x_0$ $+x_0$

$$x = x_0 + v_0 t + \tfrac{1}{2} a t^2$$

Initial position

A person left a wallet at a restaurant and the waiter is trying to return it to him. The person has a 40 m head start and is walking at a constant 5 m/s. The waiter starts from rest and accelerates at 1 m/s/s.

a) How long will it take the waiter to catch up to the person?
b) At what position will that happen?

Write the position equation for each person, then set them equal.

Since we are dealing with position, we'll need to pick an origin. (Easiest to pick the left-most object as the origin.)

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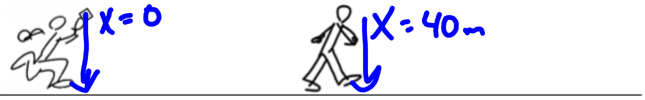

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a) How long will it take the waiter to catch up to the person?
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Waiter

$v_i = 0$

$a = 1\ m/s^2$

$x_i = 0$

Person

$v_i = 5\ m/s$

$a = 0$

} constant velocity

$x_i = 40\ m$

$$x = x_i + v_i t + \frac{1}{2}at^2$$

Waiter:

$$x = 0 + 0 + \frac{1}{2}(1)t^2$$

$$x = \frac{1}{2}t^2$$

Person:

$$x = 40 + 5t + 0$$

$$x = 40 + 5t$$

$$\frac{1}{2}t^2 = 40 + 5t$$

$$\frac{1}{2}t^2 - 5t - 40 = 0$$

(a = $\frac{1}{2}$, b = -5, c = -40)

$$\frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$$

$$\frac{5 \pm \sqrt{25 - 4(\frac{1}{2})(-40)}}{2(\frac{1}{2})}$$

$$\frac{5 \pm \sqrt{25 + 80}}{1} = 5 \pm \sqrt{105}$$

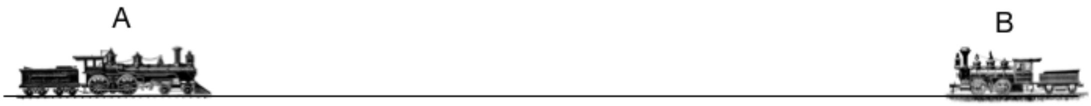
$$5 \pm 10.2$$

15.2 sec

-4.8 sec

The A train is headed to the right at 30 m/s, but is slowing down at 2 m/s/s. The B train, 300 m away, is headed to the left at 10 m/s. ← constant

a) If nothing changes, how long before the disaster happens?
b) At what position will the disaster happen?



The A train is headed to the right at 30 m/s, but is slowing down at 2 m/s/s. The B train, 300 m away, is headed to the left at 10 m/s. ← constant

a) If nothing changes, how long before the disaster happens?
b) At what position will the disaster happen?

A

$v_i = 30\,m/s$

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

$x_i = 0$

B

$v_i = -10\,m/s$

$a = 0$

$x_i = 300\,m$

$$x_f = x_i + v_i t + \frac{1}{2} a t^2$$

$$x_f = 0 + 30t + \frac{1}{2}(-2)t^2 \qquad x_f = 300 + (-10)t + 0$$

$$30t - t^2 = 300 - 10t$$

$$0 = t^2 - 40t + 300$$

$$(t - 30)(t - 10)$$

$$t = \boxed{10\,sec} \text{ or } 30\,sec$$

2: Catching up/meeting in the middle

Smash up derby! One car is moving to the right at 5 m/s but speeding up at 2 m/s/s. The other car is 50 m away and heading to the left at 20 m/s ← constant
a) How long before the crash!
b) Where does the crash happen?

$$5t + t^2 = 50 - 20t$$

$t = 1.86$ s
$X = 12.8$ m

Relay time! Runner #1 is moving at a constant 8 m/s. When the runners are 6 m apart, runner #2 starts from rest and begins to accelerate at 4 m/s/s.
a) How long before they are at the same spot?
b) Where does that happen?

$$8t = 6 + 2t^2$$

$t = 1$ sec
$X = 8$ m

Answers to some of the review problems

1) a) E
b) AC
c) DB
d) E
e) DEC (C part)
f) ABC (C part)
g) $-1.6\ m/s^2$
h) 60 m

2) a) 110 m
b) 42 m/s

4) a) 4 s
b) 108 m

5) The difference between $F_{applied}$ and $F_{friction}$ has to be 10 N

7) b) you can calculate v_i and a