Properties of Constant Acceleration

Let's consider a constant acceleration of

$a = 12 \frac{m}{s^2}$ ← that's a lot — I rounded up

— the fastest drag racer is a Porsche 919 Hybrid that can sustain 11.67 m/s² for 402m

The equations are

$$x_{i+1} = x_i + (t_{i+1} - t_i) v_i$$

$$v_{i+1} = v_i + (t_{i+1} - t_i) a$$

↑ the constant acceleration

I'm going to make things a little trickier by doing 0.5s time steps instead of our usual 1s time steps.

Focusing *just* on the second equation,

$$v_{i+1} = v_i + (t_{i+1} - t_i)\,a$$

a: $12\,m/s^2$

$(t_{i+1} - t_i)$: difference is 0.5s

$v_0 = 0$ ← drag racer begins the race stopped

Fill in all empty table cells

i	t_i	a	v_i
0	0s	$12\,m/s^2$	0 m/s ← v_0
1	0.5s	$12\,m/s^2$	6 m/s ← v_1
2	1.0s	$12\,m/s^2$	12 m/s ← v_2
3	1.5s	$12\,m/s^2$	← what goes here is $v_2 + (t_3 - t_2)\cdot a$
4	2.0s	$12\,m/s^2$	
5	2.5s	$12\,m/s^2$	← here goes $v_3 + (t_4 - t_3)\cdot a$
6		$12\,m/s^2$	
7		$12\,m/s^2$	
8		$12\,m/s^2$	
9		$12\,m/s^2$	
10		$12\,m/s^2$	
11		$12\,m/s^2$	
12		$12\,m/s^2$	
13		$12\,m/s^2$	
14		$12\,m/s^2$	
15		$12\,m/s^2$	
16		$12\,m/s^2$	
17		$12\,m/s^2$	

← etc.

Now that we have all the v_i let's expand the table to include all the x_i. We get the x_i from

$$x_{i+1} = x_i + \underbrace{(t_{i+1} - t_i)}_{\text{still } 0.5\,s} v_i$$

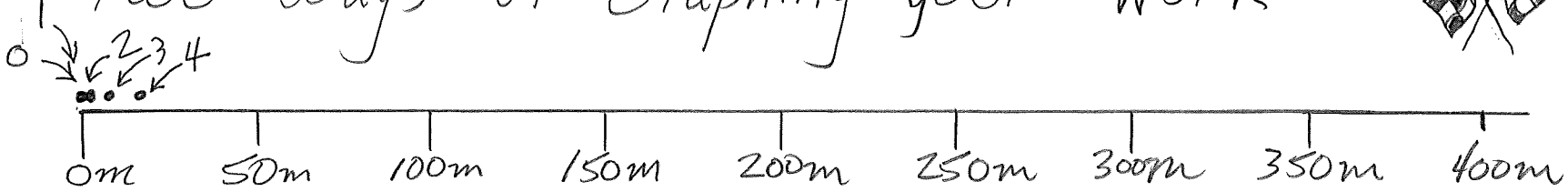
$x_0 = 0$ ← drag racer starts at start line

i	t_i (s)	a (m/s^2)	v_i (m/s)	x_i (m)
0	0	12	0	0 ← x_0
1	0.5	12	6	0 ← x_1
2	1.0	12	12	3 ← x_2
3	1.5	12	18	← what goes here is $x_2 + (t_3 - t_2) \cdot v_2$
4	2.0	12	24	
5	2.5	12	30	← here goes $x_3 + (t_4 - t_3) \cdot v_3$
6	3.0	12	36	
7	3.5	12	42	
8	4.0	12	48	
9	4.5	12	54	
10	5.0	12	60	
11	5.5	12	66	
12	6.0	12	72	
13	6.5	12	78	
14	7.0	12	84	
15	7.5	12	90	
16	8.0	12	96	
17	8.5	12	102	← HINT/CHECK LAST IS 408

etc.

finish at 402m

Two Ways of Graphing your Work



I have plotted positions x_0, x_1, x_2, x_3 and x_4 above.
You plot positions $x_5, \ldots, x_{17}$. Do $t = 2.5\text{s}$ to 8.5s below.